N.B.Navale

Date : 28.03.2025 **TEST ID: 41**
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2.GRAVITATION,GRAVITATION,LAWS OF MOTION,THERMAL PROPERTIES OF MATTER

Single Correct Answer Type

1. A force $F = -5\hat{i} - 7\hat{j} + 3\hat{k}$ acting on a particle causes a displacement $(s) = 3\hat{i} - 2\hat{j} + a\hat{k}$ in its own direction. If the work done is 14 J, then the value of a is
a) 0 b) 5
c) 15 d) 1

2. A force $F = -5\hat{i} - 7\hat{j} + 3\hat{k}$ acting on a particle causes a displacement $(s) = 3\hat{i} - 2\hat{j} + a\hat{k}$ in its own direction. If the work done is 14 J, then the value of a is
a) 0 b) 5
c) 15 d) 1

3. The ends of two rods of different materials with their thermal conductivities, radii of cross-section and lengths all in the ratio 1: 2 are maintained at the same temperature difference. If the rate of flow of heat in the larger rod is 4 cal s^{-1}, then that in the shorter rod (in cals $^{-1}$) will be
a) 1 b) 2
c) 8 d) 16

4. The radius of a ring is R and its coefficient of linear expansion is α. If the temperature of ring increases by θ, then its circumference will increase by
a) $\pi R\alpha\theta$ b) $2\pi R\alpha\theta$
c) $\pi R\alpha\frac{\theta}{2}$ d) $\pi R\alpha\frac{\theta}{4}$

5. A sphere of mass 'm' moving with velocity 'v' collides head-on with another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)
a) $\frac{e+1}{2}$ b) e
c) $\frac{e-1}{2}$ d) $\frac{e}{2}$

6. A sphere of mass 'm' moving with velocity 'v' collides head-on with another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)
a) $\frac{e+1}{2}$ b) e
c) $\frac{e-1}{2}$ d) $\frac{e}{2}$

7. An amount of water of mass 20 g at 0°C is mixed with 40 g of water at 10°C, final temperature of the mixture is
a) 5°C b) 0°C
c) 20°C d) 6.66°C

8. A body initially at rest is acted upon by a constant force (F) for time (t). The kinetic energy is time t is
a) $\frac{F^2t^2}{2m}$ b) $\frac{Ft}{2m}$
c) $\frac{F^2t^2}{m}$ d) $\left(\frac{Ft}{m}\right)^2$

9. A body initially at rest is acted upon by a constant force (F) for time (t). The kinetic energy is time t is
a) $\frac{F^2t^2}{2m}$ b) $\frac{Ft}{2m}$
c) $\frac{F^2t^2}{m}$ d) $\left(\frac{Ft}{m}\right)^2$

10. Wires A and B have identical lengths and have circular cross-sections. The radius of A is twice the radius of B, i.e. $r_A = 2r_B$. For a given temperature difference between the two ends, both wires conduct heat at the same rate. The relation between the thermal conductivities is given by
a) $K_A = 4K_B$ b) $K_A = 2K_B$
c) $K_A = \frac{K_B}{2}$ d) $K_A = \frac{K_B}{4}$

11. A wooden block of mass 'M' moves with velocity 'v' and collides with another block of mass '4M' which is at rest. After collision the block of mass 'M' comes to rest. The coefficient of restitution will be
a) 0.25 b) 0.15
c) 0.05 d) 0.30

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a) 0.25 b) 0.15
c) 0.05 d) 0.30

13. A uniform metal rod is used as a bar pendulum. If the room temperature rises by 10°C, and the coefficient of linear expansion of the metal of the rod is 2×10^{-6} per °C, the period of the pendulum will have percentage increase of

a) -2×10^{-3} b) -1×10^{-3}
c) 2×10^{-3} d) 1×10^{-3}

14. A particle at rest explodes into two particles of masses 'm_1' and 'm_2' which move in opposite directions with velocities 'V_1' and 'V_2' respectively. The ratio of kinetic energies 'E_1' to 'E_2' respectively is

a) $m_2 : m_1$ b) $1 : 1$
c) $1 : m_2$ d) $m_1 : m_2$

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a) $m_2 : m_1$ b) $1 : 1$
c) $1 : m_2$ d) $m_1 : m_2$

16. If a body cools down from 80°C to 60°C in 10 min when the temperature of the surrounding is 30°C. Then, the temperature of the body after next 10 min will be

a) 50°C b) 48°C
c) 30°C d) None of these

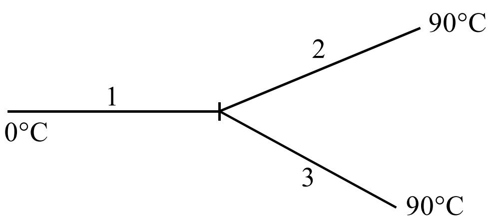
17. The dimensions of torque are same as that of

a) Pressure b) Impulse
c) Moment of force d) Acceleration

18. The dimensions of torque are same as that of

a) Pressure b) Impulse
c) Moment of force d) Acceleration

19. Three rods made of same material and having same cross-section have been joined as shown in figure. Each rod is of same length. The left and right ends are kept at 0°C and 90°C, respectively.
The temperature of the junction of the three rods will be



a) 45°C b) 60°C
c) 30°C d) 20°C

20. A particle of mass m moving with a velocity $(3\hat{i} + 2\hat{j})ms^{-1}$ collides with a stationary body of mass M and finally moves with a velocity $(-2\hat{i} + \hat{j})ms^{-1}$. If $\frac{m}{M} = \frac{1}{13}$, then

a) the impulse received by M is $m\,(5\hat{i} + \hat{j})$ b) the velocity of the M is $\frac{1}{13}(5\hat{i} + \hat{j})$
c) the coefficient of restitutions $\frac{11}{17}$ d) All of the above are correct

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c) the coefficient of restitutions $\frac{11}{17}$ d) All of the above are correct

22. $0.1\ m^3$ of water at 80°C is mixed with $0.3\ m^3$ of water at 60°C. The final temperature of the mixture is

a) 70°C b) 65°C
c) 60°C d) 75°C

23. A door 1.6 m wide requires a force of 1 N to be applied at the free end to open or close it. The force that is required at a point 0.4 m distant from the hinges for opening or closing the door is

a) 1.2 N b) 3.6 N
c) 2.4 N d) 4 N

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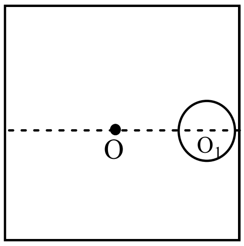
a) 1.2 N b) 3.6 N
c) 2.4 N d) 4 N

25. A liquid of mass m and specific heat c is heated to a temperature 2T. Another liquid of mass m/2 and specific heat 2c is heated to a temperature T. If these two liquids are mixed, the resulting temperature of the mixture is

a) $\left(\frac{2}{3}\right)T$ b) $\left(\frac{8}{5}\right)T$
c) $\left(\frac{3}{5}\right)T$ d) $\left(\frac{3}{2}\right)T$

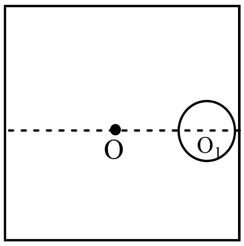
26. A square plate of side 20 cm has uniform thickness and density. A circular part of

diameter 8 cm is cut out symmetrically and show in figure. The position of centre of mass of the remaining portion is



a) at O_1
b) at O
c) 0.54 cm from O on the left hand side
d) None of the above

27. A square plate of side 20 cm has uniform thickness and density. A circular part of diameter 8 cm is cut out symmetrically and show in figure. The position of centre of mass of the remaining portion is



a) at O_1
b) at O
c) 0.54 cm from O on the left hand side
d) None of the above

28. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conduct heat 'Q_1' in time 't'. The metallic rod is now melted and the material is formed into a rod of half the radius of the original rod. This rod when placed in thermal contact with the same two reservoirs of heat, conducts heat 'Q_2' in time 't'. The difference in heat conducted, $(Q_1 - Q_2)$ is

a) $\frac{Q_1}{16}$
b) $\frac{13Q_1}{15}$
c) $\frac{15Q_1}{16}$
d) $\frac{16Q_1}{15}$

29. A smooth steel ball strikes a fixed smooth steel plate at an angle θ with the vertical. If the coefficient of restitution is e, the angle at which the rebounce will take place is

a) θ
b) $\tan^{-1}\left(\frac{\tan\theta}{e}\right)$
c) e tan θ
d) $\tan^{-1}\left(\frac{e}{\tan\theta}\right)$

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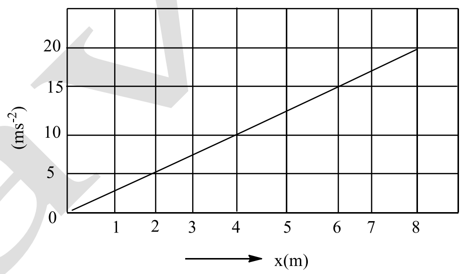
c) e tan θ
d) $\tan^{-1}\left(\frac{e}{\tan\theta}\right)$

31. On an imaginary linear scale of temperature (called 'W' scale) the freezing and boiling points of water are 39^0W and 239^0W respectively. The temperature on the new scale corresponding to 39^0C temperature on Celsius scale will be

a) 139^0W
b) 78^0W
c) 117^0W
d) 200^0W

32. A 10 kg brick moves along X - axis. Its acceleration as a function of its position is shown in figure. What is the net work performed on the brick by the force causing the acceleration as the brick moves from x = 0 to x = 8.0 m ?



a) 4 J
b) 8 J
c) 2 J
d) 1 J

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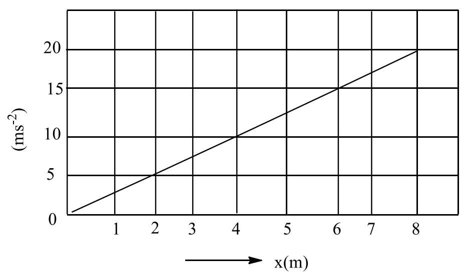


a) 4 J
b) 8 J
c) 2 J
d) 1 J

34. Snow is more heat insulating than ice because

a) air is filled in pores of snow
b) ice is more bad conductor snow
c) air is filled in pores of ice
d) density of ice is more

35. A cricket ball of mass 150 g moving with a velocity of 12 m/s is turned back with a velocity of 20 m/s on hitting the bat. The force

of the blow lasts for 0.01 s. The force exerted on the ball by the bat is

a) 480 N b) 240 N
c) 120 N d) 360 N

36. A cricket ball of mass 150 g moving with a velocity of 12 m/s is turned back with a velocity of 20 m/s on hitting the bat. The force of the blow lasts for 0.01 s. The force exerted on the ball by the bat is

a) 480 N b) 240 N
c) 120 N d) 360 N

37. A wall has two layers A and B, each made of different material. Both the layers have same thickness. The thermal conductivity of the material A is thrice that of material B. If under thermal equilibrium the temperature difference across the wall is 48°C, the temperature difference across the layer 'A' is

a) 12°C b) 24°C
c) 18°C d) 6°C

38. A force $\bar{F} = 3\hat{i} + 6\hat{j} + 2\hat{k}$ acting on a particle causes displacement $\bar{S} = -4\hat{i} + x\hat{j} + 3\hat{k}$ in the direction of $\bar{F}$. If the work done is 12 J, then value of 'x' is

a) Zero b) 1
c) 3 d) 6

39. A force $\bar{F} = 3\hat{i} + 6\hat{j} + 2\hat{k}$ acting on a particle causes displacement $\bar{S} = -4\hat{i} + x\hat{j} + 3\hat{k}$ in the direction of $\bar{F}$. If the work done is 12 J, then value of 'x' is

a) Zero b) 1
c) 3 d) 6

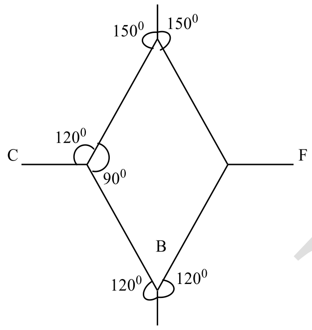
40. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its ends conduct an amount of heat 'Q_1' in time 't'. The metallic rod is melted and the material is formed into a rod of length, four times the length of original rod. The amount of heat conducted by the new rod when placed in thermal contact with the same two reservoirs in time tis 'Q_2'. Then $\frac{Q_1}{Q_2}$ is

a) $\frac{1}{4}$ b) 4
c) 16 d) $\frac{1}{16}$

41. 50 g of copper is heated to increase its temperature by 10°C. If the same quantity of heat is given to 10 g of water, the rise in its temperature is (Take, specific heat of copper = $420\ J\ kg^{-1 0}C^{-1}$)

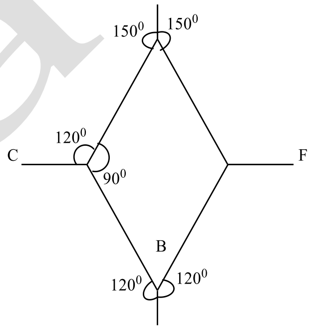
a) 5°C b) 6°C
c) 7°C d) 8°C

42. The below figure is the part of a horizontally stretched note. Section AB is stretched with a force of 10 N. The tension in the section BC and BF are



a) 10 N, 11N b) 10 N, 6 N
c) 10 N, 10 N d) Cannot be calculated due to insufficient data

43. The below figure is the part of a horizontally stretched note. Section AB is stretched with a force of 10 N. The tension in the section BC and BF are



a) 10 N, 11N b) 10 N, 6 N
c) 10 N, 10 N d) Cannot be calculated due to insufficient data

44. A mass M moving with velocity 'v' along x axis collides and sticks to another mass 2M which is moving along Y-axis with velocity 3v. After collision, the velocity of the combination is

a) $\frac{v}{3}\hat{i} - 2v\hat{j}$ b) $v\hat{i} + \frac{v}{3}\hat{j}$
c) $\frac{2v}{3}\hat{i} + \hat{j}$ d) $\frac{v}{3}\hat{i} + 2v\hat{j}$

45. A mass M moving with velocity 'v' along x axis collides and sticks to another mass 2M which is moving along Y-axis with velocity 3v. After collision, the velocity of the combination is

a) $\frac{v}{3}\hat{i} - 2v\hat{j}$ b) $v\hat{i} + \frac{v}{3}\hat{j}$
c) $\frac{2v}{3}\hat{i} + \hat{j}$ d) $\frac{v}{3}\hat{i} + 2v\hat{j}$

46. A cylindrical rod has temperature 'T_1' and 'T_2' at its ends. The rate of flow of heat is

'Q_1' cal s^{-1}. If length and radius of the rod are doubled keeping temperature constant, then the rate of flow of heat 'Q_2' will be

a) $Q_2 = \frac{Q_1}{2}$ b) $Q_2 = \frac{Q_1}{4}$

c) $Q_2 = 4Q_1$ d) $Q_2 = 2Q_1$

47. How much heat energy is gained when 5 kg of water at 20°C is brought to its boiling point (Take, specific heat of water = 4.2 kJ $kg^{-1}{}^{\circ}C^{-1}$)

a) 1680 kJ b) 1700 kJ

c) 1720 kJ d) 1740 kJ

48. The torque of a force $F = -2\hat{i} + 2\hat{j} + 3\hat{k}$ acting on a point $r = \hat{i} + 2\hat{j} + \hat{k}$ about origin will be

a) $8\hat{i} + 5\hat{j} + 2\hat{k}$ b) $-8\hat{i} - 5\hat{j} - 2\hat{k}$

c) $8\hat{i} - 5\hat{j} + 2\hat{k}$ d) $-8\hat{i} + 5\hat{j} - 2\hat{k}$

49. The torque of a force $F = -2\hat{i} + 2\hat{j} + 3\hat{k}$ acting on a point $r = \hat{i} + 2\hat{j} + \hat{k}$ about origin will be

a) $8\hat{i} + 5\hat{j} + 2\hat{k}$ b) $-8\hat{i} - 5\hat{j} - 2\hat{k}$

c) $8\hat{i} - 5\hat{j} + 2\hat{k}$ d) $-8\hat{i} + 5\hat{j} - 2\hat{k}$

50. A wall is hit elastically and normally by 'n' balls per second. All the balls have the same mass 'm' and are moving with the same velocity 'u'. The force exerted by the balls on the wall is

a) mnu b) $2mnu^2$

c) $\frac{1}{2}mnu^2$ d) 2mnu

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a) mnu b) $2mnu^2$

c) $\frac{1}{2}mnu^2$ d) 2mnu

52. Rate of flow of heat through a cylindrical rod is H_1. The temperature of the ends of the rod are T_1 and T_2. If all the dimensions of the rod become double and the temperature difference remains the same, the rate of flow of heat becomes H_2. Then the relation between H_1 and H_2 is

a) $H_2 = 4H_1$ b) $H_2 = \frac{H_1}{2}$

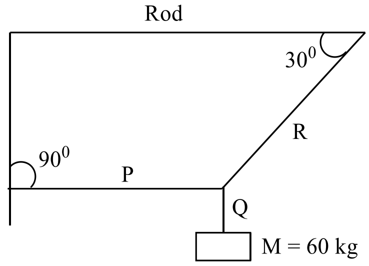
c) $H_2 = 2H_1$ d) $H_2 = \frac{H_1}{4}$

53. 22 g of carbon dioxide at 27°C is mixed in a closed container with 16 g of oxygen at 37°C. If both gases are considered as ideal gases, then the temperature of the mixture is

a) 24.2°C b) 28.5°C

c) 31.5°C d) 33.5°C

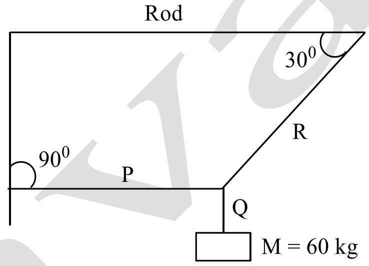
54. A body of mass 60 kg suspended by means of three strings P, Q and R as shown in the figure is in equilibrium. The tension in the string P is



a) 130.9 kgf b) 60 kgf

c) 50 kgf d) 103 kgf

55. A body of mass 60 kg suspended by means of three strings P, Q and R as shown in the figure is in equilibrium. The tension in the string P is



a) 130.9 kgf b) 60 kgf

c) 50 kgf d) 103 kgf

56. A stationary body explodes into two parts of masses 'M_1' and 'M_2'. They move in opposite directions with velocities 'v_1' and 'v_2'. The ratio of their kinetic energies is

a) $\left[\frac{M_2}{M_1}\right]$ b) $\left[\frac{M_2}{M_1}\right]^{1/2}$

c) $\left[\frac{M_2}{M_1}\right]^2$ d) $\left[\frac{M_1}{M_2}\right]^2$

57. A stationary body explodes into two parts of masses 'M_1' and 'M_2'. They move in opposite directions with velocities 'v_1' and 'v_2'. The ratio of their kinetic energies is

a) $\left[\frac{M_2}{M_1}\right]$ b) $\left[\frac{M_2}{M_1}\right]^{1/2}$

c) $\left[\frac{M_2}{M_1}\right]^2$ d) $\left[\frac{M_1}{M_2}\right]^2$

58. A bubble of 8 mol of helium is submerged at a certain depth in water. The temperature of water increases by 30°C. How much heat is added approximately to helium during expansion?

a) 4000 J b) 3000 J

c) 3500 J d) 5000 J

59. If two rods of lengths L and 2L having coefficient of linear expansion α and 2α respectively are connected end-on-end, the

average coefficient of linear expansion of the composite rod, equals

a) $\frac{3}{2}\alpha$ b) $\frac{5}{2}\alpha$

c) $\frac{5}{3}\alpha$ d) None of these

60. A black of mass m moving on a frictionless surface at speed v collides elastically with a black of same mass, initially at rest. Now, the first block moves at an angle θ with its initial direction and has speed v_1. The speed of the second of the block after collision is

a) $\sqrt{v_1^2 - v^2}$ b) $\sqrt{v^2 - v_1^2}$

c) $\sqrt{v^2 + v_1^2}$ d) $\sqrt{v - v_1}$

61. A black of mass m moving on a frictionless surface at speed v collides elastically with a black of same mass, initially at rest. Now, the first block moves at an angle θ with its initial direction and has speed v_1. The speed of the second of the block after collision is

a) $\sqrt{v_1^2 - v^2}$ b) $\sqrt{v^2 - v_1^2}$

c) $\sqrt{v^2 + v_1^2}$ d) $\sqrt{v - v_1}$

62. A bomb at rest explodes in to three parts of same mass. The momentum of two parts is $(-)3P\hat{i}$ and $2P\hat{j}$ respectively. The magnitude of the momentum of third part is

a) $\sqrt{13}P$ b) $\sqrt{15}P$

c) $\sqrt{11}P$ d) $\sqrt{7}P$

63. What is the amount of work done by a person when (i) he holds a mass of 2 kg for 5 second and (ii) he lifts the same mass through 1 meter to keep it on the top of a table? $g = 9.8 \text{ m/s}^2$

a) 4.9 J and zero b) Zero and 4.9 J

c) Zero and 19.6 J d) 19.6 J and zero

64. What is the amount of work done by a person when (i) he holds a mass of 2 kg for 5 second and (ii) he lifts the same mass through 1 meter to keep it on the top of a table? $g = 9.8 \text{ m/s}^2$

a) 4.9 J and zero b) Zero and 4.9 J

c) Zero and 19.6 J d) 19.6 J and zero

65. A thin copper wire of length / increase in length by 1%, when heated from 0°C to 100°C. If a thin copper plate of area $2l \times l$ is heated from 0°C to 100°C, the percentage increase in its area would be

a) 1% b) 4%

c) 3% d) 2%

66. A cylindrical rod is having temperature θ_1 and θ_2 at its ends. The rate of heat flow is 'Q' Js^{-1}. All the linear dimensions of the rod are doubled by keeping the temperature constant. What is the new rate of flow of heat?

a) $\frac{Q}{2}$ b) $\frac{Q}{4}$

c) 2Q d) $\frac{3Q}{2}$

67. A mass m moves with a velocity v and collides inelastically with another identical mass. After collision, the 1 st mass moves with velocity $\frac{v}{\sqrt{3}}$ *in a direction* perpendicular to the initial direction of motion . find the speed of the second mass after collision.

a) v b) $\sqrt{3}\,V$

c) $\frac{2}{\sqrt{3}}V$ d) $\frac{v}{\sqrt{3}}$

68. A mass m moves with a velocity v and collides inelastically with another identical mass. After collision, the 1 st mass moves with velocity $\frac{v}{\sqrt{3}}$ *in a direction* perpendicular to the initial direction of motion . find the speed of the second mass after collision.

a) v b) $\sqrt{3}\,V$

c) $\frac{2}{\sqrt{3}}V$ d) $\frac{v}{\sqrt{3}}$

69. A ball of mass 'm' moving with speed 'v' collides elastically with identical stationary ball which is initially at rest. After collision the first ball moves at an angle 'θ' to its initial direction and has speed '$\left(\frac{v}{3}\right)$'. The second ball moves in a straight line after collision. The speed of second ball after collision is

a) $\frac{2}{\sqrt{3}}v$ b) $\frac{4}{3}v$

c) $\frac{2\sqrt{2}}{3}v$ d) $\frac{3}{\sqrt{2}}v$

70. A ball of mass 'm' moving with speed 'v' collides elastically with identical stationary ball which is initially at rest. After collision the first ball moves at an angle 'θ' to its initial direction and has speed '$\left(\frac{v}{3}\right)$'. The second ball moves in a straight line after collision. The speed of second ball after collision is

a) $\frac{2}{\sqrt{3}}v$ b) $\frac{4}{3}v$

c) $\frac{2\sqrt{2}}{3}v$ d) $\frac{3}{\sqrt{2}}v$

71. The rate of flow of heat through a copper rod with temperature difference 28°C is 1400 cal s^{-1}. The thermal resistance of copper rod will be

a) $0.05\ \frac{°C}{s\ cal}$ b) $0.02\ \frac{°C}{s\ cal}$
c) $5\ \frac{°C}{s\ cal}$ d) $2\ \frac{°C}{s\ cal}$

72. A conducting rod of length 1 m has area of cross-section 10^{-3} m^2. One end is immersed in baiting water (100^0C) and the other end in Ice (0^0C). If coefficient of thermal conductivity of rod is 96 cal/sm^{0}C and latent heat for ice is 8×10^{-4} cal/kg then the amount of ice which will melt in one minute is
a) 5.4×10^{-3} kg b) 7.2×10^{-3} kg
c) 1.8×10^{-3} kg d) 3.6×10^{-3} kg

73. The kinetic energy of a light body and a heavy body is same. Which one of them has greater momentum?
a) A body having high velocity b) Heavy body
c) Light body d) A body having large displacement

74. The kinetic energy of a light body and a heavy body is same. Which one of them has greater momentum?
a) A body having high velocity b) Heavy body
c) Light body d) A body having large displacement

75. Two bodies of masses 1 kg and 2 kg are lying in XY - plane at (-1, 2) and (2, 4) respectively. What are the coordinates of the centre of mass?
a) $\left(1, \frac{10}{3}\right)$ b) (1,0)
c) (0,1) d) None of these

76. Two bodies of masses 1 kg and 2 kg are lying in XY - plane at (-1, 2) and (2, 4) respectively. What are the coordinates of the centre of mass?
a) $\left(1, \frac{10}{3}\right)$ b) (1,0)
c) (0,1) d) None of these

77. A child is sitting on a swing which performs S.H.M. It has minimum and maximum heights from ground 0.75 cm and 2 m respectively. Its maximum speed will be $\left[g = 10\frac{m}{s^2}\right]$
a) $\sqrt{1.25}$ m/s b) $\sqrt{12.5}$ m/s
c) 5 m/s d) 25 m/s

78. A child is sitting on a swing which performs S.H.M. It has minimum and maximum heights from ground 0.75 cm and 2 m respectively. Its maximum speed will be $\left[g = 10\frac{m}{s^2}\right]$
a) $\sqrt{1.25}$ m/s b) $\sqrt{12.5}$ m/s
c) 5 m/s d) 25 m/s

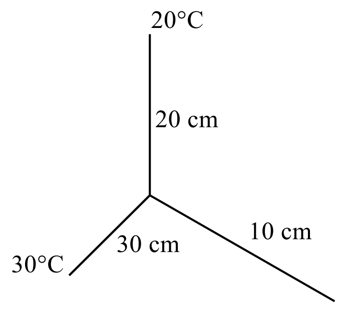
79. A body cools from 90°C to 70°C in 6 minute. If the temperature of the surroundings is 30°C, the time taken by the body to cool from 70°C to 50°C is
a) 12 minute b) 8 minute
c) 10 minute d) 15 minute

80. A liquid having coefficient of cubical expansion 'γ' is kept in a copper vessel having coefficient of linear expansion $\frac{\gamma}{3}$. If heat is supplied to the vessel, the original level of the liquid in the vessel
a) Will decrease b) May increase or decrease
c) Will increase d) Will remain almost the same

81. The torque of a force F = - 6î acting at a point r = -4j about origin will be
a) -24 $\hat{k}$ b) 24 $\hat{k}$
c) 24 $\hat{j}$ d) 24 $\hat{i}$

82. The torque of a force F = - 6î acting at a point r = -4j about origin will be
a) -24 $\hat{k}$ b) 24 $\hat{k}$
c) 24 $\hat{j}$ d) 24 $\hat{i}$

83. Three rods made of the same material and having same cross sectional area but different length 10cm, 20 cm and 30 cm are joined as shown in the figure. The temperature of the junction is



a) 10.8°C b) 14.6°C
c) 16.4°C d) 18.2°C

84. A bullet of mass m moving with velocity 'v' is fired into a wooden block of mass 'M'. If the bullet remains embedded in the block, the final velocity of the system is
a) $\frac{mv}{m + M}$ b) $\frac{m + M}{m}$
c) $\frac{M + m}{mv}$ d) $\frac{v}{m(M + m)}$

85. A bullet of mass m moving with velocity 'v' is fired into a wooden block of mass 'M'. If the

bullet remains embedded in the block, the final velocity of the system is

a) $\frac{mv}{m+M}$ b) $\frac{m+M}{m}$

c) $\frac{M+m}{mv}$ d) $\frac{v}{m(M+m)}$

86. A copper rod and a steel rod having the same area of cross-section are end. The free end of copper rod is at 100℃ and free end of steel rod is the temperature at their junction if $K_{copper} = 9K_{steel}$ and length of 3 times length of steel rod? ($K =$ Thermal conductivity)

a) 75℃ b) 90℃

c) 25℃ d) 50℃

87. N number of balls of mass m kg moving along positive direction of X- axis, strike a wall per second and return elastically. The velocity of each ball is u m/s. The force exerted on the wall by the balls (in newton) is

a) 0 b) 2mNu

c) $\frac{mNu}{2}$ d) mNu

88. N number of balls of mass m kg moving along positive direction of X- axis, strike a wall per second and return elastically. The velocity of each ball is u m/s. The force exerted on the wall by the balls (in newton) is

a) 0 b) 2mNu

c) $\frac{mNu}{2}$ d) mNu

89. A force $(3\hat{i} + 4\hat{j})$ N acts on a body and displaces it by $(3\hat{i} + 4\hat{J})$ m. The work done by the force is

a) 10 j b) 12 j

c) 16 j d) 25 j

90. A force $(3\hat{i} + 4\hat{j})$ N acts on a body and displaces it by $(3\hat{i} + 4\hat{J})$ m. The work done by the force is

a) 10 j b) 12 j

c) 16 j d) 25 j

91. A black having mass m collides with an another stationary block having mass 2 m. The lighter block comes to rest after collision. If the velocity of first block is v, then the value of coefficient of restitution must be

a) 0.5 b) 0.4

c) 0.6 d) 0.8

92. A black having mass m collides with an another stationary block having mass 2 m. The lighter block comes to rest after collision. If the velocity of first block is v, then the value of coefficient of restitution must be

a) 0.5 b) 0.4

c) 0.6 d) 0.8

93. Two metal rods P and Q have same length and same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 also cross-sectional areas A_1 and A_2 respectively. If the rate of flow of heat through rod Q is three times that in rod P, then

a) $3K_1A_1 = 2K_2A_2$ b) $3K_1A_1 = K_2A_2$

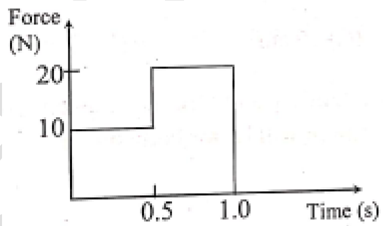
c) $K_1A_1 = 3K_2A_2$ d) $2K_1A_1 = 3K_2A_2$

94. The coefficient of linear expansion of crystal in one direction is α_1 and that in other two directions perpendicular to it is α_2. The coefficient of cubical expansion is

a) $\alpha_1 + \alpha_2$ b) $2\alpha_1 + \alpha_2$

c) $\alpha_1 + 2\alpha_2$ d) None of these

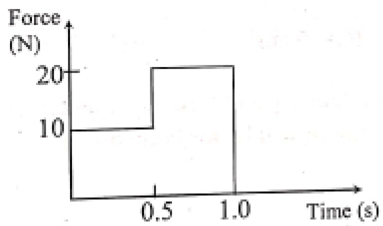
95. Force is applied to a body of mass 2kg at rest on a frictionless horizontal surface as shown in the force against time (F – t) graph. The speed of the body after 1 second is



a) 7.5 m/s b) 12.5 m/s

c) 10 m/s d) 15 m/s

96. Force is applied to a body of mass 2kg at rest on a frictionless horizontal surface as shown in the force against time (F – t) graph. The speed of the body after 1 second is



a) 7.5 m/s b) 12.5 m/s

c) 10 m/s d) 15 m/s

97. Which of the following is NOT a mode of heat transfer?

a) Conduction b) Radiation

c) Sublimation d) Convection

98. An object is cooled from 75°C to 65°C in 2 min in a room at 30°C. The time taken to cool another identical object from 55°C to 45°C in the same room, in minutes is

a) 4 b) 5

c) 6 d) 7

99. If the temperature difference on the two sides of a wall increases from 100°C to 200°C, its

thermal conductivity

a) remains unchanged b) is doubled
c) is halved d) becomes four times

100. A metal rod of Young's module 'Y' and coefficient of linear expansion 'α' has its temperature raised by 'Δθ'. The linear stress to prevent the expansion of rod is (L and l is original length of rod and expansion respectively)

a) $Y \propto \Delta\theta$ b) $Y\left(\frac{l}{L}\right)^2$
c) $Y\frac{L}{l}$ d) $\frac{Y \propto}{\Delta\theta}$

101. If there is a change of angular momentum from 1 J-s to 4J - s in 4 s, then the torque

a) $\frac{5}{4}$ J b) $\frac{3}{4}$ J
c) 1 J d) $\frac{4}{3}$ J

102. If there is a change of angular momentum from 1 J-s to 4J - s in 4 s, then the torque

a) $\frac{5}{4}$ J b) $\frac{3}{4}$ J
c) 1 J d) $\frac{4}{3}$ J

103. A piece of ice melts completely when it falls from a height 'h'. Only 25% of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during fall. The value of 'h' is (Latent heat of ice= $3.5 \times 10^5 \frac{1}{\text{kg}}, g = 10\ \text{m/s}^2$)

a) 140 km b) 125 km
c) 120 km d) 130 km

104. The temperature of equal masses of three different liquids A, B and C are 12°C, 19°C and 28°C, respectively. The temperature when A and B are mixed is 16°C and when B and C are mixed is 23°C. The temperature when A and C are mixed is

a) 18.2°C b) 22°C
c) 20.2°C d) 24.2°C

105. Two forces each of magnitude 'P' act at right angles. Their effect is neutralized by a third force acting along their bisector in opposite direction. The magnitude of the third force is $\left[\cos\frac{\pi}{2} = 0\right]$

a) P b) $P\sqrt{2}$
c) $\sqrt{2}P$ d) $\frac{P}{2}$

106. Two forces each of magnitude 'P' act at right angles. Their effect is neutralized by a third force acting along their bisector in opposite direction. The magnitude of the third force is $\left[\cos\frac{\pi}{2} = 0\right]$

a) P b) $P\sqrt{2}$
c) $\sqrt{2}P$ d) $\frac{P}{2}$

107. A wall has two layers A and B, made of two different materials. The thermal conductivity of material A is twice that of B. If the two layers have same thickness and under thermal equilibrium, the temperature difference across the wall is 48°C, the temperature difference across layer B is

a) 40°C b) 32°C
c) 16°C d) 24°C

108. Two cylindrical conductors A and B of same metallic material have their diameters in the ratio 1:2 and lengths in the ratio 2:1 , if the temperature difference between their ends is same, the ration of heat conducted respectively by A and B per second is

a) 1:2 b) 1:4
c) 1:16 d) 1:8

109. The thermal conductivity of a rod depends on

a) length b) mass
c) area of cross section d) material of the rod

110. A gardener pushes a lawn roller through a distance 20 m. If he applied a force of 20 kg-wt in a direction inclined at 60^0 to the ground, the work done by him is

a) 1960 j b) 196 j
c) 1.96 j d) 196 kj

111. A gardener pushes a lawn roller through a distance 20 m. If he applied a force of 20 kg-wt in a direction inclined at 60^0 to the ground, the work done by him is

a) 1960 j b) 196 j
c) 1.96 j d) 196 kj

112. A steel rod of diameter 1 cm is clamped firmly at each end when its temperature is 25°C, so that it cannot contract on cooling. The tension in the rod at 0°C is approximately (Take, $\alpha = 10^{-5}/\ ^\circ\text{C}, Y = 2 \times 10^{11}\text{Nm}^{-2}$)

a) 4000 N b) 7000 N
c) 7400 N d) 4700 N

113. The temperature difference between two sides of an iron plate, 1.8 cm thick 9℃. Heat is transmitted through the plate 10 k cal/sm^2 at ready state. The thermal conductivity of iron is

a) $0.02\frac{\text{kcal}}{\text{ms°C}}$ b) $0.04\ \frac{\text{kcal}}{\text{ms°C}}$

c) $0.05 \frac{\text{kcal}}{\text{ms°C}}$ d) $0.004 \frac{\text{kcal}}{\text{ms°C}}$

114. A block of mass 'm' collides with another stationary block of mass '2m'. The lighter block comes to rest after collision. If the velocity of first block is 'u', then the value of coefficient of restitution is
a) 0.6 b) 0.4
c) 0.5 d) 0.8

115. A block of mass 'm' collides with another stationary block of mass '2m'. The lighter block comes to rest after collision. If the velocity of first block is 'u', then the value of coefficient of restitution is
a) 0.6 b) 0.4
c) 0.5 d) 0.8

116. A meter rod of silver at 0°C is heated to 100°C. It's length is increased by 0.19 cm. Coefficient of volume expansion of the silver rod is
a) 5.7×10^{-5}/ °C b) 0.63×10^{-5}/ °C
c) 1.9×10^{-5}/ °C d) 16.1×10^{-5}/ °C

117. Two masses of 1 gram and 4 gram are moving with equal kinetic energy. The ratio of the magnitudes of their momenta is
a) 1:16 b) 1:2
c) $\sqrt{2}$: 1 d) 4:1

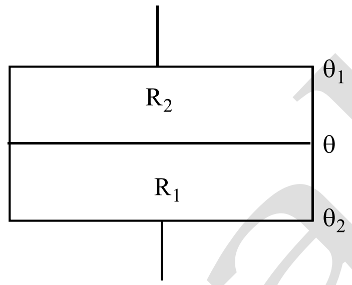
118. Two masses of 1 gram and 4 gram are moving with equal kinetic energy. The ratio of the magnitudes of their momenta is
a) 1:16 b) 1:2
c) $\sqrt{2}$: 1 d) 4:1

119. A calorimeter contains 10 g of water at 20°C. The temperature falls to 15°C in 10 min. When calorimeter contains 20 g of water at 20°C, it takes 15 min for the temperature to become 15°C. The water equivalent of the calorimeter is
a) 5 g b) 10 g
c) 25 g d) 50 g

120. A body of mass 'm' moving with speed 3 m/s collides with a body of mass '2m' at rest. The coalesced mass will start to move with a speed of
a) 3 m/s b) 1 m/s
c) 6 m/s d) 9 m/s

121. A body of mass 'm' moving with speed 3 m/s collides with a body of mass '2m' at rest. The coalesced mass will start to move with a speed of
a) 3 m/s b) 1 m/s
c) 6 m/s d) 9 m/s

122. A cylindrical rod with one end in a steam chamber and the other end in ice results in melting of 0.1 g of ice per second. If the rod is replaced by another with half the length and double the radius of the first and if the thermal conductivity of the material of the second rod is 1/4 that of the first, the rate at which ice melts (in gs^{-1}) will be



a) 3.2 b) 1.6
c) 0.2 d) 0.1

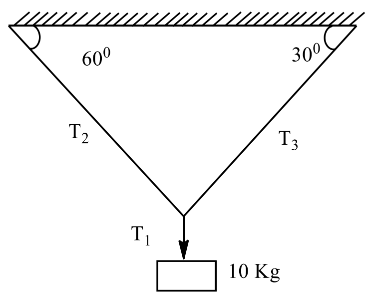
123. Two rods of copper and brass ($K_C > K_B$) of same length and area of cross-section are joined as shown in the figure. End A is kept at 100°C and end B at 0°C. The temperature at the junction

A	Copper	Brass	B

a) will be more than 50°C b) will be less than 50°C
c) will be 50°C d) may be more or less than 50°C depending upon the size of rods

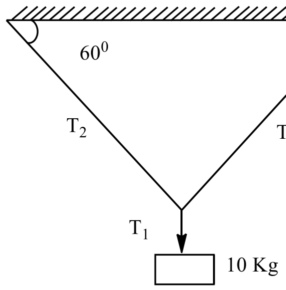
124. A metal sphere cools at the rate of 1.5 °C/min when its temperature is 80°C. At what rate will it cool when its-temperature falls to 50°C. [Temperature of surrounding is 30°C]
a) 0.9 °C/min b) 0.6 °C/min
c) 1.5 °C/min d) 1.2 °C/min

125. A block of mass 10 kg is suspended by three strings as shown in the figure. The tension T_2 is



a) 100 N b) $\frac{100}{\sqrt{3}}$ N
c) $\sqrt{3} \times 100$ N d) $50\sqrt{3}$ N

126. A block of mass 10 kg is suspended by three strings as shown in the figure. The tension T_2 is



a) 100 N　　b) $\frac{100}{\sqrt{3}}$ N
c) $\sqrt{3}\times 100$ N　　d) $50\sqrt{3}$ N

127. Two rods of same material, same length and same radius transfer a given amount of heat in 't' second when they are joined end to end. When the rods are joined one above the other then they will transfer same heat in same conditions in time

a) 2t seconds　　b) $\frac{t}{2}$ second
c) t second　　d) $\frac{t}{4}$ second

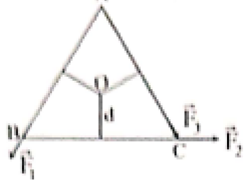
128. The thermal conductivities of copper, mercury and glass are respectively K_C, K_M and K_G such that $K_C > K_M > K_G$. If same quantity of heat flows per second per unit area of each and the corresponding temperature gradients are X_C, X_M and X_G then

a) $X_C = X_M = X_G$　　b) $X_M > X_C > X_G$
c) $X_C > X_M > X_G$　　d) $X_C < X_M < X_G$

129. In a steady state, the temperature at the ends A and B of 20 cm long rod AB are 100°C and 0°C. The temperature of a point 9 cm from A is

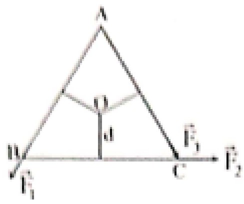
a) 45°C　　b) 55°C
c) 5°C　　d) 65°C

130. Figure shows three forces $\vec{F_1}, \vec{F_2}$ and $\vec{F_3}$ acting along the sides of an equilateral triangle. If the total torque acting at point 'O' (centre of triangle) is zero, then the magnitude of 'F_3' is



a) $F_1 - F_2$　　b) $F_1^2 - F_2^2$
c) $F_1^2 + F_2^2$　　d) $F_1 + F_2$

131. Figure shows three forces $\vec{F_1}, \vec{F_2}$ and $\vec{F_3}$ acting along the sides of an equilateral triangle. If the total torque acting at point 'O' (centre of triangle) is zero, then the magnitude of 'F_3' is



a) $F_1 - F_2$　　b) $F_1^2 - F_2^2$
c) $F_1^2 + F_2^2$　　d) $F_1 + F_2$

132. A body cools from 50°C to 40°C in 5 min. The surrounding temperature is 20°C. In what further time (in minute) will it cool to 30°C ?

a) 5　　b) $\frac{15}{2}$
c) $\frac{25}{3}$　　d) 10

133. The temperature difference between two sides of metal plate 3 cm thick is 15°C. Heat is transmitted through plate at the rate of 900 kcal per minute per m^2 at steady state. The thermal conductivity of metal is

a) $1.8\times 10^{-2}\frac{kcal}{ms°C}$　　b) $4.5\times 10^{-2}\frac{kcal}{ms°C}$
c) $3\times 10^{-2}\frac{kcal}{ms°C}$　　d) $6\times 10^{-2}\frac{kcal}{ms°C}$

134. A particle of mass m moving in the x- direction with speed 2v is hit by another particle of mass 2m moving in the y-direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to

a) 44%　　b) 50%
c) 56%　　d) 62%

135. A particle of mass m moving in the x- direction with speed 2v is hit by another particle of mass 2m moving in the y-direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to

a) 44%　　b) 50%
c) 56%　　d) 62%

136. A shell of mass 'M' initially at rest suddenly explodes in three fragments. Two of these fragments are of mass 'M/4' each, which move with velocities $3ms^{-1}$ and $4\ ms^{-1}$ respectively in mutually perpendicular directions. The magnitude of velocity of the third fragment is

a) $2.5\ ms^{-1}$　　b) $1.5\ ms^{-1}$
c) $3.0\ ms^{-1}$　　d) $2.0\ ms^{-1}$

137. A shell of mass 'M' initially at rest suddenly explodes in three fragments. Two of these fragments are of mass 'M/4' each, which move with velocities $3ms^{-1}$ and $4\ ms^{-1}$ respectively

in mutually perpendicular directions. The magnitude of velocity of the third fragment is

a) $2.5\ ms^{-1}$ b) $1.5\ ms^{-1}$
c) $3.0\ ms^{-1}$ d) $2.0\ ms^{-1}$

138. Consider a compound slab consisting of two different materials having equal thickness and thermal conductivities k and 2k in series ,The equivalent conductivity of the slab is

a) $\frac{2}{3}K$ b) $\sqrt{2}K$
c) 3 K d) $\frac{4}{3}K$

139. A metal rod having linear expansion coefficient $2 \times 10^{-5}\ °C^{-1}$ has a length of 1 m at 20°C. The temperature at which it is shortened by 1 mm is

a) −20°C b) −15°C
c) −30°C d) −25°C

140. A window glass of area $10^3\ cm^2$ and thickness 4 mm having temperature on one side is 32℃ and on the other side is−8℃. Coefficient of thermal conductivity of glass is 2.2 cal/sm℃. The rate of loss of heat through glass will be

a) $2.2\ k\ cal\ s^{-1}$ b) $2.2 \times 10^{-3}\ cal\ s^{-1}$
c) $2.2\ cal\ s^{-1}$ d) $2.2 \times 10^{3}\ k\ cal\ s^{-1}$

141. The ratio of thermal conductivity of two rods A and B having same area of cross-section is 3:2. If the thermal resistance of two rods is same, then the ratio of length of rod A to length of rod B is

a) 5:1 b) 2:3
c) 3:2 d) 1:5

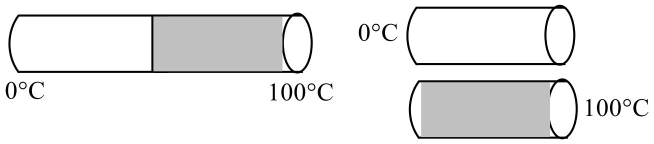
142. A wooden black of mass 'm' moves with velocity 'V' and collides with another block of mass '4m', which is at rest. After collision the block of mass 'm' comes to rest. The coefficient of restitution will be

a) 0.7 b) 0.25
c) 0.4 d) 0.5

143. A wooden black of mass 'm' moves with velocity 'V' and collides with another block of mass '4m', which is at rest. After collision the block of mass 'm' comes to rest. The coefficient of restitution will be

a) 0.7 b) 0.25
c) 0.4 d) 0.5

144. Two identical square rods of metal are welded end to end as shown in Fig. (i), 20 cal of heat flows through it in 4 min. If the rods are welded as shown in Fig. (ii), the same amount of heat will flow through the rods in



a) 1 min b) 2 min
c) 4 min d) 16 min

145. A sphere of mass 'm' moving with velocity 'v' collides head-on on another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)

a) $\frac{e-1}{2}$ b) $\frac{e}{2}$
c) $\frac{e+1}{2}$ d) e

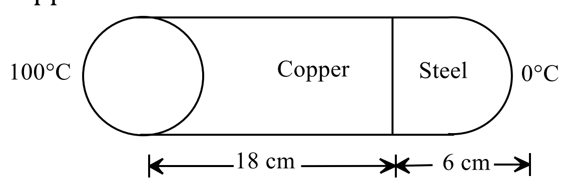
146. A sphere of mass 'm' moving with velocity 'v' collides head-on on another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)

a) $\frac{e-1}{2}$ b) $\frac{e}{2}$
c) $\frac{e+1}{2}$ d) e

147. The length of the two rods made up of the same metal and having the same area of cross-section are $0.6\ m^2$ and $0.8\ m^2$, respectively. The temperature between the ends of first rod is 90°C and 60°C and that for the other rod is 150°C and 110°C. For which rod, the rate of conduction will be greater?

a) First b) Second
c) same for both d) None of these

148. The coefficient of thermal conductivity of copper is nine times that of steel. In the composite cylindrical bar shown in figure, what will be the temperature at the junction of copper and steel?



a) 75°C b) 67°C
c) 33°C d) 25°C

149. Water is used to cool radiators of engine because

a) of its lower density b) it is easily available
c) it is cheap d) it has high specific heat

150. 100 g of ice at 0°C is mixed with 100 g of water at 100°C. What will be the final temperature of the mixture?

a) 10°C b) 20°C
c) 30°C d) 0°C

151. Work done in sliding a 1 kg block up a rough inclined plane of height 5 m is 100 J. Work done against the friction is ($g = 10\ m/s^2$)

a) 75 J b) 25 J
c) 50 J d) 100 J

152. Work done in sliding a 1 kg block up a rough inclined plane of height 5 m is 100 J. Work done against the friction is ($g = 10\ m/s^2$)

a) 75 J b) 25 J
c) 50 J d) 100 J

153. Find the value of—197°C temperature in Kelvin.

a) 47 K b) 76 K
c) 470 K d) 760 K

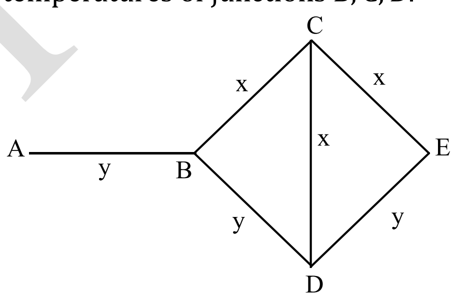
154. A block of mass 'M' is pulled along a smooth horizontal surface with a rope of mass 'm' by force 'F'. The acceleration of the block will be

a) $\frac{F}{(M - m)}$ b) $\frac{F}{M}$
c) $\frac{F}{(M + m)}$ d) $\frac{F}{m}$

155. A block of mass 'M' is pulled along a smooth horizontal surface with a rope of mass 'm' by force 'F'. The acceleration of the block will be

a) $\frac{F}{(M - m)}$ b) $\frac{F}{M}$
c) $\frac{F}{(M + m)}$ d) $\frac{F}{m}$

156. Three rods of material X and three rods of material Y are connected as shown in figure. All are identical in length and cross-sectional area. If end A is maintained at 60°C, end E at 10°C, thermal conductivity of X is $0.92 cals^{-1}\ cm^{-1}\ °C^{-1}$ and that of Y is $0.46\ cals^{-1}\ cm^{-1}\ °C^{-1}$, then find the temperatures of junctions B, C, D.



a) 20°C, 30°C, 20°C b) 30°C, 20°C, 20°C
c) 20°C, 20°C, 30°C d) 20°C, 20°C, 20°C

157. A charge q_1 is moving along the circular path of radius 'R' with a charge q_2 at its centre. A charge q_1 makes two revolutions. The work done will be

a) Zero b) $\frac{q_1 q_2}{4\pi\epsilon_0 R}$
c) $\frac{q_1}{4\pi\epsilon_0 R}$ d) $\frac{q_1 q_2}{4\pi\epsilon_0 R^2}$

158. A charge q_1 is moving along the circular path of radius 'R' with a charge q_2 at its centre. A charge q_1 makes two revolutions. The work done will be

a) Zero b) $\frac{q_1 q_2}{4\pi\epsilon_0 R}$
c) $\frac{q_1}{4\pi\epsilon_0 R}$ d) $\frac{q_1 q_2}{4\pi\epsilon_0 R^2}$

159. A liquid cools from 50°C to 45°C in 5 min and from 45°C to 41.5°C in the next 5 min. The temperature of the surrounding is

a) 27°C b) 40.3°C
c) 23.3°C d) 33.3°C

160. A force $F = (10 + 0.5x)N$ acts on a particle in the x-direction. The work done by the force in displacing the particle from $x = 0$ to $x = 2$ metre is

a) 42 J b) 63 J
c) 21 J d) 31.5 J

161. A force $F = (10 + 0.5x)N$ acts on a particle in the x-direction. The work done by the force in displacing the particle from $x = 0$ to $x = 2$ metre is

a) 42 J b) 63 J
c) 21 J d) 31.5 J

162. The volume of a metal sphere increases by 0.30% when its temperature is raised by 50°C. The coefficients of linear expansion of the metal is

a) 12×10^{-5} /°C b) 3×10^{-5} /°C
c) 6×10^{-5} /°C d) 2×10^{-5} /°C

163. A block of mass 'm', kept on a horizontal surface, is moved through a distances by applying a horizontal force (F) to it. What is the work done by the normal reaction?

a) $\frac{F}{s}$ b) Zero
c) Fs d) $\frac{s}{F}$

164. A block of mass 'm', kept on a horizontal surface, is moved through a distances by applying a horizontal force (F) to it. What is the work done by the normal reaction?

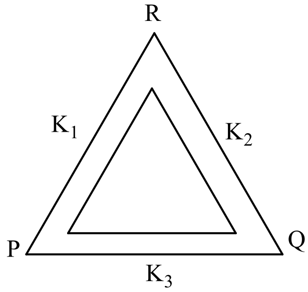
a) $\frac{F}{s}$

b) Zero

c) Fs

d) $\frac{s}{F}$

165. Three rods of same dimensions are arranged as shown in figure. They have thermal conductivities K_1, K_2 and K_3. The points P and Q are maintained at different temperatures. For the heat flow at the same rate along PRQ and PQ which of the following option is correct?



a) $K_3 = \frac{1}{2}(K_1 + K_2)$

b) $K_3 = K_1 + K_2$

c) $K_3 = \frac{K_1K_2}{K_1 + K_2}$

d) $K_3 = 2(K_1 + K_2)$

166. A block of mass 'm' moving along a straight line with constant velocity $3\bar{v}$ collides with another block of same mass at rest. They stick together and move with common velocity. The common velocity is

a) $\frac{3\bar{v}}{2}$

b) $3\bar{v}$

c) $\bar{v}$

d) $2\bar{v}$

167. A block of mass 'm' moving along a straight line with constant velocity $3\bar{v}$ collides with another block of same mass at rest. They stick together and move with common velocity. The common velocity is

a) $\frac{3\bar{v}}{2}$

b) $3\bar{v}$

c) $\bar{v}$

d) $2\bar{v}$

168. The coefficient of thermal conductivity of a rod depends on its

a) Mass

b) Area of cross section

c) Material of the rod

d) Length

169. The coefficient of linear expansion of brass and steel rod are 'α_1' and 'α_2' respectively. Lengths of brass and steel rods are 'l_1' and 'l_2' respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations is correct?

a) $\alpha_1 l_2 = \alpha_2 l_1$

b) $\alpha_1^2 l_2 = \alpha_2^2 l_1$

c) $\alpha_1 l_2^2 = \alpha_2 l_1^2$

d) $l_1 \alpha_1 = l_2 \alpha_2$

170. A thermometer bulb has volume 10^{-6} m^3 and cross-section of the stem is 0.002 cm^2. The bulb is filled with mercury at 0°C. If temperature reads the temperature as 100°C, the length of mercury column is (coefficient of cubical expansion of mercury$= 18 \times 10^{-5}$ /°C)

a) 0.9 mm

b) 90 cm

c) 9 cm

d) 9 mm

171. A ball at rest falls vertically on ground from a height of 5m. The coefficient of restitution is 0.4. The maximum height of the ball after the first rebound is $g = 10$ m/s^2

a) 0.6 m

b) 0.2 m

c) 0.8 m

d) 0.4 m

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a) 0.6 m

b) 0.2 m

c) 0.8 m

d) 0.4 m

173. If specific heat of a substance is infinite, it means

a) heat is given out

b) heat is taken in

c) no change in temperature takes place whether heat is taken in or given out

d) All of the above

174. Two metal slabs of same cross-sectional area have thickness 'd_1' and 'd_2' and thermal conductivities 'K_1' and 'K_2' respectively, connected in series. The free ends of the two slabs are kept at temperatures 'T_1' and 'T_2' $(T_1 > T_2)$. The temperature 'T' of their common junction is

a) $\frac{K_1T_1 + K_2T_2}{K_1 + K_2}$

b) $\frac{K_1T_1 + K_2T_2}{T_1 + T_2}$

c) $\frac{K_1T_1d_1 + K_2T_2d_2}{K_1d_2 + K_2d_1}$

d) $\frac{K_1T_1d_2 + K_2T_2d_1}{K_1d_2 + K_2d_1}$

175. A metal ball released from height 'h' makes perfectly elastic collision with ground. The frequency of periodic vibratory motion is ($g =$ acceleration due to gravity)

a) $\frac{1}{2}\sqrt{\frac{2h}{g}}$

b) $\frac{1}{2\pi}\sqrt{\frac{g}{h}}$

c) $\frac{1}{2\pi}\sqrt{\frac{2h}{g}}$

d) $\frac{1}{2}\sqrt{\frac{g}{2h}}$

176. A metal ball released from height 'h' makes perfectly elastic collision with ground. The frequency of periodic vibratory motion is ($g =$ acceleration due to gravity)

a) $\frac{1}{2}\sqrt{\frac{2h}{g}}$ b) $\frac{1}{2\pi}\sqrt{\frac{g}{h}}$
c) $\frac{1}{2\pi}\sqrt{\frac{2h}{g}}$ d) $\frac{1}{2}\sqrt{\frac{g}{2h}}$

177. A body is suspended from a rigid support by an inextensible string of length 'L' on which another identical body of mass 'm' struck in-elastically moving with horizontal velocity $\sqrt{2gL}$. The increase in the tension in the string just after it is struck by the body is
a) 4mg b) 3mg
c) mg d) 2mg

178. A body is suspended from a rigid support by an inextensible string of length 'L' on which another identical body of mass 'm' struck in-elastically moving with horizontal velocity $\sqrt{2gL}$. The increase in the tension in the string just after it is struck by the body is
a) 4mg b) 3mg
c) mg d) 2mg

179. A black rectangular surface of area 'A' emits energy 'E' per second at 27^0C. If length and breadth is reduced to (1/3)rd of its initial value and temperature is raised to 327^0C then energy emitted per second becomes
a) $\frac{20E}{9}$ b) $\frac{8E}{9}$
c) $\frac{16E}{9}$ d) $\frac{4E}{9}$

180. A particle of mass 'm' collides with another stationary particle of mass 'M'. A particle of mass 'm' stops just after collision. The coefficient of restitution is
a) $\frac{M}{m}$ b) $\frac{m+M}{M}$
c) $\frac{M-m}{M+m}$ d) $\frac{m}{M}$

181. A particle of mass 'm' collides with another stationary particle of mass 'M'. A particle of mass 'm' stops just after collision. The coefficient of restitution is
a) $\frac{M}{m}$ b) $\frac{m+M}{M}$
c) $\frac{M-m}{M+m}$ d) $\frac{m}{M}$

182. Two rods of different metals have coefficients of linear expansion 'α_1' and 'α_2' respectively. Their respective lengths are 'L_1' and 'L_2'. At all temperatures $(L_2 - L_1)$ is same. The correct relation is
a) $L_1\alpha_1^2 = L_2\alpha_2^2$ b) $L_1^2\alpha_1^2 = L_2^2\alpha_2^2$
c) $L_1\alpha_2 = L_2\alpha_1$ d) $L_1\alpha_1 = L_2\alpha_2$

183. Two rods of same length and material are joined end to end. They transfer heat in 8 second. When they are joined in parallel they transfer same amount of heat in same conditions in time
a) 3 s b) 2 s
c) 1 s d) 4 s

184. A constant force acting on a body of mass 3.0 kg changes its speed from 2.0 m/s to 3.5 m/s in 25 s. The direction of motion of the body remains unchanged. What is the magnitude and direction of the force?
a) 0.018 N, along the direction of motion b) 0.18 N, opposite to the direction of motion
c) 0.28 N, along the direction of motion d) 0.28 N, opposite to the direction of motion

185. A constant force acting on a body of mass 3.0 kg changes its speed from 2.0 m/s to 3.5 m/s in 25 s. The direction of motion of the body remains unchanged. What is the magnitude and direction of the force?
a) 0.018 N, along the direction of motion b) 0.18 N, opposite to the direction of motion
c) 0.28 N, along the direction of motion d) 0.28 N, opposite to the direction of motion

186. A force produces an acceleration of 6 ms^{-2} in a body of mass 'm_1' kg. The same force produces an acceleration of 4 ms^{-2} in the combination of mass $(m_1 + m_2)$kg. If the same force is applied to mass 'm_2' kg, then acceleration produced will be
a) 6 ms^{-2} b) 9 ms^{-2}
c) 12 ms^{-2} d) 3 ms^{-2}

187. A force produces an acceleration of 6 ms^{-2} in a body of mass 'm_1' kg. The same force produces an acceleration of 4 ms^{-2} in the combination of mass $(m_1 + m_2)$kg. If the same force is applied to mass 'm_2' kg, then acceleration produced will be
a) 6 ms^{-2} b) 9 ms^{-2}
c) 12 ms^{-2} d) 3 ms^{-2}

188. A metal rod of cross-section area 3×10^{-6} m^2 is suspended vertically from one end has a length 0.4 m at 100°C. Now the rod is cooled

upto 0°C, but prevented from contracting by attaching a mass 'm' at the lower end. The value of 'm' is ($Y = 10^{11}\ N/m^2$, coefficient of linear expansion= $10^{-5}/K$, $g = 10\ m/s^2$)

a) 30 kg b) 40 kg
c) 20 kg d) 10 kg

189. A body of mass 2kg is acted upon by two each of magnitude 1N and inclined at 60^0 with each other. The acceleration of the body in$\frac{m}{s}$ is$\cos 60^0 = 0.5$

a) $\sqrt{0.75}$ b) $\sqrt{0.35}$
c) $\sqrt{0.65}$ d) $\sqrt{0.20}$

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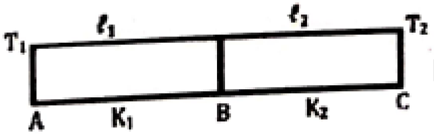
a) $\sqrt{0.75}$ b) $\sqrt{0.35}$
c) $\sqrt{0.65}$ d) $\sqrt{0.20}$

191. One end of a thermally insulted rod is kept at temperature 'T_1' and the other end at 'T_2'. The rod is composed of two sections of lengths 'l_1' and 'l_2' having thermal conductivities 'K_1' and 'K_2' respectively. The temperature 'T' at the interface of the two sections is



a) $\left(\frac{K_2l_2T_1 + K_1l_1T_2}{K_1l_1 + K_2l_2}\right)$ b) $\left(\frac{K_1l_1T_1 + K_2l_2T_2}{K_1l_1 + K_2l_2}\right)$
c) $\left(\frac{K_1l_2T_1 + K_2l_1T_2}{K_1l_2 + K_2l_1}\right)$ d) $\left(\frac{K_2l_1T_1 + K_1l_2T_2}{K_2l_1 + K_1l_2}\right)$

192. A hot body at a temperature 'T' is kept in a surrounding of temperature 'T_0'. It takes time 't_1' to cool from 'T' to 'T_2', time t_2 to cool from 'T_2' to 'T_3' and time 't_3' to cool from 'T_3' to 'T_4'. If $(T - T_2) = (T_2 - T_3) = (T_3 - T_4)$, then

a) $t_1 > t_2 > t_3$ b) $t_1 = t_2 = t_3$
c) $t_3 > t_2 > t_1$ d) $t_1 > t_2 = t_3$

193. A vehicle without passengers is moving on a frictionless horizontal road with velocity 'u' can be stopped in a distance 'd'. Now, 40% of its weight is added. If the retardation remains same the stopping distance at velocity 'u' is

a) d b) (1.2)d
c) (1.4)d d) (1.6)d

194. A vehicle without passengers is moving on a frictionless horizontal road with velocity 'u' can be stopped in a distance 'd'. Now, 40% of its weight is added. If the retardation remains same the stopping distance at velocity 'u' is

a) d b) (1.2)d
c) (1.4)d d) (1.6)d

195. A mass of 1 kg is suspended by a string. It is first lifted up with an acceleration of $4.9\ m/s^2$ and then lowered down with same acceleration. The ratio of tensions in the string in the two cases, respectively is $g = 9.8\ m/s^2$

a) 1:3 b) 2:1
c) 3:1 d) 1:2

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a) 1:3 b) 2:1
c) 3:1 d) 1:2

197. A body cools from 100°C to 70 °C in 8 s. If the room temperature is 15°C and assuming Newton's law of cooling holds good, then time required for the body to cool from 70 °C to 40 °C is

a) 14 s b) 8 s
c) 10 s d) 5 s

198. A light string passes over a smooth light pulley and connects two masses m_1 and m_2 ($m_2 > m_1$) vertically at two ends. If the acceleration of the system is $\frac{1}{6}\ m/s^2$, the ratio of masses is (g = acceleration due to gravity)

a) 7: 9 b) 5: 7
c) 2: 3 d) 3: 4

199. A light string passes over a smooth light pulley and connects two masses m_1 and m_2 ($m_2 > m_1$) vertically at two ends. If the acceleration of the system is $\frac{1}{6}\ m/s^2$, the ratio of masses is (g = acceleration due to gravity)

a) 7: 9 b) 5: 7
c) 2: 3 d) 3: 4

200. A body cools from 80°C to 50°C in 5 min. Calculate the time, it takes to cool from 60°C to 30°C. The temperature of the surroundings is 20°C.

a) 9 min b) 7 min
c) 8 min d) 10 min

201. A particle of mass 'm' collides with another stationary particle of mass 'M'. A particle of mass 'm' stops just after collision. The coefficient of restitution is

a) M/m b) m/M

c) $\frac{M-m}{M+m}$ d) $\frac{m+M}{m}$

202. A particle of mass 'm' collides with another stationary particle of mass 'M'. A particle of mass 'm' stops just after collision. The coefficient of restitution is

a) M/m b) m/M
c) $\frac{M-m}{M+m}$ d) $\frac{m+M}{m}$

203. Two rods P and Q have equal lengths. Their thermal conductivities are K_1 and K_2 and cross-sectional areas are A_1 and A_2. When the temperature at ends of each rod are T_1 and T_2 respectively, the rate of flow of heat through P and Q will be equal, if

a) $\frac{A_1}{A_2}=\frac{K_2}{K_1}$ b) $\frac{A_1}{A_2}=\frac{K_2}{K_1}\times\frac{T_2}{T_1}$
c) $\frac{A_1}{A_2}=\sqrt{\frac{K_1}{K_2}}$ d) $\frac{A_1}{A_2}=\left(\frac{K_2}{K_1}\right)^2$

204. A body cools from 80℃ to 64℃ in 5 minute and same body cools from 80℃ to 52℃ in 10 minute. The temperature of surroundings is

a) 24℃ b) 26℃
c) 28℃ d) 22℃

205. A beaker contains 200 g of water. The heat capacity of the beaker is equal to that of 20 g of water. The initial temperature of water in the beaker is 20°C. If 440 g of hot water at 92°C is poured in it, the final temperature (neglecting radiation loss) will be nearest to

a) 58°C b) 68°C
c) 73°C d) 78°C

206. Out of the fundamental forces in nature, maximum and minimum range is respectively for

a) Electromagnetic force, gravitational force b) Strong nuclear force, electromagnetic force
c) Gravitational force, weak nuclear force d) Gravitational force, electromagnetic force

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a) Electromagnetic force, gravitational force b) Strong nuclear force, electromagnetic force
c) Gravitational force, weak nuclear force d) Gravitational force, electromagnetic force

208. A bullet of mass 20 gram is fired from a gun of mass 2.5 kg with a speed of 750 m/s. The magnitude of recoil velocity of the gun is

a) 6 m/s b) 18 m/s
c) 12 m/s d) 3 m/s

209. A bullet of mass 20 gram is fired from a gun of mass 2.5 kg with a speed of 750 m/s. The magnitude of recoil velocity of the gun is

a) 6 m/s b) 18 m/s
c) 12 m/s d) 3 m/s

210. A beaker is completely filled with water at 4°C. It will overflow, if

a) heated above 4°C b) cooled below 4°C
c) both heated and cooled above and below 4°C, respectively d) None of the above

211. A Diwali cracker releases 25 gram gas per second, with a speed of 400 ms^{-1} after explosion. The force exerted by gas on the cracker is

a) 16 newton b) 100 dyne
c) 10,000 dyne d) 10 newton

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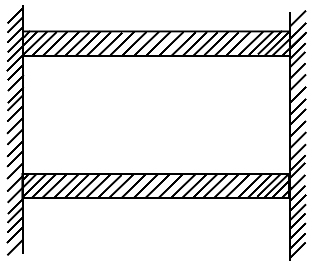
a) 16 newton b) 100 dyne
c) 10,000 dyne d) 10 newton

213. Two rods of different materials having coefficients o thermal expansions α_1, α_2 and Young's modulli Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to



a) 2:3 b) 1:1
c) 3:2 d) 4:9

214. A billet is fired from a gum. The fore on the bullet is given by $F = (600 \times 2\times 10^5\ t)$, where

F is in newton and t is second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

a) 9 N-s b) Zero
c) 0.9 N-s d) 1.8 N-s

215. A billet is fired from a gum. The fore on the bullet is given by $F = (600 \times 2\times 10^5\ t)$, where F is in newton and t is second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

a) 9 N-s b) Zero
c) 0.9 N-s d) 1.8 N-s

216. A bar of iron is 10 cm at 20°C. At 19°C, it will be ($\alpha_{Fe} = 11 \times 10^{-6}/\ °C$)

a) 11×10^{-6} cm longer b) 11×10^{-6} cm shorter
c) 11×10^{-5} cm shorter d) 11×10^{-5} cm longer

217. A block of mass 'm' moving on a frictionless horizontal surface collides with a spring of spring constant 'K' and compresses it through a distance 'x'. The maximum momentum of the block after collision is

a) $\sqrt{mK}\,x$ b) mx^2/K
c) Zero d) $Kx^2/2m$

218. A block of mass 'm' moving on a frictionless horizontal surface collides with a spring of spring constant 'K' and compresses it through a distance 'x'. The maximum momentum of the block after collision is

a) $\sqrt{mK}\,x$ b) mx^2/K
c) Zero d) $Kx^2/2m$

219. Two rods of lengths l_1 and l_2 are made of materials whose coefficient of linear expansions are α_1 and α_2, respectively. If the difference between two lengths is independent of temperature, then

a) $\frac{l_1}{l_2} = \frac{\alpha_1}{\alpha_2}$ b) $\frac{l_1}{l_2} = \frac{\alpha_2}{\alpha_1}$
c) $l_2^2\alpha_1 = l_1^2\alpha$ d) $\frac{\alpha_1^2}{l_1} = \frac{\alpha_2^2}{l_2}$

220. The rate of flow of heat through a copper rod with temperature difference 28°C is 1400 cal s^{-1}. The thermal resistance of copper rod will be

a) 0.05 $\frac{°Cs}{cal}$ b) 0.02 $\frac{°Cs}{cal}$
c) 5 $\frac{°Cs}{cal}$ d) 2 $\frac{°Cs}{cal}$

221. Two masses 'm_1' and 'm_2' moving with velocities 'v_1' and 'v_2' in opposite directions collide elastically and after collision 'm_1' and 'm_2' move with velocity 'v_2' and 'v_1' respectively, the ratio v_2/v_1 is

a) 0.5 b) 0.25
c) 1 d) 0.75

222. Two masses 'm_1' and 'm_2' moving with velocities 'v_1' and 'v_2' in opposite directions collide elastically and after collision 'm_1' and 'm_2' move with velocity 'v_2' and 'v_1' respectively, the ratio v_2/v_1 is

a) 0.5 b) 0.25
c) 1 d) 0.75

223. Equal temperature differences exist between the ends of two metallic rods 1 and 2 of equal lengths. Their thermal conductivities are K_1 and K_2 and area of cross-section are A_1 and A_2, respectively. The condition of equal rates of heat transfer is

a) $K_1A_2 = K_2A_1$ b) $K_1A_1 = K_2A_2$
c) $K_1A_1^2 = K_2A_2^2$ d) $K_1^2A_2 = K_2^2A_1$

224. A metal rod of length L and cross-sectional area A is heated through T°C. What is the force required to prevent the expansion of the rod lengthwise?
(Y = Young's modulus of material of the rod, α = coefficient of linear expansion of the rod)

a) $YA\alpha T/(1-\alpha T)$ b) $YA\alpha T/(1+\alpha T)$
c) $YA\alpha/T(1+\alpha T)$ d) $YA\alpha/(1-\alpha T)$

225. A metal ball of mass 2 kg moving with a speed of 10 ms^{-1} had a head-on collision with a stationary ball of mass 3 kg. If after collision, both the balls move together, then the loss in kinetic energy due to collision is

a) 100 J b) 60 J
c) 40 J d) 140 J

226. A metal ball of mass 2 kg moving with a speed of 10 ms^{-1} had a head-on collision with a stationary ball of mass 3 kg. If after collision, both the balls move together, then the loss in kinetic energy due to collision is

a) 100 J b) 60 J
c) 40 J d) 140 J

227. What is the change in volume of an iron sphere of volume 500 cm^3, when it is heated from 0°C to 100°C?

a) 1.6 cm^3 b) 2 cm^3
c) 1.4 cm^3 d) 1.8 cm^3

228. Newton's law of cooling holds good only, if the temperature difference between the body and

the surroundings is

a) Less than 10°C b) More than 10°C
c) Less than 100°C d) More than 100°C

229. A uniform rod of mass 'M' and length 'L' is suspended from the rigid support. A small bullet of mass 'm' hits the rod with velocity 'v' and gets embedded into the rod. The angular velocity of the system just after impact is

a) $\frac{3MV}{(M+m)L}$ b) $\frac{3MV}{(M+2m)L}$
c) $\frac{3mV}{(M+3m)L}$ d) $\frac{3mV}{(M+m)L}$

230. A uniform rod of mass 'M' and length 'L' is suspended from the rigid support. A small bullet of mass 'm' hits the rod with velocity 'v' and gets embedded into the rod. The angular velocity of the system just after impact is

a) $\frac{3MV}{(M+m)L}$ b) $\frac{3MV}{(M+2m)L}$
c) $\frac{3mV}{(M+3m)L}$ d) $\frac{3mV}{(M+m)L}$

231. A steel tape measures the length of a copper rod as 90.0 cm, when both are at 10°C, the calibration temperature for the tape. What would be tape read for the length of the rod when both are at 30°C ? (Take, α for steel is 1.2×10^{-5} °C^{-1} and α for copper is 1.7×10^{-5} °C^{-1})

a) 90.01 cm b) 89.90 cm
c) 90.22 cm d) 89.80 cm

232. In system of two particles of masses m_1 and m_2, the first particle is moved by a distance d towards the centre of mass. To keep the centre of mass unchanged, the second particle will have to be moved by a distance

a) $\frac{m_2}{m_1}$d, towards the cen b) $\frac{m_1}{m_2}$d, away from the c
c) $\frac{m_1}{m_2}$d, towards the cent d) $\frac{m_2}{m_1}$d, away from the c

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234. A body of mass 5kg is moving in a straight line. The relation between its displacement and time is $x = (t^3 - 2t - 10)$m. What is the force acting on it at the end of 5 second?

a) 120 N b) 80 N
c) 150 N d) 100 N

235. A metal rod is heated to t°C. A metal rod has length, area of cross-section, Young's modulus and coefficient of linear expansion as 'L', 'A', 'Y' and 'α' respectively. When the rod is heated, the work performed is

a) $\frac{1}{2}YAL\alpha^2t^2$ b) $\frac{1}{2}YAL^2\alpha^2t^2$
c) $\frac{1}{2}YAL\alpha t$ d) $YAL\alpha t$

236. A metal block is made from a mixture of 2.4 kg of aluminium 1.6 kg of brass and 0.8 kg of copper. The amount of heat required to raise the temperature of this block from 20°C to 80°C is (Take, specific heats of aluminium, brass and copper are 0.216, 0.0917 and 0.0931cal kg^{-1}°C^{-1}, respectively)

a) 96.2 cal b) 44.4 cal
c) 86.2 cal d) 62.8 cal

237. A wooden black of mass 'm' moves with velocity 'V' and collides with another block of mass '4m', which is at rest. After collision the block of mass 'm' comes to rest. The coefficient of restitution will be

a) 0.7 b) 0.25
c) 0.4 d) 0.5

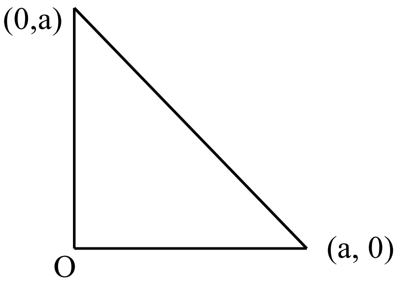
238. Rate of flow of heat through a cylindrical rod is 'H_1'. The temperature of the ends of the rod are 'T_1' and 'T_2'. If all the dimensions of the rod are doubled and the temperature difference remains the same, the rate of flow of heat becomes 'H_2'. Then

a) $H_2 = 4H_1$ b) $H_2 = 2H_1$
c) $H_2 = \frac{H_1}{2}$ d) $H_2 = \frac{H_1}{4}$

239. A clock with an iron pendulum keeps correct time at 15°C. What will be the error in second per day, if the room temperature is 20°C? (Take, coefficient of linear expansion of iron is 0.000012°C^{-1})

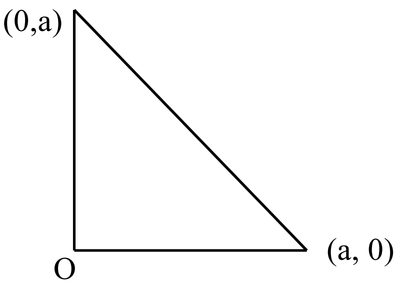
a) 2.6 s b) 6.2 s
c) 1.3 s d) 3.1 s

240. Three rods of the same mass are placed as shown in figure. What will be the coordinates of centre of mass of the system?



a) $\left[\frac{a}{2}, \frac{a}{2}\right]$ b) $\left[\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right]$
c) $[\sqrt{2}\,a, \sqrt{2}a]$ d) $\left[\frac{a}{3}, \frac{a}{3}\right]$

241. Three rods of the same mass are placed as shown in figure. What will be the coordinates of centre of mass of the system?



a) $\left[\frac{a}{2}, \frac{a}{2}\right]$ b) $\left[\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right]$
c) $[\sqrt{2}\,a, \sqrt{2}a]$ d) $\left[\frac{a}{3}, \frac{a}{3}\right]$

242. The density of a substance at 0°C is 10 g/cc and at 100°C, its density is 9.7 g/cc. The coefficient of linear expansion of the substance is
a) $10^{-4}\ °C^{-1}$ b) $10^{-2}\ °C^{-1}$
c) $10^{-3}°C^{-1}$ d) $10^{2}\ °C^{-1}$

243. If the force acting on a inversely proportional to its speed. the kinetic energy of the body is
a) constant b) directly proportional to time
c) inversely proportional to time d) directly proportional to square of time

244. If the force acting on a inversely proportional to its speed. the kinetic energy of the body is
a) constant b) directly proportional to time
c) inversely proportional to time d) directly proportional to square of time

245. The kinetic energy acquired by a body of mass 'M' in travelling a certain distance 'd', starting from rest, under the action of constant force is
a) Inversely proportional to $\sqrt{M}$ b) Directly proportional to M
c) Independent of M d) Directly proportional to $\sqrt{M}$

246. The kinetic energy acquired by a body of mass 'M' in travelling a certain distance 'd', starting from rest, under the action of constant force is
a) Inversely proportional to $\sqrt{M}$ b) Directly proportional to M
c) Independent of M d) Directly proportional to $\sqrt{M}$

247. A metal wire has cross-sectional area 'A' and elastic limit 'E'. The maximum upward acceleration (a) is given to a mass 'm' of elevator supported by the cable of metal wire, so that stress does not exceed half the elastic limit. The mass of the elevator is
(g = acceleration due to gravity)
a) $\frac{2(g+a)}{EA}$ b) $\frac{EA}{2(g+a)}$
c) $\frac{EA}{2(g-a)}$ d) $\frac{2(g-a)}{EA}$

248. A metal wire has cross-sectional area 'A' and elastic limit 'E'. The maximum upward acceleration (a) is given to a mass 'm' of elevator supported by the cable of metal wire, so that stress does not exceed half the elastic limit. The mass of the elevator is
(g = acceleration due to gravity)
a) $\frac{2(g+a)}{EA}$ b) $\frac{EA}{2(g+a)}$
c) $\frac{EA}{2(g-a)}$ d) $\frac{2(g-a)}{EA}$

249. Five objects of different masses are simultaneously released vertically downwards from height 'h' (in air). Which physical quantity associated with the objects will change at the instant they strike the ground? (neglect the air resistance)
a) Time b) Momentum
c) Velocity d) Acceleration

250. Five objects of different masses are simultaneously released vertically downwards from height 'h' (in air). Which physical quantity associated with the objects will change at the instant they strike the ground? (neglect the air resistance)
a) Time b) Momentum
c) Velocity d) Acceleration

251. A block of mass 'm' moving on a frictionless surface at speed 'V' collides elastically with a block of same mass, initially at rest. Now the first block moves at an angle 'θ' with its initial direction and has speed 'V_1'. The speed of the second block after collision is

a) $\sqrt{V - V_1}$ b) $\sqrt{V^2 + V_1^2}$
c) $\sqrt{V^2 - V_1^2}$ d) $\sqrt{V_1^2 - V^2}$

252. A block of mass 'm' moving on a frictionless surface at speed 'V' collides elastically with a block of same mass, initially at rest. Now the first block moves at an angle 'θ' with its initial direction and has speed 'V_1'. The speed of the second block after collision is
a) $\sqrt{V - V_1}$ b) $\sqrt{V^2 + V_1^2}$
c) $\sqrt{V^2 - V_1^2}$ d) $\sqrt{V_1^2 - V^2}$

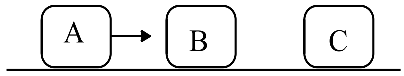
253. A ball falls in the downward direction from height 'h' with initial velocity V. It collides with ground, loses $\left(\frac{3}{4}\right)$ th of energy and comes back to the same height. The initial velocity 'V' is (g = acceleration due to gravity)
a) $\sqrt{gh}$ b) $\sqrt{2gh}$
c) $\sqrt{3gh}$ d) $\sqrt{6gh}$

254. A ball falls in the downward direction from height 'h' with initial velocity V. It collides with ground, loses $\left(\frac{3}{4}\right)$ th of energy and comes back to the same height. The initial velocity 'V' is (g = acceleration due to gravity)
a) $\sqrt{gh}$ b) $\sqrt{2gh}$
c) $\sqrt{3gh}$ d) $\sqrt{6gh}$

255. The ratio of weights of a man inside a lift when it is stationary and when it is going down with a uniform acceleration 'a' is 3:2. The value of 'a' will be($a < g$, g = acceleration due to gravity)
a) $\frac{3}{2}g$ b) $\frac{g}{3}$
c) g d) $\frac{2}{3}g$

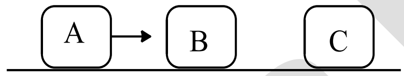
256. The ratio of weights of a man inside a lift when it is stationary and when it is going down with a uniform acceleration 'a' is 3:2. The value of 'a' will be($a < g$, g = acceleration due to gravity)
a) $\frac{3}{2}g$ b) $\frac{g}{3}$
c) g d) $\frac{2}{3}g$

257. Three identical blocks A, B and C are placed on horizontal frictionless surface. The blocks B and C are at rest. But A is approaching towards B with a speed $10ms^{-1}$. The coefficient of restitution for all collisions is 0.5. The speed of the block C just after collision is



a) $5.6\ ms^{-1}$ b) $6\ ms^{-1}$
c) $8\ ms^{-1}$ d) $10\ ms^{-1}$

258. Three identical blocks A, B and C are placed on horizontal frictionless surface. The blocks B and C are at rest. But A is approaching towards B with a speed $10ms^{-1}$. The coefficient of restitution for all collisions is 0.5. The speed of the block C just after collision is



a) $5.6\ ms^{-1}$ b) $6\ ms^{-1}$
c) $8\ ms^{-1}$ d) $10\ ms^{-1}$

259. A force of $F = 2x^2 - x + 4$ acts on a body of mass 3 kg and displaces it from $x = 0$ to $x =$ 3m. The work done by the force is
a) 30.5 J b) 35.5 J
c) 15.5 J d) 25.5 J

260. A force of $F = 2x^2 - x + 4$ acts on a body of mass 3 kg and displaces it from $x = 0$ to $x =$ 3m. The work done by the force is
a) 30.5 J b) 35.5 J
c) 15.5 J d) 25.5 J

261. A car of mass 'm' moving with velocity 'u' on a straight road in a straight line, doubles its velocity in time t. The power delivered by the engine of a car for doubling the velocity is
a) $\frac{3mu^2}{2t}$ b) $\frac{mu^2}{2t}$
c) $\frac{2mu^2}{t}$ d) $\frac{3mu^2}{t}$

262. A car of mass 'm' moving with velocity 'u' on a straight road in a straight line, doubles its velocity in time t. The power delivered by the engine of a car for doubling the velocity is
a) $\frac{3mu^2}{2t}$ b) $\frac{mu^2}{2t}$
c) $\frac{2mu^2}{t}$ d) $\frac{3mu^2}{t}$

263. A weight is suspended from the mid-point of a rope, whose ends are at the same level. In order to make the rope perfectly horizontal, the force applied to each of its ends must be
a) less than w b) equal to w
c) equal to 2w d) infinitely large

264. A weight is suspended from the mid-point of a rope, whose ends are at the same level. In order to make the rope perfectly horizontal,

the force applied to each of its ends must be

a) less than w b) equal to w
c) equal to 2w d) infinitely large

265. A stationary body explodes into two parts of masses 'M_1' and 'M_2'. They move in opposite directions with velocities 'V_1' and 'V_2'. The ratio of their kinetic energies is

a) $M_2 : M_1$ b) $3M_2 : 4M_1$
c) $2M_2 : M_1$ d) $M_2 : 2M_1$

266. A stationary body explodes into two parts of masses 'M_1' and 'M_2'. They move in opposite directions with velocities 'V_1' and 'V_2'. The ratio of their kinetic energies is

a) $M_2 : M_1$ b) $3M_2 : 4M_1$
c) $2M_2 : M_1$ d) $M_2 : 2M_1$

267. A batsman hits a ball of mass 0.2kg straight towards the bowler without changing its initial speed of 6 m/s. What is the impulse imparted to the ball?

a) 3.2 N-s b) 1.6 N-s
c) 4 N-s d) 2.4 N-s

268. A batsman hits a ball of mass 0.2kg straight towards the bowler without changing its initial speed of 6 m/s. What is the impulse imparted to the ball?

a) 3.2 N-s b) 1.6 N-s
c) 4 N-s d) 2.4 N-s

269. Two perfectly elastic particles A and B of equal masses travelling along the line joining them, with velocities 15 ms^{-1} and 10 ms^{-1}. After collision, their velocities will be

a) 10 ms^{-1}, 10 ms^{-1} b) 15 ms^{-1}, 15 ms^{-1}
c) 10 ms^{-1}, 15 ms^{-1} d) 15 ms^{-1}, 10 ms^{-1}

270. Two perfectly elastic particles A and B of equal masses travelling along the line joining them, with velocities 15 ms^{-1} and 10 ms^{-1}. After collision, their velocities will be

a) 10 ms^{-1}, 10 ms^{-1} b) 15 ms^{-1}, 15 ms^{-1}
c) 10 ms^{-1}, 15 ms^{-1} d) 15 ms^{-1}, 10 ms^{-1}

271. 'n' number of balls each having mass 'm' and velocity 'u' hit a wall elastically and normally in 2 seconds. The force exerted by them on the wall is

a) num b) $\frac{1}{2}$num
c) $-$num d) $-\frac{1}{2}$num

272. 'n' number of balls each having mass 'm' and velocity 'u' hit a wall elastically and normally in 2 seconds. The force exerted by them on the wall is

a) num b) $\frac{1}{2}$num
c) $-$num d) $-\frac{1}{2}$num

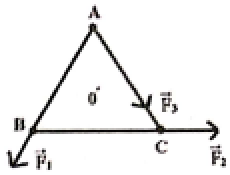
273. Two spheres of masses 2 kg and 4 kg are situated at the opposite ends of a wooden bar of length 9 m. Where will centre of mass of the system be?

a) 3 m from 2kg sphere b) 6 m from 2kg sphere
c) 6 m from 4kg sphere d) 2 m from 4kg sphere

274. Two spheres of masses 2 kg and 4 kg are situated at the opposite ends of a wooden bar of length 9 m. Where will centre of mass of the system be?

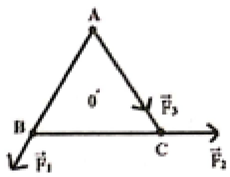
a) 3 m from 2kg sphere b) 6 m from 2kg sphere
c) 6 m from 4kg sphere d) 2 m from 4kg sphere

275. Figure shows three forces $\vec{F_1}, \vec{F_2}$ and $\vec{F_3}$ acting along the sides of an equilateral triangle. If the total torque acting at point 'O' (centre of the triangle) is zero then the magnitude of $\vec{F_3}$ is



a) $F_1 + F_2$ b) $F_1 - F_2$
c) $\frac{F_1 - F_2}{2}$ d) $\frac{F_1}{F_2}$

276. Figure shows three forces $\vec{F_1}, \vec{F_2}$ and $\vec{F_3}$ acting along the sides of an equilateral triangle. If the total torque acting at point 'O' (centre of the triangle) is zero then the magnitude of $\vec{F_3}$ is



a) $F_1 + F_2$ b) $F_1 - F_2$
c) $\frac{F_1 - F_2}{2}$ d) $\frac{F_1}{F_2}$

277. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring balance reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2, the reading of the spring balance will be
($g = 9.8\ m/s^2$)

a) 74 N b) 15 N
c) 24 N d) 49 N

278. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the

spring balance reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2, the reading of the spring balance will be
($g = 9.8\ m/s^2$)

a) 74 N
b) 15 N
c) 24 N
d) 49 N

279. A particle at rest explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2 respectively. The ratio of kinetic energies E_1 to E_2 respectively is

a) $m_2 : m_1$
b) $m_1 : m_2$
c) $1 : m_2$
d) $1 : 1$

280. A particle at rest explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2 respectively. The ratio of kinetic energies E_1 to E_2 respectively is

a) $m_2 : m_1$
b) $m_1 : m_2$
c) $1 : m_2$
d) $1 : 1$

281. In carbon monoxide molecules, the carbon and the oxygen atoms are separated by distance 1.2×10^{-10} m. The distance between the particles

a) 0.48×10^{-10} m
b) 0.51×10^{-10}m
c) 0.56×10^{-10} m
d) 0.69×10^{10}m

282. In carbon monoxide molecules, the carbon and the oxygen atoms are separated by distance 1.2×10^{-10} m. The distance between the particles

a) 0.48×10^{-10} m
b) 0.51×10^{-10}m
c) 0.56×10^{-10} m
d) 0.69×10^{10}m

283. A block of mass 'm' moving on a frictionless surface at speed 'V' collides elastically with a block of same mass, initially at rest. Now the first block moves at an angle 'θ' with its initial direction and has speed 'V_1'. The speed of the second block after collision is

a) $\sqrt{V^2 - V_1^2}$
b) $\sqrt{V_1^2 - V^2}$
c) $\sqrt{V^2 + V_1^2}$
d) $\sqrt{V - V_1}$

284. A block of mass 'm' moving on a frictionless surface at speed 'V' collides elastically with a block of same mass, initially at rest. Now the first block moves at an angle 'θ' with its initial direction and has speed 'V_1'. The speed of the second block after collision is

a) $\sqrt{V^2 - V_1^2}$
b) $\sqrt{V_1^2 - V^2}$
c) $\sqrt{V^2 + V_1^2}$
d) $\sqrt{V - V_1}$

285. A particle at rest explodes into two particles of mass 'm_1' and 'm_2' which move in opposite direction with velocities 'V_1' and 'V_2' respectively. The ratio of kinetic energies 'E_1' to 'E_2' is

a) $1 : m_2$
b) $m_2 : m_1$
c) $m_1 : m_2$
d) $1 : 1$

286. A particle at rest explodes into two particles of mass 'm_1' and 'm_2' which move in opposite direction with velocities 'V_1' and 'V_2' respectively. The ratio of kinetic energies 'E_1' to 'E_2' is

a) $1 : m_2$
b) $m_2 : m_1$
c) $m_1 : m_2$
d) $1 : 1$

287. Two masses 'm_a' and 'm_b' moving with velocities 'V_a' and 'V_b' opposite directions collide elastically. Alter the collision 'm_a' and 'm_b' move with velocities and 'V_b' and 'V_a' respectively, then the ratio $m_a : m_b$ is

a) $\frac{V_a + V_b}{V_a - V_b}$
b) $\frac{1}{2}$
c) 1
d) $\frac{V_a - V_b}{V_a + V_b}$

288. Two masses 'm_a' and 'm_b' moving with velocities 'V_a' and 'V_b' opposite directions collide elastically. Alter the collision 'm_a' and 'm_b' move with velocities and 'V_b' and 'V_a' respectively, then the ratio $m_a : m_b$ is

a) $\frac{V_a + V_b}{V_a - V_b}$
b) $\frac{1}{2}$
c) 1
d) $\frac{V_a - V_b}{V_a + V_b}$

289. Two masses 'm_1' and 'm_2' moving with velocities 'v_1' and 'v_2' in opposite directions collide elastically and after collision masses 'm_1' and 'm_2' move with velocity 'v_2' and 'v_1' respectively. The ratio $\left(\frac{v_2}{v_1}\right)$ is

a) 1
b) 1.25
c) 0.75
d) 1.5

290. Two masses 'm_1' and 'm_2' moving with velocities 'v_1' and 'v_2' in opposite directions collide elastically and after collision masses 'm_1' and 'm_2' move with velocity 'v_2' and 'v_1' respectively. The ratio $\left(\frac{v_2}{v_1}\right)$ is

a) 1
b) 1.25
c) 0.75
d) 1.5

291. A bullet of mass 'm' hits a target of mass 'M' hung to a string and gets embedded in it. If the block with embedded bullet swings and rises to a height 'h' as a result of this inelastic collision, the velocity of the bullet before

collision is

a) $\sqrt{(M+m)gh}$ b) $\left(\frac{M+m}{m}\right)\sqrt{2gh}$
c) $\left(\frac{M+m}{m}\right)2gh$ d) $(m+M)gh$

292. A bullet of mass 'm' hits a target of mass 'M' hung to a string and gets embedded in it. If the block with embedded bullet swings and rises to a height 'h' as a result of this inelastic collision, the velocity of the bullet before collision is

a) $\sqrt{(M+m)gh}$ b) $\left(\frac{M+m}{m}\right)\sqrt{2gh}$
c) $\left(\frac{M+m}{m}\right)2gh$ d) $(m+M)gh$

293. In one dimensional collision between two identical particles A and B, where B is stationary and A has momentum p before impact. During impact B gives an impulse J to A. Then, coefficient of restitution between the two is

a) $\frac{2J}{p}-1$ b) $\frac{2J}{p}+1$
c) $\frac{J}{p}+1$ d) $\frac{J}{p}-1$

294. In one dimensional collision between two identical particles A and B, where B is stationary and A has momentum p before impact. During impact B gives an impulse J to A. Then, coefficient of restitution between the two is

a) $\frac{2J}{p}-1$ b) $\frac{2J}{p}+1$
c) $\frac{J}{p}+1$ d) $\frac{J}{p}-1$

295. The work done by a force on body of mass 5 kg to accelerate it in the direction of force from rest to 20 m/s^2 in 10 second is

a) 10^{-3} J b) 4×10^{-3} J
c) 2×10^{3} J d) 10^{-3} J

296. The work done by a force on body of mass 5 kg to accelerate it in the direction of force from rest to 20 m/s^2 in 10 second is

a) 10^{-3} J b) 4×10^{-3} J
c) 2×10^{3} J d) 10^{-3} J

297. A force of 26 N is acting on a body of mass 2 kg in the x-y plane. Force is directed at an angle $\cos^{-1}\left(\frac{12}{13}\right)$ with x-axis. The component of acceleration along y-axis is

a) 5 m/s^2 b) 8 m/s^2
c) 3 m/s^2 d) 12 m/s^2

298. A force of 26 N is acting on a body of mass 2 kg in the x-y plane. Force is directed at an angle $\cos^{-1}\left(\frac{12}{13}\right)$ with x-axis. The component of acceleration along y-axis is

a) 5 m/s^2 b) 8 m/s^2
c) 3 m/s^2 d) 12 m/s^2

299. A bomb at rest explodes into 3 parts of same mass. The momentum of two parts is -3p$\hat{i}$ and 2p$\hat{j}$, respectively. The magnitude of momentum of the third part is

a) p b) $\sqrt{5}\,p$
c) $\sqrt{11}\,p$ d) $\sqrt{13}\,p$

300. A bomb at rest explodes into 3 parts of same mass. The momentum of two parts is -3p$\hat{i}$ and 2p$\hat{j}$, respectively. The magnitude of momentum of the third part is

a) p b) $\sqrt{5}\,p$
c) $\sqrt{11}\,p$ d) $\sqrt{13}\,p$

301. Three bodies each of mass 1 kg are situated at the vertices of an equilateral triangle of side 1 m. The xy-coordinates of centre of mass of the system are

a) $\left(\frac{1}{2\sqrt{3}},\frac{1}{2\sqrt{3}}\right)$ b) $\left(\frac{1}{2},\frac{1}{2\sqrt{3}}\right)$
c) $\left(\frac{1}{2},\frac{1}{3}\right)$ d) $\left(\frac{1}{2\sqrt{3}},\frac{1}{2}\right)$

302. A mass $2\sqrt{3}$ kg is acted upon by two forces which are inclined to each other at 60^0 and each of magnitude 1N. The acceleration of that mass in SI system is
$\sin 30^0=\cos 60^0=0.5$

a) 0.9 m/s^2 b) 0.7 m/s^2
c) 0.5 m/s^2 d) 0.3 m/s^2

303. A mass $2\sqrt{3}$ kg is acted upon by two forces which are inclined to each other at 60^0 and each of magnitude 1N. The acceleration of that mass in SI system is
$\sin 30^0=\cos 60^0=0.5$

a) 0.9 m/s^2 b) 0.7 m/s^2
c) 0.5 m/s^2 d) 0.3 m/s^2

304. A vehicle accelerates from speed 'V' to '2V'. Work done during this is

a) Less than the work done in accelerating it from rest to V
b) Four times as the work done in accelerating it from rest to V
c) Same as the work done in accelerating it from rest to V
d) Three times as work done in accelerating it from rest to V

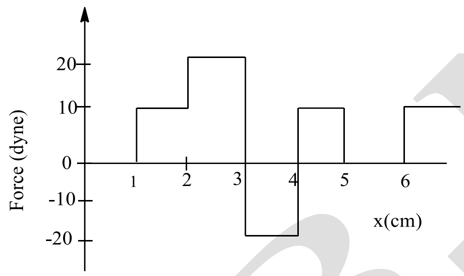
305. A vehicle accelerates from speed 'V' to '2V'. Work done during this is

a) Less than the work done in accelerating it from rest to V
b) Four times as the work done in accelerating it from rest to V
c) Same as the work done in accelerating it from rest to V
d) Three times as work done in accelerating it from rest to V

306. An objective is displaced from point A (2m, 3m, 4m) to a point B (1m, 2m,3m) to a point B (1m,2m,3m) under a constant force F = $(22\hat{\imath} + 3\hat{\jmath} + 4\hat{k})N$, then the work done by this force in this process is
a) 9 J
b) -9 J
c) 18 J
d) -18 J

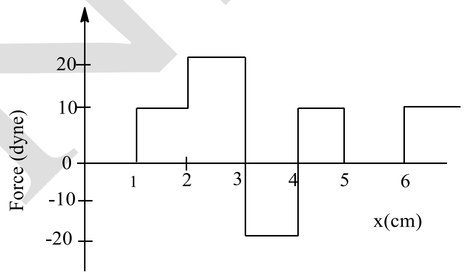
307. An objective is displaced from point A (2m, 3m, 4m) to a point B (1m, 2m,3m) to a point B (1m,2m,3m) under a constant force F = $(22\hat{\imath} + 3\hat{\jmath} + 4\hat{k})N$, then the work done by this force in this process is
a) 9 J
b) -9 J
c) 18 J
d) -18 J

308. The relationship between force and position is shown in figure given (in the dimensional case). The work done by the force in displacing a body from x = 1 cm to x = 5 cm is



a) 20 erg
b) 60 erg
c) 70 erg
d) 700 erg

309. The relationship between force and position is shown in figure given (in the dimensional case). The work done by the force in displacing a body from x = 1 cm to x = 5 cm is



a) 20 erg
b) 60 erg
c) 70 erg
d) 700 erg

310. A see-saw of length 6 m is pivoted at its centre. A child of mass 20 kg is sitting at one of its ends. Where should another child, of mass 30 kg, sit on the other end from the centre of see-saw, so that it is balanced?
a) 1 m
b) 3 m
c) 2 m
d) 4 m

311. A see-saw of length 6 m is pivoted at its centre. A child of mass 20 kg is sitting at one of its ends. Where should another child, of mass 30 kg, sit on the other end from the centre of see-saw, so that it is balanced?
a) 1 m
b) 3 m
c) 2 m
d) 4 m

312. The collision of two balls of equal mass takes place at the origin of coordinates. Before collision, the components of velocities are (v_x = - 50 cms^{-1} and v_y = 0) and (v_x = - 40 cms^{-1} and = 30 cms^{-1}). The first ball comes to rest after collision.
The velocity (components v_x and $v_{y,}$ = respectively) of the second ball are
a) 10 cms^{-1} and 30 cms^{-1}
b) 30 cms^{-1} and 10 cms^{-1}
c) 5 cms^{-1} and 15 cms^{-1}
d) 15 cms^{-1} and 5 cms^{-1}

313. The collision of two balls of equal mass takes place at the origin of coordinates. Before collision, the components of velocities are (v_x = - 50 cms^{-1} and v_y = 0) and (v_x = - 40 cms^{-1} and = 30 cms^{-1}). The first ball comes to rest after collision.
The velocity (components v_x and $v_{y,}$ = respectively) of the second ball are
a) 10 cms^{-1} and 30 cms^{-1}
b) 30 cms^{-1} and 10 cms^{-1}
c) 5 cms^{-1} and 15 cms^{-1}
d) 15 cms^{-1} and 5 cms^{-1}

314. Three bodies P, Q and R have masses 'm' kg, '2m' kg and '3m' kg respectively. If all the bodies have equal kinetic energy, then greater momentum will be for body/bodies.
a) Q
b) R
c) P and Q
d) P

315. Three bodies P, Q and R have masses 'm' kg, '2m' kg and '3m' kg respectively. If all the bodies have equal kinetic energy, then greater momentum will be for body/bodies.
a) Q
b) R
c) P and Q
d) P

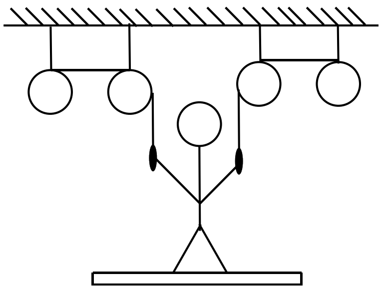
316. The kinetic energy of a light body and a heavy body is same. Which one of the following statements is CORRECT?
a) Body having high velocity has greater momentum
b) The heavy body has greater momentum

c) Both bodies have same momentum
d) The light body has greater momentum

317. The kinetic energy of a light body and a heavy body is same. Which one of the following statements is CORRECT?

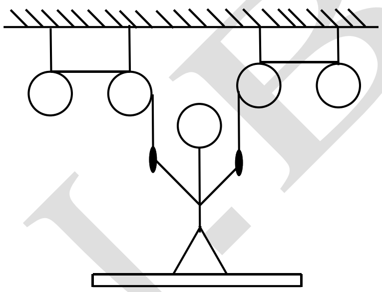
a) Body having high velocity has greater momentum
b) The heavy body has greater momentum
c) Both bodies have same momentum
d) The light body has greater momentum

318. A man of mass m stands on a platform of equal mass m and pulls himself by two ropes passing over pulleys as shown in figure. If he pulls each rope with a force equal to half his weight, then his upward acceleration would be



a) $\frac{g}{2}$
b) $\frac{g}{4}$
c) g
d) zero

319. A man of mass m stands on a platform of equal mass m and pulls himself by two ropes passing over pulleys as shown in figure. If he pulls each rope with a force equal to half his weight, then his upward acceleration would be



a) $\frac{g}{2}$
b) $\frac{g}{4}$
c) g
d) zero

320. A sphere of mass 25 gram is placed on a vertical spring. It is compressed by 0.2 m using a force 5 N. When the spring is released, the sphere will reach a height of
($g = 10\ m/s^2$)

a) 6 cm
b) 8 cm
c) 10 cm
d) 2 m

321. A sphere of mass 25 gram is placed on a vertical spring. It is compressed by 0.2 m using a force 5 N. When the spring is released, the sphere will reach a height of
($g = 10\ m/s^2$)

a) 6 cm
b) 8 cm
c) 10 cm
d) 2 m

322. A lift is tied with thick iron ropes having mass 'M'. The maximum acceleration of the lift is 'a' m/s^2 and maximum safe stress is 'S' N/m^2. The minimum diameter of the rope is
(g = acceleration due to gravity)

a) $\left[\frac{2M(g+a)}{\pi S}\right]^{1/2}$
b) $\left[\frac{2M(g-a)}{\pi S}\right]^{1/2}$
c) $\left[\frac{4M(g+a)}{\pi S}\right]^{1/2}$
d) $\left[\frac{4M(g-a)}{\pi S}\right]^{1/2}$

323. A lift is tied with thick iron ropes having mass 'M'. The maximum acceleration of the lift is 'a' m/s^2 and maximum safe stress is 'S' N/m^2. The minimum diameter of the rope is
(g = acceleration due to gravity)

a) $\left[\frac{2M(g+a)}{\pi S}\right]^{1/2}$
b) $\left[\frac{2M(g-a)}{\pi S}\right]^{1/2}$
c) $\left[\frac{4M(g+a)}{\pi S}\right]^{1/2}$
d) $\left[\frac{4M(g-a)}{\pi S}\right]^{1/2}$

324. A 40 n block supported by two ropes. One rope is horizontal and the other makes an angle of 30^0 with the ceiling. The tension in the rope attached to the ceiling is approximately

a) 80 N
b) 40 N
c) $40\sqrt{3}$ N
d) $\frac{40}{\sqrt{3}}$ N

325. A 40 n block supported by two ropes. One rope is horizontal and the other makes an angle of 30^0 with the ceiling. The tension in the rope attached to the ceiling is approximately

a) 80 N
b) 40 N
c) $40\sqrt{3}$ N
d) $\frac{40}{\sqrt{3}}$ N

326. A body of mass m collides on, elastically with velocity u with another identical body at rest. After collision, velocity of the second body will be

a) zero
b) u
c) 2u
d) Data insufficient

327. A body of mass m collides on, elastically with velocity u with another identical body at rest. After collision, velocity of the second body will be

a) zero
b) u
c) 2u
d) Data insufficient

328. A bullet of mass 20 g moving with a velocity of 200 m/s strikes a target and is brought to rest

in $(1/50)^{th}$ of a second. The impulse and average force of impact are respectively

a) 2 Ns, 100 N b) 4 Ns, 200 N
c) 2 Ns, 200 N d) 4 Ns, 100 N

329. A bullet of mass 20 g moving with a velocity of 200 m/s strikes a target and is brought to rest in $(1/50)^{th}$ of a second. The impulse and average force of impact are respectively

a) 2 Ns, 100 N b) 4 Ns, 200 N
c) 2 Ns, 200 N d) 4 Ns, 100 N

330. A ball of mass 'm' falls from height 'h' on a floor for which the coefficient of restitution is 'e'. After two rebounds, the height attained by the ball is

a) eh b) $\sqrt{eh}$
c) e^4h d) e^2h

331. A ball of mass 'm' falls from height 'h' on a floor for which the coefficient of restitution is 'e'. After two rebounds, the height attained by the ball is

a) eh b) $\sqrt{eh}$
c) e^4h d) e^2h

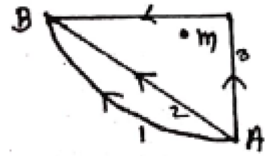
332. A body of mass 'm' begins to move under the action of time dependent force $\vec{F} = (t\hat{i} + 2t^2\hat{j})$N where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis respectively. The power developed by the force in watt at time 't' is

a) $\left(\frac{t^3}{3m} + \frac{3t^3}{2m}\right)$ b) $\left(\frac{t^2}{m} + \frac{4t^5}{3m}\right)$
c) $\left(\frac{t^3}{2m} + \frac{3t^4}{2m}\right)$ d) $\left(\frac{t^3}{2m} + \frac{4t^5}{3m}\right)$

333. A body of mass 'm' begins to move under the action of time dependent force $\vec{F} = (t\hat{i} + 2t^2\hat{j})$N where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis respectively. The power developed by the force in watt at time 't' is

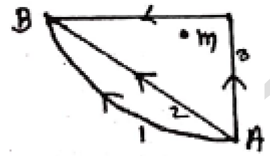
a) $\left(\frac{t^3}{3m} + \frac{3t^3}{2m}\right)$ b) $\left(\frac{t^2}{m} + \frac{4t^5}{3m}\right)$
c) $\left(\frac{t^3}{2m} + \frac{3t^4}{2m}\right)$ d) $\left(\frac{t^3}{2m} + \frac{4t^5}{3m}\right)$

334. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 (as shown in figure) in the gravitational field of the point mass 'm'. Find the correct relation between 'W_1', 'W_2' and 'W_3'.



a) $W_1 < W_3 < W_2$ b) $W_1 > W_3 > W_2$
c) $W_1 = W_2 = W_3$ d) $W_1 < W_2 < W_3$

335. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 (as shown in figure) in the gravitational field of the point mass 'm'. Find the correct relation between 'W_1', 'W_2' and 'W_3'.



a) $W_1 < W_3 < W_2$ b) $W_1 > W_3 > W_2$
c) $W_1 = W_2 = W_3$ d) $W_1 < W_2 < W_3$

336. If bullet of mass 'm_1' is fired from a gun of mass 'm_2' with a speed of 'V_1', then the recoil velocity of gun is

a) $-\frac{m_1V_1}{m_2}$ b) $-\frac{m_2}{m_1V_1}$
c) $-\frac{m_2}{m_1V_1}$ d) $\frac{m_1V_1}{m_2}$

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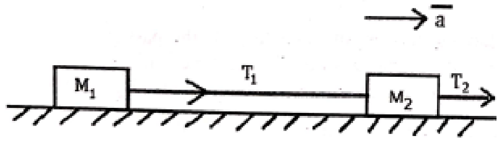
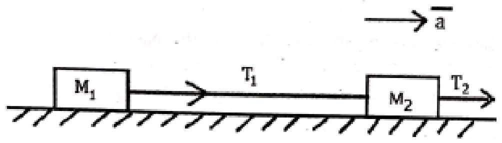
a) $-\frac{m_1V_1}{m_2}$ b) $-\frac{m_2}{m_1V_1}$
c) $-\frac{m_2}{m_1V_1}$ d) $\frac{m_1V_1}{m_2}$

338. Two masses M_1 and M_2 are accelerated uniformly on frictionless surface as shown in figure. The ratio of the tensions T_1/T_2 is



a) $\frac{M_1}{M_1 + M_2}$ b) $\frac{M_1}{M_2}$
c) $\frac{M_1 + M_2}{M_2}$ d) $\frac{M_2}{M_1}$

339. Two masses M_1 and M_2 are accelerated uniformly on frictionless surface as shown in figure. The ratio of the tensions T_1/T_2 is



a) $\frac{M_1}{M_1 + M_2}$ b) $\frac{M_1}{M_2}$

c) $\frac{M_1 + M_2}{M_2}$ d) $\frac{M_2}{M_1}$

340. If torque is zero, then
a) angular momentum is conserved
b) linear momentum is conserved
c) energy is conserved
d) angular momentum is not conserved

341. If torque is zero, then
a) angular momentum is conserved
b) linear momentum is conserved
c) energy is conserved
d) angular momentum is not conserved

342. A force $(\bar{F}) = -5\hat{i} - 7\hat{j} + 3\hat{k}$ acting on a particle causes a displacement $(\bar{g}) = 3\hat{i} - 2\hat{j} + a\hat{k}$ in its own direction. If the work done is 14 J, then the value of 'a' is
a) 0 b) 15
c) 5 d) 1

343. A force $(\bar{F}) = -5\hat{i} - 7\hat{j} + 3\hat{k}$ acting on a particle causes a displacement $(\bar{g}) = 3\hat{i} - 2\hat{j} + a\hat{k}$ in its own direction. If the work done is 14 J, then the value of 'a' is
a) 0 b) 15
c) 5 d) 1

344. A ball at test falls vertically on the ground from a height of 5m. The coefficient of restitution is 0.4. The maximum height of the ball after the first rebound is $[g = 10\ ms^{-2}]$
a) 1 m b) 0.8 m
c) 4 m d) 2 m

345. A ball at test falls vertically on the ground from a height of 5m. The coefficient of restitution is 0.4. The maximum height of the ball after the first rebound is $[g = 10\ ms^{-2}]$
a) 1 m b) 0.8 m
c) 4 m d) 2 m

346. A body of mass 'M' moving with velocity 'V' explodes into two equal parts. If one part comes to rest and the other part moves with velocity 'v_0'. What would be the value of 'v_0'?
a) V b) 2V
c) $\frac{V}{\sqrt{2}}$ d) 4V

347. A body of mass 'M' moving with velocity 'V' explodes into two equal parts. If one part comes to rest and the other part moves with velocity 'v_0'. What would be the value of 'v_0'?
a) V b) 2V
c) $\frac{V}{\sqrt{2}}$ d) 4V

348. Consider a system of two particles having masses 'm_1' and 'm_2'. If the particle of mass m_1 is pushed towards the centre of mass of the particles through a distance 'd', by what distance particle of mass m_2 move so as to keep the centre of mass of particles at the original position?
a) $\frac{m_2}{m_1} \times d$ b) $\frac{m_1}{m_1 + m_2} \times d$
c) $\frac{m_1}{m_2} \times d$ d) d

349. Consider a system of two particles having masses 'm_1' and 'm_2'. If the particle of mass m_1 is pushed towards the centre of mass of the particles through a distance 'd', by what distance particle of mass m_2 move so as to keep the centre of mass of particles at the original position?
a) $\frac{m_2}{m_1} \times d$ b) $\frac{m_1}{m_1 + m_2} \times d$
c) $\frac{m_1}{m_2} \times d$ d) d

350. In a system of two particles of masses 'm_1' and 'm_2', the second particle is moved by a distance 'd' towards the centre of mass. To keep the centre of mass unchanged, the first particle will have to be moved by a distance
a) $\frac{m_1}{m_2}$d, away from the centre of mass
b) $\frac{m_2}{m_1}$d, towards the centre of mass
c) $\frac{m_2}{m_1}$d, away from the centre of mass
d) $\frac{m_1}{m_2}$d, towards the centre of mass

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a) $\frac{m_1}{m_2}$d, away from the centre of mass
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c) $\frac{m_2}{m_1}$d, away from the centre of mass
d) $\frac{m_1}{m_2}$d, towards the centre of mass

352. 'n' balls each of mass 'm' moving with the same velocity 'u' hit a wall elastically and normally in 2 second. The force exerted by the balls on the wall is
a) $\frac{mun^2}{2}$ b) 2mun
c) mun d) $\frac{mun}{2}$

353. 'n' balls each of mass 'm' moving with the same velocity 'u' hit a wall elastically and normally in

2 second. The force exerted by the balls on the wall is

a) $\frac{mun^2}{2}$ b) 2mun

c) mun d) $\frac{mun}{2}$

354. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision. their final velocities are v' and v, respectively. The value of v is

a) $\frac{2uM}{m}$ b) $\frac{2um}{M}$

c) $\frac{2u}{1+\frac{m}{M}}$ d) $\frac{2u}{1+\frac{M}{m}}$

355. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision. their final velocities are v' and v, respectively. The value of v is

a) $\frac{2uM}{m}$ b) $\frac{2um}{M}$

c) $\frac{2u}{1+\frac{m}{M}}$ d) $\frac{2u}{1+\frac{M}{m}}$

356. A force $F = (10 + 0.5x)$ acts on a particle in the x-director. What would be the work done by this force during a displacement from $x = 0$ to $x = 2m$ (F is in newton and x in metre)?

a) 31.5 J b) 63 J

c) 21 J d) 42 J

357. A force $F = (10 + 0.5x)$ acts on a particle in the x-director. What would be the work done by this force during a displacement from $x = 0$ to $x = 2m$ (F is in newton and x in metre)?

a) 31.5 J b) 63 J

c) 21 J d) 42 J

358. A lift is tied with thick iron rope having mass 'm'. The maximum acceleration of the lift is 'a' m/s^2 and maximum safe stress is 's' $\frac{N}{m^2}$. The minimum diameter of the rope is g = acceleration due to gravity

a) $\left[\frac{4m(g+a)}{\pi s}\right]^{1/2}$ b) $\left[\frac{4m(g+a)}{2\pi s}\right]^{1/2}$

c) $\left[\frac{m(g+a)}{\pi s}\right]^{1/2}$ d) $\left[\frac{4m(g-a)}{\pi s}\right]^{1/2}$

359. A lift is tied with thick iron rope having mass 'm'. The maximum acceleration of the lift is 'a' m/s^2 and maximum safe stress is 's' $\frac{N}{m^2}$. The minimum diameter of the rope is g = acceleration due to gravity

a) $\left[\frac{4m(g+a)}{\pi s}\right]^{1/2}$ b) $\left[\frac{4m(g+a)}{2\pi s}\right]^{1/2}$

c) $\left[\frac{m(g+a)}{\pi s}\right]^{1/2}$ d) $\left[\frac{4m(g-a)}{\pi s}\right]^{1/2}$

360. A body of mass '4m' lying in x – y plane suddenly explodes into three parts. Two parts each of mass 'm' move with same speed 'v' as shown in figure. The total kinetic energy generated due to explosion is

$\left(\sin 45^0 = \cos 45^0 = \frac{1}{\sqrt{2}}\right)$

a) mv^2 b) $2mv^2$

c) $\frac{1}{2}mv^2$ d) $\frac{3}{2}mv^2$

361. A body of mass '4m' lying in x – y plane suddenly explodes into three parts. Two parts each of mass 'm' move with same speed 'v' as shown in figure. The total kinetic energy generated due to explosion is

$\left(\sin 45^0 = \cos 45^0 = \frac{1}{\sqrt{2}}\right)$

a) mv^2 b) $2mv^2$

c) $\frac{1}{2}mv^2$ d) $\frac{3}{2}mv^2$

362. An aircraft is moving with uniform velocity 150 m/s in the space. If all the forces acting on it are balanced, then it will

a) Fall down on earth b) Keep moving with same velocity

c) Escape in space d) Remain floating at its place.

363. An aircraft is moving with uniform velocity 150 m/s in the space. If all the forces acting on it are balanced, then it will

a) Fall down on earth b) Keep moving with same velocity

c) Escape in space d) Remain floating at its place.

364. A smooth sphere of mass 'M' moving with velocity 'u' directly collides elastically with another sphere of mass 'm' at rest. After collision, their final velocities are V' and V respectively. The value of V is given by

a) $\frac{2u}{1+\frac{m}{M}}$ b) $\frac{2u}{1+\frac{M}{m}}$

c) $\frac{2uM}{m}$ d) $\frac{2um}{M}$

365. A smooth sphere of mass 'M' moving with

velocity 'u' directly collides elastically with another sphere of mass 'm' at rest. After collision, their final velocities are V' and V respectively. The value of V is given by

a) $\frac{2u}{1+\frac{m}{M}}$ b) $\frac{2u}{1+\frac{M}{m}}$

c) $\frac{2uM}{m}$ d) $\frac{2um}{M}$

366. The centre of mass of a system of particles done not depend on

a) masses of the particles b) internal force on the particles

c) position of the particles d) relative distance between the particles

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a) masses of the particles b) internal force on the particles

c) position of the particles d) relative distance between the particles

368. For a perfectly elastic collision, the coefficient of restitution is

a) 1 b) 0.75

c) Zero d) 0.5

369. For a perfectly elastic collision, the coefficient of restitution is

a) 1 b) 0.75

c) Zero d) 0.5

370. 'N' number of balls of mass 'm' kg moving along positive direction of x-axis, strike a wall per second and return elastically. The velocity of each ball is 'u' m/s. The force exerted on the wall by the balls in newton, is

a) 2mNu b) $\frac{mNu}{2}$

c) 0 d) mNu

371. 'N' number of balls of mass 'm' kg moving along positive direction of x-axis, strike a wall per second and return elastically. The velocity of each ball is 'u' m/s. The force exerted on the wall by the balls in newton, is

a) 2mNu b) $\frac{mNu}{2}$

c) 0 d) mNu

372. A uniform metal disc of radius R is taken and out of it a disc of diameter R is cut- off from the end. The centre of mass of the remaining part will be

a) $\frac{R}{4}$ from the centre b) $\frac{R}{3}$ from the centre

c) $\frac{R}{5}$ from the centre d) $\frac{R}{6}$ from the centre

373. A uniform metal disc of radius R is taken and out of it a disc of diameter R is cut- off from the end. The centre of mass of the remaining part will be

a) $\frac{R}{4}$ from the centre b) $\frac{R}{3}$ from the centre

c) $\frac{R}{5}$ from the centre d) $\frac{R}{6}$ from the centre

374. A body of mass 6 kg is acted upon by a force , so that its velocity changes from 3 ms^{-1}, then change in momentum is

a) 48 N-s b) 24 N-s

c) 30 N-s d) 12 N-s

375. A body of mass 6 kg is acted upon by a force , so that its velocity changes from 3 ms^{-1}, then change in momentum is

a) 48 N-s b) 24 N-s

c) 30 N-s d) 12 N-s

376. A man of weight 'W' is standing in a lift which is moving upwards with acceleration 'a'. The apparent weight of the man is

a) W b) $W\left(1+\frac{a}{g}\right)$

c) $W\left(1-\frac{a}{g}\right)$ d) Zero

377. A man of weight 'W' is standing in a lift which is moving upwards with acceleration 'a'. The apparent weight of the man is

a) W b) $W\left(1+\frac{a}{g}\right)$

c) $W\left(1-\frac{a}{g}\right)$ d) Zero

378. A body of mass 5 kg is moving with velocity of $v = (2\hat{i} + 6\hat{j})$ m^{-1} at t = 0 s. After time t = 2 s, velocity of body is $(10\hat{i} + 6\hat{j})$, then change in momentum of body is

a) $40\hat{i}$ kg-ms^{-1} b) $20\hat{i}$ kg-ms^{-1}

c) $30\hat{i}$ kg-ms^{-1} d) $(50\hat{i} + 30\hat{j})$ kg-ms^{-1}

379. A body of mass 5 kg is moving with velocity of $v = (2\hat{i} + 6\hat{j})$ m^{-1} at t = 0 s. After time t = 2 s, velocity of body is $(10\hat{i} + 6\hat{j})$, then change in momentum of body is

a) $40\hat{i}$ kg-ms^{-1} b) $20\hat{i}$ kg-ms^{-1}

c) $30\hat{i}$ kg-ms^{-1} d) $(50\hat{i} + 30\hat{j})$ kg-ms^{-1}

380. A ball kept at 20 m height falls freely in

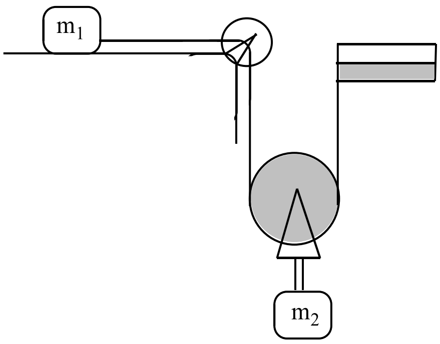
downward direction vertically and hits the ground. The coefficient of restitution is 0.4. After the first rebound the upward velocity is $g = 10\ m/s^2$

a) 4 m/s b) 8 m/s
c) 16 m/s d) 12 m/s

381. A ball kept at 20 m height falls freely in downward direction vertically and hits the ground. The coefficient of restitution is 0.4. After the first rebound the upward velocity is $g = 10\ m/s^2$

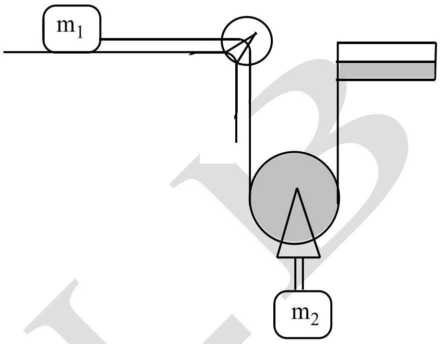
a) 4 m/s b) 8 m/s
c) 16 m/s d) 12 m/s

382. If the surface is smooth, the acceleration of the block m_2 will be



a) $\frac{m_2 g}{4m_1 + m_2}$ b) $\frac{2\ m_2 g}{4\ m_1 + m_2}$
c) $\frac{2\ m_2 g}{m_1 + 4m_2}$ d) $\frac{2\ m_1 g}{m_1 + m_2}$

383. If the surface is smooth, the acceleration of the block m_2 will be



a) $\frac{m_2 g}{4m_1 + m_2}$ b) $\frac{2\ m_2 g}{4\ m_1 + m_2}$
c) $\frac{2\ m_2 g}{m_1 + 4m_2}$ d) $\frac{2\ m_1 g}{m_1 + m_2}$

384. If a force of 250 N act on body, the momentum acquired is 125 kg-m/s. What is the period for which force act on the body?

a) 0.5 s b) 0.2 s
c) 0.4 s d) 0.25 s

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a) 0.5 s b) 0.2 s
c) 0.4 s d) 0.25 s

386. A body of mass 'M' begins to move under the action of time dependent force $\vec{F} = (t\hat{i} + 2t^2\hat{j})N$ where $\hat{i}$ and $\hat{j}$ are unit vectors along X and Y axis respectively. The power developed by the force in watt at time t is

a) $\left(\frac{t^2}{3m} + \frac{3t^4}{4m}\right)$ b) $\left(\frac{t^3}{m} + \frac{4t^5}{2m}\right)$
c) $\left(\frac{t^2}{2m} + \frac{3t^4}{5m}\right)$ d) $\left(\frac{t^3}{2m} + \frac{4t^5}{3m}\right)$

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388. Let a force $\vec{F} = -F\hat{k}$ acts on the origin of Cartesian frame of reference. The moment of force about a point $(1, -1)$ will be

a) $F(\hat{i} - \hat{j})$ b) $F(\hat{i} + \hat{j})$
c) $-F(\hat{i} - \hat{j})$ d) $-F(\hat{i} + \hat{j})$

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c) $-F(\hat{i} - \hat{j})$ d) $-F(\hat{i} + \hat{j})$

390. Moment of a force of magnitude 20 N acting along positive x- direction at point (3, 0, 0) about the point (0, 2, 0) (in N-m) is

a) 20 b) 60
c) 40 d) 30

391. Moment of a force of magnitude 20 N acting along positive x- direction at point (3, 0, 0) about the point (0, 2, 0) (in N-m) is

a) 20 b) 60
c) 40 d) 30

392. A particle of mass 'm' collides with another stationary particle of mass 'M'. The particle of mass 'm' stops just after collision. The coefficient of restitution is

a) $\frac{M}{m}$ b) $\frac{m + M}{m}$
c) $\frac{m}{M}$ d) $\frac{M - m}{M + m}$

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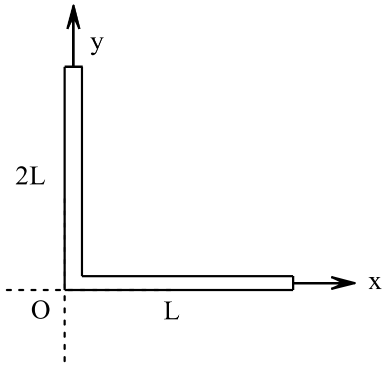
c) $\frac{m}{M}$ d) $\frac{M-m}{M+m}$

394. Figure shows a composite system of two uniform roads of lengths as indicated. Then, the coordinates of the centre of mass of the system of roads are



a) $\left(\frac{L}{2}, \frac{2L}{3}\right)$ b) $\left(\frac{L}{4}, \frac{2L}{3}\right)$
c) $\left(\frac{L}{6}, \frac{2L}{3}\right)$ d) $\left(\frac{L}{6}, \frac{L}{3}\right)$

395. A block of mass ‘m’ collides with another stationary block of mass ‘2m’. The lighter block comes to rest after collision. If the velocity of first block is ‘u’, then the value of coefficient of restitution is
a) 0.8 b) 0.4
c) 0.5 d) 0.6

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a) 0.8 b) 0.4
c) 0.5 d) 0.6

397. A lift of mass ‘m’ is ascending with an acceleration ‘a’ ($a < g$). The tension in the cable of the lift is (g = acceleration due to gravity)
a) $m(a-g)$ b) $m(g-a)$
c) $m(2g+a)$ d) $m(g+a)$

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399. The motion of a rocket in upward direction with high speed is based on the principle of conservation of
a) Angular momentum b) Kinetic energy
c) Linear momentum d) Mass

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a) Angular momentum b) Kinetic energy
c) Linear momentum d) Mass

401. A gardener pushes a lawn roller through a distance 20 m. If he applies a force of 30 kg-wt in a direction inclined at 60^0 to the ground, the work done by the gardener in pushing the roller is

$$\left[g = 9.8\frac{m}{s^2}, \sin 30^0 = \cos 60^0 = \frac{1}{4}, \cos 30^0 = \sin 60^0 = \frac{\sqrt{3}}{2}\right]$$

a) 3940 J b) 2460 J
c) 2940 J d) 3640 J

402. A metal sphere is hanging from the ceiling of a vehicle. If the vehicle is moving along the horizontal road with uniform acceleration ‘a’ then the suspended thread of the sphere gets inclined to the vertical at an angle ‘θ’. The value of acceleration ‘a’ is (g = acceleration due to gravity)
a) g b) $g\cos\theta$
c) $g\sin\theta$ d) $g\tan\theta$

403. A metal sphere is hanging from the ceiling of a vehicle. If the vehicle is moving along the horizontal road with uniform acceleration ‘a’ then the suspended thread of the sphere gets inclined to the vertical at an angle ‘θ’. The value of acceleration ‘a’ is (g = acceleration due to gravity)
a) g b) $g\cos\theta$
c) $g\sin\theta$ d) $g\tan\theta$

404. The kinetic energy acquired by a body of mass ‘M’ in travelling a certain distance ‘d’, starting from rest, under the action of constant force is
a) Directly proportional to $\sqrt{M}$ b) Inversely proportional to $\sqrt{M}$
c) Independent of M d) Directly proportional to $\sqrt{M}$

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406. A body of mass m moving with velocity v collides head on with another body of mass 2m which is initially at rest. The ratio of KE of colliding body before and after collision will be

a) 1:1 b) 2:1
c) 4:1 d) 9:1

407. A body of mass m moving with velocity v collides head on with another body of mass 2m which is initially at rest. The ratio of KE of colliding body before and after collision will be
a) 1:1 b) 2:1
c) 4:1 d) 9:1

408. In a system of two particles of masses 'm_1' and 'm_2', the first particle is moved by a distance 'd' towards the centre of mass. To keep the centre of mass unchanged, the second particle will have to be moved by a distance
a) $\frac{m_1}{m_2}$d, away from the centre of mass
b) $\frac{m_1}{m_2}$d, towards the centre of mass
c) $\frac{m_2}{m_1}$d, away from the centre of mass
d) $\frac{m_2}{m_1}$d, towards the centre of mass

409. In a system of two particles of masses 'm_1' and 'm_2', the first particle is moved by a distance 'd' towards the centre of mass. To keep the centre of mass unchanged, the second particle will have to be moved by a distance
a) $\frac{m_1}{m_2}$d, away from the centre of mass
b) $\frac{m_1}{m_2}$d, towards the centre of mass
c) $\frac{m_2}{m_1}$d, away from the centre of mass
d) $\frac{m_2}{m_1}$d, towards the centre of mass

410. A uniform metal rod of length 1 m is bent at 90^0, so as to form two arms of equal length. The centre of mass of this bent rod is
a) on the bisector of the angle, $\left(\frac{1}{\sqrt{2}}\right)$ m from vertex
b) on the bisector of the angle, $\left(\frac{1}{2\sqrt{2}}\right)$ m from vertex
c) on the bisector of the angle,$\left(\frac{1}{2}\right)$m from vertex
d) on the bisector of the angle, $\left(\frac{1}{4\sqrt{2}}\right)$ m from vertex

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d) on the bisector of the angle, $\left(\frac{1}{4\sqrt{2}}\right)$ m from vertex

412. The weight of a man in a lift moving upwards with an acceleration 'a' is 620 N. When the lift moves downwards with the same acceleration, his weight is found to be 340 N. The real weight of the man is
a) 620 N b) 680 N
c) 380 N d) 480 N

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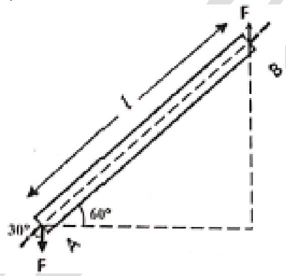
a) 620 N b) 680 N
c) 380 N d) 480 N

414. A rod 'l' m long is acted upon by a couple as shown in figure. The moment of couple is 'τ' Nm. If the force at each end of the rod, the magnitude of each force is
($\sin 30^0 = \cos 60^0 = 0.5$)



a) $\frac{l}{2\tau}$ b) $\frac{\tau}{l}$
c) $\frac{2l}{\tau}$ d) $\frac{2\tau}{l}$

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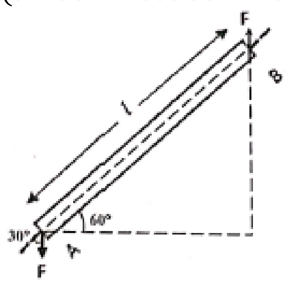

a) $\frac{l}{2\tau}$ b) $\frac{\tau}{l}$
c) $\frac{2l}{\tau}$ d) $\frac{2\tau}{l}$

416. A door 1.2 m wide requires a force of 1 N to be applied perpendicular at the free end to open or close it. The perpendicular force required at a point 0.2 m distant from the hinges for opening or closing the door is
a) 6.0 N b) 3.6 N
c) 1.2 N d) 2.4 N

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applied perpendicular at the free end to open or close it. The perpendicular force required at a point 0.2 m distant from the hinges for opening or closing the door is

a) 6.0 N b) 3.6 N
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418. A ball of mass 'm' falls height 'h' on a floor for which the coefficient of restitution is 'e'. After two rebounds, the height attained by the ball is

a) $\sqrt{eh}$ b) eh
c) e^2h d) e^4h

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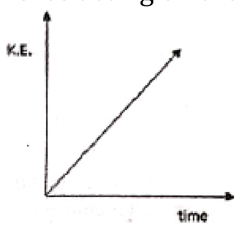
c) e^2h d) e^4h

420. A body moves along a straight line and the variation of its kinetic energy with time is linear as shown in the figure below. Then the force acting on the body is



a) Zero b) Constant greater than zero
c) Inversely proportional to velocity d) Directly proportional to velocity

421. A spring of spring constant 'k' is compressed through 'x' cm and is used to push a metal ball of mass 'm'. The velocity with which the metal ball moves is

a) $x\left(\frac{m}{k}\right)^{1/2}$ b) $\frac{kx}{m}$
c) $x\left(\frac{k}{m}\right)^{1/2}$ d) $\frac{m}{kx}$

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c) $x\left(\frac{k}{m}\right)^{1/2}$ d) $\frac{m}{kx}$

423. 10^4 small balls, each weighing 1 gram strike 1 cm^2 area per second with a velocity 100 m/s in perpendicular direction and rebound with the same velocity. The value of pressure on the surface will be

a) 2×10^7 N/m^2 b) 10^7 N/m^2
c) 2×10^3 N/m^2 d) 7×10^5 N/m^2

424. 10^4 small balls, each weighing 1 gram strike 1 cm^2 area per second with a velocity 100 m/s in perpendicular direction and rebound with the same velocity. The value of pressure on the surface will be

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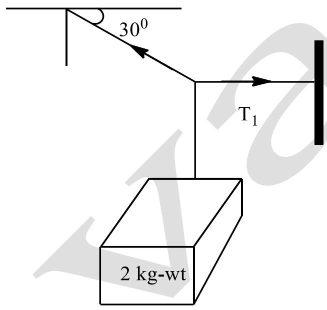
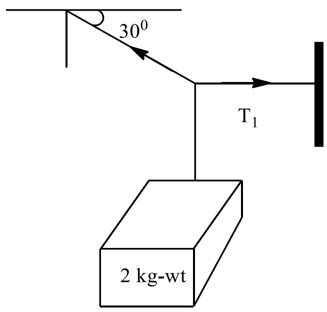
425. A body of weight 2 kg is suspended as shown in figure. The tension T_1 in the horizontal string (in kg-wt) is



a) $2/\sqrt{3}$ b) $\sqrt{3}/2$
c) $2\sqrt{3}$ d) 2

426. A body of weight 2 kg is suspended as shown in figure. The tension T_1 in the horizontal string (in kg-wt) is



a) $2/\sqrt{3}$ b) $\sqrt{3}/2$
c) $2\sqrt{3}$ d) 2

427. A 4 kg mass and a 1 kg mass are moving with equal energies. The ratio of the magnitude of their momenta is

a) 4: 1 b) 1: 1
c) 1: 2 d) 2: 1

428. A 4 kg mass and a 1 kg mass are moving with equal energies. The ratio of the magnitude of their momenta is

a) 4: 1 b) 1: 1
c) 1: 2 d) 2: 1

429. A cricket ball of mass 150 g has an initial velocity
$u = (3\hat{i} + 4\hat{j})ms^{-1}$ and a final velocity
$v = (3\hat{i} + 4\hat{j})ms^{-1}$, after being hit.

The change in momentum (final momentum - initial momentum) is (in kg ms^{-1})

a) zero b) $-(0.45\hat{i} + 0.6\hat{j})$

c) $-(0.9\hat{i} + 1.2\hat{j})$ d) $-5(\hat{i} + \hat{j})\hat{i}$

430. A cricket ball of mass 150 g has an initial velocity
$u = (3\hat{i} + 4\hat{j})ms^{-1}$ and a final velocity
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The change in momentum (final momentum - initial momentum) is (in kg ms^{-1})

a) zero b) $-(0.45\hat{i} + 0.6\hat{j})$

c) $-(0.9\hat{i} + 1.2\hat{j})$ d) $-5(\hat{i} + \hat{j})\hat{i}$

431. A force $F = Ay^2 + By + C$ acts on a body in the y -direction. The work done by force during a displacement from y = -a to y = a is

a) $\frac{2Aa^3}{3}$ b) $\frac{2Aa^3}{3} + 2Ca$

c) $\frac{2Aa^3}{3} + \frac{Ba^2}{2} + Ca$ d) None of these

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c) $\frac{2Aa^3}{3} + \frac{Ba^2}{2} + Ca$ d) None of these

433. A bullet is fired from the gun. It hits the solid block resting on a frictionless surface, gets embedded into it and both move jointly. In this process,

a) Only kinetic energy is conserved b) Both momentum and kinetic energy are not conserved

c) Both momentum and kinetic energy are conserved d) Only momentum is conserved

434. A bullet is fired from the gun. It hits the solid block resting on a frictionless surface, gets embedded into it and both move jointly. In this process,

a) Only kinetic energy is conserved b) Both momentum and kinetic energy are not conserved

c) Both momentum and kinetic energy are conserved d) Only momentum is conserved

435. The torque of a force $F = -3\hat{i} + \hat{j} + 5\hat{k}$ acting on a point $r = 7\hat{i} + 3\hat{j} + \hat{k}$ about origin will be

a) $14\hat{i} - 38\hat{j} + 16\hat{k}$ b) $4\hat{i} + 4\hat{j} + 6\hat{k}$

c) $-14\hat{i} + 38\hat{j} - 16\hat{k}$ d) $-21\hat{i} + 3\hat{j} + 5\hat{k}$

436. The torque of a force $F = -3\hat{i} + \hat{j} + 5\hat{k}$ acting on a point $r = 7\hat{i} + 3\hat{j} + \hat{k}$ about origin will be

a) $14\hat{i} - 38\hat{j} + 16\hat{k}$ b) $4\hat{i} + 4\hat{j} + 6\hat{k}$

c) $-14\hat{i} + 38\hat{j} - 16\hat{k}$ d) $-21\hat{i} + 3\hat{j} + 5\hat{k}$

437. Force acting on a particle is (2i + 3j) N. Work done by this force is zero, when a particle is moved on the line 3y + kx = 5. value of k is

a) 2 b) 4

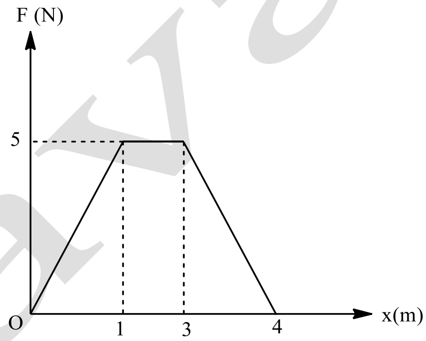
c) 6 d) 8

438. Force acting on a particle is (2i + 3j) N. Work done by this force is zero, when a particle is moved on the line 3y + kx = 5. value of k is

a) 2 b) 4

c) 6 d) 8

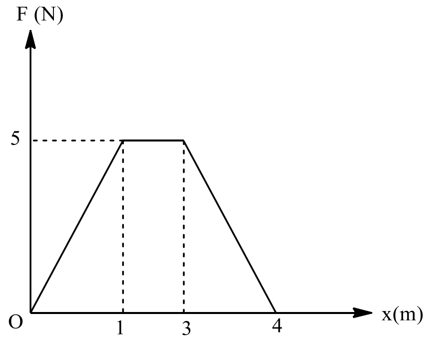
439. The force F acting on a particle is moving in a straight line as show in figure. What is the work done by the force on the 4 m of the trajectory



a) 5 J b) 10 J

c) 15 J d) 2.5 J

440. The force F acting on a particle is moving in a straight line as show in figure. What is the work done by the force on the 4 m of the trajectory



a) 5 J b) 10 J

c) 15 J d) 2.5 J

441. A ball released from a certain height strikes the ground after 2 second. After bouncing from the ground it rises to a highest point in 1 second. The coefficient of restitution is

a) 0.4 b) 0.3

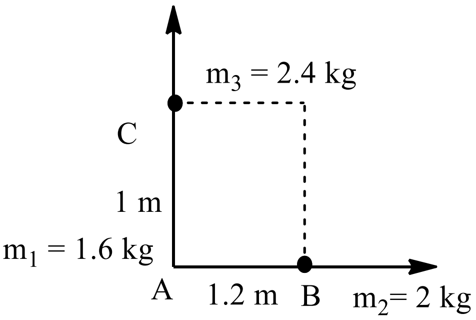
c) 0.2 d) 0.5

442. A ball released from a certain height strikes the ground after 2 second. After bouncing from the ground it rises to a highest point in 1 second.

The coefficient of restitution is

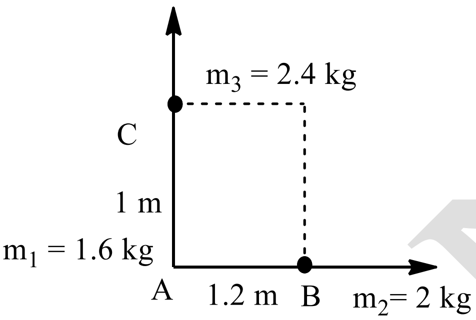
a) 0.4   b) 0.3
c) 0.2   d) 0.5

443. Three point masses m_1, m_2 and M_3 are placed at the corners of a thin massless rectangular sheet (1.2 m × 1 m) as shown. Centre of mass will be located at the point?



a) (0.8, 0.6) m   b) (0.6, 0.8) m
c) (0.4, 0.4) m   d) (0.5, 0.6) m

444. Three point masses m_1, m_2 and M_3 are placed at the corners of a thin massless rectangular sheet (1.2 m × 1 m) as shown. Centre of mass will be located at the point?



a) (0.8, 0.6) m   b) (0.6, 0.8) m
c) (0.4, 0.4) m   d) (0.5, 0.6) m

445. Centre of mass is a point

a) Which is the geometric centre of a body
b) Which is the origin of reference frame
c) Where the whole mass of the body is supposed to be concentrated
d) From which distances of all particles are same

446. Centre of mass is a point

a) Which is the geometric centre of a body
b) Which is the origin of reference frame
c) Where the whole mass of the body is supposed to be concentrated
d) From which distances of all particles are same

447. How much work must be done by a force on 50 kg body in order to accelerate it in the direction of force from rest to 20 ms^{-1} in 10 s ?

a) 10^{-3} J   b) 10^4 J
c) 2×10^3 J   d) 4×10^4 J

448. How much work must be done by a force on 50 kg body in order to accelerate it in the direction of force from rest to 20 ms^{-1} in 10 s ?

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449. A body is projected in vertically upward direction from the surface of the earth of radius 'R' into the space with velocity 'nV_e' (n < 1). The maximum height from the surface of earth to which a body can reach is (V_e = escape velocity)

a) $\frac{n^2R^2}{1-n}$ b) $\frac{n^2R^2}{1-n^2}$
c) $\frac{n^2R^2}{1+n}$ d) $\frac{nR^2}{1+n^2}$

450. Two satellites 'A' and 'B' of same mass are revolving round the earth at height '2R' and '3R' respectively above the surface of the earth. The ratio of kinetic energies of A to B will be

a) 3:2   b) 4:3
c) 3:4   d) 2:3

451. An artificial satellite stays in the orbit around the earth because

a) Earth's attraction on it is balanced by the attraction of the planets
b) The fuel in the satellite burns and releases hot gases which produce thrust
c) Earth's attraction on it is just balanced by the viscous force on it produced by the atmosphere
d) Earth's attraction on in produces necessary centripetal force

452. The binding energy of a body does not depend upon

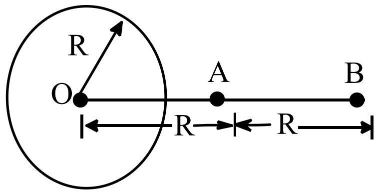
a) Mass of the planet
b) Its distance from the centre of the planet
c) Mass of the body
d) Shape of the body

453. A satellite in a circular of the earth has a K.E.(E_k). What is the minimum amount of energy to be added so that it escapes from the earth?

a) $\frac{E_k}{4}$ b) $\frac{E_k}{2}$ c) E_k d) $2E_k$

454. A ring having non-uniform distribution of mass having mass M and radius R is being considered. A point mass m_0 is taken slowly from A to B along the axis of the ring. In doing so, work done by the external force against the

gravitational force exerted by ring is



a) $\frac{GMm_0}{\sqrt{2}R}$
b) $\frac{GMm_0}{R}\left[\frac{1}{\sqrt{2}}-\frac{1}{\sqrt{5}}\right]$
c) $\frac{GMm_0}{R}\left[\frac{1}{\sqrt{5}}-\frac{1}{\sqrt{2}}\right]$
d) It is not possible to find the required work as the nature of distribution of mass is not known

455. Assuming that the earth is a solid sphere of radius R, the mass M of the earth would be given by
a) $\frac{gR^2}{G}$ b) $\frac{GR^2}{g}$ c) $R\sqrt{\frac{G}{g}}$ d) $R\sqrt{\frac{g}{G}}$

456. What should be the angular speed of earth in radian/second so that a body of 5 kg weights zero at the equator? [Take $g = 10 m/s^2$ and radius of earth = 6400 km]
a) 1/1600 b) 1/800 c) 1/400 d) 1/80

457. Kepler's second law states that the straight line joining the planet to the sun sweeps out equal areas in equal times. This statement is equivalent to saying that
a) total acceleration is zero
b) tangential acceleration is zero
c) longitudinal acceleration is zero
d) radial acceleration is zero

458. An earth satellite is moved from one stable circular orbit, which one of the following quantities increase?
a) Gravitational force
b) Gravitational potential energy
c) Linear orbital speed
d) Centripetal acceleration

459. A satellite launch station should be
a) Near the equatorial region
b) Near the polar region
c) On the polar axis
d) All the locations are equally good

460. The mean radius of the earth is 'R', its angular speed about its own axis is 'ω' and acceleration due to gravity on earth's surface is 'g'. The radius of the orbit of a geostationary satellite will be
a) $\left(\frac{R^2\omega^2}{g}\right)^{1/3}$ b) $\left(\frac{R^2 g}{\omega}\right)^{1/3}$
c) $\left(\frac{Rg}{\omega^2}\right)^{1/3}$ d) $\left(\frac{R^2 g}{\omega^2}\right)^{1/3}$

461. A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius $(1.01)R$. The period of the second satellite is larger than that of the first one by approximately
a) 0.5% b) 1.0% c) 1.5% d) 3.0%

462. What is the energy required to launch a $m\ kg$ satellite from earth's surface in a circular orbit at an altitude of $7R$? ($R =$ radius of the earth)
a) $\frac{12}{13}mgR$ b) mgR
c) $\frac{15}{16}mgA$ d) $\frac{1}{9}mgR$

463. A solid sphere of mass M and radius R has a spherical cavity of radius $R/2$ such that the centre of cavity is at a distance $R/2$ from the centre of the sphere. A point mass m is placed inside the cavity at a distance $R/4$ from the centre of sphere. The gravitational pull between the sphere and the point mass m is
a) $\frac{11GMm}{R^2}$ b) $\frac{14GMm}{R^2}$
c) $\frac{GMm}{2R^2}$ d) $\frac{GMm}{R^2}$

464. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small as compared to the mass of the earth. Which of the following statements is correct?
a) The acceleration of S is always directed towards the centre of the earth.
b) The angular momentum of S about the centre of the earth changes in direction but its magnitude remains constant.
c) The total mechanical energy of S varies periodically with time.
d) The linear momentum of S remains constant in magnitude.

465. A body is projected vertically from the surface of the earth of radius R with velocity equal to half of the escape velocity. The maximum height reached by the body is
a) $\frac{R}{5}$ b) $\frac{R}{3}$

c) $\frac{R}{2}$ d) $\frac{R}{4}$

466. Gas escapes from the surface of a planet because it acquires an escape velocity. The escape velocity will depend on which of the following factors?
I. Mass of the planet
II. Mass of the particle escaping
III. Temperature of the planet
IV. Radius of the planet
Select the correct answer from the codes given below
a) I and II b) II and IV
c) I and IV d) I, III and IV

467. If the mean distance of Mars from the Sun is 1.525 times that of the earth from the sun, in how many years will Mars complete one revolution about the sun?
a) 1.883 b) 2 c) 3.766 d) 4

468. A body is projected vertically upwards from the surface of a planet of radius R with a velocity equal to half the escape velocity for that planet. The maximum height attained by the body is
a) R/3 b) R/2 c) R/4 d) R/5

469. The weight of body on the moon's surface is less than that on earth surface because:
a) Moon has no atmosphere
b) Moon is far from earth
c) Moon is closer to earth
d) Acceleration due to gravity on moon is less

470. If the distance between two bodies is doubled, the force of gravitational attraction between them
a) Becomes four times
b) Is doubled
c) Is reduced to one-fourth
d) Is reduced to half

471. When a satellite moves around the earth (consider elliptical orbits),
a) Its angular momentum remains constant
b) Its angular speed remains constant
c) Its linear speed remains constant
d) Its linear momentum remains constant

472. The time period of the moon is T = 27.3 days and radius of orbit is $R_m = 3.84 \times 10^8$ m. The value of centripetal acceleration due to earth's gravity is
a) much smaller than the value of acceleration due to gravity g on the surface of the earth
b) is equal to the value of acceleration due to gravity g on the surface of the earth
c) much larger than the value of acceleration due to gravity g on the surface of the earth
d) Either (a) or (b)

473. By what per cent, the energy of a satellite has to be increased to shift it from an orbit of radius r to $\frac{3}{2}r$?
a) 15 % b) 20.3%
c) 66.7% d) 33.33%

474. There are two particles of masses m_1 and m_2 separated by a distance r.
With reference to the above situation, match the items in Column I with terms in Column II and choose the option from the codes given below.

Column I	Column II
A. Gravitational potential energy (GPE) associated with the particle	1. $-\frac{Gm_2}{r}$
B. Gravitational potential due to m_1 at a	2. $-\frac{Gm_1m_2}{r}$
C. distance r	3. $-\frac{Gm_1}{r}$

a) 1 2 3 b) 2 3 1
c) 2 1 3 d) 3 1 2

475. Two equal masses, each equal to m are suspended from a balance whose scale pans differ in vertical height by h. The error in weighing in terms of density of earth ρ is
a) πGρmh b) $\frac{1}{2}$ πGρmh
c) $\frac{8}{3}$ πGρmh d) $\frac{4}{3}$ πGρmh

476. As we go from the equator to the poles, weight of a body
a) Remains the same
b) Increases
c) Decreases
d) May increase of decrease

477. If the earth is at one fourth of its present distance from the sun, the duration of the year will be

a) Half the present year
b) One-eight the present year
c) One-fourth the present year
d) One-sixth the present year

478. The geo-synchronous satellite of the earth orbit from:
a) North to south in the polar plane
b) South to north in the polar plane
c) East to west in equatorial plane
d) West to east in equatorial plane

479. Earth has mass 'M_1' and Radius 'R_1'. Moon has mass 'M_2' and radius 'R_2'. Distance between their centres is 'r'. A body of mass 'M' is placed on the line joining them at a distance r/3 from centre of the earth. To project the mass 'M' to escape to infinity, the minimum speed required is

a) $\left[\frac{3G}{r}\left(M_1+\frac{M_1}{2}\right)\right]^{1/2}$ b) $\left[\frac{6G}{r}\left(M_1-\frac{M_2}{2}\right)\right]^{1/2}$
c) $\left[\frac{6G}{r}\left(M_1+\frac{M_2}{2}\right)\right]^{1/2}$ d) $\left[\frac{3G}{r}\left(M_1-\frac{M_2}{2}\right)\right]^{1/2}$

480. A particle of mass m is subjected to an attractive central force of magnitude $\frac{k}{r^2}$, k being a constant. At the instant when the particle is at its extreme position in its closed orbit at a distance 'a' from the centre of force, its speed is $\frac{k}{2ma}$. If the distance of other extreme is b, find $\frac{a}{b}$
a) −1 b) 2 c) 3 d) 4

481. The acceleration due to gravity on a planet is $1.96\ ms^{-2}$. If it is safe to jump from a height of 3 m on the earth, the corresponding height on the planet will be
a) 3 m b) 6 m
c) 9 m d) 15 m

482. The mass and radius of the earth and moon are M_1, R_1 and M_2, R_2 respectively. Their centres are at a distance 'd' apart. The minimum speed with which a body of mass 'm' should be projected from a distance (2d/3) from the centre of M_1 so as to escape to ∞ is

a) $\left[\frac{3G(M_1-M_2)}{2d}\right]^{1/2}$ b) $\left[\frac{6G(M_1+2M_2)}{2d}\right]^{1/2}$
c) $\left[\frac{3G(M_1-M_2)}{d}\right]^{1/2}$ d) $\left[\frac{6G(M_1-M_2)}{2d}\right]^{1/2}$

483. A comet is moving around the earth in highly elliptical orbit. Identify the incorrect statement
a) Its K.E. and P.E. both change over the orbit
b) Its T.E. changes over the orbit
c) Its linear momentum changes in magnitude as well as in direction over the orbit
d) Its angular momentum remains constant over the orbit

484. A particle is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done per unit mass against the gravitational force between them, to take the particle far away from the sphere. (Take, $h = 6.67\times10^{-11} Nm^2\,kg^{-2}$)
a) $13.34\times10^{-10}\ J$ b) $3.33\times10^{-10}\ J$
c) $6.67\times10^{-9}\ J$ d) $6.67\times10^{-8}\ J$

485. The radius of the orbit of a geostationary satellite is (mean radius of the earth R, angular velocity about an axis in ω and acceleration due to gravity on earth's surface is g)

a) $\frac{gR^2}{\omega^2}$ b) $\left(\frac{gR^2}{\omega^2}\right)^{1/2}$
c) $\left(\frac{gR^2}{\omega^2}\right)^{1/3}$ d) $\left(\frac{gR^2}{\omega^2}\right)^{2/3}$

486. If the horizontal velocity given to the satellite is greater than escape velocity, then the satellite moves
a) Circular path
b) Elliptical path
c) Parabolic path
d) Tangent to the curve path

487. The height at which the weight of a body becomes $\frac{1}{16}$th, its weight on the surface of earth (radius R), is
a) 5R b) 15R c) 3R d) 4R

488. A satellite is revolving round the earth with orbital speed v_0. If it stops suddenly, the speed with which it will strike the surface of earth would be (where, v_θ = escape velocity of a particle on earth's surface)

a) $\frac{v_e^2}{v_0}$ b) $2v_0$
c) $\sqrt{v_e^2-v_o^2}$ d) $\sqrt{v_e^2-2v_0^2}$

489. Suppose the gravitational force varies inversely as the n^{th} power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to
a) $R^{\left(\frac{n+1}{2}\right)}$ b) $R^{\left(\frac{n-1}{2}\right)}$ c) R^n d) $R^{\left(\frac{n-2}{2}\right)}$

490. The mean radius of the earth is R, its angular speed on its own axis is ω and the acceleration due to gravity at earth's surface is g. The cube

of the radius of the orbit of a geostationary satellite will be

a) R^2g/ω b) $R^2\omega^2/g$ c) Rg/ω^2 d) R^2g/ω^2

491. Two particles of masses m and $9m$ are separated by a distance r. At a point on the line joining them the gravitational field is zero. The gravitational potential at that point is ($G =$ universal constant of gravitation)

a) $-\frac{4Gm}{r}$ b) $-\frac{8Gm}{r}$
c) $-\frac{16Gm}{r}$ d) $\frac{32Gm}{r}$

492. A man inside an artificial satellite feels weightlessness because the force of attraction due to earth is:

a) Zero at the place
b) Is balanced by the force of attraction due to moon
c) Equal to the centripetal force
d) Not effective due to particular design of the satellite

493. If a body is taken from a deep mine to a point at certain height above the ground, its weight

a) Decreases
b) Increases
c) Increases up to the surface of the earth and then decreases
d) Remains same

494. The acceleration due to gravity at a height (1/20) th of the radius of the earth above the earth's surface is 9 ms^{-2}. Its value at a point at an equal distance below the surface of the earth (in ms^{-2}) is about

a) 8.5 b) 9.5
c) 9.8 d) 11.5

495. The orbital velocity of a body at height h above the surface of Earth is 36% of that near the surface of the Earth of radius R. If the escape velocity at the surface of Earth is 11.2 km s^{-1}, then its value at the height h will be

a) 11.2 km s^{-1} b) $\sqrt{\frac{h}{R}} \times 11.2$ km s^{-1}
c) $\frac{9}{25} \times 11.2$ km s^{-1} d) $\sqrt{\frac{R}{h}} \times 11.2$ km s^{-1}

496. The mass of the moon is (1/81) th of earth's mass and its radius is (1/4) th that of the earth. If the escape velocity from the earth's surface is $11.2 kms^{-1}$, its value for the moon will be

a) $0.15 kms^{-1}$ b) $5 kms^{-1}$
c) $2.5 kms^{-1}$ d) $0.5 kms^{-1}$

497. If density of the earth is doubled keeping radius constant, the new acceleration due to gravity is ($g = 9.8$ m/s^2)

a) 9.8 m/s^2 b) 19.6 m/s^2
c) 4.9 m/s^2 d) 39.2 m/s^2

498. Kepler's third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet i.e., $T^2 = Kr^3$ here K is constant.
If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is $F = \frac{GMm}{r^2}$, here G is gravitational constant. The relation between G and K is described as

a) $GK = 4\pi^2$ b) $GMK = 4\pi^2$
c) $K = G$ d) $K = \frac{1}{G}$

499. At what height from the earth's surface, the gravitational potential and the value of gravitational acceleration are $5.4 \times 10^7 \frac{J}{kg^3}$ and 6.0m/s^2 respectively? (Radius of earth = 6400 km)

a) 200 km b) 1600 km
c) 1200 km d) 2600 km

500. Calculate angular velocity of earth so that acceleration due to gravity at 60° latitude becomes zero. (Radius of earth = 6400 km, gravitational acceleration at poles = 10m/s^2, $\cos 60° = 0.5$)

a) 7.8×10^{-2}rad/s b) 0.5×10^{-3}rad/s
c) 1×10^{-3}rad/s d) 2.5×10^{-3}rad/s

501. The magnitudes of the gravitational force at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are F_1 and F_2, respectively. Then,

a) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$
b) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 > R$ and $r_2 > R$
c) $\frac{F_1}{F_2} = \frac{r_2}{r_1}$ if $r_1 < R$ and $r_2 < R$
d) None of the above

502. A body weighs 45 N on the surface of the earth. What is the gravitational force on it due to the earth at a height equal to half of the radius of the earth?

a) 20 N b) 45 N
c) 40 N d) 90 N

503. A body of mass 'm' is dropped from a height R/2, to the surface of earth where 'R' is radius of earth. It's speed when it will hit the earth's surface is (V_e = escape velocity from earth's surface)

a) $\sqrt{3}V_e$ b) $V_e/\sqrt{2}$
c) $V_e/\sqrt{3}$ d) $\sqrt{2}V_e$

504. A satellite of mass 'm' is revolving around the earth of mass 'M' in an orbit of radius 'r' with constant angular velocity 'ω'. The angular momentum of the satellite is (G = gravitational constant)

a) $\left(\frac{GMr}{m}\right)^2$ b) $m(GMr)^{1/2}$
c) $m(GMr)$ d) $(GMmr)^{1/2}$

505. A satellite is moving very close to a planet of density $8 \times 10^3 \text{kg m}^{-3}$. If $G = 6.67 \times 10^{-11} \text{Nm}^2\text{kg}^{-2}$, then the time period of the satellite is nearly

a) 420 s b) 4200 s c) 1 hour d) 1 day

506. Earth has mass M_1 and radius R_1. Moon has mass M_2 and radius R_2. Distance between their centre is r. A body of mass M is placed on the line joining them at a distance $\frac{r}{3}$ from centre of the earth. To project the mass M to escape to infinity, the minimum speed required is

a) $\left[\frac{3G}{r}\left(M_1 + \frac{M_2}{2}\right)\right]^{\frac{1}{2}}$ b) $\left[\frac{6G}{r}\left(M_1 + \frac{M_2}{2}\right)\right]^{\frac{1}{2}}$
c) $\left[\frac{6G}{r}\left(M_1 - \frac{M_2}{2}\right)\right]^{\frac{1}{2}}$ d) $\left[\frac{3G}{r}\left(M_1 - \frac{M_2}{2}\right)\right]^{\frac{1}{2}}$

507. A satellite is moving in an orbit around the earth due to

a) Burning of fuel
b) Gravitational attraction between sun and earth
c) Ejection of gases from the exhaust of the satellite
d) Gravitational attraction between earth and the satellite

508. Which of the following is conserved in the planetary motion around the sun?

a) Linear momentum b) Kinetic energy
c) Potential energy d) Angular momentum

509. The total energy of an artificial satellite moving in a circular orbit at some height around the earth is E_0. Its potential energy is

a) $-E_0$ b) E_0
c) $-2E_0$ d) $2E_0$

510. Which of the following is the S.I. unit of universal gravitational constant?

a) Nm/kg^2 b) $\text{Nm}^2\text{/kg}$ c) Nm/kg d) $\text{Nm}^2\text{/kg}^2$

511. If a satellite is travelling in the same direction as the rotation of earth i.e., west to east, what is the interval between two successive times at which it will appear vertically overhead to an observer at a fixed point on the equator?

a) 7417 s b) 6831 s c) 5082.9 s d) 1 day

512. A satellite is revolving in a circular orbit around the earth has total energy 'E'. Its potential energy in that orbit is

a) 4E b) E
c) 2E d) E/2

513. The nature of the path of the satellite depends upon

a) The horizontal velocity
b) The escape velocity
c) The critical velocity
d) All of the above

514. A body is projected vertically upwards from earth's surface. If its kinetic energy of projection is equal to half of its minimum value required to escape from earth's gravitational influence then the height upto which it rises is (R = radius of earth)

a) 2R b) R
c) 4R d) 3R

515. A body is attached with satellite revolving in circular orbit. After some revolutions the body is detached from satellite. What happens with the body?

a) Body will come back to earth in parabolic path
b) Body will come back to earth in straight line path
c) Body will revolve in circular orbit
d) Body will escape in tangential path

516. The time period of a satellite of earth is 5 h. If the separation between the earth and the satellite is increased to 4 times the previous value, the new time period will become

a) 10 h b) 80 h
c) 40 h d) 20 h

517. A satellite of mass M is orbiting the earth in a circular orbit of radius r. It starts losing energy due to small air resistance at the rate of C J/s. Find the time taken for satellite to reach the earth

a) $\frac{GMm}{C}\left(\frac{1}{R} - \frac{1}{r}\right)$ b) $\frac{GMm}{2C}\left(\frac{1}{R} - \frac{1}{r}\right)$

c) $\frac{GMm}{2CR}$ d) $\frac{3GMm}{2C}\left(\frac{1}{R}-\frac{1}{r}\right)$

518. If a satellite is orbiting the earth very close to its surface, then the orbital velocity mainly depends on
a) The mass of the satellite only
b) The radius of the earth only
c) The orbital radius only
d) The mass of the earth only

519. In a gravitational field, work done in moving a mass from one point to another
a) Depends on the end points only
b) Depends on the length of the path
c) Depends on the end points and length of the path
d) Neither 'a' nor 'b'

520. Which of the following is the evidence to show that there must be a force acting on the earth and directed towards the sun?
a) Deviation of the falling bodies toward East
b) Revolution of the earth around the sun
c) Phenomenon of day and night
d) Apparent motion of sun round the earth

521. The relay satellite transmits the TV programme continuously from one par of the world to another because its:
a) Period is greater than the period of rotation of the earth
b) Period is less than the period of the earth about its axis
c) Period has no relation with the period of the earth about its axis
d) Period is equal to the period of rotations of the earth about its axis

522. The escape velocity of a body from the surface of the earth is equal to
a) 3 times critical velocity of body orbiting close to surface of the earth
b) $\sqrt{2}$ times critical velocity of a body orbiting very close to surface of the earth
c) Critical velocity of a body orbiting very close to surface of the earth
d) $\frac{1}{2}$ times critical velocity of a body orbiting very close to surface of the earth

523. Two particles of equal mass go around a circle of radius R under the action of their mutual gravitational force of attraction. The speed of each particle is (M = mass of the particle)
a) $\sqrt{\frac{GM}{R}}$ b) $\frac{1}{2}\sqrt{\frac{GM}{R}}$ c) $\frac{1}{3}\sqrt{\frac{GM}{R}}$ d) $\frac{1}{4}\sqrt{\frac{GM}{R}}$

524. The tidal wave in the sea are primarily due to gravitational effect of
a) Earth on the sea
b) Sun on the earth
c) Earth on the moon
d) Moon on the earth

525. The mass and diameter of a planet are twice those of earth. The period of oscillation of pendulum on this planet will be (if it is a seconds pendulum on earth)
a) $2\sqrt{2}$ s
b) $(2)^{1/3}$ s
c) 2 s
d) $\sqrt{2}$ s

526. The speed with which the earth would have to rotate about its axis so that a person on the equator would weight $\frac{3}{5}$th as much as at present is (g = gravitational acceleration, R = equatorial radius of the earth)
a) $\sqrt{\frac{5R}{2g}}$
b) $\sqrt{\frac{3g}{5R}}$
c) $\sqrt{\frac{2g}{5R}}$
d) $\sqrt{\frac{3}{5}gR}$

527. Gravitational force is
a) Mass and charge dependent
b) Mass and charge independent
c) Mass dependent and charge independent
d) Mass independent and charge dependent

528. Consider earth to be sphere of radius 'R_e' rotating about its own axis with angular speed 'ω'. If 'g_e' and 'g_P' are the accelerations due to gravity at the equator and the poles respectively, then $(g_e - g_P)$ is given by $\left(\cos 0^0 = \sin\frac{\pi}{2} = 1, \sin 0^0 = \cos\frac{\pi}{2} = 0\right)$
a) $R_e^2\omega^2$
b) $\frac{R_e}{\omega^2}$
c) $R_e\omega$
d) $R_e\omega^2$

529. Two artificial satellites are revolving in the same circular orbit. Then they must have the same
a) Mass
b) Angular momentum
c) Kinetic energy
d) Period of revolution

530. Time period of second pendulum on a planet, whose mass and diameter are twice that of earth, is
a) $2\sqrt{2}$ s b) 2 s c) $\sqrt{2}$ s d) $\frac{1}{\sqrt{2}}$ s

531. Which of the following statements is correct about

satellites?

a) A satellite cannot move in a stable orbit in a plane passing through the earth's centre.
b) Geostationary satellites are launched in the equatorial plane.
c) We can use just one geostationary satellite for global communication around the globe.
d) The speed of satellite increases with the increase in the radius of its orbit.

532. The distance between centre of the earth and moon is 384000 km. If the mass of the earth is 6×10^{24} kg and $G = 6.66 \times 10^{-11}$ $N - m^2\ kg^{-2}$. The speed of the moori is nearly

a) $1kms^{-1}$
b) $4kms^{-1}$
c) $8kms^{-1}$
d) $11.2kms^{-1}$

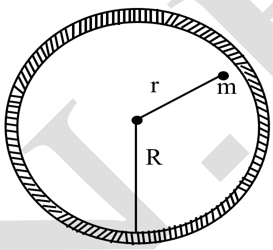
533. If the value of the gravitational acceleration at the height h be 1% of its value at the surface of the earth, then h is equal to (given $R_e =$ 6400 km)

a) 6400 km
b) 57600 km
c) 2560 km
d) 64000 km

534. The magnitude of gravitational potential energy of a body at a distance r from the centre of earth is u. Its weight at a distance $2r$ from the centre of earth is

a) $\frac{u}{r}$
b) $\frac{u}{4r}$
c) $\frac{u}{2r}$
d) $\frac{4r}{u}$

535. A mass m is placed inside a hollow sphere of mass M as shown in figure. The gravitational force on mass m is



a) $\frac{GMm}{R^2}$
b) $\frac{GM\text{m}}{r^2}$
c) $\frac{GMm}{(R-r)^2}$
d) zero

536. A body is raised to a height nR above the surface of the earth of radius R. The ratio of gravitational acceleration on earth's surface to that at a given height is

a) $(n+1)^2$
b) $(n-1)^2$
c) n
d) n^2

537. Earth revolves round the sun in a circular orbit of radius 'R'. The angular momentum f the moving earth is directly proportional to

a) R^3
b) R^2
c) R
d) $\sqrt{R}$

538. An object weights W newton on earth. It is suspended from the lower end of a spring balance whose upper end is fixed to the ceiling of a space capsule in a stable orbit around the earth. The reading of the spring balance will be

a) W
b) Less than W
c) More than W
d) Zero

539. Earth revolves round the sun in a circular orbit of radius 'R'. The angular momentum of the revolving earth is directly proportional to

a) R^3
b) R^2
c) $\sqrt{R}$
d) R

540. The moon revolves around the earth in a circular orbit of radius -3.84×10^5km with velocity 1 km/s. The additional velocity required to escape from influencing earth satellite is

a) 2.414 km/s
b) 1.414 km/s
c) 0.414 km/s
d) 1.000 km/s

541. The centripetal force on a satellite orbiting round the earth and the gravitational force of earth acting on the satellite both equal F. The net force on the satellite is

a) Zero
b) F
c) $F\sqrt{2}$
d) 2 F

542. The depth d at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the surface is [R = radius of the earth]

a) $\frac{R}{n}$
b) $R\left(\frac{n-1}{n}\right)$
c) $\frac{R}{n^2}$
d) $R\left(\frac{n}{n+1}\right)$

543. The period (T) of an artificial satellite of earth depends on the density of the earth (assumed constant) as:

a) $T \propto \frac{1}{\sqrt{d}}$
b) $T \propto \sqrt{d}$
c) $T \propto d$
d) $T \propto 1/d$

544. What is the percentage decrease in the weight of a body when it is taken to a height of 32 km from the surface of earth?

a) 0.5%
b) 2%
c) 1.5%
d) 1%

545. A satellite is revolving round a planet in a circular orbit close to its surface. If ρ is mean density and R is the radius of planet then the period of the satellite is
(G = Universal constant of gravitation)

a) $\sqrt{\frac{5\pi}{\rho G}}$ b) $\sqrt{\frac{\pi}{\rho G}}$
c) $\sqrt{\frac{2\pi}{\rho G}}$ d) $\sqrt{\frac{3\pi}{\rho G}}$

546. The gravitational force on a body of mass 5 kg at the surface of the earth is 50 N. If earth is a perfect sphere, the gravitational force on a satellite of mass 200 kg in a circular orbit of radius same as diameter of the earth is
a) 200 N b) 400 N c) 500 N d) 800 N

547. A body is projected vertically upwards from earth's surface. If velocity of projection is $(1/3)^{rd}$ of escape velocity, then the height upto which a body rises is (R = radius of earth)
a) $\frac{R}{4}$ b) 2R
c) R d) $\frac{R}{8}$

548. The mass of a spherical planet is 4 times the mass of the earth, but its radius (R) is same as that of the earth. How much work is done is lifting a body of mass 5 kg through a distance of 2 m on the planet? ($g = 10\ ms^{-2}$)
a) 400 J b) 200 J
c) 800 J d) 300 J

549. Height at which value of 'g' becomes one-fourth to that on earth is
a) R b) 2 R c) (3/2) R d) 4R

550. In a gravitational field, at a point where the gravitational potential is zero
a) The gravitational field is necessarily zero
b) The gravitational field is not necessarily zero
c) Nothing can be said definitely about the gravitational field
d) None of these

551. A body is thrown from the surface of the earth with velocity 'u' m/s. The maximum height in m above the surface of the earth upto which it will reach is (R = radius of earth, g = acceleration due to gravity)
a) $\frac{u^2R}{2gR - u^2}$ b) $\frac{2u^2R}{gR - u^2}$
c) $\frac{u^2R^2}{2gR^2 - u^2}$ d) $\frac{u^2R}{gR - u^2}$

552. Weight of body at the centre of earth is:
a) Zero b) 9.8 mg c) Infinity d) Mg

553. Suppose the universal gravitational constant starts do decrease, then
Which of the below statements is wrong?
a) Length of the day does not change
b) Length of the year will increase
c) The earth will follow a spiral path of decreasing radius
d) Kinetic energy of the earth will decrease

554. Some aliens living beneath the surface of the earth want to send a parcel to their friends just outside earth's pull. What should be the velocity with which they must throw the parcel from a depth of R/2?
a) 11.2 km/s b) 15.84 km/s
c) 16.37 km/s d) 12.8 km/s

555. If a satellite is orbiting in space having air and no energy is being supplied, then path of that satellite would be
a) Circular
b) Spiral of increasing radius
c) Spiral of decreasing radius
d) Elliptical

556. The maximum possible velocity of a satellite orbiting round the earth in a stable orbit is
a) $\sqrt{2R_eg}$ b) $\sqrt{R_eg}$ c) $\sqrt{\frac{R_eg}{2}}$ d) Infinite

557. A system of binary stars of masses m_A and m_B are moving in circular orbits of radii r_A and r_B respectively. If T_A and T_B are the times periods of masses m_A and m_B respectively then,
a) $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$ b) $T_A > T_B (\text{if } r_A > r_B)$
c) $T_A > T_B (\text{if } m_A > m_B)$ d) $T_A = T_B$

558. Gravitational force is one of the force of:
a) Attraction b) Repulsion
c) Either a or b d) Neither 'a' nor 'b'

559. What should be the velocity of earth due to rotation about its own axis so that the weight at equator becomes 3/5 of initial value? Radius of earth on equator is 6400 km
a) 7.4×10^{-4}rad/s b) 6.7×10^{-4}rad/s
c) 7.9×10^{-4}rad/s d) 8.7×10^{-4}rad/s

560. A body is thrown from the surface of earth with velocity 'V' m/s. The maximum height above the earth's surface upto which it will reach is [R = radius of earth, g = acceleration due to gravity]
a) $\frac{VR}{2gR - V}$ b) $\frac{VR^2}{gR - V}$
c) $\frac{V^2R}{2gR - V^2}$ d) $\frac{2gR}{V^2(R - 1)}$

561. The escape velocities of the two planets, of

densities ρ_1 and ρ_2 and having same radius, are v_1 and v_2 respectively. Then

a) $\frac{v_1}{v_2} = \frac{\rho_1}{\rho_2}$ b) $\frac{v_2}{v_1} = \frac{\rho_2}{\rho_1}$

c) $\frac{v_1}{v_2} = \left(\frac{\rho_1}{\rho_2}\right)^2$ d) $\frac{v_1}{v_2} = \sqrt{\frac{\rho_1}{\rho_2}}$

562. A pendulum swings at depth 'd' below the surface of the earth with period 'T'. Same pendulum oscillates with same period 'T' at height 'h' above the surface of earth. The ration '$\frac{d}{h}$' will be

a) 1:4 b) 2:1
c) 1:1 d) 1:2

563. Who among the following did first give the experimental value of G?

a) Cavendish b) Copernicus
c) Brook Taylor d) None of these

564. A clock 'S' is working on oscillations of a spring and a clock 'P' is working on pendulum motion. Both clocks are running at the same rate on earth. What will happen to their functioning on a planet which has the same density as that of earth, but the radius is twice that of earth?

a) P will run faster than S
b) Both will run at the same rate, but not the same as on earth
c) Both will run at the same rate as on the earth
d) 'S' will run faster than 'P'

565. As we go from pole to the equator, the effective value of acceleration due to gravity decreases due to

a) Rotation of the earth only
b) Shape of the earth only
c) Both rotation and shape of the earth
d) Neither rotation nor shape of the earth

566. A body is projected from earth's surface with thrice the escape velocity from the surface of the earth. What will be its velocity when it will escape the gravitational pull?

a) $2V_e$ b) $4V_e$
c) $2\sqrt{2}V_e$ d) $\frac{V_e}{2}$

567. B.E. of a satellite is always

a) Infinity b) Positive c) Zero d) Negative

568. The average density of the earth is [g is acceleration due to gravity]

a) Inversely proportional to g^2
b) Directly proportional to g
c) Inversely proportional to g
d) Directly proportional to g^2

569. If a body is taken from the surface of earth to moon, then its weight will

a) First decrease then increase
b) First increase then decrease
c) Continuously increase
d) Continuously decrease

570. Artificial satellite moving around the earth is just like a

a) Projectile
b) Freely falling body
c) Body projected vertically up
d) Body at rest

571. If earth's satellite is moved from one stable orbit to a farther stable orbit, then which of the following quantities increase?

a) Potential energy
b) Linear speed
c) Gravitational force
d) Centripetal acceleration

572. The value of 'g' at a certain height above the surface of the earth is 16% of its value on the surface. The height is (R = 6300 km)

a) 10500 km b) 12500 km
c) 3000 km d) 9450 km

573. A body weighs 81 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface?

a) 72 N b) 28 N c) 36 N d) 32 N

574. Two masses m_1 and $m_2 (m_1 < m_2)$ are released from rest from a finite distance. They start under their mutual gravitational attraction. Then the wrong statement is,

a) Acceleration of m_1 is more than that of m_2
b) Acceleration of m_2 is more than that of m_1
c) Centre of mass remains at rest
d) Total energy of the system remains constant

575. Assuming the earth to be a sphere of uniform density, the ratio of accelerating due to gravity on the earth's surface to its value at halfway towards the centre of the earth, will be

a) 1:1 b) 1:2
c) 2:3 d) 2:1

576. If a missile is launched with a velocity less than the escape velocity, then the sum of its kinetic and potential energy will be

a) Positive
b) Negative
c) Zero

d) May be positive or negative depending upon its initial velocity

577. If the distance the sun and the earth is increased by three times, then attraction between two will

a) Remain constant b) Decrease by 63%
c) Decrease by 83% d) Decrease by 89%

578. The critical velocity of a satellite of mass 100 kg is 20 km/hr. The critical velocity of another satellite of mass 200 kg in the same orbit is

a) 20 km/hr b) 14.14 km/hr
c) 72 km/hr d) 10 km/hr

579. Mass M is divided into two parts 'x' m and $(1-x)$m. For a given separation, the value of x_m for which the gravitational attraction between the two pieces becomes maximum is

a) $\frac{1}{2}$ b) $\frac{3}{5}$ c) 1 d) 2

580. A satellite of mass 'm' is moving in a circular orbit of radius 'r' around the earth. The angular momentum of the satellite about the centre of orbit is (M = mass of earth, G = gravitational constant)

a) $(GMm^2r)^{1/2}$ b) $(GMmr)$
c) $(GM^2mr)^{1/2}$ d) $(GMm^2r^2)^{1/2}$

581. The length of the second pendulum is 1 m on earth. If the mass and diameter of the planet is 1.5 times that of the earth, the length of the seconds pendulum on the planet will be nearly.

a) 0.60 m b) 0.45 m
c) 0.76 m d) 0.67 m

582. Two identical solid copper spheres of radius R placed in contact with each other. The gravitational attraction between them is proportional to

a) R^2 b) R^{-2} c) R^4 d) R^{-4}

583. Given mass of the moon is 1/81 of the mass of the earth and corresponding radius 1/4 of the radius of earth. If escape velocity on the earth's surface is 11.2 km/s, the value of same on the surface of the moon is

a) 0.14 km/s b) 0.5 km/s
c) 2.5 km/s d) 5 km/s

584. For a close orbiting satellite period (T) of a satellite is in proportional to the density of planet (ρ) as:

a) $T \propto \rho$ b) $T\frac{1}{\sqrt{\rho}}$ c) $T \propto \frac{1}{\rho}$ d) $T^2 \propto \sqrt{\rho}$

585. The binding energy of a satellite of mass m in an orbit of radius r is (R=radius of earth, g=acceleration due to gravity)

a) $\frac{mgR^2}{r}$ b) $-\frac{mrgR^2}{r}$ c) $\frac{mgR^2}{2r}$ d) $-\frac{mgR^2}{2r}$

586. If three particles each of mass M are placed at the three corners of an equilateral triangle of side a, then the forces exerted by this system on another particle of mass M placed at the mid-point of a side and at the centre of the triangle are respectively,

a) (0,0) b) $\left(\frac{4GM^2}{3a^2}, 0\right)$
c) $\left(0, \frac{4GM^2}{3a^2}\right)$ d) $\left(\frac{3GM^2}{a^2}, \frac{GM^2}{a^2}\right)$

587. Two small satellites move in circular orbits around the earth, at distances r and $r + \Delta r$ from the centre of the earth. Their time periods of rotation are T and $T + \Delta T (\Delta r \ll r, \Delta T \ll T)$, then ΔT is equal to

a) $\frac{3}{2}T\frac{\Delta r}{r}$ b) $\frac{2}{3}T\frac{\Delta r}{r}$
c) $\frac{-3}{2}T\frac{\Delta r}{r}$ d) $T\frac{\Delta r}{r}$

588. A particle is dropped on Earth from height R (radius of earth) and it bounces back to height h. If the coefficient of restitution of collision is $\sqrt{\frac{2}{3}}$, then find h

a) $\frac{R}{3}$ b) $\frac{R}{4}$ c) R d) $\frac{R}{2}$

589. If an object is thrown with a velocity less than the escape velocity, its total energy is

a) Equal to zero b) Positive
c) Negative d) Infinite

590. Acceleration due to gravity does not vary with:

a) Altitude b) Depth
c) Latitude d) Mass of body

591. Two bodies of different masses reach simultaneously on ground from height h in vacuum because:

a) Acceleration of both bodies is same
b) Acceleration is independent of mass
c) In vacuum there is no frictional force
d) Statement itself is wrong

592. Law of gravitation is due to:

a) Galileo b) Einstein c) Newton d) Kepler

593. According to kepler's second law, line joining the planet to the sun sweeps out equal areas in equal time intervals. This suggests that for the planet.

a) Radial acceleration is zero
b) Tangential acceleration is zero

c) Transverse acceleration is zero
d) All of the above

594. The depth 'd' below the surface of the earth at which acceleration due to gravity becomes $\left(\frac{g}{n}\right)$ is
R = radius of the earth, 'g' = acceleration due to gravity, n = integer
a) $d = \frac{1}{R}\left(\frac{n-1}{n}\right)$ b) $d = \frac{1}{R}\left(\frac{n+1}{n}\right)$
c) $d = R\left(\frac{n}{n-1}\right)$ d) $d = R\left(\frac{n-1}{n}\right)$

595. The escape velocity for a planet whose mass is six times the mass of earth and radius is twice the radius of earth will be
[V_e = escape velocity from the earth]
a) $\sqrt{3}V_e$ b) $\sqrt{2}V_e$
c) $\frac{3}{2}V_e$ d) $2\sqrt{2}V_e$

596. A satellite orbits around the earth in a circular orbit with a speed v and orbital radius r. If it loses some energy, then v and r change as:
a) v decreases and r increases
b) v increases and r decreases
c) Both v and r decreases
d) Both v and r increases

597. If R is the radius of the earth and g the acceleration due to gravity on the earth's surface, the mean density of the earth is
a) $4\pi G/3gR$ b) $3\pi R/4gG$
c) $3g/4\pi RG$ d) $\pi RG/12g$

598. The depth from the surface of the earth of radius R, at which acceleration due to gravity will be 60% of the value on the earth surface is
a) $\frac{2R}{3}$ b) $\frac{2R}{5}$
c) $\frac{3R}{5}$ d) $\frac{5R}{3}$

599. If the gravitational force varies inversely as the nth power of the distance (R) then the time period of the planet in a circular orbit of radius 'R' around the sun will be proportional to
a) $R^{\frac{(n-1)}{2}}$ b) R^{-n}
c) R^n d) $R^{\frac{(n+1)}{2}}$

600. The atmosphere is held to the earth by
a) Winds b) Gravity c) Clouds d) Nature

601. A body of mass m is taken to the bottom of a deep mine. Then
a) It mass increases b) Its mass decreases
c) Its weight increases d) Its weight decreases

602. The ration of inertial to gravitational mass is:
a) +1 b) -1 c) Zero d) Infinity

603. At a height 'R' above the earth's surface the gravitational acceleration is
(R = radius of earth, g = acceleration due to gravity on earth's surface)
a) g b) $\frac{g}{8}$
c) $\frac{g}{4}$ d) $\frac{g}{2}$

604. Two planets have density in the ratio 2 : 3 and radii in the ratio 1 : 2. The ratio of acceleration due to gravity at their surface is
a) 1 : 3 b) 3 : 1 c) 1 : 9 d) 9 : 4

605. A satellite S_1 of mass 'm' is moving in an orbit of radius 'r'. Another satellite S_2 of mass '2m' is moving in an orbit of radius '2r'. The ratio of time period of satellite S_2 to that of S_1 is
a) 1:4 b) 1:8
c) 2:1 d) $2\sqrt{2}$: 1

606. For a particle projected in a transverse direction from a height h above earth's surface, find the minimum initial velocity so that it grazes the surface of earth such that path of this particle would be an ellipse with centre of earth as the farther focus, point of projection as the apogee and a diametrically opposite point on earth as perigee
a) $\sqrt{2GM_e\frac{R}{r(R+r)}}$ b) $\sqrt{2GM_e\frac{R}{R(R+r)}}$
c) $\sqrt{2GM_e\frac{r}{R(R+r)}}$ d) $\sqrt{2GM_e\left(\frac{R}{r^2}\right)}$

607. A body is raised to a height 'nR' from the surface of the earth of radius R. The ratio of acceleration due to gravity on the surface to that of a given height is
a) $(n+1)^{-3}$ b) $(n+1)^{-2}$
c) $(n+1)^2$ d) $(n+1)$

608. If a body is taken to a place where there is no gravity, then
a) Both its mass and its weight become zero
b) Neither its mass nor its weight becomes zero
c) Its mass becomes zero but not its weight
d) Its weight becomes zero but its mass remains the same

609. A satellite of mass 'm' is revolving around the earth of mass 'M' in an orbit of radius 'r'. The angular momentum of the satellite about the centre of orbit will be
a) $\sqrt{GMm}$ b) $\sqrt{GMmr}$

c) $\sqrt{GMm^2r}$ d) $\sqrt{mvr}$

610. The maximum vertical distance through which a full dressed astronaut can jump on the earth is 0.5 m. Estimate the maximum vertical distance through which he can jump on the moon, which has a mean density $2/3^{rd}$ that of earth and radius one quarter that of the earth
a) 1.5 m   b) 3 m   c) 6 m   d) 7.5 m

611. The escape velocity from a spherical planet is v_e. What is escape velocity corresponding to another planet of twice the radius and half the mean density?
a) $\sqrt{2}\,v_e$ b) $v_e/\sqrt{2}$ c) $2v_e$ d) $4\,v_e$

612. Suppose the earth increases its speed of rotation, at what new time period, will the weight of a body on the equator become zero? (Take $g = 10\ m/s^2$, Radius of earth, $R = 6400$ km, $\pi = 3.14$)
a) 1.3 h   b) 1.2 h
c) 1.5 h   d) 1.4 h

613. The earth revolves about the sun in an elliptical orbit with mean radius 9.3×10^7 m in a period of 1 year. Assuming that there are no outside influences, then
a) The earth's kinetic energy remains constant
b) The earth's angular momentum remains constant
c) The earth's potential energy remains constant
d) All the statements above are correct

614. If g is the acceleration due to gravity on the earth's surface, then the change in potential energy of the earth at a height equal to radius of earth will be
a) mgR   b) $\frac{1}{2}$mgR   c) $\frac{3}{2}$mgR   d) $\frac{1}{3}$mgR

615. The escape velocity is:
a) More for big massive bodies
b) Same for all bodies
c) Minimum for heavier bodies
d) Maximum for heavier bodies

616. A satellite moving along a circular orbit, a larger orbit corresponds to
a) Longer period and slower velocity
b) Larger velocity and longer periods
c) Smaller periods and smaller velocity
d) Smaller periods and larger velocity

617. At a height R above the earth's surface the gravitational acceleration is (R = radius of earth, g = acceleration due to gravity on earth's surface)
a) g   b) g/8
c) g/2   d) g/4

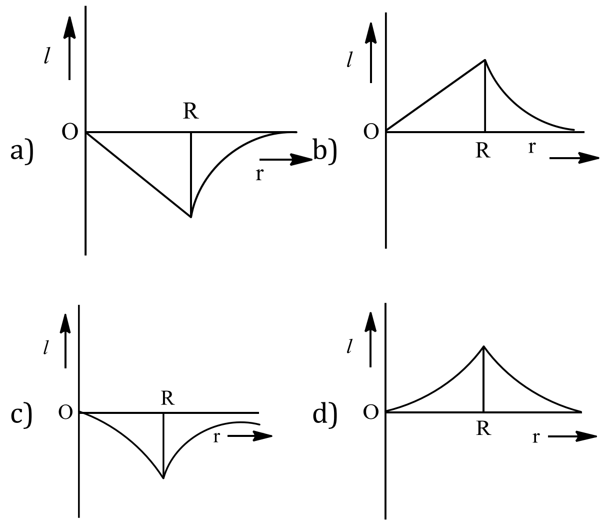
618. Two satellites of masses 'm' and '2m' are revolving in a circular orbit of radius 'r', around the earth. The ratio of their frequencies of revolution will be
a) 2:1   b) 1:1
c) 1:2   d) 1:3

619. A triple star consists of two stars, each of mass m in the same circular orbit about a central star of mass $M = 10 \times 10^{30}$kg. The two opposite stars always lie at opposite ends of a diameter. The radius of circular orbit is $r = 2 \times 10^{11}$m and orbital period of each star is 0.6×10^7s. Find m. (in kg)
[Given $\pi^2 = 10$ and $G = \frac{20}{3} \times 10^{-11}\,Nm^2kg^{-2}$]
a) $\frac{11}{8} \times 10^{30}$ b) $\frac{15}{16} \times 10^{30}$
c) $\frac{40}{3} \times 10^{30}$ d) $\frac{20}{3} \times 10^{30}$

620. The value of gravitational acceleration 'g' at a height 'h' above the earth's surface is g/4 then (R = radius of earth)
a) $h = R$ b) $h = \frac{R}{2}$
c) $h = \frac{R}{3}$ d) $h = \frac{R}{4}$

621. A satellite of mass m moving around the earth of mass m_E in a circular orbit of radius R has angular momentum L. The rate of the area swept by the line joining the centre of the earth and satellite is
a) L/2 m   b) L/m   c) 2L/m   d) $2L/m_E$

622. Dependence of intensity of gravitational field I of earth with distance r from centre of earth is correctly represented by



623. The orbital velocity of a satellite very near to

the surface of earth is v. What will be its orbital velocity at an altitude 7 times the radius of the earth?

a) $v/\sqrt{2}$ b) $v/2$ c) $v/2\sqrt{2}$ d) $v/4$

624. A body is projected upwards with a velocity of $4 \times 11.2 kms^{-1}$ from the surface of earth. What will be the velocity of the body when it escapes from the gravitational pull of earth ?

a) $11.2 kms^{-1}$ b) $2 \times 11.2 kms^{-1}$
c) $3 \times 11.2 kms^{-1}$ d) $\sqrt{15} \times 11.2 kms^{-1}$

625. According to Kepler's law, the period of revolution of a planet (T) and its mean distance from the sun (r) are related by the equation

a) $T^2 r =$ Constant b) $T^2 r^{-3} =$ Constant
c) $Tr^3 =$ Constant d) $T^3 r^3 =$ Constant

626. A body falls freely under gravity. Its speed is v when it has lost an amount U of the gravitational energy. Then its mass is

a) $\frac{Ug}{v^2}$ b) $\frac{U^2}{g}$ c) $\frac{2U}{v^2}$ d) $2\ Ugv^2$

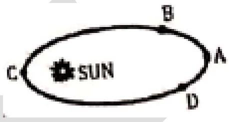
627. A satellite is orbiting the earth in a circular orbit of radius r. Its period of revolution varies as

a) $\sqrt{r}$ b) R c) $r^{\frac{3}{2}}$ d) r^2

628. If the horizontal velocity given to the satellite is equal to critical velocity, then the satellite performs

a) Circular path
b) Elliptical path
c) Parabolic path
d) Tangent to the curve path

629. A planet is moving around the sun in an elliptical orbit at different positions A, B, C, D. The maximum rotational kinetic energy of a planet is at position.



a) B b) A
c) D d) C

630. Radius of earth is equal to 6×10^6 m. Acceleration due to gravity is equal to 9.8 m/s^2. Gravitational constant G is equal to $6.67 \times 10^{-11} Nm^2 kg^{-2}$. Then mass of the earth is

a) 6.0×10^{24}kg b) 5.3×10^{24}kg
c) 5.9×10^{24}kg d) 6.6×10^{24}kg

631. The escape velocity of a body from the surface of the earth is v_e and the escape velocity of the body from a satellite orbiting at a height 'h' above the surface of the earth is v_e' then

a) $v_e = v_e'$ b) $v_e < v_e'$ c) $v_e > v_e'$ d) $v_e \le v_e'$

632. If the distance between the sun and the earth is increased by three times, then attraction between two will

a) remain constant b) decrease by 63%
c) increase by 63% d) decrease by 89%

633. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

a) 2R b) 4R c) $\frac{1}{4}R$ d) $\frac{1}{2}R$

634. The depth d, at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the surface, is (where, R = radius of the earth)

a) $\frac{R}{n}$ b) $R\left(\frac{n-1}{n}\right)$
c) $\frac{R}{n^2}$ d) $R\left(\frac{n}{n+1}\right)$

635. Calculate angular velocity of the earth, so that acceleration due to gravity at 60° latitude becomes zero. (Take, radius of the earth = 6400 km, gravitational acceleration at poles = 10 ms^{-2} and $\cos 60° = 0.5$)

a) $7.8 \times 10^{-2} rads^{-1}$ b) $0.5 \times 10^{-3} rads^{-1}$
c) $1 \times 10^{-3} rads^{-1}$ d) $2.5 \times 10^{-3} rads^{-1}$

636. Two spherical planets P and Q have the same uniform density ρ, masses M_P and M_Q and surface areas A and $4A$, respectively. A spherical planet R also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the planets P, Q and R are v_P, v_Q and v_A, respectively. Then,

a) $v_Q > v_A > v_P$ b) $v_A > v_Q > v_P$
c) $v_A/v_P = 3$ d) $v_p/v_Q = \frac{1}{2}$

637. The depth at which acceleration due to gravity becomes g/n is
[R = radius of earth, g = acceleration due to gravity, n = integer]

a) $\frac{R(n-1)}{n}$ b) $\frac{(n-1)}{nR}$
c) $\frac{Rn}{(n-1)}$ d) $\frac{n}{R(n-1)}$

638. Two satellite of masses m_1 and $m_2 (m_1 > m_2)$ are revolving round the earth in circular orbits of radii r_1 and $r_2 (r_1 > r_2)$ respectively. Which

of the following statements is true regarding their speeds v_1 and v_2?

a) $v_1 = v_2$ b) $v_1 > v_2$ c) $v_1 < v_2$ d) $\frac{v_1}{r_1} = \frac{v_2}{r_2}$

639. The ratio of the acceleration due to gravity on two planets P_1 and P_2 is k_1. The ratio, of their respective radii is k_2. The ratio of their respective escape velocities is

a) $\sqrt{k_1 k_2}$ b) $\sqrt{2k_1 k_2}$ c) $\sqrt{\frac{k_1}{k_2}}$ d) $\sqrt{\frac{k_2}{k_1}}$

640. A launching vehicle carrying an artificial satellite of mass m is set for launch on the surface of the earth of mass M and radius R. If the satellite is intended to move in a circular orbit of radius 7R, the minimum energy required to be spent by the launching vehicle on the satellite is (Gravitational constant = G)

a) $\frac{GMm}{R}$ b) $-\frac{13GMm}{14R}$

c) $\frac{GMm}{7R}$ d) $\frac{GMm}{14R}$

641. If the radius of the earth was to shrink by 2%, its mass remaining same, the acceleration due to gravity on the earth's surface would be

a) decrease by 2% b) increase by 2%

c) increase by 4% d) decrease by 4%

642. A body is projected vertically upwards from earth's surface. If its K. E. of projection is equal to half of its minimum value required to escape from the gravitational influence, then the height upto which it rises is (R = radius of the earth)

a) 4R b) R

c) 2R d) 3R

643. The period of revolution of planet A around the Sun is 8 times that of B. The distance of A from the Sun is n times greater than the distance of B from the sun. The value of n is

a) 4 b) 8 c) 12 d) 16

644. The mass and radius of earth is M_e and R_e respectively and that of moon is M_m and R_m respectively. The distance between the centre of earth and that of moon is 'D'. The minimum speed required for a body (mass 'm') to project from a point midway between their centers to escape to infinity is (G = Universal constant of gravitation)

a) $\frac{G(M_e + M_m)}{2D}$ b) $\sqrt{\frac{M_e + M_m}{D}}$

c) $\left(\frac{GD}{M_e}\right)^{1/2}$ d) $2\left(\sqrt{\frac{G(M_e + M_m)}{D}}\right)$

645. A uniform spherical planet (Radius R) has acceleration due to gravity at its surface as g. Points P and Q located inside and outside the planet respectively have acceleration due to gravity $\frac{g}{4}$. Maximum possible separation between P and Q is,

a) $\frac{3R}{2}$ b) $\frac{9R}{4}$ c) $\frac{7R}{4}$ d) None

646. What should be the velocity of earth due to rotation about its own axis so that the weight at equator becomes $(3/5)^{th}$ of initial value? (Radius of earth on equator = 6400 km, g = $10\frac{m}{s^2}$, $\cos 0^0 = 1$)

a) 7.91×10^{-4} rad/s b) 2.5×10^{-4} rad/s

c) 3.5×10^{-4} rad/s d) 6.5×10^{-4} rad/s

647. A black body is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass = 5.98×10^{24}kg) have to be compressed to be a black hole?

a) 10^{-9}m b) 10^{-6}m c) 10^{-2}m d) 100 m

648. The mass of the moon is (1/8) th of the earth but the gravitational pull is (1/6) th of the earth. It is due to the fact that,

a) moon is the satellite of the earth

b) the radius of the earth is (8/6) th of the moon radius

c) the radius of the earth is $\sqrt{(8/6)}$ th of the moon radius

d) the radius of the moon is (6/8) th of the earth radius

N.B.Navale

Date : 28.03.2025 **TEST ID: 41**
Time : 12:43:12 **PHYSICS**
Marks : 848

2.GRAVITATION,GRAVITATION,LAWS OF MOTION,THERMAL PROPERTIES OF MATTER

: ANSWER KEY :

1)	b	2)	b	3)	a	4)	b	165)	c	166)	a	167)	a	168)	c
5)	a	6)	a	7)	d	8)	a	169)	d	170)	d	171)	c	172)	c
9)	a	10)	d	11)	a	12)	a	173)	c	174)	d	175)	d	176)	d
13)	d	14)	a	15)	a	16)	b	177)	d	178)	d	179)	c	180)	d
17)	c	18)	c	19)	b	20)	d	181)	d	182)	d	183)	b	184)	a
21)	d	22)	b	23)	d	24)	d	185)	a	186)	c	187)	c	188)	a
25)	d	26)	d	27)	d	28)	c	189)	a	190)	a	191)	c	192)	c
29)	b	30)	b	31)	c	32)	b	193)	c	194)	c	195)	c	196)	c
33)	b	34)	a	35)	a	36)	a	197)	a	198)	b	199)	b	200)	a
37)	a	38)	c	39)	c	40)	c	201)	b	202)	b	203)	a	204)	a
41)	a	42)	c	43)	c	44)	d	205)	b	206)	c	207)	c	208)	a
45)	d	46)	d	47)	a	48)	b	209)	a	210)	c	211)	d	212)	d
49)	b	50)	d	51)	d	52)	c	213)	c	214)	c	215)	c	216)	c
53)	c	54)	d	55)	d	56)	a	217)	a	218)	a	219)	b	220)	b
57)	a	58)	d	59)	c	60)	b	221)	c	222)	c	223)	b	224)	b
61)	b	62)	a	63)	c	64)	c	225)	b	226)	b	227)	d	228)	a
65)	d	66)	c	67)	c	68)	c	229)	c	230)	c	231)	a	232)	c
69)	c	70)	c	71)	b	72)	b	233)	c	234)	c	235)	a	236)	b
73)	b	74)	b	75)	a	76)	a	237)	b	238)	b	239)	a	240)	d
77)	c	78)	c	79)	c	80)	d	241)	d	242)	a	243)	b	244)	b
81)	b	82)	b	83)	c	84)	a	245)	c	246)	c	247)	b	248)	b
85)	a	86)	a	87)	b	88)	b	249)	b	250)	b	251)	c	252)	c
89)	d	90)	d	91)	a	92)	a	253)	d	254)	d	255)	b	256)	b
93)	b	94)	c	95)	a	96)	a	257)	a	258)	a	259)	d	260)	d
97)	c	98)	a	99)	a	100)	a	261)	a	262)	a	263)	d	264)	d
101)	b	102)	b	103)	a	104)	c	265)	a	266)	a	267)	d	268)	d
105)	c	106)	c	107)	b	108)	d	269)	c	270)	c	271)	a	272)	a
109)	d	110)	a	111)	a	112)	a	273)	b	274)	b	275)	a	276)	a
113)	a	114)	c	115)	c	116)	a	277)	c	278)	c	279)	a	280)	a
117)	b	118)	b	119)	b	120)	b	281)	d	282)	d	283)	a	284)	a
121)	b	122)	c	123)	a	124)	b	285)	b	286)	b	287)	c	288)	c
125)	d	126)	d	127)	d	128)	d	289)	a	290)	a	291)	b	292)	b
129)	b	130)	d	131)	d	132)	c	293)	a	294)	a	295)	d	296)	d
133)	c	134)	c	135)	c	136)	a	297)	a	298)	a	299)	d	300)	d
137)	a	138)	d	139)	c	140)	a	301)	b	302)	c	303)	c	304)	d
141)	c	142)	b	143)	b	144)	a	305)	d	306)	b	307)	b	308)	a
145)	c	146)	c	147)	c	148)	a	309)	a	310)	c	311)	c	312)	a
149)	d	150)	a	151)	c	152)	c	313)	a	314)	c	315)	c	316)	b
153)	b	154)	c	155)	c	156)	b	317)	b	318)	d	319)	d	320)	d
157)	a	158)	a	159)	d	160)	c	321)	d	322)	c	323)	c	324)	a
161)	c	162)	d	163)	b	164)	b	325)	a	326)	b	327)	b	328)	b

329)	b	330)	d	331)	d	332)	d
333)	d	334)	c	335)	c	336)	a
337)	a	338)	a	339)	a	340)	a
341)	a	342)	c	343)	c	344)	b
345)	b	346)	b	347)	b	348)	c
349)	c	350)	b	351)	b	352)	c
353)	c	354)	c	355)	c	356)	c
357)	c	358)	a	359)	a	360)	d
361)	d	362)	b	363)	b	364)	a
365)	a	366)	b	367)	b	368)	a
369)	a	370)	a	371)	a	372)	d
373)	d	374)	d	375)	d	376)	a
377)	a	378)	a	379)	a	380)	b
381)	b	382)	a	383)	a	384)	a
385)	a	386)	d	387)	d	388)	b
389)	b	390)	c	391)	c	392)	c
393)	c	394)	c	395)	c	396)	c
397)	d	398)	d	399)	c	400)	c
401)	c	402)	d	403)	d	404)	c
405)	c	406)	d	407)	d	408)	b
409)	b	410)	d	411)	d	412)	d
413)	d	414)	d	415)	d	416)	a
417)	a	418)	d	419)	d	420)	b
421)	c	422)	c	423)	a	424)	a
425)	c	426)	c	427)	d	428)	d
429)	c	430)	c	431)	b	432)	b
433)	d	434)	d	435)	a	436)	a
437)	a	438)	a	439)	c	440)	c
441)	d	442)	d	443)	c	444)	c
445)	c	446)	c	447)	b	448)	b
449)	b	450)	b	451)	d	452)	d
453)	c	454)	b	455)	a	456)	b
457)	b	458)	b	459)	a	460)	d
461)	c	462)	c	463)	b	464)	a
465)	b	466)	c	467)	a	468)	a
469)	d	470)	c	471)	a	472)	a
473)	d	474)	b	475)	c	476)	b
477)	b	478)	d	479)	c	480)	c
481)	d	482)	b	483)	b	484)	d
485)	c	486)	d	487)	c	488)	d
489)	a	490)	d	491)	c	492)	c

493)	c	494)	b	495)	c	496)	c
497)	b	498)	b	499)	d	500)	d
501)	a	502)	a	503)	c	504)	b
505)	b	506)	b	507)	d	508)	d
509)	d	510)	d	511)	a	512)	c
513)	a	514)	b	515)	c	516)	c
517)	b	518)	b	519)	a	520)	b
521)	d	522)	b	523)	b	524)	d
525)	a	526)	c	527)	c	528)	d
529)	d	530)	a	531)	b	532)	a
533)	b	534)	b	535)	d	536)	a
537)	d	538)	d	539)	c	540)	c
541)	b	542)	b	543)	a	544)	d
545)	d	546)	c	547)	d	548)	a
549)	a	550)	a	551)	a	552)	d
553)	c	554)	b	555)	c	556)	b
557)	d	558)	a	559)	c	560)	c
561)	d	562)	b	563)	a	564)	d
565)	c	566)	c	567)	b	568)	b
569)	a	570)	b	571)	a	572)	d
573)	c	574)	b	575)	d	576)	b
577)	d	578)	a	579)	a	580)	a
581)	d	582)	c	583)	c	584)	c
585)	c	586)	b	587)	a	588)	d
589)	c	590)	d	591)	a	592)	c
593)	c	594)	d	595)	a	596)	b
597)	c	598)	b	599)	d	600)	b
601)	c	602)	a	603)	c	604)	a
605)	d	606)	a	607)	c	608)	d
609)	c	610)	b	611)	a	612)	d
613)	b	614)	b	615)	b	616)	a
617)	d	618)	b	619)	c	620)	a
621)	a	622)	b	623)	c	624)	d
625)	b	626)	c	627)	c	628)	a
629)	d	630)	b	631)	c	632)	d
633)	d	634)	b	635)	d	636)	b
637)	a	638)	c	639)	a	640)	b
641)	c	642)	b	643)	a	644)	d
645)	b	646)	a	647)	c	648)	c

N.B.Navale

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2.GRAVITATION,GRAVITATION,LAWS OF MOTION,THERMAL PROPERTIES OF MATTER

: HINTS AND SOLUTIONS :

Single Correct Answer Type

1 **(b)**

Given, $F = -5\hat{i} - 7\hat{j} + 3\hat{k}, s = 3\hat{i} - 2\hat{j} + a\hat{k}$ and $W = 14$ J

The work done by a force in displacing a particle through a distance is given by

$W = F.s$ ...(i)

Substituting above values in Eq. (i), we get

$14 = (-5\hat{i} - 7\hat{j} + 3\hat{k}) \cdot (3\hat{i} - 2\hat{j} + a\,\hat{k})$

$\Rightarrow 14 = -15 + 14 + 3a$

$\Rightarrow a = \frac{15}{3} = 5$

2 **(b)**

Given, $F = -5\hat{i} - 7\hat{j} + 3\hat{k}, s = 3\hat{i} - 2\hat{j} + a\hat{k}$ and $W = 14$ J

The work done by a force in displacing a particle through a distance is given by

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Substituting above values in Eq. (i), we get

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$\Rightarrow 14 = -15 + 14 + 3a$

$\Rightarrow a = \frac{15}{3} = 5$

3 **(a)**

$\because \frac{dQ}{dt} = \frac{K(\pi r^2)\Delta\theta}{l}$

$\Rightarrow \frac{\left(\frac{dQ}{dt}\right)_2}{\left(\frac{dQ}{dt}\right)_1} = \frac{K_2 \times r_2^2 \times l_1}{K_1 \times r_1^2 \times l_2} = \frac{1}{2} \times \frac{1}{4} \times \frac{2}{1}$

$\Rightarrow \left(\frac{dQ}{dt}\right)_2 = \frac{\left(\frac{dQ}{dt}\right)_1}{4} = \frac{4}{4} = 1$

4 **(b)**

Original value of circumference, $I = 2\,\pi R$

$\therefore\ \Delta l = l\ \alpha\theta = (2\pi R)\alpha\theta$

5 **(a)**

Let initial velocity of first sphere be $u_1 = v, u_2 = 0$

Let v_1 and v_2 be their final velocities.

By law of conservation of momentum: $mu_1 = mv_1 + mv_2$

$\therefore u_1 = v_1 + v_2$

$\therefore v_1 = u_1 - v_2$

Coefficient of restitution: $e = \frac{v_2 - v_1}{u_1 - 0} = \frac{v_2 - v_1}{u_1}$

$= \frac{v_2}{u_1} - \frac{v_1}{u_1}$

$\therefore \frac{v_2}{u_1} = e + \frac{v_1}{u_1} = e + \left(\frac{u_1 - v_2}{u_1}\right) = e + 1 - \frac{v_2}{u_1}$

$\therefore 2\frac{v_2}{u_1} = e + 1$

$\therefore \frac{v_2}{u_1} = \frac{e+1}{2}$

6 **(a)**

Let initial velocity of first sphere be $u_1 = v, u_2 = 0$

Let v_1 and v_2 be their final velocities.

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$\therefore u_1 = v_1 + v_2$

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$= \frac{v_2}{u_1} - \frac{v_1}{u_1}$

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$\therefore 2\frac{v_2}{u_1} = e + 1$

$\therefore \frac{v_2}{u_1} = \frac{e+1}{2}$

7 **(d)**
Let θ be the temperature of the mixture.

Heat gained by water at 0°C = Heat lost by water at 10°C

$c_2 m_1(\theta - 0) = c_2 m_2(10 - \theta)$

$\theta = \frac{400}{60} = 6.66°C$

8 **(a)**
acceleration $a = \frac{F}{m}$

At time t, velocity $v = at = \frac{Ft}{m}$

Kinetic energy $= \frac{1}{2}mv^2$

$= \frac{1}{2}m\frac{F^2t^2}{m^2} = \frac{1}{2}\frac{F^2t^2}{m}$

9 **(a)**
acceleration $a = \frac{F}{m}$

At time t, velocity $v = at = \frac{Ft}{m}$

Kinetic energy $= \frac{1}{2}mv^2$

$= \frac{1}{2}m\frac{F^2t^2}{m^2} = \frac{1}{2}\frac{F^2t^2}{m}$

10 **(d)**
Rate of heat flow, $\frac{Q}{t} = \frac{KA\Delta\theta}{l}$

$\Rightarrow \frac{K_A}{K_B} = \frac{A_B}{A_A} = \left(\frac{r_B}{r_A}\right)^2 = \frac{1}{4}$

$\Rightarrow K_A = \frac{K_B}{4}$

11 **(a)**
$Mv + 0 = 0 + 4MV$

$\therefore V = \frac{Mv}{4M} = \frac{v}{4}$

$e = \frac{v/4}{v} = \frac{1}{4} = 0.25$

12 **(a)**
$Mv + 0 = 0 + 4MV$

$\therefore V = \frac{Mv}{4M} = \frac{v}{4}$

$e = \frac{v/4}{v} = \frac{1}{4} = 0.25$

13 **(d)**
Fractional change in period,

$\frac{\Delta T}{T} = \frac{1}{2}\alpha\Delta\theta = \frac{1}{2} \times 2 \times 10^{-6} \times 10 = 10^{-5}$

% change $= \frac{\Delta T}{T} \times 100 = 10^{-5} \times 100 = 10^{-3}\%$

14 **(a)**
Since the particle is initially at rest, its initial momentum is zero. Since no external force is acting on it, its momentum should remain constant.

$\therefore m_1v_1 + m_2v_2 = 0$

$\therefore m_1v_1 = -m_2v_2$

Their momenta will be same in magnitude (but opposite in direction)

Kinetic energy (k) is given by

$k = \frac{p^2}{2m}$

$\therefore p = \sqrt{2mk} =$

$\therefore \sqrt{2m_1k_1} = \sqrt{2m_2k_2}$

15 **(a)**
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$\therefore \sqrt{2m_1k_1} = \sqrt{2m_2k_2}$

16 **(b)**

Applying, $\frac{T_1 - T_2}{t} = \alpha\left[\frac{T_1+T_2}{2} - T_0\right]$

where, α is constant.

$\frac{80-60}{10} = \alpha\left[\frac{80+60}{2} - 30\right]$ ...(i)

$\frac{60-\theta}{10} = \alpha\left[\frac{60+\theta}{2} - 30\right]$ ...(ii)

Solving these two equations, we get

$\theta = 48°C$

17 **(c)**

Torque = force × distance

Moment of force = force × distance

18 **(c)**

Torque = force × distance

Moment of force = force × distance

19 **(b)**

Let the temperature of junction be Q.

In equilibrium, rate of flow of heat through rod 1 = sum of rate of heat through rods 2 and 3.

$$\left(\frac{dQ}{dt}\right)_1 = \left(\frac{dQ}{dt}\right)_2 + \left(\frac{dQ}{dt}\right)_3$$

$$KA\frac{(\theta - 0)}{I} = \frac{KA(90° - \theta)}{I} + \frac{KA(90° - \theta)}{I}$$

$\Rightarrow \theta = 2(90° - \theta)$

or $3\theta = 180° \Rightarrow \theta = \frac{180°}{3} = 60°$

20 **(d)**

impulse received by m

$J = m(v_f - v_i)$

$= m\,(-2\,\hat{i} + \hat{j} - 3\,\hat{i} - 2\,\hat{j})$

$= m(-5\,\hat{i} - J)$

a. Impulse received by M = -J = m $(5\,\hat{i} + \hat{j})$

b. Mv = m $(5\,\hat{i} + \hat{j})$

or $v = \frac{m}{M}(5\,\hat{i} + \hat{j}) = \frac{1}{13}(5\,\hat{i} + \hat{J})$

c. e= (relative velocity of separation / relative velocity of approach) in the direction of $-\hat{J}$ = 11/17

21 **(d)**

impulse received by m

$J = m(v_f - v_i)$

$= m\,(-2\,\hat{i} + \hat{j} - 3\,\hat{i} - 2\,\hat{j})$

$= m(-5\,\hat{i} - J)$

a. Impulse received by M = -J = m $(5\,\hat{i} + \hat{j})$

b. Mv = m $(5\,\hat{i} + \hat{j})$

or $v = \frac{m}{M}(5\,\hat{i} + \hat{j}) = \frac{1}{13}(5\,\hat{i} + \hat{J})$

c. e= (relative velocity of separation / relative velocity of approach) in the direction of $-\hat{J}$ = 11/17

22 **(b)**

Density of water = 10^3 kg m^{-3}

Let the final temperature of the mixture be t.

Assuming no heat transfer to or from container,

Heat lost by water = $0.1 \times 10^3 \times S_{water} \times (80 - t)$

Heat gained by water = $0.3 \times 10^3 \times S_{water}\,(t - 60)$

According to principle of calorimetry,

Heat lost = Heat gain

$$0.1 \times 10^3 \times S_{water} \times (80 - t) = 0.3 \times 10^3 \times S_{water} \times (t - 60)$$

$\Rightarrow 1 \times (80 - t) = 3 \times (t - 60)$

$\Rightarrow t = 65°C$

23 **(d)**

τ required to open/close the door will remain constant.

$$r_1 \times F_1 = r_2 \times F_2$$

$$1.6 \times 1 = 0.4 \times F_2 \Rightarrow F_2 = 4\ \text{N}$$

24 **(d)**
τ required to open/close the door will remain constant.

$$r_1 \times F_1 = r_2 \times F_2$$

$$1.6 \times 1 = 0.4 \times F_2 \Rightarrow F_2 = 4\ \text{N}$$

25 **(d)**
Temperature of mixture,

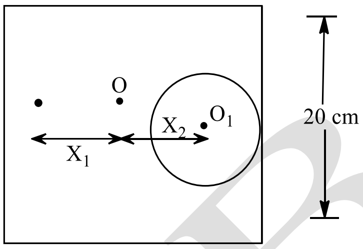
$$\theta_{mix} = \frac{m_1c_1T_1 + m_2c_2T_2}{m_1c_1 + m_2c_2}$$

$$= \frac{m \times c \times 2T + \frac{m}{2}(2c)T}{m \times c + \frac{m}{2}(2c)} = \frac{3}{2}T$$

26 **(d)**
As, here, $A_1x_1 = A_2x_2$

or $x_1 = \frac{A_2}{A_1}.x_2$

$$= \frac{\left(\frac{\pi}{4}\right)(8)^2}{(20)^2} \times 6$$

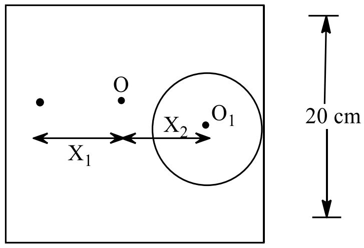


$= 0.7539$ cm from O

27 **(d)**
As, here, $A_1x_1 = A_2x_2$

or $x_1 = \frac{A_2}{A_1}.x_2$

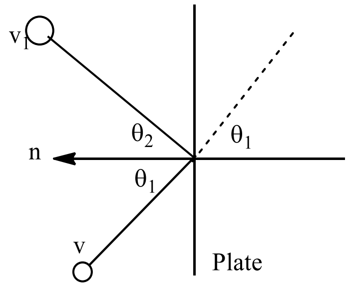
$$= \frac{\left(\frac{\pi}{4}\right)(8)^2}{(20)^2} \times 6$$



$= 0.7539$ cm from O

28 **(c)**
$r_2 = \frac{r_1}{2}$
$\therefore \frac{A_2}{A_1} = \left(\frac{r_2}{r_1}\right)^2 = \frac{1}{4}$
Since volume of rod will remains constant
$V = L_1A_1 = L_2A_2$
$\therefore \frac{L_2}{L_1} = \frac{A_1}{A_2} = 4$
$Q_1 = \frac{KA_1\Delta\theta}{L_1}, Q_2 = \frac{KA_2\Delta\theta}{L_2}$
$\frac{Q_1}{Q_2} = \frac{A_1}{A_2}.\frac{L_2}{L_1} = 4 \times 4 = 16$
$\therefore Q_1 = 16Q_2$
$\therefore Q_1 - Q_2 = 16Q_2 - Q_2 = 15Q_2$
$\therefore \frac{Q_1 - Q_2}{Q_1} = \frac{15}{16}$
or $Q_1 - Q_2 = \frac{15}{16}Q_1$

29 **(b)**
Since, no force is present along the surface, so momentum conservation principle for ball is applicable along the surface of plate.



$$mv\sin\theta_1 = mv_1\sin\theta_2$$

or $v\sin\theta_1 = v_1\sin\theta_2$

$\because \quad e = \frac{v_1\cos\theta_2}{v\cos\theta_1} = \frac{v_1\cos\theta_2}{v\cos\theta} \quad [\because\ \theta_1 = \theta]$

$\Rightarrow \quad v_1\cos\theta_2 = ev\cos\theta$

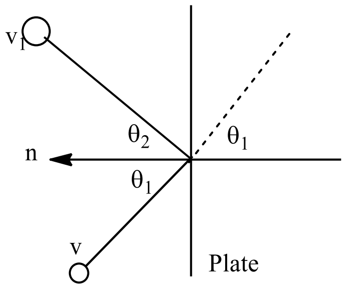
$\therefore \quad \frac{v_1\sin\theta_2}{v_1\cos\theta_2} = \frac{v\sin\theta}{ev\cos\theta} = \frac{\tan\theta}{e}$

$\Rightarrow \quad \tan\theta_2 = \frac{\tan\theta}{e}$

$\Rightarrow \quad \theta_2 = \tan^{-1}\left(\tan\frac{\theta}{e}\right)$

30 **(b)**

Since, no force is present along the surface, so momentum conservation principle for ball is applicable along the surface of plate.



$mv\sin\theta_1 = mv_1\sin\theta_2$

or $\quad v\sin\theta_1 = v_1\sin\theta_2$

$\because \quad e = \frac{v_1\cos\theta_2}{v\cos\theta_1} = \frac{v_1\cos\theta_2}{v\cos\theta} \quad [\because \theta_1 = \theta]$

$\Rightarrow \quad v_1\cos\theta_2 = ev\cos\theta$

$\therefore \quad \frac{v_1\sin\theta_2}{v_1\cos\theta_2} = \frac{v\sin\theta}{ev\cos\theta} = \frac{\tan\theta}{e}$

$\Rightarrow \quad \tan\theta_2 = \frac{\tan\theta}{e}$

$\Rightarrow \quad \theta_2 = \tan^{-1}\left(\tan\frac{\theta}{e}\right)$

31 **(c)**

In Celsius scale the freezing and boiling points are 0°C to 100°C. In the given imaginary scale the freezing and boiling points are 39^0W and 239^0W. Hence we can write

$$\frac{C}{100} = \frac{W-39}{200}$$

For $C = 39^0, \frac{39}{100} = \frac{W-39}{200}$

Solving, W = 117°C

32 **(b)**

According to the graph, the acceleration a varies linearly with the coordinate x. We may write a= αx, where α is the slope of the graph.

$\alpha = \frac{20}{8} = 2.5\ s^{-2}$

The force on the brick is in the positive x - direction and according to Newton's second law, its magnitude is given by

$$F = \frac{a}{m} = \frac{\alpha}{m}x$$

If x_f is the final coordinate, the work done by the force is

$$W = \int_0^{x_f} F\,dx = \frac{\alpha}{m}\int_0^{x_f} x\,dx$$

$$= \frac{\alpha}{2m}x_f^2 = \frac{2.5}{2\times10}\times(8)^2 = 8\ J$$

33 **(b)**

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34 **(a)**

Snow contains air pockets.

35 **(a)**

$$\text{Force} = \frac{\text{change in momentum}}{\text{time}} = mv - mu$$

Taking initial direction as negative

$u = -12\frac{m}{s}, v = 20\frac{m}{s}$

$$\therefore F = \frac{0.150[20-(-12)]}{0.01} = \frac{0.150[20+12]}{0.01}$$
$$= 480\ N$$

36 **(a)**

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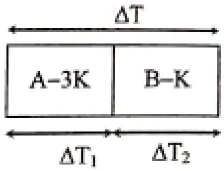
37 **(a)**



$\Delta T = 48°C$

Thermal resistance of layer A will be one third of the layer B.

$$\therefore \Delta T_1 = \frac{\Delta T_2}{3}$$

or $\Delta T_2 = 3\Delta T_1$

$\Delta T_1 + \Delta T_2 = \Delta T$

$4\Delta T_1 = \Delta T$

$$\therefore \Delta T_1 = \frac{\Delta T}{4} = \frac{48}{4} = 12°C$$

38 **(c)**
$F = 3i + 6j + 2k$

$s = -4i + xj + 3k$

$12 = -12 + 6x + 6$

$\therefore x = 3$

39 **(c)**
$F = 3i + 6j + 2k$

$s = -4i + xj + 3k$

$12 = -12 + 6x + 6$

$\therefore x = 3$

40 **(c)**
The volume of the rod will remain same. Hence if the length becomes four times. Its area of cross-section will become one-fourth.

$$\therefore \frac{L_2}{L_1} = \frac{4}{1}, \frac{A_2}{A_1} = \frac{1}{4}$$

$$\frac{Q_1}{t} = \frac{KA_1\Delta\theta}{L_1} \text{ and } \frac{Q_2}{t} = \frac{KA_2\Delta\theta}{L_2}$$

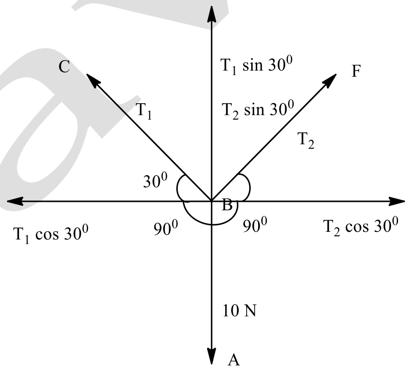
$$\therefore \frac{Q_1}{Q_2} = \frac{A_1}{A_2}.\frac{L_2}{L_1} = 4 \times 4 = 16$$

41 **(a)**
Same amount of heat is supplied to copper and water.

So, $m_C c_C \Delta T_C = m_W c_W \Delta T_W$

$$\Rightarrow \Delta T_W = \frac{m_C c_C (\Delta T)_C}{m_W c_W}$$
$$= \frac{50 \times 10^{-3} \times 420 \times 10}{10 \times 10^{-3} \times 4200} = 5°C$$

42 **(c)**
As shown in figure



$T_1 \cos 30^0 = T_2 \cos 30^0$

$\therefore \quad T_1 = T_2 = T \quad$ (let)

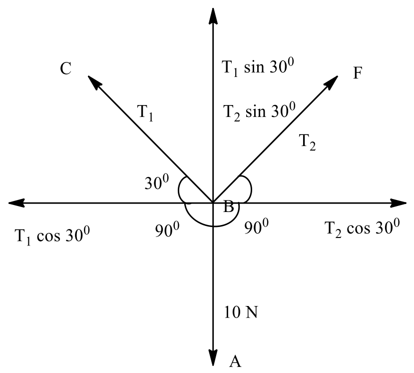
Again, $T_1 \sin 30^0 + T_2 \sin 30^0 = 10$ and $2T \sin 30^0 = 10$

$\Rightarrow \quad 2T.\frac{1}{2} = 10$

$\Rightarrow \quad T = 10 \text{ N}$

Thus, the tension in the sections BC and BF are 10 N and 10 N, respectively.

43 **(c)**
As shown in figure



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$\Rightarrow \quad 2T.\frac{1}{2} = 10$

$\Rightarrow \quad T = 10$ N

Thus, the tension in the sections BC and BF are 10 N and 10 N, respectively.

44 **(d)**
$M \times v\hat{i} + 2M \times 3v\hat{j} = 3M\bar{v}$

$v\hat{i} + 6v\hat{j} = 3\bar{v}$

$\frac{v}{3}\hat{i} + 2v\hat{j} = \bar{v}$

45 **(d)**
$M \times v\hat{i} + 2M \times 3v\hat{j} = 3M\bar{v}$

$v\hat{i} + 6v\hat{j} = 3\bar{v}$

$\frac{v}{3}\hat{i} + 2v\hat{j} = \bar{v}$

46 **(d)**
$$Q_1 = \frac{kA(T_1 - T_2)}{L_1} = \frac{k\pi r_1^2(T_1 - T_2)}{L_1}$$

$$Q_2 = \frac{k\pi r_2^2(T_1 - T_2)}{L_2}$$

$$\frac{Q_2}{Q_1} = \frac{r_2^2}{r_1^2}.\frac{L_1}{L_2} = (2)^2.\frac{1}{2} = 2$$

$\therefore Q_2 = 2Q_1$

47 **(a)**
Heat energy gained,

$Q = mc\,\Delta T = 5 \times (1000 \times 4.2) \times (100 - 20)$

$= 1680 \times 10^3$ J $= 1680$ kJ

48 **(b)**
Torque, $\tau = r \times F$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ -2 & 2 & 3 \end{vmatrix}$$

$= \hat{i}(-6-2) + \hat{j}(-2-3) + \hat{k}(2-4)$

Torque of force, $\tau = -8\hat{i} - 5\hat{j} - 2\hat{k}$

49 **(b)**
Torque, $\tau = r \times F$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ -2 & 2 & 3 \end{vmatrix}$$

$= \hat{i}(-6-2) + \hat{j}(-2-3) + \hat{k}(2-4)$

Torque of force, $\tau = -8\hat{i} - 5\hat{j} - 2\hat{k}$

50 **(d)**
Since the balls hit elastically, they will rebound with the same velocity. Hence the change in momentum for each collision is$-(-mv) = 2mv$

Since n balls hit per second, the change in momentum per second is 2nmv. This is equal to force.

51 **(d)**
Since the balls hit elastically, they will rebound with the same velocity. Hence the change in momentum for each collision is$-(-mv) = 2mv$

Since n balls hit per second, the change in momentum per second is 2nmv. This is equal to force.

52 **(c)**
$$H = \frac{KA(T_1 - T_2)}{l} = \frac{K\pi r^2(T_1 - T_2)}{l}$$

$$\frac{H_2}{H_1} = \left(\frac{r_2}{r_1}\right)^2\left(\frac{l_1}{l_2}\right) = (2)^2 \times \frac{1}{2} = 2$$

$\therefore H_2 = 2H$

53 **(c)**

For carbon dioxide, number of moles, $n_1 = \frac{22}{44} = \frac{1}{2}$;

molar specific heat of CO_2 at constant volume, $C_{V_1} = 3R$

For oxygen, number of moles, $n_2 = \frac{16}{32} = \frac{1}{2}$;

molar specific heat of O_2 at constant volume, $C_{V_2} = \frac{5R}{2}$

Let T kelvin be the temperature of mixture.

Heat lost by O_2 = Heat gained by CO_2

$$n_2 C_{V_2} \Delta T_2 = n_1 C_{V_1} \Delta T_1$$

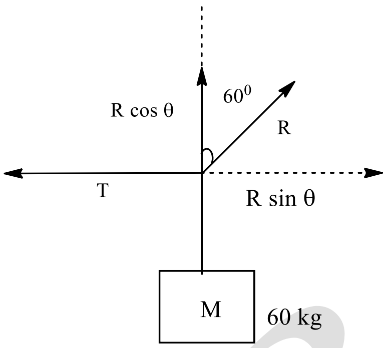
$$\frac{1}{2}\left(\frac{5}{2}R\right)(310 - T) = \frac{1}{2} \times (3R)(T - 300)$$

or $1550 - 5T = 6T - 1800$

or $T = 304.54\ K = 31.5°C$

54 **(d)**

The given figure can be drawn as



Taking component of forces, $R \cos\theta = Mg$

$\Rightarrow \quad R \cos 60^0 = Mg \quad$ ...(i)

and $\quad R \sin 60^0 = T \quad$ ...(ii)

From Eqs. (i) and (ii), we get

$\Rightarrow \tan 60^0 = \frac{T}{Mg} \Rightarrow T = Mg \tan 60^0$

or $\quad T = 60 \times g \times \sqrt{3} = 103.9$ kgf

55 **(d)**

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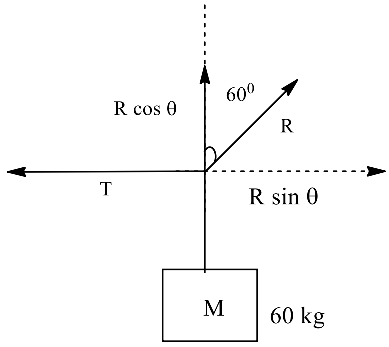

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56 **(a)**

Law of conservation of momentum:

$$M_1V_1 + M_2V_2 = 0$$

$$\therefore M_1V_1 = -M_2V_2$$

$$(KE)_1 = \frac{(M_1V_1)^2}{2M_1};$$

$$(KE)_2 = \frac{(M_2V_2)^2}{2M_2} = \frac{(M_1V_1)^2}{2M_2}$$

$$\therefore \frac{(KE)_1}{(KE)_2} = \frac{M_2}{M_1}$$

57 **(a)**

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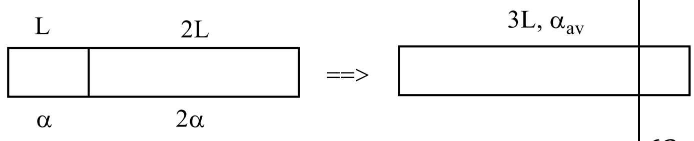
$$\therefore \frac{(KE)_1}{(KE)_2} = \frac{M_2}{M_1}$$

58 **(d)**

Given, $n = 8$ mol, $\Delta t = 30°C$

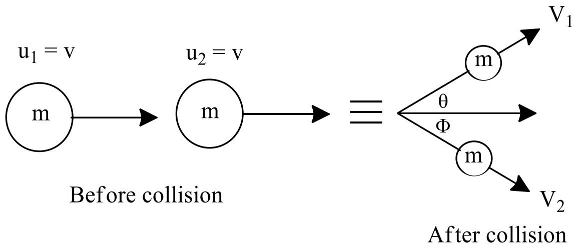
$$\therefore\ Q = nC_p\Delta T \Rightarrow Q = 8 \times \frac{5}{2} \times 8.31 \times 30 \approx 5000$$

59 **(c)**
$L\alpha\Delta\theta + 2L(2\alpha)(\Delta\theta) = (3L)(\alpha_{av})\Delta\theta$



or $\alpha_{av} = \frac{5}{3}\alpha$

60 **(b)**
The situation can be shown as below.



Applying law of conservation of kinetic energy,

KE (before collision) = KE (after collision)

$$\frac{1}{2}mv^2 + \frac{1}{2}m(0)^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$$

$$\Rightarrow v^2 = v_1^2 + v_2^2$$

$$\Rightarrow v_2 = \sqrt{v^2 - v_1^2}$$

Thus, the velocity of second block after collision is $\sqrt{v^2 - v_1^2}$

61 **(b)**
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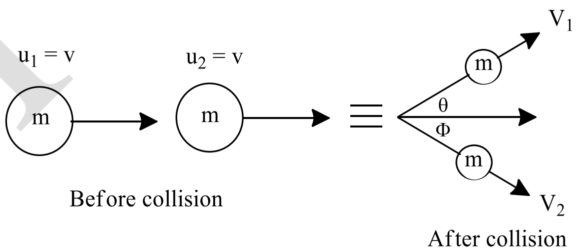

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Thus, the velocity of second block after collision is $\sqrt{v^2 - v_1^2}$

62 **(a)**
Before explosion momentum = 0

After explosion total momentum will be zero

$\therefore -3P\hat{i} + 2P\hat{j} + A = 0$

$A = 3P\hat{i} - 2P\hat{j}$

$|A| = \sqrt{9 + 4P} = \sqrt{13}P$

63 **(c)**
In the first case, there is no displacement. Hence work done is zero.

In the second case, work done

$W = mgh = 2 \times 9.8 \times 1 = 19.6$ J

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In the second case, work done

$W = mgh = 2 \times 9.8 \times 1 = 19.6$ J

65 **(d)**
As, $I = I_0\left(1 + \frac{1}{100}\right)$

or $2I^2 = 2I_0^2\left(1 + \frac{1}{100}\right)^2$

$\Rightarrow\ 2I^2 - 2I_0^2 = 2I_0^2 \times \frac{2}{100}$

$\Delta A = A \times \frac{2}{100}$

or $\frac{\Delta A}{A} = \frac{2}{100} = 2\%$

66 **(c)**
$Q = \frac{kAd\theta}{d}$
If the radius of the cylindrical rod is doubled, then its area of cross-section will become four times.
$\therefore A_2 = 4A_1$
Also $d_2 = d_1$

$\therefore \frac{Q'}{Q} = \frac{A_2}{A_1}.\frac{d_1}{d_2} = 4 \times \frac{1}{2} = 2$

$\therefore Q' = 2Q$

67 **(c)**

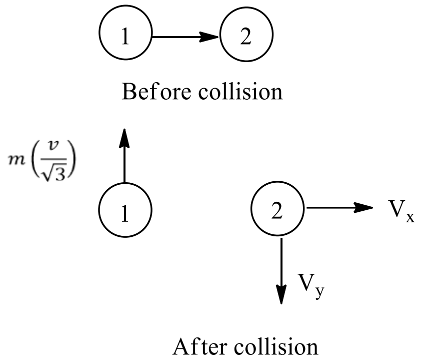
in x- direction,

Apply conservation of momentum, we get

$mu_1 + 0 = mv_x$

$\Rightarrow \quad mv = mv_x$

$\Rightarrow \quad v_x = v$



In y-direction, apply conservation of momentum, we get

$$0 + 0 = m\left(\frac{v}{\sqrt{3})}\right) - mv_y \Rightarrow v_y = \frac{v}{\sqrt{3}}$$

Velocity of second mass after collision ,

$$v' = \sqrt{\left(\frac{v}{\sqrt{3}}\right)^2 + v^2} = \sqrt{\frac{4}{3}v^2}$$

or $\quad v' = \frac{2}{\sqrt{3}}\ v$

68 **(c)**

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$mu_1 + 0 = mv_x$

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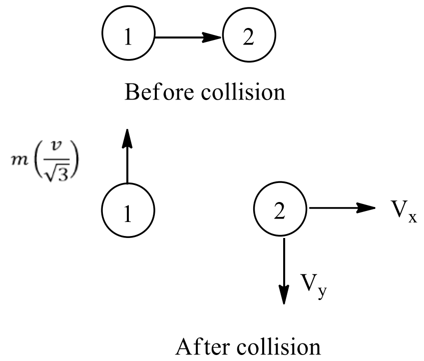

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or $\quad v' = \frac{2}{\sqrt{3}}\ v$

69 **(c)**

Let V' be the speed of the second ball after collision. Since the collision is elastic, the kinetic energy is conserved.

$$\therefore \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{v}{3}\right)^2 + \frac{1}{2}mv'^2$$

$$\therefore v^2 = \left(\frac{v}{3}\right)^2 + v'^2$$

$$v'^2 = v^2 - \frac{v^2}{9} = \frac{8v^2}{9}$$

$$\therefore v' = \frac{2\sqrt{2}v}{3}$$

70 **(c)**

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$$\therefore v^2 = \left(\frac{v}{3}\right)^2 + v'^2$$

$$v'^2 = v^2 - \frac{v^2}{9} = \frac{8v^2}{9}$$

$\therefore v' = \frac{2\sqrt{2}v}{3}$

71 **(b)**

$\text{Thermal resistance} = \frac{\text{Temp. difference}}{\text{Thermal current}} = \frac{28}{1400}$
$= 0.02°\text{C/s cal}$

72 **(b)**

$d = 1\text{m}, A = 10^{-3}\text{m}^2, K = 96\frac{\text{cal}}{\text{s}}\text{m°C}, L$
$= 8 \times 10^4 \text{ cal/kg}$

$t = 1 \text{ min} = 60 \text{ s}, \theta_1 = 0°\text{C}, \theta_2 = 100°\text{C}$

$Q = \frac{KA\Delta\theta t}{d} = mL$

$\therefore m = \frac{KA\Delta\theta t}{L} = \frac{96 \times 10^{-3} \times 100 \times 60}{80 \times 10^4}$
$= 7.2 \times 10^{-3} \text{ kg}$

73 **(b)**

If k is the kinetic energy and p is the momentum then

$k = \frac{p^2}{2m}$

$\therefore p^2 = 2mk$

If k is constant, then $p^2 \propto m$

74 **(b)**

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$k = \frac{p^2}{2m}$

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If k is constant, then $p^2 \propto m$

75 **(a)**

Let the coordination of the centre of mass be (x,y).

$x = \frac{m_1x_1 + m_2x_2}{m_1 + m_2} = \frac{1 \times (-1) + 2 \times 2}{3} = \frac{-1+4}{3} =$
1

$Y = \frac{m_1y_1 + m_2y_2}{m_1 + m_2} = \frac{1 \times 2 + 2 \times 4}{3} \ \frac{2+8}{3} = \frac{10}{3}$

Therefore, the coordinates of centre of mass be $\left(1, \frac{10}{3}\right)$.

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$Y = \frac{m_1y_1 + m_2y_2}{m_1 + m_2} = \frac{1 \times 2 + 2 \times 4}{3} \ \frac{2+8}{3} = \frac{10}{3}$

Therefore, the coordinates of centre of mass be $\left(1, \frac{10}{3}\right)$.

77 **(c)**

Maximum potential energy is attained at the highest point which gets converted into kinetic energy at the lowest point.

$h = 2 - 0.75 = 1.25 \text{ m}$

$\frac{1}{2}mv^2 = mgh$

$\therefore v^2 = 2gh = 2 \times 10 \times 1.25 = 25$

$\therefore v = 5 \text{ m/s}$

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79 **(c)**

Applying Newton's law of cooling,

$\frac{90-70}{6} = K\left(\frac{90+70}{2} - 30\right)$

$\text{or} \frac{20}{6} = K(80 - 30) = 50 \text{ K}$

$\therefore K = \frac{20}{6 \times 50} = \frac{1}{15}$

$\text{Also,} \frac{70-50}{t} = K\left(\frac{70+50}{2} - 30\right)$

$\text{or} \frac{20}{t} = K(60 - 30) = 30 \text{ K}$

$\therefore t = \frac{20}{30K} = \frac{2}{3K} = \frac{2 \times 15}{3} = 10$ min

80 **(d)**
Coefficient of cubical expansion of liquid= γ

Coefficient of linear expansion of copper= $\frac{\gamma}{3}$

$\therefore$ coefficient of cubical expansion of copper= $3 \times \frac{\gamma}{3} = \gamma$

$\therefore$ Since the coefficient of cubical expansion of liquid and the container is same. They will expand by almost same amount and hence liquid level will remain almost the same.

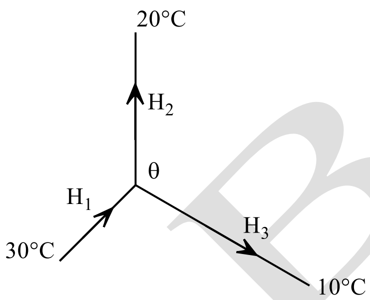
81 **(b)**
Torque, τ r× F

$\Rightarrow \tau = 4\hat{j} \times (-6\hat{i}) = -(-24\hat{k}) = 24\hat{k}$

82 **(b)**
Torque, τ r× F

$\Rightarrow \tau = 4\hat{j} \times (-6\hat{i}) = -(-24\hat{k}) = 24\hat{k}$

83 **(c)**
Let θ be the temperature of junction and H_1, H_2 and H_3 the heat currents. Then,



$H_1 = H_2 + H_3$

$\text{or } \frac{30-\theta}{\left(\frac{30}{KA}\right)} = \frac{\theta-20}{\left(\frac{20}{KA}\right)} + \frac{\theta-10}{\left(\frac{10}{KA}\right)}$

or $2(30-\theta) = 3(\theta-20) + 3(2\theta-20)$

or $\theta = 16.36°C \approx 16.4°C$

84 **(a)**
According to law of conservation of momentum

$mv = (m+M)v'$

$\therefore v' = \frac{m}{m+M}v$

85 **(a)**
According to law of conservation of momentum

$mv = (m+M)v'$

$\therefore v' = \frac{m}{m+M}v$

86 **(a)**

$K_c = 9K_s, L_c = 3Ls$

$\frac{Q}{t} = \frac{K_c A(100-\theta)}{L_c} = \frac{K_s A(\theta-0)}{L_s}$

Putting $K_c = 9K_s$ and $L_c = 3L_s$ and solving $\theta = 75°C$

87 **(b)**
The change in momentum of one ball,

$\Delta p = mu - (-mu) = 2mu$

The force exerted on the wall by N balls,

$F = \frac{\text{Change in momentum for N balls}}{\text{Total time (t)}}$

$= \frac{2mNu}{1} \quad (\because t = 1\text{ s})$

$= 2\text{ n Nu}$

88 **(b)**
The change in momentum of one ball,

$\Delta p = mu - (-mu) = 2mu$

The force exerted on the wall by N balls,

$F = \frac{\text{Change in momentum for N balls}}{\text{Total time (t)}}$

$= \frac{2mNu}{1} \quad (\because t = 1\text{ s})$

$= 2\text{ n Nu}$

89 **(d)**
Given, force, $F = (3\hat{i} + 4\hat{j})$ N

Displacement, $s = (3\hat{i} + 4\hat{j})$ m

$\therefore$ Work done, $W = F.s$

$= (3\hat{i} + 4\hat{j}).(3\hat{i} + 4\hat{j}) = 9 + 16$

$\Rightarrow$ $W = 25$ J

90 **(d)**
Given, force, $F = (3\hat{i} + 4\hat{j})$ N

Displacement, $s = (3\hat{i} + 4\hat{j})$ m

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$= (3\hat{i} + 4\hat{j}).(3\hat{i} + 4\hat{j}) = 9 + 16$

$\Rightarrow$ $W = 25$ J

91 **(a)**
Let the velocity of block of mass 2 m after the collision be v', then from conservation of momentum,

$$mv = 2mv' \Rightarrow v' = \frac{v}{2}$$

Now, the coefficient of restitution,

$$e = \frac{\text{velocity of separation}}{\text{velocity of approach}}$$

$$= \frac{v'}{v} = \frac{\frac{v}{2}}{v} = \frac{1}{2} = 0.5$$

92 **(a)**
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$$= \frac{v'}{v} = \frac{\frac{v}{2}}{v} = \frac{1}{2} = 0.5$$

93 **(b)**
$$R_1 = \left(\frac{Q}{t}\right)_1 = \frac{K_1A_1\Delta\theta}{L}, R_2 = \left(\frac{Q}{t}\right)_2 = \frac{K_2A_2\Delta\theta}{L}$$

$R_2 = 3R_1$

$$\therefore 3\ \frac{K_1A_1\Delta\theta}{L} = \frac{K_2A_2\Delta\theta}{L}$$

$\therefore 3K_1A_1 = K_2A_2$

94 **(c)**
$V = V_0(1 + \gamma\Delta\theta)$
$L^3 = L_0(1 + \alpha_1\Delta\theta)L_0^2(1 + \alpha_2\Delta\theta)^2$
$= L_0^3(1 + \alpha_1\Delta\theta)(1 + \alpha_2\Delta\theta)^2$
Since, $L_0^3 = V_0$ and $L^3 = V$,
Hence $1 + \gamma\Delta\theta = (1 + \alpha_1\Delta\theta)(1 + \alpha_2\Delta\theta)^2$

$\cong (1 + \alpha_1\Delta\theta)(1 + 2\alpha_2\Delta\theta)$

$\cong (1 + \alpha_1\Delta\theta + 2\alpha_2\Delta\theta)$

$\Rightarrow \gamma = \alpha_1 + 2\alpha_2$

95 **(a)**
Area under the F-t graph gives change in momentum. Since the body is initially at rest, it gives the momentum of the body after 1 second.

Area $= 10 \times 0.5 + 20 \times 0.5$

$= 5 + 10 = 15$ N $-$ s

$\therefore mV = 15$ N $-$ s

$$V = \frac{15}{m} = \frac{15}{3} = 7.5 \text{ m/s}$$

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$= 5 + 10 = 15$ N $-$ s

$\therefore mV = 15$ N $-$ s

$$V = \frac{15}{m} = \frac{15}{3} = 7.5 \text{ m/s}$$

97 **(c)**
Sublimation is not a mode of transfer of heat.

98 **(a)**
According to Newton's law of cooling,

$$-\frac{d\theta}{dt} \propto (\theta - \theta_0)$$

$$-\frac{d\theta}{dt} = k(\theta - \theta_0)$$

Where, k is a constant of proportionality.

Now, $\frac{75-65}{2} = k\left(\frac{75+65}{2} - 30\right) = k \times 40 \Rightarrow k = \frac{1}{8}$

In case of second identical object,

$$\frac{55-45}{t} = k\left(\frac{55+45}{2} - 30\right)$$

$$\frac{10}{t} = \frac{1}{8} \times 20$$

$$\Rightarrow t = \frac{80}{20} = 4 \text{ min}$$

99 **(a)**

Thermal conductivity is independent of temperatures of the wall, it is a constant for the material, so it will remain unchanged.

100 **(a)**

For thermal expansion

$\Delta L = L\Delta\theta$

If rod is compress by ΔL then

$$\Delta L = \frac{FL}{AY}$$

$$\therefore \frac{FL}{AY} = L \propto \Delta\theta$$

$$\therefore \frac{F}{A} = Y \propto \Delta\theta$$

101 **(b)**

In rotational motion, the relation between torque τ and angular momentum L is $\tau = \frac{dL}{dt}$

Here, $dL = (4-1) = 3\text{ J} - \text{s}$

and $dt = 4\text{ s}$

$$\therefore \tau = \frac{3\text{ J} - \text{s}}{4\text{ s}} = \frac{3}{4}\text{ J}$$

102 **(b)**

In rotational motion, the relation between torque τ and angular momentum L is $\tau = \frac{dL}{dt}$

Here, $dL = (4-1) = 3\text{ J} - \text{s}$

and $dt = 4\text{ s}$

$$\therefore \tau = \frac{3\text{ J} - \text{s}}{4\text{ s}} = \frac{3}{4}\text{ J}$$

103 **(a)**

25% of the energy is absorbed by ice and it melts completely.

$\therefore 0.25\text{ mgh} = \text{mL}$

$$\therefore h = \frac{L}{0.25 \times g} = \frac{3.5 \times 10^5}{0.25 \times 10} = 1.4 \times 10^5\text{ m}$$

$= 140$ km

104 **(c)**

Let $m_1 = m_2 = m_3 = m$

Let s_1, s_2, s_3 be the respective specific heats of the three liquids.

When A and B are mixed,

temperature of mixture = 16°C

As, heat gained by A = heat lost by B

$\therefore ms_1(16-12) = ms_2(19-16)$

$4s_1 = 3s_2$ ... (i)

When B and C are mixed, temperature of mixture = 23°C.

As, heat gained by B = heat lost by C

$ms_2(23-19) = ms_3(28-23)$

$4s_2 = 5s_3$ ...(ii)

From Eqs.(i) and (ii), we get

$$s_1 = \frac{3}{4}s_2 = \frac{15}{16}s_3$$

When A and C are mixed, suppose temperature of mixture = t

As, heat gained by A = heat lost by C

$ms_1(t-12) = ms_3(28-t)$

$$\frac{15}{16}s_3(t-12) = s_3(28-t)$$

$\Rightarrow 15t - 180 = 448 - 16t$

$$\Rightarrow t = \frac{628}{31} = 20.2°\text{C}$$

105 **(c)**

The third force will have magnitude equal to their resultant. The resultant is given by

$$R = \sqrt{P^2 + P^2 + 2P^2\cos 90}$$

$$= \sqrt{2P^2} = \sqrt{2}P$$

106 **(c)**

The third force will have magnitude equal to their resultant. The resultant is given by

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$= \sqrt{2P^2} = \sqrt{2}P$

107 **(b)**

Here, $K_A = 2K_B$ and $(dx)_A = (dx)_B$

If θ is temperature of junction, $(dT)_A = \theta_A - \theta$ and $(dT)_B = (\theta - \theta_B)$

As, $\left(\frac{dQ}{dt}\right)_A = \left(\frac{dQ}{dt}\right)_B$

$\therefore K_A A \frac{(dT)_A}{(dx)_A} = K_B \frac{A(dT)_B}{(dx)_B}$

$2K_B(\theta_A - \theta) = K_B(\theta - \theta_B)$

$\Rightarrow 2\theta_A - 2\theta = \theta - \theta_B$

$\Rightarrow 2\theta_A + \theta_B = 3\theta$

As, $\theta_A - \theta_B = 48°$

$\theta_A = 48 + \theta_B$ ...(i)

Put in Eq.(i), we get

$2(48 + \theta_B) + \theta_B = 3\theta$

$\Rightarrow 96 + 3\theta_B = 3\theta$

$\Rightarrow 96 = 3(\theta - \theta_B)$

$\therefore \theta - \theta_B = 96/3 = 32°C$

108 **(d)**

Here, $\frac{D_1}{D_2} = \frac{1}{2}$

$\therefore \frac{A_1}{A_2} = \frac{D_1^2}{D_2^2} = \frac{1}{4} \Rightarrow \frac{dx_1}{dx_2} = \frac{2}{1}$

$\because \frac{dQ_1}{dt}\left(= KA_1 \frac{dT}{dx_1}\right)$ and $\frac{dQ_2}{dt}\left(= KA_2 \frac{dT}{dx_2}\right)$

$\therefore \frac{dQ_1/dt}{dQ_2/dt} = \frac{A_1}{dx_1} \cdot \frac{dx_2}{A_2} = \frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$

109 **(d)**

Thermal conductivity of a rod depends on material of the rod.

110 **(a)**

Given, F = 20 kg-wt = 20 × 9.8 N and s = 20 m , θ = 60^0

∴ Work done = F s cos θ

$= 20 \times 9.8 \times 20 \times \cos 60^0 =$ 1960 j

111 **(a)**

Given, F = 20 kg-wt = 20 × 9.8 N and s = 20 m , θ = 60^0

∴ Work done = F s cos θ

$= 20 \times 9.8 \times 20 \times \cos 60^0 =$ 1960 j

112 **(a)**

Strain $= \frac{\Delta l}{l} = \alpha\Delta\theta$

Stress = Y × Strain = Y αΔθ

∴ Force or tension, T = Stress × Area = YA αΔθ

$= \frac{\pi Y \alpha d^2 \Delta\theta}{4} \quad \left(\because A = \frac{\pi d^2}{4}\right)$

or $T = \frac{\pi \times 2 \times 10^{11} \times 10^{-5} \times 10^{-4} \times 25}{4}$

= 3926 N ≈ 4000 N

113 **(a)**

$\frac{Q}{At} = \frac{k\Delta\theta}{d}$

$\therefore 10 = k \times \frac{9}{1.8 \times 10^{-2}}$

$\therefore k = \frac{18 \times 10^{-2}}{9} = 2 \times 10^{-2}$ kcal/mS°C

114 **(c)**

If V is the velocity of heavier block after collision, then by law of conservation of momentum

mu = 2mV

$\therefore e = \frac{V}{u} = \frac{1}{2} = 0.5$

115 **(c)**

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mu = 2mV

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116 **(a)**

As, $\Delta L = L\alpha\,\Delta T \Rightarrow 0.19 = 100 \times \alpha \times 100$

$\Rightarrow\ \alpha = 0.19 \times 10^{-4} = 1.9 \times 10^{-5}\,°C^{-1}$

$\Rightarrow\ \gamma = 3\alpha = 5.7 \times 10^{-5}/\,°C$

117 **(b)**

$m_1 = 1gm$

$m_2 = 4gm$

$\therefore \frac{1}{2}\frac{p_1^2}{m_1} = \frac{1}{2}\frac{p_2^2}{m_2}$

$\frac{p_1^2}{1} = \frac{p_2^2}{4}$

$\therefore \frac{p_1}{p_2} = \frac{1}{2}$

118 **(b)**

$m_1 = 1gm$

$m_2 = 4gm$

$\therefore \frac{1}{2}\frac{p_1^2}{m_1} = \frac{1}{2}\frac{p_2^2}{m_2}$

$\frac{p_1^2}{1} = \frac{p_2^2}{4}$

$\therefore \frac{p_1}{p_2} = \frac{1}{2}$

119 **(b)**

Let water equivalent be x.

$\therefore\ (10 + x)c\frac{\Delta T}{\Delta t} = -k\left(\frac{T_1 + T_2}{2} - T_0\right)$

where, c is the specific heat of water,

ΔT = change in temperature

and Δt = time at which temperature falls.

$\therefore (10 + x)c\frac{(20-15)}{10} = -k\left(\frac{20+15}{2} - T_0\right)$...(i)

$(20 + x)c\frac{(20-15)}{15} = -k\left(\frac{20+15}{2} - T_0\right)$...(ii)

From Eqs. (i) and (ii), we get

$\frac{10 + x}{10} = \frac{20 + x}{15}$

$\Rightarrow 150 + 15x = 200 + 10x$

$\Rightarrow 5x = 50$

$\Rightarrow x = 10$ g

120 **(b)**

$v(m_1 + m_2) = m \times 3 + 0$

$\therefore v = \frac{3m}{m + 2m} = 1$ m/s

121 **(b)**

$v(m_1 + m_2) = m \times 3 + 0$

$\therefore v = \frac{3m}{m + 2m} = 1$ m/s

122 **(c)**

As $\frac{dQ}{dt} = KA\frac{dT}{dx}$, therefore when

$dt \rightarrow \frac{1}{2}, A \rightarrow (2)^2 = 4, K \rightarrow \frac{1}{4}$

$\frac{dQ}{dt}$ becomes twice; m would become twice.

Mass of ice melted /s $= 2 \times 0.1 = 0.2$ g s^{-1}

123 **(a)**

$K_C > K_B\ \therefore\ R_C < R_B$

Temperature difference across copper $= HR_C = (TD)_C$

and temperature difference across brass $= HR_B = (TD)_B$

Heat current H will be same in both, as they are in series.

Since, $R_C < R_B$

$(TD)_C < (TD)_B$

Or temperature of junction is more than 50°C.

124 **(b)**

When temperature is 80℃, by Newton's law of cooling, we have

$1.5 = k\left(\frac{80 + 30}{2} - 30\right) = k(55 - 30) = 25K$

When temperature is 50℃, let r be the rate of cooling.

Then,

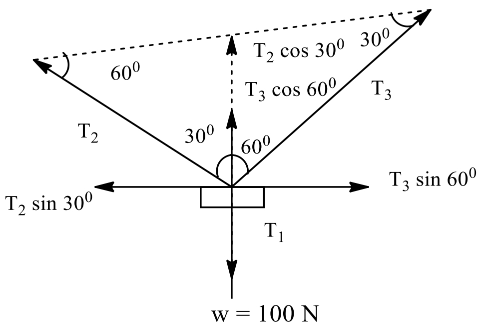
$r = k\left(\frac{50 + 30}{2} - 30\right) = k(40 - 30) = 10$ K

$\therefore \frac{r}{1.5} = \frac{10}{25}$

$\therefore r = \frac{10}{25} \times 1.5 = \frac{3}{5} = 0.6$ ℃/min

125 **(d)**

$\because \quad T_3 \sin 60^0 = T_2 \sin 30^0 \Rightarrow T_3 = \frac{T_2}{\sqrt{3}}$



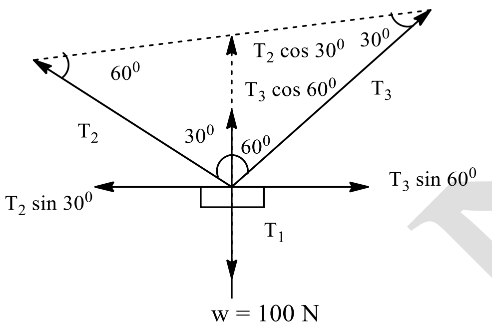
Now, $T_2 \cos 30^0 + T_3 \cos 60^0 = T_1 = 100$

or $\quad \frac{\sqrt{3}T_2}{2} + \frac{T_2}{\sqrt{3}} \times \frac{1}{2} = 100$ or $\frac{8T_2}{4\sqrt{3}} = 100$

$T_2 = 50\sqrt{3}$ N

126 **(d)**

$\because \quad T_3 \sin 60^0 = T_2 \sin 30^0 \Rightarrow T_3 = \frac{T_2}{\sqrt{3}}$



Now, $T_2 \cos 30^0 + T_3 \cos 60^0 = T_1 = 100$

or $\quad \frac{\sqrt{3}T_2}{2} + \frac{T_2}{\sqrt{3}} \times \frac{1}{2} = 100$ or $\frac{8T_2}{4\sqrt{3}} = 100$

$T_2 = 50\sqrt{3}$ N

127 **(d)**

If R is the thermal resistance of each rod, then in series, their equivalent resistance will be $R_s = 2R$ and in parallel it will be $R_P = \frac{R}{2}$

Hence the ratio $\frac{R_P}{R_S} = \frac{1}{4}$

Since thermal resistance becomes one fourth, the rate of transfer of heat will become four times.

Hence time required will be $\frac{1}{4}$ s.

128 **(d)**

$$\frac{Q}{At} = k\frac{\Delta\theta}{\Delta L} = kx$$

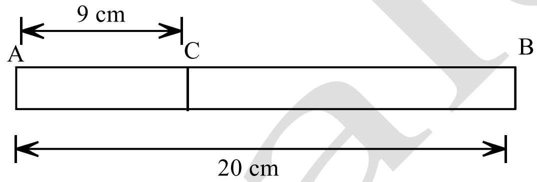
$\therefore K_e X_e = K_m X_m = K_G X_G$

$\therefore K \propto \frac{1}{X}$

$\therefore X_c < X_m < X_G$

129 **(b)**

$H = \frac{100 - 0}{R_{AB}} = \text{Heat current} = \frac{100}{R_{AB}} \quad$ ...(i)



$100 - \theta_C = H \cdot R_{AC} = \frac{100}{R_{AB}} \cdot R_{AC}$ [from Eq. (i)]

$= \frac{100 \times 9}{20} = 45$

$\therefore \theta_C = 55°C$

130 **(d)**

Torques due to $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are in anticlockwise direction and that due to $\overrightarrow{F_3}$ is in clockwise direction. The perpendicular distance from the centre 'd' is same for all the forces. Since, the net torque about the centre is zero, the clockwise torque must be equal to the anticlockwise torque.

$\therefore F_1 d + F_2 d = F_3 d$

or $F_1 + F_2 = F_3$

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$\therefore F_1 d + F_2 d = F_3 d$

or $F_1 + F_2 = F_3$

132 **(c)**

Applying, $\frac{T_1 - T_2}{t} = \alpha\left[\frac{T_1 + T_2}{2} - T_0\right]$

$\frac{50-40}{5} = \alpha\left[\frac{50+40}{2} - 20\right] \quad$ ...(i)

and $\quad \frac{40-30}{t} = \alpha\left[\frac{40+30}{2} - 20\right] \quad$ ...(ii)

Solving these two equations ,we get

$t = \frac{25}{3}$ min

133 **(c)**

$\frac{Q}{tA} = \frac{k\Delta\theta}{d}$

$\therefore k = \frac{Q}{tA} . \frac{d}{\Delta\theta}$

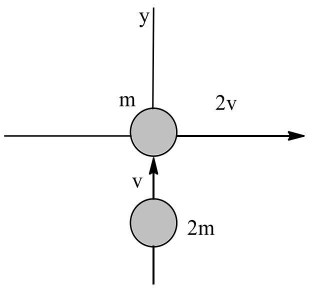
$\frac{Q}{tA} = 900 \text{ kcal per minute per m}^2 = \frac{900}{60} = 15 \frac{\text{kcal}}{\text{sm}^2}$

$d = 3 \text{ cm} = 3 \times 10^{-2}\text{m}, \Delta\theta = 15°\text{C}$

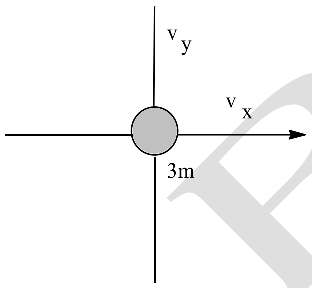
$\therefore k = \frac{15 \times 3 \times 10^{-2}}{15} = 3 \times 10^{-2} \frac{\text{kcal}}{\text{ms°C}}$

134 **(c)**

Conservation of linear momentum can be applied but energy is not conserved. Consider the movement of two particles as shown below.



(Just before collision)



(Just after collision)

According to conservation of linear momentum in x - direction, we have

$(p_1)_x = (P_2)_x$ or $2mv = (2m + m)v_x$

or $v_x = \frac{2}{3} v$

As, conserving linear momentum in y-direction , we get $(p_1)_x = (p_2)_y$

or $2mv = (2m + m)v_y$ or $v_y = \frac{2}{3} v$

Initial kinetic energy of the two particles system is

$E_1 = \frac{1}{2} m(2v)^2 + \frac{1}{2}(2m)(v)^2$

$= \frac{1}{2} \times 4 \text{ mv}^2 + \frac{1}{2} \times 2\text{mv}^2$

$= 2 \text{ mv}^2 + \text{mv}^2 = 3 \text{ mv}^2$

Final energy of the combined two particles system is

$E_2 = \frac{1}{2}(3m)\left(v_x^2 + v_y^2\right)$

$= \frac{1}{2}(3m)\left[\frac{4v^2}{9} + \frac{4v^2}{9}\right]$

$= \frac{3m}{2}\left[\frac{8v^2}{9}\right] = \frac{4mv^2}{3}$

Loss in the energy.

$\Delta E = E_1 - E_2 = mv^2\left[3 - \frac{4}{3}\right] = \frac{5}{3} mv^2$

Percentage loss in the energy during the collision,

$\frac{\Delta E}{E_1} \times 100 = \frac{\frac{5}{3}mv^2}{3 \text{ mv}^2} \times 100 = \frac{5}{3} \times 100 = 56\%$

135 **(c)**

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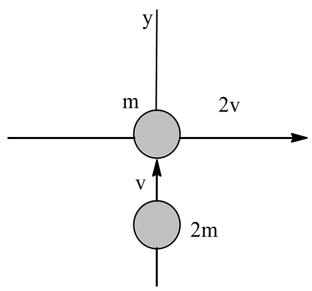

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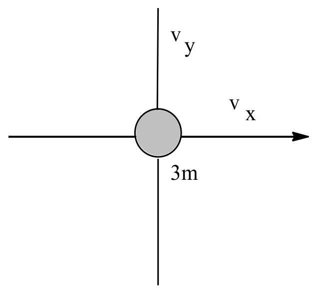

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or $\quad v_x = \frac{2}{3}v$

As, conserving linear momentum in y-direction, we get $(p_1)_x = (p_2)_y$

or $2mv = (2m + m)v_y$ or $v_y = \frac{2}{3}v$

Initial kinetic energy of the two particles system is

$$E_1 = \frac{1}{2}m(2v)^2 + \frac{1}{2}(2m)(v)^2$$

$$= \frac{1}{2} \times 4\ mv^2 + \frac{1}{2} \times 2mv^2$$

$$= 2\ mv^2 + mv^2 = 3\ mv^2$$

Final energy of the combined two particles system is

$$E_2 = \frac{1}{2}(3m)\left(v_x^2 + v_y^2\right)$$

$$= \frac{1}{2}(3m)\left[\frac{4v^2}{9} + \frac{4v^2}{9}\right]$$

$$= \frac{3m}{2}\left[\frac{8v^2}{9}\right] = \frac{4mv^2}{3}$$

Loss in the energy.

$$\Delta E = E_1 - E_2 = mv^2\left[3 - \frac{4}{3}\right] = \frac{5}{3}\ mv^2$$

Percentage loss in the energy during the collision,

$$\frac{\Delta E}{E_1} \times 100 = \frac{\frac{5}{3}mv^2}{3\ mv^2} \times 100 = \frac{5}{3} \times 100 = 56\%$$

136 **(a)**

The mass M is initially at rest, hence its initial momentum is zero. By law or conservation of momentum, the net momentum of the three pieces should be zero.

$$p_1 = \frac{3M}{4} \text{ and } p_2 = \frac{5M}{4}$$

Three are at right angles to each other.

Their resultant will be $p = \sqrt{p_1^2 + p_2^2}$

$$= \sqrt{\left(\frac{3M}{4}\right)^2 + \left(\frac{4M}{4}\right)^2} = \frac{M}{4}\sqrt{3^2 + 4^2} = \frac{M}{4\sqrt{25}} = \frac{5M}{4}$$

The momentum of the third piece will be equal and opposite to this.

The mass of the third piece will be $\frac{M}{2}$

If its velocity is V, then

$$\frac{M}{2}.V = \frac{5M}{4}$$

$\therefore V = 2.5\ ms^{-1}$

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The mass of the third piece will be $\frac{M}{2}$

If its velocity is V, then

$$\frac{M}{2}.V = \frac{5M}{4}$$

$\therefore V = 2.5\ ms^{-1}$

138 **(d)**

$$K_{eq} = \frac{2K_1K_2}{K_1 + K_2} = \frac{2(K)(2K)}{K + 2K} = \frac{4}{3}K$$

139 **(c)**

From $l_2 = l_1[1 + \alpha(t_2 - t_1)]$

$$\Rightarrow\ t_2 = t_1 + \frac{l_2 - l_1}{l_1\alpha}$$

$$= 20 + \frac{(-10^3)}{1.0 \times 2 \times 10^{-5}} = -30°C$$

140 **(a)**

$\frac{Q}{t}=\frac{kA(\theta_1-\theta_2)}{d}$

$=\frac{2.2\times(10^3\times10^{-4})\times[32-(-8)]}{4\times10^{-3}}$

$=\frac{2.2\times10^{-1}\times40}{4\times10^{-3}}$

$=2.2\times10^3$ cal/s

$=2.2$ kcal/s

141 **(c)**

$\frac{K_A}{K_B}=\frac{3}{2}$

Thermal resistance is given by

$R=\frac{l}{KA}$

$R_A=R_B$

$\therefore\frac{l_A}{l_B}=\frac{K_A}{K_B}=\frac{3}{2}$

142 **(b)**

$m_1=m, u_1=v, \vartheta_1=0$

$m_2=4m, u_2=0, \vartheta_2=?$

By law of conservation of momentum we have

$m_1u_1+m_2u_2=m_1\vartheta_1+m_2\vartheta_2$

$\therefore mv+0=0+4m_2\vartheta_2$

$\therefore v=4\vartheta_2$ or $\vartheta_2=\frac{v}{4}$

Coefficien of restitution $e=\frac{\vartheta_2-\vartheta_1}{u_1-u_2}=\frac{\frac{v}{4}-0}{v-0}=\frac{1}{4}$

$=0.25$

143 **(b)**

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Coefficien of restitution $e=\frac{\vartheta_2-\vartheta_1}{u_1-u_2}=\frac{\frac{v}{4}-0}{v-0}=\frac{1}{4}$

$=0.25$

144 **(a)**

As; $\frac{Q}{t}=\frac{KA\Delta\theta}{l}=\frac{\Delta\theta}{\left(\frac{l}{KA}\right)}=\frac{\Delta\theta}{R}$ (where, R = thermal resistance)

Series resistance, $R_s=R_1+R_2=2R$

and parallel resistance, $R_p=\frac{R_1R_2}{R_1+R_2}=\frac{R}{2}$

$t\propto R$

$\frac{t_p}{t_s}=\frac{R_p}{R_s}=\frac{\frac{R}{2}}{2R}=\frac{1}{4}$

$t_p=\frac{t_s}{4}=\frac{4}{4}=1$ min

145 **(c)**

$e=\frac{u_2-u_1}{u_1-u_2}$

$\frac{u_2}{v}=?$

$u_1=v, u_2=0$

$e=\frac{u_2-u_1}{v}=\frac{u_2}{v}-\frac{u_1}{v}$ ... (1)

By law of conservation of momentum:

$mv=mu_1+mu_2$

$1=\frac{u_1}{v}+\frac{u_2}{v}$

$\therefore\frac{u_1}{v}=1-\frac{u_2}{v}$ ... (2)

Putting in equation (1)

$e=\frac{u_2}{v}-\left(1-\frac{u_2}{v}\right)$

$\therefore e=\frac{u_2}{v}-1+\frac{u_2}{v}$

$e=\frac{2u_2}{v}-1$

$\therefore\frac{2u_2}{v}=e+1$

$\therefore\frac{u_2}{v}=\frac{e+1}{2}$

146 **(c)**

$e=\frac{u_2-u_1}{u_1-u_2}$

$\frac{u_2}{v}=?$

$u_1=v, u_2=0$

$e=\frac{u_2-u_1}{v}=\frac{u_2}{v}-\frac{u_1}{v}$ ... (1)

By law of conservation of momentum:

$mv=mu_1+mu_2$

$$1 = \frac{u_1}{v} + \frac{u_2}{v}$$

$$\therefore \frac{u_1}{v} = 1 - \frac{u_2}{v} \quad ...(2)$$

Putting in equation (1)

$$e = \frac{u_2}{v} - \left(1 - \frac{u_2}{v}\right)$$

$$\therefore e = \frac{u_2}{v} - 1 + \frac{u_2}{v}$$

$$e = \frac{2u_2}{v} - 1$$

$$\therefore \frac{2u_2}{v} = e + 1$$

$$\therefore \frac{u_2}{v} = \frac{e+1}{2}$$

147 **(c)**

Rate of heat transfer,

$$\frac{Q_1}{t} = \frac{KA(90-60)}{0.6} = 50\ KA$$

and $\frac{Q_2}{t} = \frac{KA(150-110)}{0.8} = 50\ KA$

Hence, heat transfer is same for both.

148 **(a)**

Let the temperature of junction be θ.

$$\left(\frac{\Delta Q}{\Delta t}\right)_{copper} = \left(\frac{\Delta Q}{\Delta t}\right)_{steel}$$

$$\Rightarrow K_1A\frac{(100-\theta)}{18} = \frac{K_2A(\theta-0)}{6}$$

$$\Rightarrow 9K_2\frac{(100-\theta)}{3} = K_2\theta$$

or $3\theta = 900 - 9\theta$

or $12\theta = 900$

or $\theta = 75°C$

149 **(d)**

Due to large specific heat of water, it releases large heat with very small temperature change.

150 **(a)**

Heat lost = Heat gained

$\therefore (100\times 80)+(100\times 1\times T) = 100\times 1\times (100\text{-}T)$

or $T = 10^0C$

151 **(c)**

Total work done $W = W_1 + W_2$

where W_1 = work done against gravity

and W_2 = work done against friction

$W = 100$ J,

$W_1 = mgh = 1 \times 10 \times 5 = 50$ J

$W_2 = W - W_1 = 100 - 50 = 50$ J

152 **(c)**

Total work done $W = W_1 + W_2$

where W_1 = work done against gravity

and W_2 = work done against friction

$W = 100$ J,

$W_1 = mgh = 1 \times 10 \times 5 = 50$ J

$W_2 = W - W_1 = 100 - 50 = 50$ J

153 **(b)**

Temperature in kelvin$= -197 + 273 = 76$ K

154 **(c)**

Total mass (m + M)

$$\therefore \text{acceleration} = \frac{F}{M+m}$$

155 **(c)**

Total mass (m + M)

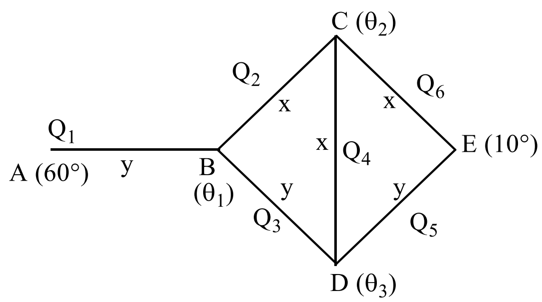
$$\therefore \text{acceleration} = \frac{F}{M+m}$$

156 **(b)**

Let L be the length of each rod.

Temperature of A = 60°C, temperature of E = 10°C

Let $\theta_1, \theta_2, \theta_3$ be respective temperature of B, C, D. If $Q_1, Q_2, Q_3, Q_4, Q_5, Q_6$ are the amounts of heat flowing per second respectively from A to B; B to C; B to D; C to D; D to E and C to E, then using figure,



$$Q_1 = \frac{0.46A(60-\theta_1)}{L}, Q_2 = \frac{0.92A(\theta_1-\theta_2)}{L}$$

$$Q_3 = \frac{0.46A(\theta_1-\theta_3)}{L}, Q_4 = \frac{0.92A(\theta_2-\theta_3)}{L}$$

$$Q_5 = \frac{0.46A(\theta_3-10)}{L}, Q_6 = \frac{0.92A(\theta_2-10)}{L}$$

$$Q_1 = Q_2 + Q_3$$

$$\text{Now,} \frac{0.46A(60-\theta_1)}{L} = \frac{0.92A(\theta_1-\theta_2)}{L} + \frac{0.46A(\theta_1-\theta_3)}{L}$$

$$60 - \theta_1 = 2(\theta_1 - \theta_2) + \theta_1 - \theta_3$$

or $4\theta_1 - 2\theta_2 - \theta_3 = 60°$ ...(i)

Again, $Q_2 = Q_4 + Q_6$ (gives)

$\theta_1 - 3\theta_2 - \theta_3 = 10°$ ...(ii)

Again, $Q_5 = Q_3 + Q_4$ (gives)

$\theta_1 + 2\theta_2 - 4\theta_3 = 10°$ ...(iii)

Solving Eqs. (i), (ii) and (iii), we get

$\theta_1 = 30°C, \theta_2 = 20°C, \theta_3 = 20°C$

159 **(d)**

Applying, $\frac{T_1-T_2}{t} = \alpha\left[\frac{T_1+T_2}{2} - T_0\right]$ where α is constant.

$\frac{50-45}{5} = \alpha\left[\frac{50+45}{2} - T_0\right]$ ... (i)

$\frac{45-41.5}{5} = \alpha\left[\frac{45+41.5}{2} - T_0\right]$ ...(ii)

Solving these two equations, we get

T_0 = temperature of atmosphere = 33.3°C

160 **(c)**

$$W = \int_0^2 F\,dx = \int_0^2 (10 + 0.5x)\,dx = [10x + 0.5\,x^2/2]_0^2 = 21\text{ J}$$

161 **(c)**

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162 **(d)**

$$\gamma = \frac{\Delta V}{V.\Delta\theta} = \frac{0.3}{100 \times 50} = 6 \times 10^{-5}\ /°C$$

$$\alpha = \frac{\gamma}{3} = 2 \times 10^{-5}\ /°C$$

163 **(b)**

$W = NS\cos\theta$

Angle between the normal reaction N and the displacement S is 90^0. Hence the work done will be zero.

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Angle between the normal reaction N and the displacement S is 90^0. Hence the work done will be zero.

165 **(c)**

$\because R_{PR} + R_{RQ} = R_{PQ}$

$\therefore \frac{l}{K_1A} + \frac{l}{K_2A} = \frac{l}{K_3A}$ or $K_3 = \frac{K_1K_2}{K_1+K_2}$

166 **(a)**

$(m + m)v_2 = m \times 3v$

$v_2 = \frac{3}{2}\bar{v}$

167 **(a)**

$(m + m)v_2 = m \times 3v$

$v_2 = \frac{3}{2}\bar{v}$

168 **(c)**

The coefficient of thermal conductivity of a rod depends on its material of the rod.

169 **(d)**

$\Delta l_1 = l_1\alpha_1\Delta$ and $\Delta l_2 = l_2\alpha_2\Delta\theta$

$\Delta l_1 = \Delta l_2$

$\therefore l_1\alpha_1\Delta\theta = l_2\alpha_2\Delta\theta$

$\therefore l_1\alpha_1 = l_2\alpha_2$

170 **(d)**

Increase in volume $\Delta V = V_0\gamma\Delta\theta$

$= 10^{-6} \times 18 \times 10^{-5} \times 100$

$= 18 \times 10^{-9}\ m^3$

$\Delta V = l \times A$

$\therefore l = \frac{\Delta V}{A} = \frac{18 \times 10^{-9}}{0.002 \times 10^{-4}}$

$= 9 \times 10^{-2}$ m $= 9$ cm

171 **(c)**

The coefficient of restitution $e = \sqrt{\frac{h_2}{h_1}}$

$\therefore \frac{h_2}{h_1} = e^2$

or $h_2 = e^2 h_1 = (0.4)^2 \times 5 = 0.16 \times 5 = 0.8$ m

172 **(c)**

The coefficient of restitution $e = \sqrt{\frac{h_2}{h_1}}$

$\therefore \frac{h_2}{h_1} = e^2$

or $h_2 = e^2 h_1 = (0.4)^2 \times 5 = 0.16 \times 5 = 0.8$ m

173 **(c)**

$Q = mcQ\Delta T \Rightarrow c = \frac{Q}{m\Delta T}$

When $\Delta T = 0 \Rightarrow c = \infty$

174 **(d)**

T is the temperature of the junction then we have

$\frac{Q}{t} = \frac{K_1 A(T_1 - T)}{d_1} = \frac{K_2 A(T - T_2)}{d_2}$

$\therefore (K_1 T_1 - K_1 T)d_2 = (K_2 T - K_2 T_2)d_1$

Solving this for T we get

$T = \frac{K_1 T_1 d_2 + K_2 T_2 d_1}{K_1 d_2 + K_2 d_1}$

175 **(d)**

$h = \frac{1}{2} g t^2$

$\therefore t = \sqrt{\frac{2h}{g}}$

$t_{total} = 2t = 2\sqrt{\frac{2h}{g}}$

$\therefore f = \frac{1}{t_{total}} = \frac{1}{2}\sqrt{\frac{g}{2h}}$

176 **(d)**

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$\therefore t = \sqrt{\frac{2h}{g}}$

$t_{total} = 2t = 2\sqrt{\frac{2h}{g}}$

$\therefore f = \frac{1}{t_{total}} = \frac{1}{2}\sqrt{\frac{g}{2h}}$

177 **(d)**

Let velocity after the collision be V $mv = 2mV$

$V = \frac{V}{2} = \sqrt{\frac{2gL}{2}}$

Initially the tension is $T_1 = mg$ after collision

$T_2 - 2mg = 2m\frac{V^2}{L} = 2m\frac{2gL}{4L} = mg$

$\Longrightarrow T_2 = 3mg$

Thus, $T_2 - T_1 = 2mg$

178 **(d)**

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$\Longrightarrow T_2 = 3mg$

Thus, $T_2 - T_1 = 2mg$

179 **(c)**

$E = \sigma A T^4$

$E' = \sigma A' T'^4$

$A = L \times B$

$A' = \frac{L}{3} \times \frac{B}{3} = \frac{LB}{9} = \frac{A}{9}$

$T = 27°C = 300\ K$

$T' = 327°C = 600\ K$

$$\frac{E'}{E} = \frac{A'}{A}\left(\frac{T'}{T}\right)^4 = \frac{1}{9}(2)^4$$

$$\therefore E' = \frac{16E}{9}$$

180 **(d)**
Let v be the velocity of mass m and v' be the velocity of mass M after collision.

By law of conservation of momentum

$mv = Mv'$

$$\therefore \frac{v'}{v} = \frac{m}{M}$$

Coefficient of restitution

$$= \frac{\text{Relative velocity after collision}}{\text{Relative velocity before collision}} = \frac{v'}{v}$$

181 **(d)**
Let v be the velocity of mass m and v' be the velocity of mass M after collision.

By law of conservation of momentum

$mv = Mv'$

$$\therefore \frac{v'}{v} = \frac{m}{M}$$

Coefficient of restitution

$$= \frac{\text{Relative velocity after collision}}{\text{Relative velocity before collision}} = \frac{v'}{v}$$

182 **(d)**
For same change in temperature the change in length is same for both the rods.

Change in length $\Delta L = L\alpha T$

$\therefore L_1\alpha_1\Delta T = L_2\alpha_2\Delta T$

or $L_1\alpha_1 = L_2\alpha_2$

183 **(b)**
Let R be the thermal resistance of each rod when connected in series, the total resistance will be

$R_s = 2R$

When they are connected in parallel, the effective resistance will be

$$R_p = \frac{R}{2}$$

$$\therefore \frac{R_p}{R_s} = \frac{1}{4}$$

In parallel combination, the resistance becomes one-fourth and hence time will also become one-fourth

$\therefore$ Time taken $\frac{8}{4} = 2s$

184 **(a)**
Mass of the body, m = 3.0 kg

Initial speed, u =2.0 m/s

Final speed, v = 3.5 m/s

Time, t = 25s

Force, F =?

Using the first equation of motion of motion, v = u + at

$\Rightarrow \quad 3.5 = 2.0 + a \times 25$

$\Rightarrow \quad a = \frac{3.5 - 2.0}{25}$

Acceleration, $a = \frac{1.5}{25}\ m/s^2$

$\therefore$ Force acting on the body,

$$F = ma = 3.0 \times \frac{1.5}{25} = 0.18\ N$$

As, direction of motion of the body remains unchanged, therefore the direction of force acting on the body is along the direction of motion.

185 **(a)**
Mass of the body, m = 3.0 kg

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Final speed, v = 3.5 m/s

Time, t = 25s

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$\Rightarrow \quad 3.5 = 2.0 + a \times 25$

$\Rightarrow \quad a = \frac{3.5 - 2.0}{25}$

Acceleration, $a = \frac{1.5}{25}\ m/s^2$

∴ Force acting on the body,

$$F = ma = 3.0 \times \frac{1.5}{25} = 0.18\ N$$

As, direction of motion of the body remains unchanged, therefore the direction of force acting on the body is along the direction of motion.

186 **(c)**

Acceleration $a_1 = 6\ ms^{-2} = \frac{F}{m_1}$

$\therefore F = 6m_1 \quad ... (i)$

Acceleration $a = 4\ ms^{-2} = \frac{F}{m_1 + m_2}$

$\therefore F = 4m_1 + 4m_2 \quad ... (ii)$

By (i) and (ii),

$6m_1 = 4m_1 + 4m_2$

$\therefore 2m_1 = 4m_2$

$\therefore m_2 = \frac{m_1}{2}$

$a_2 = \frac{F}{m_2} = \frac{2F}{m_1} = 2a_1 = 2 \times 6 = 12\ ms^{-2}$

187 **(c)**

Acceleration $a_1 = 6\ ms^{-2} = \frac{F}{m_1}$

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Acceleration $a = 4\ ms^{-2} = \frac{F}{m_1 + m_2}$

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By (i) and (ii),

$6m_1 = 4m_1 + 4m_2$

$\therefore 2m_1 = 4m_2$

$\therefore m_2 = \frac{m_1}{2}$

$a_2 = \frac{F}{m_2} = \frac{2F}{m_1} = 2a_1 = 2 \times 6 = 12\ ms^{-2}$

188 **(a)**

$\Delta L = L \propto \Delta T = \frac{FL}{AY}$

$\therefore F = AY \propto \Delta T$

$\therefore Mg = AY \propto \Delta T$

$M = \frac{AY \propto \Delta T}{g} = \frac{3 \times 10^{-6} \times 10^{11} \times 10^{-5} \times 100}{10}$
$= 30\ kg$

189 **(a)**

M = 2 kg

$F_1 = F_2 = 1\ N$

$\theta = 60^0$

Total effective force $= 2 \times F \cos 30^0 = 2 \times 1 \times \frac{\sqrt{3}}{2}$
$= \sqrt{3}$

$\therefore$ acceleration $= \frac{\sqrt{3}}{2} = \sqrt{3/4} = \sqrt{0.75}$

190 **(a)**

M = 2 kg

$F_1 = F_2 = 1\ N$

$\theta = 60^0$

Total effective force $= 2 \times F \cos 30^0 = 2 \times 1 \times \frac{\sqrt{3}}{2}$
$= \sqrt{3}$

$\therefore$ acceleration $= \frac{\sqrt{3}}{2} = \sqrt{3/4} = \sqrt{0.75}$

191 **(c)**

In steady state, the rate of flow of heat is same through the two sections

$$\therefore \frac{Q}{t} = \frac{K_1A(T_1 - T)}{l_1} = \frac{K_2A(A - T_2)}{l_2}$$

$$\therefore K_1T_1l_2 - K_1Tl_2 = K_2Tl_1 - K_2T_2l_1$$

Solving, we get

$$T = \frac{K_1l_2T_1 + K_2l_1T_2}{K_1l_2 + K_2l_1}$$

193 **(c)**

If u is the initial velocity and d is the distance

then $u^2 = 2ad$ ... (i)

Where a is the retardation

If m is increase to 1.4 m, and the retarding force remains same, then the retardation becomes $\frac{a}{1.4}$

$$\therefore u^2 = \frac{2ad'}{1.4} \quad \text{... (ii)}$$

By (i)and (ii)

$$2ad = \frac{2ad'}{1.4}$$

$$\therefore d' = 1.4d$$

194 **(c)**

If u is the initial velocity and d is the distance

then $u^2 = 2ad$ ... (i)

Where a is the retardation

If m is increase to 1.4 m, and the retarding force remains same, then the retardation becomes $\frac{a}{1.4}$

$$\therefore u^2 = \frac{2ad'}{1.4} \quad \text{... (ii)}$$

By (i)and (ii)

$$2ad = \frac{2ad'}{1.4}$$

$$\therefore d' = 1.4d$$

195 **(c)**

$$\frac{a_1}{a_2} = \frac{a+g}{g-a} = \frac{g+g/2}{g-g/2} = \frac{3/2}{1/2} = \frac{3}{1}$$

196 **(c)**

$$\frac{a_1}{a_2} = \frac{a+g}{g-a} = \frac{g+g/2}{g-g/2} = \frac{3/2}{1/2} = \frac{3}{1}$$

197 **(a)**

According to Newton's law of cooling law,

$$\frac{\theta_1 - \theta_2}{t} = K\left(\frac{\theta_1 + \theta_2}{2} - \theta_0\right)$$

Where, θ_0 = temperature of surrounding

Case I

$$\frac{100 - 70}{8} - K\left(\frac{100 + 70}{2} - 15\right) \text{ or } \frac{15}{4} = K(70)$$

Case II

$$\frac{70 - 40}{t} = K\left(\frac{70 + 40}{2} - 15\right) \text{ or } \frac{30}{t} = K(40)$$

Dividing Eq. (i) by Eq. (ii), we have

$$\frac{15}{4} \times \frac{t}{30} = \frac{70}{40}$$

$$t = \frac{7}{4} \times \frac{4 \times 30}{15}$$

$$\therefore t = 14 \text{ s}$$

200 **(a)**

Given, initial temperature, $T_1 = 80°C$

Final temperature, $T_2 = 50°C$

Temperature of the surroundings, $T_0 = 20°C$ $t_1 = 5$ min

According to Newton's law of cooling,

$$\text{Rate of cooling, } \frac{dT}{dt} = k\left[\frac{T_1 + T_2}{2} - T_0\right]$$

$$\frac{(80 - 50)}{5} = k\left[\frac{80 + 50}{2} - 20\right]$$

$$\frac{30}{5} = k(65 - 20)$$

$6 = k \times 45$ or $k = \frac{6}{45} = \frac{2}{15}$ ... (i)

In second condition,

Initial temperature, $T_1' = 60°C$

Final temperature, $T_2' = 30°C$

$t' = ?$

Now, $\frac{(60-30)}{t'} = \frac{2}{15}\left(\frac{60+30}{2} - 20\right)$

$$\frac{30}{t'} = \frac{2}{15}(45 - 20)$$

or $t' = \frac{30 \times 15}{2 \times 25} = 9$ min

201 **(b)**

According to conservation of linear momentum

$$Mu + 0 = Mv + 0$$

u and v are respective initial and final velocities of m and M

$\therefore e = \frac{v}{u} = \frac{m}{M}$

202 **(b)**

According to conservation of linear momentum

$Mu + 0 = Mv + 0$

u and v are respective initial and final velocities of m and M

$\therefore e = \frac{v}{u} = \frac{m}{M}$

203 **(a)**

As, $\left(\frac{\Delta Q}{\Delta t}\right)_P = \left(\frac{\Delta Q}{\Delta t}\right)_Q$

$\Rightarrow K_1A_1\frac{(T_1 - T_2)}{l} = K_2A_2\frac{(T_1 - T_2)}{l}$

or $K_1A_1 = K_2A_2$

or $\frac{A_1}{A_2} = \frac{K_2}{K_1}$

204 **(a)**

Using Newton's law of cooling:

$\frac{80 - 64}{5} = K\left(\frac{80 + 64}{2} - \theta\right),$

θ = temperature of surroundings

$\frac{80 - 52}{10} = K\left(\frac{80 + 52}{2} - \theta\right)$

$\therefore \frac{16}{5} = K(72 - \theta)$ ... (i)

and $\frac{28}{10} = K(66 - \theta)$ ... (ii)

Dividing (i) by (ii), and solving we get

$\theta = 24°C$

205 **(b)**

Heat lost by hot water = Heat gained by cold water in beaker + Heat absorbed by beaker

$\Rightarrow 440(92\text{-}T) = 200\times(T\text{-}20) + 20\times(T\text{-}20)$

$\Rightarrow T = 68^0C$

206 **(c)**

Theoretical equation

207 **(c)**

Theoretical equation

208 **(a)**

$mv = Mv$

$v = \frac{mv}{M} = \frac{20 \times 10^{-3} \times 750}{2.5} = 6 \text{ m/s}$

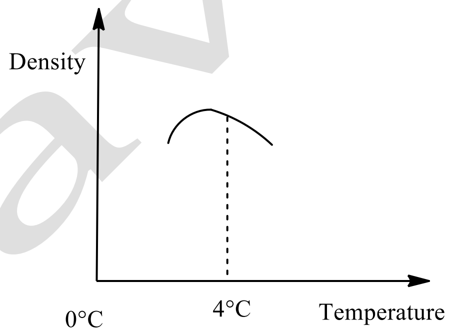
209 **(a)**

$mv = Mv$

$v = \frac{mv}{M} = \frac{20 \times 10^{-3} \times 750}{2.5} = 6 \text{ m/s}$

210 **(c)**

Water has maximum density at 4°C so, if the water is heated above 4°C or cooled below 4°C density decreases, i.e., volume increases. In other words, it expands, so it overflows in both the cases.



211 **(d)**

F = rate of change of momentum

$= 25 \times 10^{-3}$ kg/s $\times 400$

= 10 N

212 **(d)**

F = rate of change of momentum

$= 25 \times 10^{-3}$ kg/s $\times 400$

= 10 N

213 **(c)**

Strain $= \frac{\Delta l}{l} = \frac{l\alpha\Delta\theta}{l} = \alpha\Delta\theta$

Stress = Y × Strain = $Y\alpha\Delta\theta$

$(\text{Stress})_1 = (\text{Stress})_2$

$\therefore Y_1\alpha_1 = Y_2\alpha_2$ ($\because \Delta\theta \rightarrow$ same)

or $\frac{Y_1}{Y_2} = \frac{\alpha_2}{\alpha_1} = \frac{3}{2}$

214 **(c)**

Given, $F = 600 - 2 \times 10^5 t$

At t = 0, F = 600 N

According to equation ,

F = 0, on leaving the barrel

⇒ $0 = 600 - 2 \times 10^5 t$

∴ $t = \frac{600}{2 \times 10^5} = 3 \times 10^{-3}$ s

This is the time spent by the bullet in the barrel.

Average force, $F = \frac{600 + 0}{2} = 300$ N

Average impulse imparted = F × t

$= 300 \times 3 \times 10^{-3} = 0.9$ N -s

215 **(c)**
Given, $F = 600 - 2 \times 10^5 t$

At t = 0, F = 600 N

According to equation ,

F = 0, on leaving the barrel

⇒ $0 = 600 - 2 \times 10^5 t$

∴ $t = \frac{600}{2 \times 10^5} = 3 \times 10^{-3}$ s

This is the time spent by the bullet in the barrel.

Average force, $F = \frac{600 + 0}{2} = 300$ N

Average impulse imparted = F × t

$= 300 \times 3 \times 10^{-3} = 0.9$ N -s

216 **(c)**
Change in length,

$\Delta l = I_0 \alpha \, \Delta T = 10 \times 11 \times 10^{-6}(19 - 20)$

$= -11 \times 10^{-5}$ cm

217 **(a)**
Initial kinetic energy= $\frac{1}{2}mv^2 = \frac{1}{2}\frac{m^2v^2}{m} = \frac{p^2}{2m}$

The potential energy of the spring= $\frac{1}{2}kx^2$

$\therefore \frac{p^2}{2m} = \frac{1}{2}kx^2$

$\therefore p = \sqrt{mk}x$

218 **(a)**
Initial kinetic energy= $\frac{1}{2}mv^2 = \frac{1}{2}\frac{m^2v^2}{m} = \frac{p^2}{2m}$

The potential energy of the spring= $\frac{1}{2}kx^2$

$\therefore \frac{p^2}{2m} = \frac{1}{2}kx^2$

$\therefore p = \sqrt{mk}x$

219 **(b)**
$\because \Delta l_1 = \Delta l_2$ or $l_1\alpha_1\Delta\theta = l_2\alpha_2\Delta\theta$

or $\frac{l_1}{l_2} = \frac{\alpha_2}{\alpha_1}$

220 **(b)**
Thermal resistance $= \frac{\text{Temp. difference}}{\text{Thermal current}} = \frac{28}{1400}$
$= 0.02$ °Cs/cal

221 **(c)**
Initial velocity of m_1 is v_1 and of m_2 is v_2. The final velocity of m_1 is v_2

Hence, we have the relation:

$$v_2 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1 + \frac{2m_2v_2}{m_1 + m_2}$$

$$\therefore v_2 - \frac{2m_2v_2}{m_1 + m_2} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1$$

$$\therefore \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_2 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1$$

$\therefore v_2 = v_1$

or $\frac{v_2}{v_1} = 1$

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$\therefore v_2 = v_1$

or $\frac{v_2}{v_1} = 1$

223 **(b)**

$\because H_1 = H_2$

$\therefore \left(\frac{TD}{R}\right)_1 = \left(\frac{TD}{R}\right)_2$ (where, TD = temperature difference)

or $R_1 = R_2$

$\frac{1}{K_1A_1} = \frac{1}{K_2A_2}$ or $K_1A_1 = K_2A_2$

224 **(b)**

The increase in length due to heating is given by

$L = L_0(1 + \alpha T)$ or $L - L_0 = \Delta L = L_0\alpha T$

To compress the rod by ΔL, the force required is given by

$F = \frac{YA\Delta L}{L}$

Substituting the value of L and ΔL we get

$F = \frac{YA \times L_0\alpha T}{L_0(1 + \alpha T)} = \frac{YA\alpha T}{1 + \alpha T}$

225 **(b)**

Initial kinetic energy

$k_1 = \frac{1}{2}m_1u_1^2 = \frac{1}{2} \times 2 \times (10)^2 = 100$ J

By law of conservation of momentum

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$\therefore v = \frac{m_1u_1 + m_2u_2}{m_1 + m_2}$

$= \frac{2 \times 10 + 0}{2 + 3} = \frac{20}{5} = 4\frac{m}{s}$

$\therefore$ Final kinetic energy $k_2 = \frac{1}{2}(m_1 + m_2)v^2$

$= \frac{1}{2} \times 5 \times (4)^2 = \frac{5 \times 16}{2} = 40$ J

$\therefore$ Loss of kinetic energy $= k_1 - k_2 = 100 - 40$

$= 60$ J

226 **(b)**

Initial kinetic energy

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$= 60$ J

227 **(d)**

$V = 500\ cm^3, \alpha = 12 \times 10^{-6}$ /°C

$\gamma = 3\alpha = 36 \times 10^{-6}$ /°C

$\Delta V = V\alpha\Delta\theta = 500 \times 36 \times 10^{-6} \times 100 = 1.8\ cm^3$

228 **(a)**

Newton's law of cooling states that the rate of cooling of a body is directly proportional to temperature difference between the body and the surroundings, provided the temperature difference between the body and the surroundings, provided the temperature difference is small, (less than 10°C) and Newton's law of cooling is given by $dT/dt \propto (\theta - \theta_0)$

229 **(c)**

Angular momentum of the bullet about the pivoted end of the rod is $L = mVL$

The angular momentum of the system just after the collision is

$L' = \frac{ML^2}{3}\omega + mL^2\omega = \left(\frac{M}{3} + m\right)L^2\omega$

$= \left(\frac{M + 3m}{3}\right)L^2\omega$

$\therefore$ By law of conservation of angular momentum

$L' = L$

$\therefore \left(\frac{M + 3m}{3}\right)L^2\omega = mVL$

$\therefore \omega = \frac{3mV}{(M + 3m)L}$

230 **(c)**

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$L' = L$

$\therefore \left(\frac{M + 3m}{3}\right) L^2 \omega = mVL$

$\therefore \omega = \frac{3mV}{(M + 3m)L}$

231 **(a)**
As the steel tape is calibrated at 10°C, therefore adjacent centimetre marks on the steel tape will be separated by a distance of

$l_t = l_{10}(1 + \alpha_s \Delta T) = (1 + \alpha_s \times 20)\text{cm}$

Length of copper rod at 30°C

$= 90(1 + \alpha_c \times 20)\text{cm}$

Therefore, number of centimeters read on the tape will be

$= \frac{90(1 + \alpha_c \times 20)}{1(1 + \alpha_s \times 20)}$

$= \frac{90(1 + 1.7 \times 10^{-5} \times 20)}{1(1 + 1.2 \times 10^{-5} \times 20)}$

$= \frac{90 \times 1.00034}{1.00024} = 90.01 \text{ cm}$

232 **(c)**
Let x_1 and x_2 be the position of masses m_1 and m_2, respectively.

The position of centre of mass, $x_{CM} = \frac{x_1 m_1 + x_2 m_2}{m_1 + m_2}$

If Δx_1 and Δx_2 be the changes in positions, then change in the position of centre of mass,

$\Delta x_{CM} = \frac{\Delta x_1 m_1 + \Delta x_2 m_2}{m_1 + m_2}$

Given, the centre of mass remains unchanged, i.e. $\Delta x_{CM} = 0$ and $\Delta x_1 = d$

$\Rightarrow 0 = \frac{d m_1 + m_2 \Delta x_2}{m_1 + m_2}$

Or $\Delta x_2 = -\frac{m_1}{m_2} d$

Here, negative sign shows that the second particle should be moved towards the centre of mass.

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234 **(c)**
$x = t^3 - 2t - 10$

$\frac{dx}{dt} = 3t^2 - 2$

$\frac{d^2x}{dt^2} = 6t$

$\therefore \frac{d^2x}{dt^2}|_5 = 30$

$m = 5 \text{ kg}$

$\therefore F = 5 \times 30 = 150 \text{ N}$

235 **(a)**
Work done

$W = \frac{1}{2} Fl$

Where l is the extension

$l = L\alpha t$

Force $F = \frac{YAl}{L}$

$\therefore W = \frac{1}{2} . \frac{YAl^2}{L} = \frac{YA(L^2\alpha^2 t^2)}{2L} = \frac{YAL\alpha^2 t^2}{2}$

236 **(b)**

Heat required,

$Q = m_1c_1\Delta T + m_2c_2\Delta T + m_3c_3\Delta T$

$= (2.4 \times 0.216 + 1.6 \times 0.0917 + 0.8 \times 0.0931)(60)$

$= 44.376 \text{ cal} \approx 44.4 \text{ cal}$

237 **(b)**

$m_1 = m, u_1 = v, \vartheta_1 = 0$

$m_2 = 4m, u_2 = 0, \vartheta_2 = ?$

By law of conservation of momentum we have

$m_1u_1 + m_2u_2 = m_1\vartheta_1 + m_2\vartheta_2$

$\therefore mv + 0 = 0 + 4m_2\vartheta_2$

$\therefore v = 4\vartheta_2 \text{ or } \vartheta_2 = \frac{v}{4}$

Coefficien of restitution $e = \frac{\vartheta_2 - \vartheta_1}{u_1 - u_2} = \frac{\frac{v}{4} - 0}{v - 0} = \frac{1}{4}$

$= 0.25$

238 **(b)**

Let l_1 be the initial length of the rod and r_1 be the radius of the rod. Then

$H_1 = \frac{KA_1(T_2 - T_1)}{l_1}$

$H_2 = \frac{KA_2(T_2 - T_1)}{l_2}$

$\therefore \frac{H_2}{H_1} = \frac{A_2}{A_1} \cdot \frac{l_1}{l_2}$

If $r_2 = 2r_1$, then $A_2 = 4A_1$

$\therefore \frac{H_2}{H_1} = 4 \times \frac{1}{2} = 2$

$\therefore H_2 = 2H_1$

239 **(a)**

Here, $\Delta T = 20 - 15 = 5°C$,

$\alpha = 0.000012°C^{-1} = 12 \times 10^{-6} \,°C^{-1}$

Time lost per day $= \frac{1}{2}\alpha(\Delta T) \times 86400 \text{ s}$

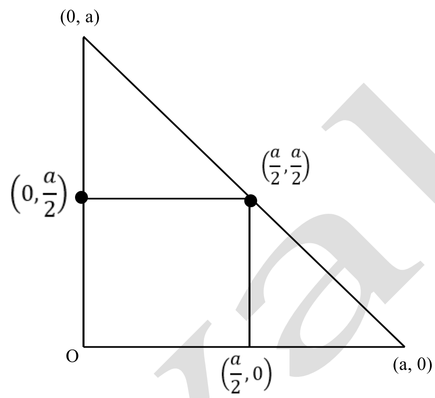
$= \frac{1}{2} \times 12 \times 10^{-6} \times 5 \times 86400 \text{ s}$

$= 2.590 \text{ s} \simeq 2.6 \text{ s}$

240 **(d)**

As shown in figure, centre of mass of respective rods are at their respective mid-points.

Hence, centre of mass of the system has coordinates (x_{CM}, Y_{CM}), then



$X_{CM} = \frac{m \times \frac{a}{2} + m \times \frac{a}{2} + m \times 0}{3 \text{ m}} = \frac{a}{3}$

$Y_{CM} = \frac{m \times 0 + m \times \frac{a}{2} + m \times \frac{a}{2}}{3 \text{ m}} = \frac{a}{3}$

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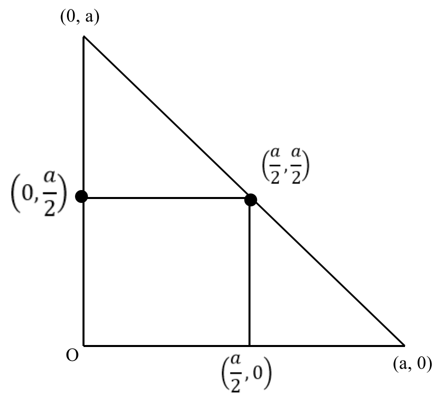
Hence, centre of mass of the system has coordinates (x_{CM}, Y_{CM}), then



$X_{CM} = \frac{m \times \frac{a}{2} + m \times \frac{a}{2} + m \times 0}{3 \text{ m}} = \frac{a}{3}$

$Y_{CM} = \frac{m \times 0 + m \times \frac{a}{2} + m \times \frac{a}{2}}{3 \text{ m}} = \frac{a}{3}$

242 **(a)**

As, $\rho = \rho_0(1 - \gamma\Delta T)$

$\therefore 9.7 = 10(1 - \gamma \times 100)$

$\Rightarrow \frac{9.7}{10} = 1 - \gamma \times 100$

$\Rightarrow \gamma \times 100 = 1 - \frac{9.7}{10} = \frac{0.3}{10} = 3 \times 10^{-2}$

$\Rightarrow \gamma = 3 \times 10^{-4}$

$\therefore \alpha = \frac{1}{3}\gamma = 10^{-4}{}^\circ C^{-1}$

243 **(b)**

Given, $F \propto \frac{1}{v}$

$F = \frac{\lambda}{v}$, where λ = constant,

$\because \; ma = m\frac{dv}{dt} = \frac{\lambda}{v} \Rightarrow m\int_0^V V\,dv = \lambda\int_0^t dt$

$\Rightarrow \quad m\left|\frac{v^2}{2}\right|_0^V = \lambda\,|t|_0^t \Rightarrow \frac{1}{2}mv^2 = k = \lambda t$

$\because \quad K \propto t$

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$\because \quad K \propto t$

245 **(c)**

Acceleration $a = \frac{F}{M}$

$V^2 = 2as$

$K.E. = \frac{1}{2}MV^2 = \frac{1}{2}M \times 2as = Mas$

$= M \times \frac{F}{M} \times s = FS$

Kinetic energy is independent of M

246 **(c)**

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$V^2 = 2as$

$K.E. = \frac{1}{2}MV^2 = \frac{1}{2}M \times 2as = Mas$

$= M \times \frac{F}{M} \times s = FS$

Kinetic energy is independent of M

247 **(b)**

$\text{Stress} = \frac{F}{A} = \frac{E}{2}$

$\therefore F = \frac{EA}{2}$

For upward motion

$m(a+g) = F = \frac{EA}{2}$

$\therefore m = \frac{EA}{2(a+g)}$

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249 **(b)**

$h = \frac{1}{2}gt^2$

$\therefore t = \sqrt{\frac{2h}{g}}$

$\therefore$ Time is same for all

Acceleration is equal to g for all

p = mV, Since m is different, momentum p will be different for all.

250 **(b)**

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Acceleration is equal to g for all

p = mV, Since m is different, momentum p will be different for all.

251 **(c)**

$$\frac{1}{2}mV^2 + 0 = \frac{1}{2}mV_1^2 + \frac{1}{2}mV_2^2$$

$$V_2 = \sqrt{V^2 - V_1^2}$$

252 **(c)**

$$\frac{1}{2}mV^2 + 0 = \frac{1}{2}mV_1^2 + \frac{1}{2}mV_2^2$$

$$V_2 = \sqrt{V^2 - V_1^2}$$

253 **(d)**

$$TE(\text{at h}) = \frac{1}{2}mV^2 + mgh$$

Energy of the ball after collision

$$\frac{1}{4}\left(\frac{1}{2}mV^2 + mgh\right)$$

As the ball rebounds to the same height

$$\therefore mgh = \frac{1}{2}\left(\frac{1}{2}mV^2 + mgh\right) = \frac{1}{8}mV^2 + \frac{1}{4}mgh$$

$$\frac{3}{4}mgh = \frac{1}{8}mV^2$$

$$V^2 = 6gh$$

$$v = \sqrt{6gh}$$

254 **(d)**

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$$\frac{3}{4}mgh = \frac{1}{8}mV^2$$

$$V^2 = 6gh$$

$$v = \sqrt{6gh}$$

255 **(b)**

$$\frac{W_1}{W_2} = \frac{mg}{m(g-a)} = \frac{3}{2}$$

$$\therefore \frac{g}{g-a} = \frac{3}{2}$$

$$\therefore 2g = 3g - 3a$$

$$g = 3a$$

$$\therefore a = \frac{g}{3}$$

256 **(b)**

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$$g = 3a$$

$$\therefore a = \frac{g}{3}$$

257 **(a)**

For collision between blocks A and B,

$$e = \frac{v_B - v_A}{u_A - u_B} = \frac{v_B - v_A}{10 - 0} = \frac{v_B - v_A}{10}$$

$\therefore$ $v_B - v_A = 10\,e = 10 \times 0.5 = 5$ ...(i)

From principle of momentum conservation,

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

or $m \times 10 + 0 = mv_A + mv_B$

$\therefore$ $v_A + v_B = 10$ ...(ii)

On adding Eqs. (i) and (ii), we get

$v_B = 7.5\ ms^{-1}$ ...(iii)

Similarly, for collision between B and C,

$$v_C - v_B = 7.5\,e = 7.5 \times 0.5 = 3.75$$

$v_C - v_B = 3.75$ ...(iv)

and $v_C + v_B = 7.5$ ...(v)

On adding Eqs. (iv) and (v), we get

$$2V_C = 11.25$$

$$V_C = \frac{11.25}{2} = 5.6\ ms^{-1}$$

258 **(a)**

For collision between blocks A and B,

$$e = \frac{v_B - v_A}{u_A - u_B} = \frac{v_B - v_A}{10 - 0} = \frac{v_B - v_A}{10}$$

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$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

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On adding Eqs. (iv) and (v), we get

$$2V_C = 11.25$$

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259 **(d)**

$$W = \int_0^3 F\,dx = \int_0^3 (2x^2 - x + 4)dx$$

$$= \left[2.\frac{x^3}{3} - \frac{x^2}{2} + 4x\right]_0^3 = 2.\frac{27}{3} - \frac{9}{2} + 12$$

$$= 18 - 4.5 + 12 = 25.5\ J$$

260 **(d)**

$$W = \int_0^3 F\,dx = \int_0^3 (2x^2 - x + 4)dx$$

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$$= 18 - 4.5 + 12 = 25.5\ J$$

261 **(a)**

Initial kinetic energy $k_1 = \frac{1}{2}mu_1^2$

Final kinetic energy $k_2 = \frac{1}{2}mu_2^2 = \frac{1}{2}m(2u_1^2)$

$$= \frac{1}{2}(4mu^2)$$

$\therefore k_2 - k_1 = \frac{3}{2}mu^2$

Change in K. E. is work done

power p$\frac{\text{Work done}}{t} = 3mu^2/2t$

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Change in K. E. is work done

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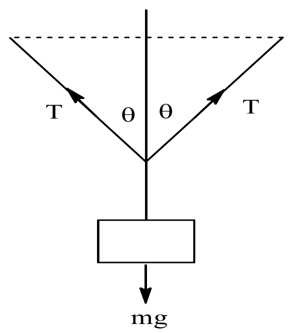
263 **(d)**

For equilibrium of body, mg =2T cos θ

$$\Rightarrow \qquad T = \frac{mg}{2\cos\theta}$$



For the string to be horizontal, $\theta = 90^0$

$\therefore \qquad T = \frac{mg}{2\cos 90°} \Rightarrow T = \infty$

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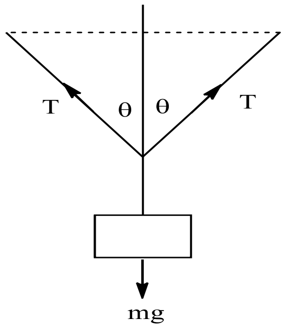

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265 **(a)**
Initially the body is at rest and its momentum is zero.

$\therefore$ by law of conservation of linear momentum we have

$M_1V_1 + M_2V_2 = 0$

$\therefore M_1V_1 = -M_2V_2$

The magnitude of their momenta in same.

Kinetic energy is given by $K = \frac{p^2}{2m}$

Where p = momentum

$\therefore \frac{K_1}{K_2} = \frac{M_2}{M_1}$

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267 **(d)**
The impulse is equals to change in linear momentum. Change in momentum $= m(v - u) = 0.2(-6 - 6) = -2.4$ N − s The negative sign shows the direction of impulse is from batsman to bowler.

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269 **(c)**
In perfectly elastic collision between two bodies of equal masses, velocities are exchanged. So, after collision, particle A will move with 10 $ms^{-1}$and particle B with 15 ms^{-1}.

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271 **(a)**
Change in momentum $= nmu - (-mu) = 2nmu$

Rate of change of momentum $= \frac{2nmu}{2} = num$

272 **(a)**
Change in momentum $= nmu - (-mu) = 2nmu$

Rate of change of momentum $= \frac{2nmu}{2} = num$

273 **(b)**
$m_1 = 2$ kg, $m_2 = 4$ kg

Taking m_1 as origin, the centre of mass is given by

$$x_{cm} = \frac{2 \times 0 + 9 \times 4}{2 + 4} = \frac{36}{6} = 6 \text{ m}$$

274 **(b)**
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275 **(a)**

Force $\overline{F_1}$ and $\overline{F_2}$ produce anticlockwise torques while force $\overline{F_3}$ produce clockwise torque. The torques in the two directions balance each other. The perpendicular distance of the forces from the centre is the same.

$\therefore F_1 r + F_2 r = R_3 r$ or $F_1 + F_2 = F_3$

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277 **(c)**
$W = 49\ N$

$$\therefore m = \frac{W}{g} = \frac{49}{9.8} = 5\ kg$$

$W' = W - ma = 49 - 5 \times 5 = 49 - 25 = 24\ N$

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279 **(a)**
Since the particle was initially at rest its momentum was zero. Hence the net momentum of the two fragments should be zero. Hence the momentum of the two fragments must be equal to in magnitude but opposite in direction.

Kinetic energy $E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$ where p is the momentum

or $p^2 = 2mE$

If p is constant then $m_1E_1 = m_2E_2$ or $\frac{E_1}{E_2} = \frac{m_2}{m_1}$

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281 **(d)**
Distance distributes in inverse ratio of masses.

Hence, $r_c = d\left(\frac{m_o}{m_o+m_c}\right) = 1.2 \times 10^{10} \left(\frac{16}{16+12}\right)$

$= 0.69 \times 10^{-10} m$

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283 **(a)**
$mV + 0 = mV_1 + mV_2$

$V = V_1 + V_2 \quad \ldots(1)$

$V^2 = V_1^2 + V_2^2 \quad \ldots(2)$

$V_2^2 = V^2 - V_1^2$

$V_2 = \sqrt{V^2 - V_1^2}$

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285 **(b)**
Particle is initially at rest. Hence by law of conservation of momentum

$m_1v_1 + m_2v_2 = 0$

$\therefore m_1v_1 = -m_2v_2$

Their momenta are equal and opposite.

$K.E.(K) = \frac{P^2}{2m}$

$\therefore K \propto \frac{1}{m}$; if P is constant

$\therefore \frac{E_1}{E_2} = \frac{m_2}{m_1}$

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287 **(c)**
When two bodies of equal masses collide elastically, they exchange their velocities. Since the two masses are exchanging their velocities, their masses must be equal.

Hence, $\frac{m_a}{m_b} = 1$

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289 **(a)**
By law of conservation of momentum

$m_1v_1 + m_2v_2 = m_1v_2 + m_2v_1$

$\therefore (m_1 - m_2)v_1 = (m_1 - m_2)v_2$

$\therefore v_1 = v_2$

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291 **(b)**
$mv = (M + m)V$

$v = \frac{M + m}{m}V$

But $(M + m)gh = \frac{1}{2}(M + m)V^2$

$\therefore V = \sqrt{2gh}$

$\therefore v = \left(\frac{M + m}{m}\right)\sqrt{2gh}$

292 **(b)**
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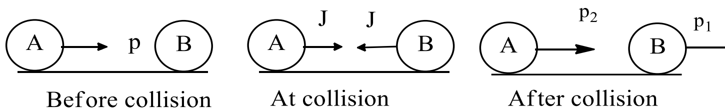
293 **(a)**
Let p_1 and p_2 be the momenta of A and B after collision.



Then, impulse = change in linear momentum of two particles

For B, $J = p_1$ ……………………..(i)

For A, $J = p - p_2$

..........................(ii)

or p_2 =p - J ....(iii)

Coefficient of restitution, $e = \frac{p_1 - p_2}{p} = \frac{p_1 - p_2 + J}{p}$

$$= \frac{J - p + J}{p} = \frac{2J}{p} - 1$$

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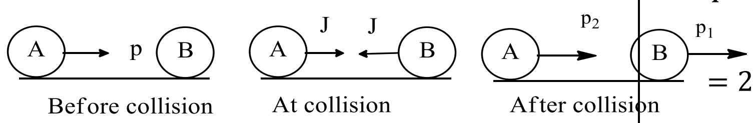

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295 **(d)**

Work done by the force is equal to gain in kinetic energy.

$$K.E. = \frac{1}{2}mv^2 = \frac{1}{2} \times 5 \times (20)^2 = 1000\ J$$

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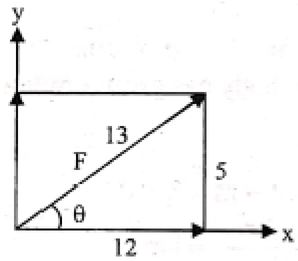
297 **(a)**



$$\cos\theta = \frac{12}{13}$$

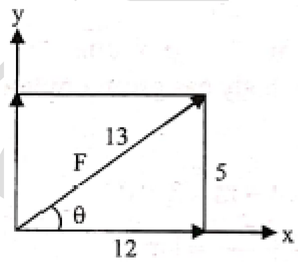
$$\sin\theta = \frac{5}{13}$$

Y − component of the force $F_y = F\sin\theta$

$$= 26 \times \frac{5}{13} = 10\ N$$

∴ Acceleration along y − axis $a_y = \frac{F_y}{m} = \frac{10}{2} 5\ m/s^2$

298 **(a)**



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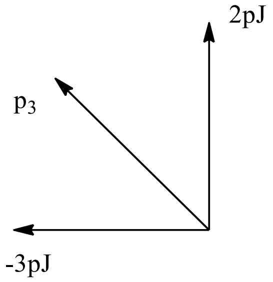
299 **(d)**

According to the question, we can draw the following diagram



Now, the magnitude of momentum of the third part is given by

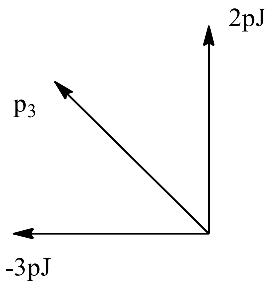
$$p_3 = \sqrt{(p_1^2) + (p_2)^2}$$

$$= \sqrt{(-3p)^2 + (2p)^2}$$

$$= \sqrt{9p^2 + 4p^2} = \sqrt{13p^2}$$

$$p_3 = \sqrt{13}p$$

300 **(d)**
According to the question, we can draw the following diagram



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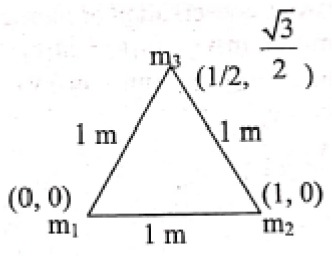
301 **(b)**



$$x_{cm} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

$$m_1 = m_2 = m_3$$

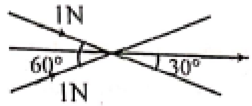
$$\therefore x_{cm} = \frac{1 \times 0 + 1 \times 1 + \frac{1}{2} \times 1}{1 + 1 + 1} = \frac{1.5}{3} = \frac{1}{2}$$

$$y_{cm} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$

$$= \frac{1 \times 0 + 1 \times 0 + 1 \times \sqrt{3}/2}{1 + 1 + 1}$$

$$= \frac{1}{2\sqrt{3}} = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}\right)$$

302 **(c)**



$m = 2\sqrt{3}$ kg,

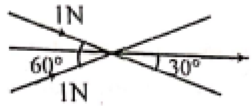
$$F_1 = 1 \cos 30^0 = \frac{\sqrt{3}}{2} N$$

$$F_2 = \frac{\sqrt{3}}{2} N$$

$$\therefore F_1 + F_2 = \sqrt{3}\ N$$

$$\therefore a = \frac{F}{m} = \frac{\sqrt{3}}{2\sqrt{3}} = \frac{1}{2} = 0.5\ m/s^2$$

303 **(c)**



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304 **(d)**
Work done = Change in KE

$$= \frac{1}{2}m(4V^2 - V^2) = \frac{3V^2m}{2} = 3\left(\frac{1}{2}mv^2\right)$$

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306 **(b)**
Given, $F = (2\hat{i} + 3\hat{j} + 4\hat{k})N$

We know that $W = F \cdot s$

Here , $s = r_f - r_i = (\hat{i} + 2\hat{j} + 3\hat{k}) - (2\hat{i} + 3\hat{j} + 4\hat{k})$

$= (-\hat{i} - \hat{j} - \hat{k})$

$\therefore \quad W = (2\hat{i} + 3\hat{j} + 4\hat{k}) \cdot (-\hat{i} - \hat{j} - \hat{k})$

$= -2 - 3 - 4 = -9$ J

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308 **(a)**
Work done = Area between the graph and position axis

$W = 10 \times 1 + 20 \times 1 - 20 \times 1 + 10 \times 1 = 20$ erg

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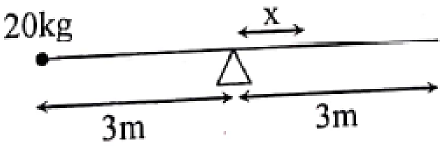
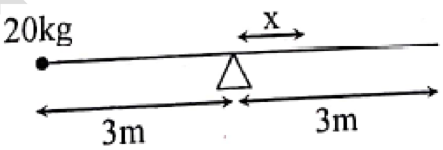
310 **(c)**



$\therefore 20 \times 3 = x \times 30$

$\therefore x = \frac{60}{30} = 2$ m

311 **(c)**



$\therefore 20 \times 3 = x \times 30$

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312 **(a)**
In x - direction, $m \times 50 - m \times 40 = m \times 0 + mv_x$

$\Rightarrow \quad v_x = 10$ cms^{-1}

In y- direction, $m \times 0 = m \times 30 = m \times 0 + mv_y$

$\Rightarrow \quad v_y = 30$ cms^{-1}

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314 **(c)**
Kinetic energy $k = \frac{p^2}{2m}$

Where p is the momentum

$\therefore p^2 = 2mk$ or $p = \sqrt{2mk}$

$\therefore p \propto \sqrt{m}$

Hence bodies having greater mass will have greater momentum. Hence p and Q will have greater momentum compared to R.

315 **(c)**
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316 **(b)**
$E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

$\therefore p^2 \propto m$

$p \propto \sqrt{m}$

$\therefore$ heavy body has greater momentum.

317 **(b)**

$E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

$\therefore p^2 \propto m$

$p \propto \sqrt{m}$

∴ heavy body has greater momentum.

318 **(d)**

Total upward force $=2\left(\frac{mg}{2}\right) = mg$.

(weight of man is balance by total tension acting upwards)

Total downward force is also mg.

$\therefore \quad F_{net} = 0 = a_{net}$

319 **(d)**

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Total downward force is also mg.

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320 **(d)**

Gravitational potential energy gained by the ball = Elastic potential energy in the spring

$mgh = \frac{1}{2}Fx$

$\therefore h = \frac{Fx}{2mg} = \frac{5 \times 0.2}{2 \times 25 \times 10^{-3} \times 10} = 2m$

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$\therefore h = \frac{Fx}{2mg} = \frac{5 \times 0.2}{2 \times 25 \times 10^{-3} \times 10} = 2m$

322 **(c)**

Stress × area= $M(g + a)$

$S \times \pi\frac{d^2}{4} = M(g + a)$

$d^2 = \frac{4M(g + a)}{S\pi}$

$d = \left[\frac{4M(g + a)}{\pi S}\right]^{1/2}$

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Stress × area= $M(g + a)$

$S \times \pi\frac{d^2}{4} = M(g + a)$

$d^2 = \frac{4M(g + a)}{S\pi}$

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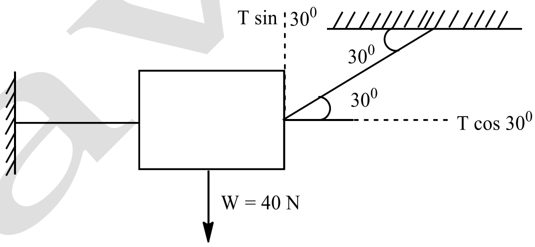
324 **(a)**

$T \sin 30^0 = w = 40N$



$\therefore \quad \frac{T}{2} = 40$ or T= 80 N

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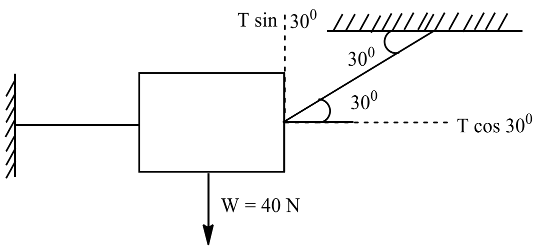

$\therefore \quad \frac{T}{2} = 40$ or T= 80 N

328 **(b)**

Initial momentum $P_1 = mV$

$= 20 \times 10^{-3}$ kg × 200 m/s

Final momentum = 0

Change in momentum = 4 kg m/s

Impulse = change in momentum = 4 kg m/s

$$\text{Force} = \frac{\text{Impulse}}{\text{time}} = \frac{4\text{Ns}}{\left(\frac{1}{50}\right)\text{s}} = 200\text{ N}$$

329 **(b)**

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$= 20 \times 10^{-3}\text{ kg} \times 200\text{ m/s}$

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Impulse = change in momentum = 4 kg m/s

$$\text{Force} = \frac{\text{Impulse}}{\text{time}} = \frac{4\text{Ns}}{\left(\frac{1}{50}\right)\text{s}} = 200\text{ N}$$

330 **(d)**

$$e = \sqrt{\frac{h_1}{h}}$$

$$\therefore e^2 = \frac{h_1}{h} \text{ or } h_1 = e^2h$$

similarly, $h_2 = e^2h_1 = e^4h$

331 **(d)**

$$e = \sqrt{\frac{h_1}{h}}$$

$$\therefore e^2 = \frac{h_1}{h} \text{ or } h_1 = e^2h$$

similarly, $h_2 = e^2h_1 = e^4h$

332 **(d)**

$F = t\hat{i} + 2t^2\hat{j}$

$ma = t\hat{i} + 2t^2\hat{j}$

$$m\frac{dv}{dt} = t\hat{i} + 2t^2\hat{j}$$

$$mv = \frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}$$

$$v = \frac{t^2}{2m}\hat{i} + \frac{2t^3}{3m}\hat{j}$$

$$\therefore P = F.v = \frac{t^3}{2m} + \frac{4t^5}{3m}$$

333 **(d)**

$F = t\hat{i} + 2t^2\hat{j}$

$ma = t\hat{i} + 2t^2\hat{j}$

$$m\frac{dv}{dt} = t\hat{i} + 2t^2\hat{j}$$

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$$v = \frac{t^2}{2m}\hat{i} + \frac{2t^3}{3m}\hat{j}$$

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334 **(c)**

Since gravitational field is conservative type, so $W_1 = W_2 = W_3$

335 **(c)**

Since gravitational field is conservative type, so $W_1 = W_2 = W_3$

336 **(a)**

$m_1V_1 - m_2V_2 = 0$

$$\therefore V_2 = -\frac{m_1V_1}{m_2}$$

337 **(a)**

$m_1V_1 - m_2V_2 = 0$

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338 **(a)**

$T_2 = (M_1 + M_2)a$

$T_1 = M_1a$

$$\therefore \frac{T_1}{T_2} = \frac{M_1}{M_1 + M_2}$$

339 **(a)**

$T_2 = (M_1 + M_2)a$

$T_1 = M_1a$

$$\therefore \frac{T_1}{T_2} = \frac{M_1}{M_1 + M_2}$$

340 **(a)**

Torque, $\tau = \frac{dL}{dt}$

where, L = angular momentum.

If $\tau = 0$, then

en $\frac{dL}{dt} = 0$

i.e $L = \text{constant}$

341 **(a)**

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342 **(c)**

$F = -5i - 7j + 3k$

$S = 3i - 2j + ak$

$14 = -15 + 14 + 3a$

$a = \frac{15}{3} = 5$

343 **(c)**

$F = -5i - 7j + 3k$

$S = 3i - 2j + ak$

$14 = -15 + 14 + 3a$

$a = \frac{15}{3} = 5$

344 **(b)**

$h_1 = 2m, e = 0.4$

$e = \sqrt{\frac{h_2}{h_1}}$

$\therefore e^2 = \frac{h_2}{h_1}$

$\therefore h_2 = e^2 h_1$

$= (0.4)^2 \times 2 = 0.16 \times 2 = 0.8 \text{ m}$

345 **(b)**

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$e = \sqrt{\frac{h_2}{h_1}}$

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346 **(b)**

By law of conservation of momentum

$MV = \frac{M}{2} v_0$

$\therefore v_0 = 2V$

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By law of conservation of momentum

$MV = \frac{M}{2} v_0$

$\therefore v_0 = 2V$

348 **(c)**

If x_1 and x_2 are distances from centre of mass, then we have

$m_1 x_1 = m_2 x_2$

$\therefore m_1(x - d) = m_2(x_2 - d')$

$\therefore m_1 x_1 - m_1 d = m_2 x - m_2 d'$

$\therefore m_1 d = m_2 d'$

$\therefore d' = \frac{m_1}{m_2} d$

349 **(c)**

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$m_1 x_1 = m_2 x_2$

$\therefore m_1(x - d) = m_2(x_2 - d')$

$\therefore m_1 x_1 - m_1 d = m_2 x - m_2 d'$

$\therefore m_1 d = m_2 d'$

$\therefore d' = \frac{m_1}{m_2} d$

350 **(b)**

For centre of mass we have $m_1 x_1 = m_2 x_2$

If x_1 decreases x_2 should also decrease.

$\therefore m_1(x_1 - d') = m_2(x_2 - d)$

$\therefore m_1x_1 - m_1d' = m_2x_2 - m_2d$

$\therefore m_1d' = m_2d$ or $d' = \frac{m_2}{m_1}d$

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352 **(c)**

Since the collision is elastic, the ball rebound with the same velocity.

$\therefore$ Change in momentum= 2mun, time 2s

Force = Rate of change of momentum

$= \frac{2mun}{2} = mun$

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$v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1u_1}{m_1 + m_2}$

$\because \quad v = \frac{2Mu}{M + m} \qquad (\because u_2 = 0)$

$\Rightarrow \quad v = \frac{2u}{1 + \frac{m}{M}}$

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356 **(c)**

Given, force , $F = 10 + 0.5x = 10 + \frac{1}{2}x$

Let during small displacement, the work done by the force is $dW = Fdx$.

So, work done during displacement from from $x = 0$ to $x = 2$ m is

$W = \int_0^w dW = \int_0^2 Fdx = \int_0^2 \left(10 + \frac{1}{2}x\right)dx$

$= \left[10x + \frac{x^2}{4}\right]_0^2 = 20 + \frac{2^2}{4} - 0 - 0 = 21$ J

357 **(c)**

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$= \left[10x + \frac{x^2}{4}\right]_0^2 = 20 + \frac{2^2}{4} - 0 - 0 = 21$ J

358 **(a)**

$F = m(a + g)$

$s \times \frac{\pi d^2}{4} = m(a + g)$

$d^2 = \frac{4m(a + g)}{s\pi}$

$d = \left(\frac{4m(a + g)}{\pi s}\right)^{1/2}$

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$s \times \frac{\pi d^2}{4} = m(a + g)$

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360 **(d)**

The body is initially at rest and hence its momentum is zero. By law of conservation of momentum its total momentum after explosion should also be zero.

The two fragments of mass m are at right angles to each other. Each has momentum $p = mv$. The resultant momentum of these will be

$$P' = mv\cos 45^0 + mv\cos 45^0$$

$$= 2mv\cos 45^0 = 2mv\frac{1}{\sqrt{2}} = \sqrt{2}\,mv$$

(The sine components are equal and opposite and get cancelled)

The momentum of the third fragment will be equal and opposite to P'

$$\therefore 2mV_0 = \sqrt{2}mV$$

$$\therefore V_0 = \frac{V}{\sqrt{2}}$$

The total kinetic energy

$$= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}\times 2m \times \left(\frac{V}{\sqrt{2}}\right)^2$$

$$= mv^2 + \frac{1}{2}mv^2 = \frac{3}{2}mv^2$$

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364 **(a)**

Velocity of the second sphere is given by

$$v_2 = \frac{2m_1u_1}{m_1+m_2} + \frac{m_2-m_1}{m_1+m_2}.u_2$$

Here, $m_1 = M, m_2 = m, u_1 = u, u_2 = 0$

$$\therefore v = \frac{2Mu}{M+m} = \frac{2u}{1+m/M}$$

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370 **(a)**

Force = rate of change of momentum= Nmu— Nmu = 2Nmu

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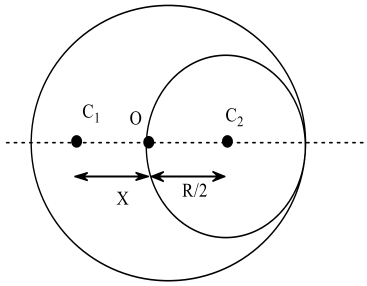
372 **(d)**

Centre of mass of complete disc should lie at point O. C_1 is the position of centre of mass of remaining portion and C_2 the position of mass of the removed disc.

$\therefore$ x (Area of remaining portion) = $\frac{R}{2}$(Area of removed disc)



$\therefore \quad x\left[\pi R^2 - \frac{\pi R^2}{4}\right] = \frac{R}{2}\left[\frac{\pi R^2}{4}\right]$

$\therefore \quad x = \frac{R}{6}$

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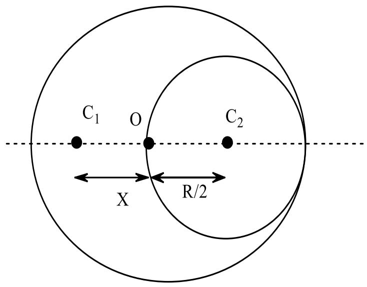

$\therefore \quad x\left[\pi R^2 - \frac{\pi R^2}{4}\right] = \frac{R}{2}\left[\frac{\pi R^2}{4}\right]$

$\therefore \quad x = \frac{R}{6}$

374 **(d)**

Given, mass, m = 6 kg

velocity, $v = v_2 - v_1 = 5 - 3 = 2\ ms^{-1}$

$\therefore$ Momentum, $p = mv = 6 \times 2 = 12$ N-s

375 **(d)**

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velocity, $v = v_2 - v_1 = 5 - 3 = 2\ ms^{-1}$

$\therefore$ Momentum, $p = mv = 6 \times 2 = 12$ N-s

376 **(a)**

Apparent weight $W' = m(g + a)$

$= mg\left(1 + \frac{a}{g}\right) = w\left(1 + \frac{a}{g}\right)$

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378 **(a)**

Here, mass, m = 5 kg

Change in velocity, $\Delta v = v_f - v_i = [(10 - 2)\hat{i} + (6 - 6)\hat{j}]$

$\therefore$ Change in momentum $= m\Delta v = 5[8\hat{i}] = 40\hat{i}$ kg-ms^{-1}

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$\therefore$ Change in momentum $= m\Delta v = 5[8\hat{i}] = 40\hat{i}$ kg-ms^{-1}

380 **(b)**

$h = 20$ m, $e = 0.4$ m

$\therefore v^2 = 0 + 2gh = 2 \times 10 \times 20$

$\therefore v = 2 \times 10 = 20$

$e = \frac{u}{v}$

$\therefore u = ev = 0.4 \times 20 = 8$ m/s

381 **(b)**

$h = 20$ m, $e = 0.4$ m

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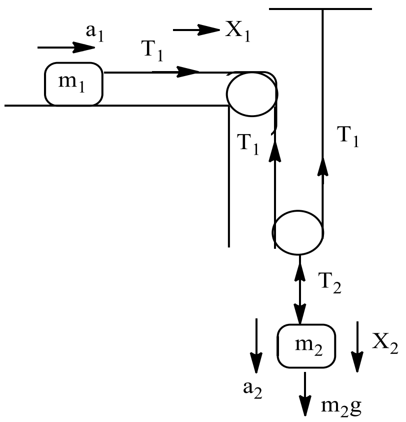
382 **(a)**



From force diagram, $T_1 = m_1 a_1$ ....(i)

$T_2 = 2T_1$

……………………….(ii)

$$m_2g - T_2 = m_2a_2$$

$$m_2g - 2T_1 = m_2a_2$$
……………………….(iii)

Total work done by tension should be zero.

$\therefore \quad T_1x_1 - T_2x_2 = 0$

or $\quad T_1x_1 = T_2x_2$

or $\quad T_1x_1 = 2T_2x_2$

or $\quad x_1 = 2x_2$

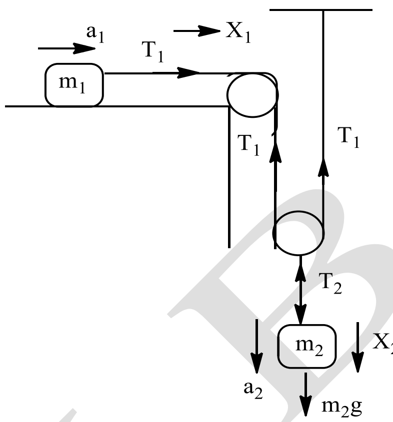
or $\quad \frac{d^2x_1}{dt_2} = \frac{2d^2x_2}{dt^2}$

$\therefore \quad a_1 = 2a_2$
………………………….(iv)

After solving Eqs. (i). (iii) and (iv), we get

$$a_2 = \frac{m_2g}{4m_1+m_2}$$

383 **(a)**



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$$T_2 = 2T_1$$
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After solving Eqs. (i). (iii) and (iv), we get

$$a_2 = \frac{m_2g}{4m_1+m_2}$$

384 **(a)**
Change in momentum = Impulse $\Rightarrow \Delta p = F \times \Delta t$

$\Rightarrow \quad \Delta t = \frac{\Delta p}{F} = \frac{125}{250} = 0.5$ s

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386 **(d)**
$\vec{F} = (t\hat{i} + 2t^2\hat{j})N$

$\therefore$ acceleration $\vec{a} = \frac{\vec{F}}{m} = \frac{1}{m}(t\hat{i} + 2t^2\hat{j})\frac{m}{s^2}$

$\vec{a} = \frac{d\vec{v}}{dt}$

$\therefore d\vec{v} = \vec{a} = dt$

$$\therefore \vec{v} = \int \vec{a}.dt = \int \frac{1}{m}(t\hat{i} + 2t^2\hat{j})\,dt$$
$$= \frac{1}{m}\left(\frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}\right)$$

$$p = \vec{F} - \vec{v} = (t\hat{i} + 2t^2\hat{j}).\frac{1}{m}\left(\frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}\right)$$
$$= \frac{1}{m}\left(\frac{t^3}{2} + \frac{4}{3}t^5\right)$$

387 **(d)**
$\vec{F} = (t\hat{i} + 2t^2\hat{j})N$

$\therefore$ acceleration $\vec{a} = \frac{\vec{F}}{m} = \frac{1}{m}(t\hat{i} + 2t^2\hat{j})\frac{m}{s^2}$

$\vec{a} = \frac{d\vec{v}}{dt}$

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$\therefore \vec{v} = \int \vec{a}.dt = \int \frac{1}{m}(t\hat{i} + 2t^2\hat{j})\,dt$
$= \frac{1}{m}\left(\frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}\right)$

$p = \vec{F} - \vec{v} = (t\hat{i} + 2t^2\hat{j}).\frac{1}{m}\left(\frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}\right)$
$= \frac{1}{m}\left(\frac{t^3}{2} + \frac{4}{3}t^5\right)$

388 **(b)**
$F = -F\hat{k}$

$P(1, -1)$

$\vec{r} = \hat{i} - \hat{j}$

$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 0 \\ 0 & 0 & -F \end{vmatrix}$

$= F\hat{i} - \hat{j}(-F) = F(\hat{i} + \hat{j})$

389 **(b)**
$F = -F\hat{k}$

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$= F\hat{i} - \hat{j}(-F) = F(\hat{i} + \hat{j})$

390 **(c)**
Torque, $\tau = r \times F = [(0-3)\,\hat{i} + (2-0)\,\hat{j} + (0-0)\hat{k}] \times [20\,\hat{i}]$

$= [-3\,\hat{i} + 2\,\hat{j}] \times [20\,\hat{i}]$

$= -40\hat{k}$

$|\tau| = 40$ N − m

391 **(c)**
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$= [-3\,\hat{i} + 2\,\hat{j}] \times [20\,\hat{i}]$

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$|\tau| = 40$ N − m

392 **(c)**
Let u_1 be the initial velocity of 'm' and its velocity after collision $v_1 = 0$. For mass 'm' initial velocity $u_2 = 0$. By law of conservation of momentum

$\therefore \frac{m}{M} = \frac{v_2}{u_1}$

coefficient of restitution $= \frac{v_2 - v_1}{u_1 - u_2} = \frac{v_2}{u_1}$

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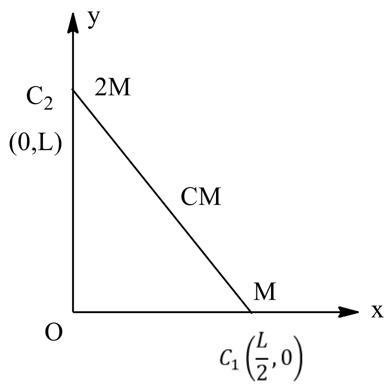
coefficient of restitution $= \frac{v_2 - v_1}{u_1 - u_2} = \frac{v_2}{u_1}$

394 **(c)**
As rods are uniform, therefore centre of mass of both rods will be at their geometrical centres. The coordinates of CM of first rod C_1 are $\left(\frac{L}{2}, o\right)$ and second rods C_2 are $(0, L)$



$\therefore \quad x_{CM} = \frac{M\left(\frac{L}{2}\right) + 2M(0)}{M + 2M} = \frac{L}{6}$

and $y_{CM} = \frac{M(0) + 2M(L)}{M + 2M} = \frac{2L}{3}$

Hence, coordinates of CM are $\left(\frac{L}{6}, \frac{2L}{3}\right)$.

395 **(c)**

$e = \frac{v_2 - v_1}{u_1 - u_2}$

$mu = 2m \times v$

$\therefore v = \frac{u}{2}$

$= \frac{\frac{u}{2} - 0}{u - 0} = \frac{1}{2} = 0.5$

396 **(c)**

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$mu = 2m \times v$

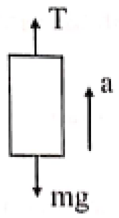
$\therefore v = \frac{u}{2}$

$= \frac{\frac{u}{2} - 0}{u - 0} = \frac{1}{2} = 0.5$

397 **(d)**

$T - mg = ma$

$\therefore T = m(g + a)$



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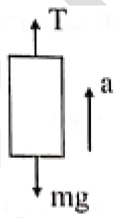


399 **(c)**

Theory question

400 **(c)**

Theory question

401 **(c)**

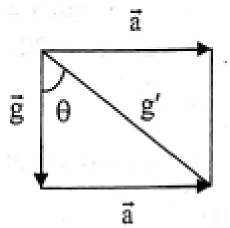
Force = 30 kg wt = $30 \times 9.8 = 294$ N

Displacement S = 20 m

$W = FS\cos 60^0 = 294 \times 20 \times \frac{1}{2} = 2940$ J

402 **(d)**

The effective acceleration due to gravity due to gravity is the resultant of $\vec{a}$ and $\vec{g}$.



$\tan\theta = \frac{a}{g}$

$\therefore a = g\tan\theta$

403 **(d)**

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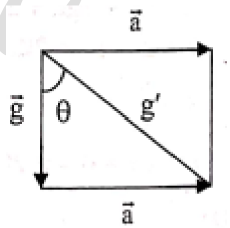

$\tan\theta = \frac{a}{g}$

$\therefore a = g\tan\theta$

404 **(c)**

$v^2 = u^2 + 2ad$

$v^2 = 2 \times \frac{F}{m}.d$

$E = \frac{1}{2}mv^2 = \frac{1}{2}m \times 2\frac{F}{m}d = Fd$

405 **(c)**

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$v^2 = 2 \times \frac{F}{m}.d$

$E = \frac{1}{2}mv^2 = \frac{1}{2}m \times 2\frac{F}{m}d = Fd$

406 **(d)**

$$v_2 = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) v_2 + \left(\frac{2m_1}{m_1 + m_2}\right) v_1$$

As, $v_1 = 0$

$$\therefore \quad \frac{V_2}{V_2'} = \left(\frac{m_2 + m_1}{m_2 - m_1}\right) = \left(\frac{m + 2m}{m - 2m}\right) = -3$$

$$\therefore \quad \frac{K_2}{K_2'} = \left(\frac{v_2}{v_2'}\right)^2 = 9 \text{ or } 9 : 1$$

407 **(d)**

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408 **(b)**

For centre of mass we have $m_1x_1 = m_2x_2$

If x_1 decreases x_2 should also decrease.

$\therefore m_1(x_1 - d) = m_2(x_2 - d')$

$\therefore m_1x_1 - m_1d = m_2x_2 - m_2d'$

$\therefore m_1d = m_2d'$ or $d' = \frac{m_1}{m_2}d$

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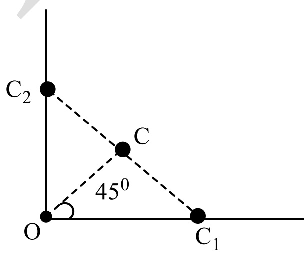
410 **(d)**

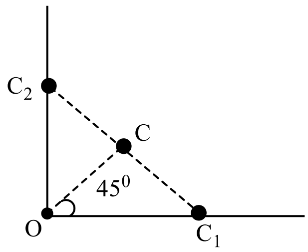
As, here in figure below, $OC_1 = \frac{1}{4}$ m



$\therefore \quad OC = OC_1 \cos 45^0 = \frac{1}{4\sqrt{2}}$ m

411 **(d)**

As, here in figure below, $OC_1 = \frac{1}{4}$ m



$\therefore \quad OC = OC_1 \cos 45^0 = \frac{1}{4\sqrt{2}}$ m

412 **(d)**

$W_1 = 620$ N, $W_2 = 340$ N

$W_1 = m(g + a)$ ... (i)

$W_2 = m(g - a)$ ... (ii)

$\therefore \frac{W_1}{W_2} = \frac{620}{340} = \frac{g + a}{g - a}$

$\therefore \frac{31}{17} = \frac{g + a}{g - a}$

Solving: $a = \frac{7}{24}g$

Putting this value in Eq. (i) and solving we get $mg = 480$ N

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414 **(d)**

$\tau = F \times l \cos 60^0 = \frac{Fl}{2}$

$\therefore F = \frac{2\tau}{l}$

415 **(d)**

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$\therefore F = \frac{2\tau}{l}$

416 **(a)**

$F_1 = 1 \text{ N}, r_1 = 1.2 \text{ m}, F_2 = 0.2 \text{ m}$

Torque should be same in the two cases.

$\therefore \tau = F_1 r_1 = F_2 r_2$

$\therefore F_2 = F_1 \frac{r_1}{r_2} = \frac{1 \times 1.2}{0.2} = 6 \text{ N}$

417 **(a)**

$F_1 = 1 \text{ N}, r_1 = 1.2 \text{ m}, F_2 = 0.2 \text{ m}$

Torque should be same in the two cases.

$\therefore \tau = F_1 r_1 = F_2 r_2$

$\therefore F_2 = F_1 \frac{r_1}{r_2} = \frac{1 \times 1.2}{0.2} = 6 \text{ N}$

418 **(d)**

Coefficient of restitution is given by

$e = \sqrt{\frac{h_2}{h_1}}$

$\therefore h_2 = e^2 h_1$

$h_3 = e^2 h_2 = e^4 h_1 = e^4 h$

419 **(d)**

Coefficient of restitution is given by

$e = \sqrt{\frac{h_2}{h_1}}$

$\therefore h_2 = e^2 h_1$

$h_3 = e^2 h_2 = e^4 h_1 = e^4 h$

420 **(b)**

KE is constantly increasing

$\therefore \frac{1}{2} mv^2 =$ constantly increasing

$v^2 =$ constantly increasing

$\therefore$ acceleration = constant and positive

$\therefore$ force is constant and greater than zero.

421 **(c)**

Potential energy of the spring = kinetic energy of the ball

$\therefore \frac{1}{2} kx^2 = \frac{1}{2} mv^2$

$\therefore v^2 = \frac{k}{m} x^2$

$\therefore v = x\sqrt{\frac{k}{m}}$

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423 **(a)**

$N = 10^4, m = 1 \text{ g} = 10^{-3} \text{ kg}, A = 1 \text{ cm}^2$
$= 10^{-4} \text{ m}^2, v = 100 \frac{\text{m}}{\text{s}}$

Change in momentum in each collision=
$m[v — v) = 2 \text{ mv}$

$\therefore$ change in momentum per second $= 10^4 \times 2\text{mv}$
$= 10^4 \times 2 \times 10^{-3} \times 100$

$= 2000 \text{ N}$

Pressure $= \frac{F}{A} = \frac{2000}{10^{-4}} = 2 \times 10^7 \text{ N/m}^2$

424 **(a)**

$N = 10^4, m = 1 \text{ g} = 10^{-3} \text{ kg}, A = 1 \text{ cm}^2$
$= 10^{-4} \text{ m}^2, v = 100 \frac{\text{m}}{\text{s}}$

Change in momentum in each collision=
$m[v — v) = 2 \text{ mv}$

$\therefore$ change in momentum per second $= 10^4 \times 2mv$

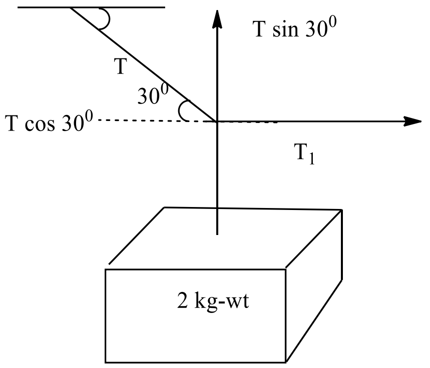
$= 10^4 \times 2 \times 10^{-3} \times 100$

$= 2000$ N

$$\text{Pressure} = \frac{F}{A} = \frac{2000}{10^{-4}} = 2 \times 10^7 \text{ N/m}^2$$

425 **(c)**

$T \sin 30^0 = 2$ kg - wt

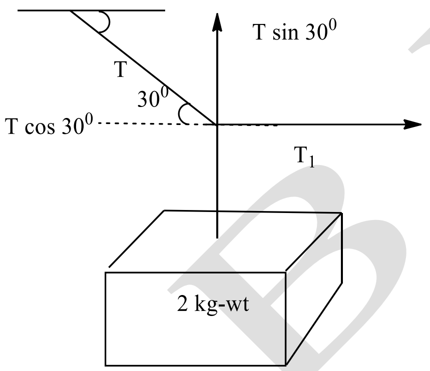


T = 4 kg-wt

$\Rightarrow \quad T_1 = T\cos 30^0 = 4\cos 30^0 = 2\sqrt{3}\text{ kg} - \text{wt}$

426 **(c)**

$T \sin 30^0 = 2$ kg - wt



T = 4 kg-wt

$\Rightarrow \quad T_1 = T\cos 30^0 = 4\cos 30^0 = 2\sqrt{3}\text{ kg} - \text{wt}$

427 **(d)**

$$\text{Kinetic energy} = \frac{p_1^2}{2m_1} = \frac{p_2^2}{2m_2}$$

$$\therefore \frac{p_1^2}{p_2^2} = \frac{m_1}{m_2}$$

$$\therefore \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{4/1} = 2$$

428 **(d)**

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429 **(c)**

Given, $u = (3\hat{i} + 4\hat{j})\text{ms}^{-1}$ and $v = -(3\hat{i} + 4\hat{j})\text{ms}^{-1}$

Mass of the ball $= 150$ g $= 0.15$kg

Δp = Change in momentum

= Final momentum - Initial momentum

= mv-mu

$= m(v-u) = (0.15)[-(3\hat{i} + 4\hat{j}) - (3\hat{i} + 4\hat{j})]$

$= (0.15)[-6\hat{i} - 8\hat{j}] = -[0.15 \times 6\hat{i} + 0.15 \times 8\hat{j}]$

$= -(0.9\hat{i} + 1.2\hat{j})$

Hence, $\Delta p = -(0.9\hat{i} + 1.2\hat{j})$

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Hence, $\Delta p = -(0.9\hat{i} + 1.2\hat{j})$

431 **(b)**

Work done,

$W = \int_{-a}^{+a} F dy = \left[\frac{Ay^3}{3} + \frac{By^2}{2} + Cy\right]_{-a}^{+a} = \frac{2Aa^3}{3} + 2Ca$

432 **(b)**

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433 **(d)**

It is a perfectly inelastic collision and hence there is a loss of kinetic energy, but momentum is conserved.

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435 **(a)**

Torque of the force, $\tau = r \times F$

$$\tau = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & 3 & 1 \\ -3 & 1 & 5 \end{vmatrix} = (14\hat{i} - 38\hat{j} + 16\hat{k})$$

436 **(a)**

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437 **(a)**

Given, force, $F = (2\hat{i} + 3\hat{j})$ N

Displacement , $ds = (dx\,\hat{i} + dy\hat{j})\ dz\,\hat{k}$

Work done, $W = \int F . ds = \int(2dx + 3dy)$

Also, $3y + kx = 5 \Rightarrow \frac{3dy}{dx} + k = 0$

$\Rightarrow \quad 3dy = - kdx \Rightarrow W = \int(2dx - kdx) = 0$

$\Rightarrow \quad 2x = kx \Rightarrow k = 2$

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439 **(c)**

Work done, W Area under the F - x graph

$= \text{Area of trapezium} = \frac{1}{2} \times (4 + 2) \times 5 = 15$ J

440 **(c)**

Work done, W Area under the F - x graph

$= \text{Area of trapezium} = \frac{1}{2} \times (4 + 2) \times 5 = 15$ J

441 **(d)**

When the ball is released $u = 0$

$v = gt_1 = 2g$

After bouncing let u' be the initial velocity.

Final velocity is zero, $t_2 = 1s$

$0 = u' - gt_2$

$\therefore u' = gt_2 = g$

Coefficient of restitution $v = \frac{u'}{V} = \frac{g}{2g} = 0.5$

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443 **(c)**

$m_1 = 1.6$ kg; $(x_1\ y_1) = (0,0)$

$m_2 = 2\ kg\ ; (x_2, y_2) = (1.2, 0)$

$m_3 = 2.4$ kg; $(x_3, y_3) = (0,1)$

∴ Coordinates of centre of mass will be

$$x_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} = \frac{(1.6)(0) + (2)(1.2) + (2.4)(0)}{1.6 + 2 + 2.4}$$

$x_{CM} = 0.4$ m

$$\text{and } y_{CM} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{(1.6)(0)+(2)(0)+(2.4)(1)}{1.6 + 2 + 2.4}$$

$y_{CM} = 0.4$ m

∴ Coordinates of centre of mass = (0.4, 0.4) m.

444 **(c)**

$m_1 = 1.6$ kg; $(x_1\ y_1) = (0,0)$

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$x_{CM} = 0.4$ m

$$\text{and } y_{CM} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{(1.6)(0)+(2)(0)+(2.4)(1)}{1.6 + 2 + 2.4}$$

$y_{CM} = 0.4$ m

∴ Coordinates of centre of mass = (0.4, 0.4) m.

447 **(b)**

From first equation of motion,

$$v = u + at \Rightarrow 20 = 0 + a \times 10$$

$\Rightarrow \quad 20 = a \times 10 \Rightarrow a = 2\ m/s^2$

Now, distance, $s = ut + \frac{1}{2}at^2$

$\Rightarrow \quad s = 0 + \frac{1}{2} \times 2 \times 10 \times 10$

or $\quad s = 100$ m

∴ Work done, $W = F.s = mass$ $\quad (\because F = ma)$

$= 50 \times 2 \times 100 = 10^4$ J

448 **(b)**

From first equation of motion,

$$v = u + at \Rightarrow 20 = 0 + a \times 10$$

$\Rightarrow \quad 20 = a \times 10 \Rightarrow a = 2\ m/s^2$

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or $\quad s = 100$ m

∴ Work done, $W = F.s = mass$ $\quad (\because F = ma)$

$= 50 \times 2 \times 100 = 10^4$ J

449 **(b)**

$$v_e = \sqrt{\frac{2GM}{R}}$$

$v = nv_e$

Initial kinetic energy,

$$K.E. = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times m \times \frac{2GM}{R} \times n^2$$

$$\therefore K.E. = \frac{GMm}{R}.n^2 \quad ...(1)$$

Change in potential energy,

$$P.E. = \frac{GMm}{R} - \frac{GMm}{R+h}$$

$$P.E. = GMm\left[\frac{h}{R(R+h)}\right] \; ...(2)$$

Equating (1) and (2)

$$\therefore \frac{GMm}{R}.n^2 = GMm\left[\frac{h}{R(R+h)}\right]$$

$$\therefore n^2(R+h) = h$$

Solving for h we get:

$$h = \frac{n^2 R}{1 - n^2}$$

450 **(b)**

$$K.E. = \frac{1}{2}\frac{GMm}{r}$$

$$\therefore \frac{K_1}{K_2} = \frac{r_2}{r_1} = \frac{3R + R}{3R + R} = \frac{4}{3}$$

454 **(b)**

Even though the distribution of mass is unknown or non-uniform but we can find the potential due to ring on any axial point because from any axial point the entire mass is at the same distance (whatever would be the nature of distribution).

Potential at A due to ring is $V_A = -\frac{GM}{\sqrt{2}R}$

Potential at B due to ring is $V_B = -\frac{GM}{\sqrt{5}R}$

$$dU = U_f - U_i = U_B - U_{A'} = m_0(V_B - V_A)$$
$$= \frac{GMm_0}{R}\left[-\frac{1}{\sqrt{5}} + \frac{1}{\sqrt{2}}\right]$$
$$W_{gr} = -W_{ext} \Rightarrow W_{gr} = -dU = -W_{ext}$$
$$\therefore W_{ext} = dU = \frac{GMm_0}{R}\left[\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{5}}\right]$$

455 **(a)**

$$F = \frac{GmM}{R^2} \text{ and } g = \frac{GM}{R^2}$$

456 **(b)**

$$\phi = 0°, g' = g - R\,\omega^2 \cos^2 \phi = 0$$
$$\therefore \omega = \sqrt{g/R} = \sqrt{10/(6400 \times 10^3)} = 1/800$$

457 **(b)**

Earth and all other planets move around the sun under the effect of gravitational force. This force always acts along the line joining the centre of the planet and the sun and is directed towards the sun.

$$\frac{\Delta \boldsymbol{A}}{\Delta t} = \frac{L}{2m} = a \text{ constant vector}$$

Therefore, Kepler's second law is the consequence of the principle of conservation of angular momentum (L).

$$\tau = \frac{dL}{dt} = 0$$

Now, $\tau = l\alpha$

$\therefore l\alpha = 0$

Or $\alpha = 0$

Or $a_T = r\,\alpha = 0$

i.e., Tangential acceleration is zero.

459 **(a)**

Earth has the maximum speed in the equatorial region. To take advantage of its, the launch station should be in the equatorial region.

460 **(d)**

$$mr\omega^2 = \frac{GMm}{r^2}$$

$$r\omega^2 = \frac{GM}{r^2}$$

$$r^3 = \frac{GM}{\omega^2} = \frac{GM}{R^2} \times \frac{R^2}{\omega^2} = g\frac{R^2}{\omega^2}$$

$$r = \left(\frac{R^2 g}{\omega^2}\right)^{1/3}$$

461 **(c)**

In the problem, orbital radius is increased by 1%

Time period of satellite $T \propto r^{3/2}$

Percentage change in time period

$= \frac{3}{2}$ (% change in orbital radius)

$$= \frac{3}{2}(1\%) = 1.5\%$$

462 **(c)**

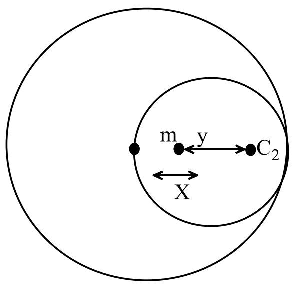
E = Energy of satellite at altitude of 7R – Energy of satellite on surface of earth

$$= -\frac{GMm}{2(8R)} - \left[-\frac{Gmm}{R}\right] = \frac{15}{16}\frac{GMm}{R} = \frac{15}{16}mgR$$

$$\left(as, \frac{GM}{R} = gR\right)$$

463 **(b)**

To calculate the force of attraction on the point mass m, we should calculate the force due to the solid sphere and mass m and subtract the force which the mass of the hollow sphere would have exerted on m.



i.e. $F = \frac{GmM}{x^2} - \frac{GmM'}{y^2}$ [$\because x = R/4, x + y = R/2$]

$$M = \left(\frac{4}{3}\right)\pi R^3 \rho$$

and $M' = \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 \rho = \frac{M}{8}$

$\therefore\ F = \frac{GMm}{(R/4)^2} - \frac{Gm(M/8)}{(R/4)^2} = \frac{14GmM}{R^2}$

464 **(a)**

Only statement (a) is correct. The corrected form of rest is as

When a satellite is moving in an elliptical orbit, it's angular momentum ($= \boldsymbol{r} \times \boldsymbol{p}$) about the centre of earth does not change its direction. The linear momentum (=mv) does not remain constant as velocity of satellite is not constant. The total mechanical energy of S is constant at all locations.

465 **(b)**

According to the law of conservation of energy,

(Total energy) surface =

(Total energy)$_{(\text{max height})}$

$\Rightarrow\ (KE + PE)_{\text{surface}} = (KE + PE)_{max\ \text{height}}$

$\Rightarrow\ \frac{1}{2}mv^2 + \left(-\frac{GMm}{R}\right) = 0 + \left(-\frac{GMm}{R+h}\right)$

Given, $v = \frac{1}{2}v_\theta = \frac{1}{2}\sqrt{\frac{2GM}{R}}$

$\Rightarrow\ \frac{1}{2}m\left[\frac{1}{4}\cdot\frac{2GM}{R}\right] - \frac{GMm}{R} = -\frac{GMm}{R+h}$

$\Rightarrow\ \frac{1}{4}\frac{GMm}{R} - \frac{GMm}{R} = -\frac{GMm}{R+h}$

$\Rightarrow\ \frac{-3}{4R} = -\frac{1}{R+h}$

$\Rightarrow\ R - 3h = 0 \Rightarrow h = \frac{R}{3}$

467 **(a)**

$r_M = 1.525\ r_E$

$\therefore \frac{r_M}{r_E} = 1.525$

$\therefore \left(\frac{T_M}{T_E}\right)^2 = \left(\frac{r_B}{r_E}\right)^3 = (1.525)^3$

$\therefore T_M^2 = T_E^2 \times (1.525)^3$

$= (1)^2(1.525)^3$

$\therefore T_M = (1.525)^{3/2}$

$= 1.883$ years

468 **(a)**

If body is projected with velocity $v(v < v_e)$ then height up to which it will rise, $h = \frac{R}{\left(\frac{v_e^2}{v^2}-1\right)}$

$v = \frac{v_e}{2}$ (Given)

$\therefore h = \frac{R}{\left(\frac{v_e}{v_e/2}\right)^2 - 1} = \frac{R}{4-1} = \frac{R}{3}$

470 **(c)**

$r' = 2r$ .....[Given]

Now, $F \propto \frac{1}{r^2}$

$\therefore F' \propto \frac{1}{(2r)^2} = \frac{1}{4r^2} \Rightarrow F' = \frac{F}{4}$

$\therefore$ Force is reduced to one-fourth

472 **(a)**

$a = \frac{4\pi^2 R_m}{T^2} = \frac{4 \times \left(\frac{22}{7}\right)^2 \times (3.84 \times 10^8)}{[27.3 \times 24 \times 60 \times 60]^2}$

$\approx 0.0027\ \text{ms}^{-2}$

Hence, centripetal acceleration of the moon due to earth's gravity is much smaller than the value of acceleration due to gravity g on the surface of the earth.

473 **(d)**

Binding energy of satellite is

Case I $BE_1 = \frac{GMm}{2r}$

where, r is the radius of orbit.

Case II $BE_2 = \frac{GMm}{2\times\frac{3r}{2}} = \frac{GMm}{3r}$

$\therefore \Delta E = BE_1 - BE_2 = \frac{GMm}{r}\left(\frac{1}{2} - \frac{1}{3}\right) = \frac{GMm}{6r}$

% increase in energy of a satellite

$= \frac{\frac{GMm}{6r}}{\frac{GMm}{2r}} \times 100 = \frac{2}{6} \times 100 = 33.33\%$

474 **(b)**

A. GPE of the system $= -\frac{Gm_1m_2}{r}$

B. Gravitational potential due to m_1 at a distance r

$V_1(r) = \frac{-Gm_1}{r}$

C. Gravitational potential due to m_2 at a distance r

$V_2(r) = -\frac{Gm_2}{r}$

Hence, $A \to 2, B \to 3$ and $C \to 1$

477 **(b)**

$r_2 = \frac{1}{4}r_1, T_1 = 1$ years

Now, $T^2 \propto r^3$

$\therefore T_2 = T_1\left(\frac{r_2}{r_1}\right)^{3/2} = 1\left(\frac{1}{4}\right)^{3/2} = \left(\frac{1}{8}\right)$ year

479 **(c)**

The binding energy of the body is given by

$B.E. = \frac{GM_1M}{\frac{r}{3}} + \frac{GM_2M}{\frac{2r}{3}} = \frac{3GM_1M}{r} + \frac{3GM_2M}{2r}$

$= \frac{3GM}{r}\left[M_1 + \frac{M_2}{2}\right]$

If V is the velocity given to the body, then

$$\frac{1}{2}mV^2 = \frac{3GM}{r}\left[M_1 + \frac{M_2}{2}\right]$$

$$\therefore V = \left[\frac{6G}{r}\left(M_1 + \frac{M_2}{2}\right)\right]^{\frac{1}{2}}$$

481 **(d)**

A person is safe, if his velocity while reaching the surface of the planet from a height h ' is equal to his velocity while falling from height h on the earth. So,

$$\sqrt{2g'h'} = \sqrt{2gh}$$

$$h' = \frac{gh}{g'} = 9.8 \times \frac{3}{1.96} = 15 \text{ m}$$

482 **(b)**

If mass m is placed at $\frac{2}{3}$d from M_1, then potential energy of the mass is

$$U = -\frac{GM_1m}{\left(\frac{2}{3}d\right)} - \frac{GM_2m}{\left(\frac{d}{3}\right)} = -\frac{3GM_1m}{2d} - 3GM_2m/d$$

If it is given velocity V so that it escapes to infinity then

$$\frac{1}{2}mv^2 - \frac{3GM_1m}{2d} - \frac{3GM_2m}{d} = 0$$

$$\therefore \frac{1}{2}mV^2 = \frac{3GM_1m}{2d} - \frac{3GM_2m}{d}$$

$$\therefore V^2 = \frac{6GM_1}{2d} + \frac{6GM_2}{d} = \frac{6G}{d}\left(\frac{M_1}{2} + M_2\right)$$

$$V = \left[\frac{6G}{d}\left(\frac{M_1}{2} + M_2\right)\right]$$

484 **(d)**

Gravitational potential $V_i = -\frac{GM}{r}$

$$V_i = -\frac{6.67 \times 10^{-11} \times 100}{0.1}$$

$$V_i = -\frac{6.67 \times 10^{-9}}{0.1} = -6.67 \times 10^{-8} J$$

$$V_t = 0$$

∴ Work done per unit mass,

$$W = \Delta V = (V_f - V_i) = 6.67 \times 10^{-8} J$$

485 **(c)**

If r is the radius of the orbit of the satellite and ω is the angular velocity which is same as the angular velocity of the earth about its axis then we have

$$mr\omega^2 = \frac{GMm}{r^2}$$

$$\therefore \omega^2 = \frac{GM}{r^3} = \frac{gR^2}{r^3}$$

$$\therefore r^3 = \frac{gR^2}{\omega^2}$$

$$\therefore r = (gR^2/\omega^2)^{1/3}$$

487 **(c)**

$$g' = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

$$\therefore \frac{g}{16} = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

$$\therefore \left(1 + \frac{h}{R}\right)^2 = 16$$

$$\therefore 1 + \frac{h}{R} = 4 \Rightarrow \frac{h}{R} = 3 \Rightarrow h = 3R$$

488 **(d)**

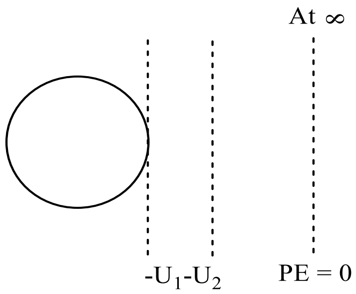
$$v_\theta^2 = \frac{2GM}{R}$$

and $v_o^2 = \frac{GM}{r}$

Now, $\frac{1}{2}mv^2 = -U_2 + U_1 = U_1 - U_2$

$$= \frac{GMm}{R} - \frac{GMm}{r}$$

$$\therefore v = \sqrt{v_\theta^2 - 2v_o^2}$$



489 **(a)**

$$m\omega^2 R \propto \frac{1}{R^n} \Rightarrow m\left(\frac{4\pi^2}{T^2}\right)R \propto \frac{1}{R^n} \Rightarrow T^2 \propto R^{n+1}$$

$$\therefore T \propto R^{\left(\frac{n+1}{2}\right)}$$

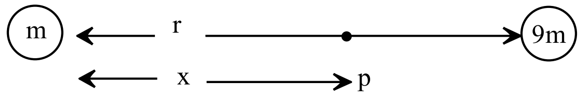
490 **(d)**

$$v_e = \sqrt{\frac{GM}{r}} = \sqrt{\frac{gR^2}{r}} \text{ and } v_e = r\omega$$

This gives $r^3 = \frac{R^2g}{\omega^2}$

491 **(c)**

According to question, for the given system of particles,



Let at point P, gravitational field is zero, so

$$\frac{Gm}{x^2} = \frac{G \times 9m}{(r-x)^2} \Rightarrow \frac{1}{x^2} = \frac{9}{(r-x)^2}$$

$$\Rightarrow \sqrt{(r-x)^2} = \sqrt{9x^2}$$

$$\Rightarrow r - x = 3x$$

$$\Rightarrow x = \frac{r}{4}$$

Gravitational potential at this point is given by

$$V = -\left(\frac{4Gm}{r} + \frac{G \times 9m \times 4}{3r}\right) \quad \left(\because r - x = \frac{3r}{4}\right)$$

$$= -\left(\frac{4Gm + 12Gm}{r}\right) = -\left(\frac{16Gm}{r}\right)$$

494 **(b)**

Given, $g_h = 9 = \frac{gR^2}{(R+R/20)^2} = \frac{20\times20}{21\times21}g$

or $g = \frac{9\times21\times21}{20\times20}\ ms^{-2}$

Now, $g_d = g\left(1 - \frac{d}{R}\right) = \frac{9\times21\times21}{20\times20}\left(1 - \frac{R/20}{R}\right)$

$= 9.5\ ms^{-2}$

495 **(c)**

$v_e = \sqrt{2}\,v_c$. Clearly, if v_e becomes 36%, v_e will also become 36%

$$\therefore v_e{}' = \frac{36}{100} \times 11.2 \text{ km s}^{-1} = \frac{9}{25} \times 11.2 \text{km s}^{-1}$$

496 **(c)**

Here, $\frac{g_m}{g_e} = \frac{M_m}{M_e} \times \left(\frac{R_\theta}{R_m}\right)^2$

$$= \frac{1}{81} \times (4)^2 = \frac{16}{81} \Rightarrow g_m = \frac{16}{81} g_\theta$$

Given, $v_\theta = \sqrt{2g_\theta R_e} \approx 11.2 kms^{-1}$

$$v_m = \sqrt{2g_m R_m} = \sqrt{2 \times \frac{16}{81} g_e \times \frac{1}{4} R_e}$$

$$= \frac{2}{9}\sqrt{2g_e R_e} = \frac{2}{9} \times 11.2 \approx 2.5 kms^{-1}$$

497 **(b)**

$\rho_2 = 2\rho_1, R_1 = R_2$

$g \propto \rho R \Rightarrow g_1 \propto \rho_1 R_1$ and $g_2 \propto \rho_2 R_2$

$$\therefore \frac{g_1}{g_2} = \frac{\rho_1}{\rho_2} \times \frac{R_1}{R_2} = \frac{1}{2} \times 1 = \frac{1}{2}$$

$\therefore g_2 = 2 \times 9.8 = 19.6 \text{m/s}^2$

498 **(b)**

$F_{CP} = F_G$

$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$v = \sqrt{\frac{GM}{r}}$$

$$T = \frac{2\pi r}{v}$$

$T^2 = \frac{4\pi^2 r^3}{GM}$ ...(i)

$T^2 = Kr^3$ ...(ii)

$$K = \frac{4\pi^2}{GM}$$

$GMK = 4\pi^2$

499 **(d)**

$$|V| = \frac{GM}{R+h}$$

$$g = \frac{GM}{(R+h)^2}$$

$$\therefore \frac{|V|}{g} = \frac{(R+h)^2}{R+h} = R + h$$

$$\therefore h = \frac{|V|}{g} - R = \frac{5.4 \times 10^7}{6.0} - 6.4 \times 10^6$$

$= 9.0 \times 10^6 - 6.4 \times 10^6$

$= 2.6 \times 10^6 = 2600$ km

500 **(d)**

$g' = g - \omega^2 R\cos^2\lambda, \lambda = 60°$

$$\therefore 0 = 1 - \omega^2 \times 6400 \times 10^3 \times \frac{1}{4}$$

$$\therefore \omega^2 = \frac{10^{-4}}{16}$$

$$\Rightarrow \omega = \frac{10^{-2}}{4}$$

$\therefore \omega = 2.5 \times 10^{-3}$rad/s

501 **(a)**

$g = \frac{4}{3}\pi\rho G r$ or $g \propto r$ (if $r < R$)

$g = \frac{GM}{r^2}$ or $g \propto \frac{1}{r^2}$ (if $r > R$)

If $r_1 < R$ and $r_2 < R$, then $\frac{F_1}{F_2} = \frac{g_1}{g_2} = \frac{r_1}{r_2}$

502 **(a)**

Weight of the body at the surface of the earth,

$w = mg = 45$ N

Using, $g' = \frac{g}{\left(1+\frac{h}{R}\right)^2} \Rightarrow mg' = \frac{mg}{\left(1+\frac{R}{2R}\right)^2}$ $\left[h = \frac{R}{2}\right]$

$$w' = \frac{45}{\left(1+\frac{1}{2}\right)^2} = \frac{4 \times 45}{9} = 20 \text{ N} \ (\because w' = mg')$$

503 **(c)**

At a height

$$h = \frac{R}{2}$$

The potential energy is P. E.

$$= -\frac{GMm}{R + \frac{R}{2}} = -\frac{2GMm}{3R}$$

Initial K. E. is zero.

When it hits the surface, it has kinetic and potential energy

∵ total energy is conserved.

$$\therefore \frac{1}{2}mv^2 - \frac{GMm}{R} = -\frac{2GMm}{3R}$$

$$\therefore \frac{1}{2}mv^2 = \frac{GMm}{R} - \frac{2}{3}\frac{GMm}{R} = \frac{1}{3}\frac{GMm}{R}$$

$$\therefore V^2 = \frac{2}{3}\frac{Gm}{R}$$

$$\therefore V = \sqrt{\frac{2}{3}\frac{GM}{R}} = \frac{1}{\sqrt{3}}\sqrt{\frac{2Gm}{R}} = \frac{V_e}{\sqrt{3}}$$

504 **(b)**

$$\text{Angular momentum} = mvr = m\sqrt{\frac{GM}{r}}r = m\sqrt{GMr}$$

$$= m(GMr)^{1/2}$$

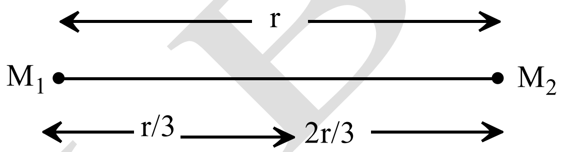
505 **(b)**

$$T = \sqrt{\frac{3\pi}{G\rho}} = \sqrt{\frac{3 \times 3.14}{6.67 \times 10^{-11} \times 8 \times 10^3}} = s$$

$$\approx 4200 \text{ s}$$

506 **(b)**

The given situation can be drawn as



The gravitational potential at P is

$$V_P = -\left(\frac{GM_1}{\frac{r}{3}} + \frac{GM_2}{\frac{2r}{3}}\right)$$

$$= \frac{-3G(2M_1 + M_2)}{2r}$$

The work done to escape the mass M to infinity is

$$W = M(V_\infty - V_P)$$

$$= \frac{3GM(2M_1 + M_2)}{2r}$$

As, work done is equal to kinetic energy of mass M.

$$\Rightarrow \frac{1}{2}Mv_\theta^2 = \frac{3GM(2M_1 + M_2)}{2r}$$

$$v_\theta = \left[\frac{3G}{r}(2M_1 + M_2)\right]^{1/2} \text{ or } v_e = \left[\frac{6G}{r}\left(M_1 + \frac{M_2}{2}\right)\right]^{1/2}$$

509 **(d)**

The total energy of an artificial satellite moving in a circular orbit at some height around the earth is E_0. Its potential energy is $2E_0$.

510 **(d)**

$$F = G\frac{m_1 m_2}{r^2}$$

$$\therefore G = \frac{Fr^2}{m_1 m_2}$$

∴ Units of G is $\frac{Nm^2}{kg^2}$

512 **(c)**

PE = 2TE

514 **(b)**

$$\text{Escape velocity } V_e = \sqrt{\frac{2Gm}{R}}$$

∴ Energy required to escape from earth's gravitational influence

$$= \frac{1}{2}mV_e^2 = \frac{1}{2}m \times \frac{2GM}{R} = \frac{GMm}{R}$$

$$\therefore \text{K. E. of projection} = \frac{1}{2}\frac{GMm}{R}$$

$$\text{P. E. on earth's surface} = -\frac{GMm}{R}$$

∴ Total energy on earth's surface

$$= -\frac{GMm}{R} + \frac{1}{2}\frac{GMm}{R} = -\frac{1}{2}.\frac{GMm}{R}$$

Total energy at the maximum height

$$= -\frac{GMm}{R + h}$$

$$\therefore -\frac{GMm}{R + h} = \frac{1}{2}\frac{GMm}{R}$$

$$\therefore R + h = 2R$$

$\therefore h = R$

516 **(c)**

According to Kepler's third law, $T^2 \propto r^3$

or

$5^2 \propto r^3$ ..... (i)

and

$(T')^2 \propto (4r)^3$ .... (ii)

From Eqs. (i) and (ii), we get

$\frac{25}{(T')^2} = \frac{r^3}{64r^3} \Rightarrow T' = \sqrt{1600} = 40h$

520 **(b)**

Among the following options, option (b), i.e. revolution of the earth around the sun is the best evidence to show that there must be a force acting on earth directed towards the sun.

523 **(b)**

$\frac{GM^2}{(2R)^2} = \frac{Mv^2}{R}$ or $\frac{GM}{4R} = v^2$

$\therefore v = \frac{1}{2}\sqrt{\frac{GM}{R}}$

525 **(a)**

$M_P = 2M_e$

$D_P = 2D_e$

$G_P = \frac{GM_P}{(R_P)^2} = \frac{GM_e}{(R_e)^2} = \frac{g_e}{2}$

$T_P = 2\pi\sqrt{\frac{l}{g_P}} = 2\pi\sqrt{\frac{l \times 2}{g_e}} = \sqrt{2} \times 2\pi\sqrt{\frac{l}{g_e}}$

$= \sqrt{2} \times 2 = 2\sqrt{2}$ s

526 **(c)**

$\frac{3}{5}g = g - R\omega^2$

$\therefore R\omega^2 = g - \frac{3}{5}g = \frac{2}{5}g$

$\therefore \omega^2 = \frac{2g}{5R}$

$\therefore \omega = \sqrt{\frac{2g}{5R}}$

528 **(d)**

We have $g' = g - r\omega^2\cos^2\theta$

At equator $\theta = 0$

$\therefore g_e = g - R\omega^2$

At pole $\theta = 90^0$

$\therefore g_\rho = g$

$\therefore g_\rho - g_e = R\omega^2$

530 **(a)**

$M_P = 2M_E, D_P = 2D_E \Rightarrow R_P = 2R_E$

$T_E = 2$ s

$g_E = \frac{GM_E}{R_E}, g_P = \frac{GM_P}{R_P^2}$

$\therefore g_P = g_E \times \frac{M_P}{M_E} \times \left(\frac{R_E}{R_P}\right)^2$

$= g_E \times 2 \times \left(\frac{1}{2}\right)^2 = \frac{g_E}{2} \Rightarrow \frac{g_E}{g_P} = 2$

Now, $T \propto \frac{1}{\sqrt{g}}$

$\therefore T_P = T_E \times \sqrt{\frac{g_E}{g_P}} = T_E\sqrt{2} = 2\sqrt{2}$

531 **(b)**

Only statement (b) is correct, the corrected form of rest are as,

Orbital speed, $v_o = \sqrt{\frac{GM}{r}}$, so speed of satellite decreases with the increase in the radius of its orbit.

We need more than one satellite for global communication.

For stable orbit, its plane must pass through the centre of earth.

532 **(a)**

Relation for the orbital velocity is

$v_o = \sqrt{\frac{GM_e}{r}}$

$= \sqrt{\frac{6.66 \times 10^{-11} \times 6 \times 10^{24}}{3.84 \times 10^8}}$

$v_0 = 1 \times 10^3 \text{ ms}^{-1} = 1\text{kms}^{-1}$

533 **(b)**

$\frac{g_h}{g} = \left(\frac{R+h}{R}\right)^2$

$\therefore \frac{g_h}{g} = \frac{1}{100}$

$\therefore \frac{R}{R+h} = \frac{1}{10}$

$\therefore h = 9R = 9 \times 6400 = 57600$ km

534 **(b)**

Potential energy, $u = \frac{GMm}{r}$

At distance $2r$, $g = \frac{GM}{(2r)^2} = \frac{GM}{4r^2} = \frac{u}{4mr}$

Now, weight,

$w = mg = \frac{u}{4r}$

535 **(d)**

Inside a shell, gravitational field strength is zero. Therefore, gravitational force on a particle is zero.

536 **(a)**

On earth's surface $g = \frac{GM}{R^2}$

AT a height nR above earth's surface

$$g' = \frac{GM}{(R + nR)^2} = \frac{GM}{R^2(1 + n)^2}$$

$$\therefore \frac{g}{g'} = (1 + n)^2$$

537 **(d)**

Angular momentum L = mVR

Where m is the mass of the earth and V its orbital velocity

$$V = \sqrt{\frac{GM}{R}}$$

Where M is mass of the sun

$$\therefore L = m \times \sqrt{\frac{GM}{R}} \times R = m\sqrt{GmR}$$

$$\therefore L \propto \sqrt{R}$$

538 **(d)**

Since the object in the space capsule is in a state of weightlessness (0r zero gravity), the reading of the spring balance will be zero.

539 **(c)**

Angular momentum L = mvR

$$\text{But } v = \sqrt{\frac{GM}{R}}$$

$$\therefore L = m.\times \sqrt{\frac{GM}{R}}.R = m\sqrt{GMR}$$

$$\therefore L \propto \sqrt{R}$$

540 **(c)**

Since $v_e = \sqrt{2}\, v_c = 1.414\, v_c$

Additional velocity $= v_e - v_c = v_c(\sqrt{2} - 1)$

$= v_c(1.414 - 1)$

$= 1 \times 0.414$

$= 0.414$ km/s

541 **(b)**

Actually gravitational force provides the centripetal force. Therefore, the net force on the satellite will be F.

542 **(b)**

$$g' = g\left(1 - \frac{d}{R}\right)$$

$$\therefore \frac{g}{n} = g\left(1 - \frac{d}{R}\right) \qquad \therefore d = \left(\frac{n-1}{n}\right)R$$

544 **(d)**

At a height h (<<R), the acceleration due to gravity is given by

$$g' = g\left(1 - \frac{2h}{R}\right)$$

$$\therefore \frac{g - g'}{g} = \frac{2h}{R}$$

$$\therefore \frac{g - g'}{g} \times 100 = \frac{2 \times 32 \times 100}{6400} = 1\%$$

545 **(d)**

ρ = density, R = radius of planet

$$T^2 = \frac{4\pi^2}{GM}R^3$$

$$M = \frac{4}{3}\pi R^3 \rho$$

$$\therefore T^2 = \frac{4\pi^2 R^3}{G}.\frac{3}{4\pi R^3 \rho} = \frac{3\pi}{\rho G}$$

$$\therefore T = \sqrt{3\pi/\rho G}$$

546 **(c)**

$F_e = \frac{GMm}{R^2} = 50$ N ...(i)

$F_e = \frac{GMm'}{4R^2} = F$ ...(ii)

$\therefore$ Dividing equation (ii) by (i) we get

$$\frac{F}{50} = \frac{m'}{4m} = \frac{200}{4 \times 5}$$

$\therefore F = 10 \times 50 = 500$ N

547 **(d)**

$$V = \frac{1}{3}\sqrt{\frac{2GM}{R}}$$

$$TE_{\text{At surface}} = TE_{\text{at height h}}$$

$$-\frac{GMm}{R} + \frac{1}{2}mv^2 = -\frac{GMm}{R + h} + 0$$

$$-\frac{GMm}{R}+\frac{1}{2}m\frac{1}{9}\times\frac{2GM}{R}=-\frac{GMm}{R+h}$$

$$\left(\frac{1}{9}-1\right)\frac{GMm}{R}=-\frac{GMm}{R+h}$$

$$-\frac{8}{9}\frac{GMm}{R}=-\frac{GMm}{R+h}$$

$$\frac{8}{9}\frac{1}{R}=\frac{1}{R+h}$$

$$\Rightarrow 8R+8h=9R$$

$$8h=R$$

$$\therefore h=\frac{R}{8}$$

548 **(a)**

$$g=\frac{GM}{R^2}, g'=\frac{GM'}{R^2}=\frac{G\times 4M}{R^2}=4g$$

$$W=mg'h=4mgh=4\times 5\times 10\times 2$$

$$=400\text{ J}$$

551 **(a)**

$$\frac{1}{2}mu^2=-\frac{GMm}{R+h}-\left(-\frac{GMm}{R}\right)=\frac{GMm}{R}-\frac{GMm}{R+h}$$

$$=GMm\left[\frac{1}{R}-\frac{1}{R+h}\right]$$

$$\therefore u^2=2GM\left[\frac{1}{R}-\frac{1}{R+h}\right]$$

$$u^2=2gR^2\left[\frac{R+h-R}{R(R+h)}\right]$$

$$u^2=2gR\left[\frac{h}{R+h}\right]$$

$$\therefore \frac{u^2}{2gR}=\left[\frac{h}{R+h}\right]$$

$$\therefore \frac{R+h}{R}=\frac{2gR}{u^2}$$

$$\frac{R}{h}+1=\frac{2gR}{u^2}$$

$$\therefore \frac{R}{h}=\frac{2gR}{u^2}-1=\frac{2gR-u^2}{u^2}$$

$$\therefore h=\frac{Ru^2}{2gR-u^2}$$

556 **(b)**

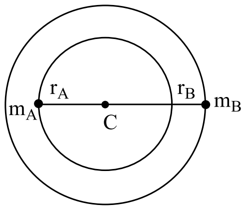
If it is so, then the centrifugal force would exceed the force of attraction or we can say that gravitational force won't be able to keep the satellite in circular motion

557 **(d)**

$$\frac{Gm_Am_B}{(r_A+r_B)^2}=\frac{m_Ar_A4\pi^2}{T_A^2}=\frac{m_Br_B4\pi^2}{T_B^2}$$

$$\Rightarrow m_Ar_A=m_Br_B$$

$$\therefore T_A=T_B$$



559 **(c)**

Weight of the body at equator

$=\frac{3}{5}$ of initial weight

$\therefore g'=\frac{3}{5}g$ (because mass remains constant)

$$g'=g-\omega^2R\cos^2\phi$$

$$\frac{3}{5}g=g-\omega^2R\cos^2(0°)$$

$$\therefore \omega^2=\frac{2g}{5R}$$

$$\therefore \omega=\sqrt{\frac{2g}{5R}}=\sqrt{\frac{2\times 10}{5\times 6400\times 10^3}}$$

$$=\sqrt{62.5\times 10^{-8}}=7.9\times 10^{-4}\text{ rad/s}$$

560 **(c)**

Total energy on the surface of the earth

$$=\frac{1}{2}mV^2-\frac{GMm}{R}$$

Total energy at maximum height $=-\frac{GMm}{R+h}$

$$\therefore \frac{1}{2}mV^2-\frac{GMm}{R}=-\frac{GMm}{R+h}$$

$$\therefore \frac{V^2}{2}-\frac{GM}{R}=-\frac{GM}{R+h}$$

Putting $GM=gR^2$, we get

$$\frac{V^2}{2}-gR=-\frac{gR^2}{R+h}$$

$$\frac{V^2-2gR}{2}=-\frac{gR^2}{R+h}$$

$$\therefore \frac{2gR-V^2}{2}=\frac{gR^2}{R+h}$$

$$\therefore \frac{2gR-V^2}{2gR^2}=\frac{1}{R+h}$$

$$\therefore R+h=\frac{2gR^2}{2gR-V^2}$$

$$\therefore h=\frac{2gR^2}{2gR-V^2}-R=\frac{RV^2}{2gR-V^2}$$

561 **(d)**

$v_e\propto\sqrt{\rho}\Rightarrow v_1\propto\sqrt{\rho_1}$ and $v_2\propto\sqrt{\rho}$

$$\therefore \frac{v_1}{v_2}=\sqrt{\frac{\rho_1}{\rho_2}}$$

562 **(b)**

$$g_d=g\left(1-\frac{d}{R}\right)$$

$$g_h = g\left(1 - \frac{2h}{R}\right)$$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

since $g_d = g_h$

$$1 - \frac{d}{R} = 1 - \frac{2h}{R}$$

$$\therefore \frac{d}{h} = 2$$

564 **(d)**

$$g = \frac{GM}{R^2} = \frac{G\frac{4}{3}\pi R^3 \rho}{R^2} \propto R$$

$$T = 2\pi\sqrt{\frac{l}{g}} \propto \frac{1}{\sqrt{R}}$$

$$\frac{T_{P_1}}{T_{P_2}} = \sqrt{\frac{2R}{R}} = \sqrt{2}$$

$$T_{P_1} > T_{P_2}$$

$$\frac{T_{S_1}}{T_{S_2}} = \sqrt{\frac{k_2}{k_1}} = 1$$

$(\because F = kx$

$mg = kx$

$$\frac{g}{x} = \frac{k}{m} = \text{constant}$$

$\therefore T_{2p}$ will be double of T_{1p}

$$\because \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{F}{xm}} = \sqrt{\frac{mg}{xm}} = \sqrt{\frac{g}{x}} = \text{constant}$$

$\therefore g \propto x)$

566 **(c)**

Energy required to escape the earth's gravitational field is

$$\frac{1}{2}mV_e^2$$

Energy given to the body is

$$= \frac{1}{2}m(3V_e)^2$$

$$= \frac{9}{2}mV_e^2$$

$\therefore$ If V is the velocity of the body when it has escaped from earth's gravitational field then

$$\frac{1}{2}mV^2 = \frac{9}{2}mV_e^2 - \frac{1}{2}mV_e^2$$

$$\therefore \frac{1}{2}mV^2 = 4mV_e^2$$

$$\therefore V^2 = 8V_e^2$$

$$V = 2\sqrt{2}V_e$$

568 **(b)**

$$g = \frac{GM}{R^2} = \frac{G}{R^2}.\frac{4}{3}\pi R^3.\rho = G\frac{4}{3}.\pi R\rho$$

$$\therefore g \propto \rho$$

572 **(d)**

$$g' = 16\%\, g = \frac{16g}{100} \Rightarrow \frac{g'}{g} = \frac{16}{100}$$

$$\therefore \frac{R^2}{(R+h)^2} = \frac{16}{100} \Rightarrow \frac{R+h}{R} = \frac{5}{2}$$

$$\therefore \frac{h}{R} = \frac{3}{2} \Rightarrow h = \frac{3}{2} \times 6300 = 9450 \text{ km}$$

573 **(c)**

$$F = mg = 81 = \frac{GMm}{R^2}$$

$$\therefore F = mg = \frac{GMm}{\left(R + \frac{R}{2}\right)^2}$$

$$\therefore F = \frac{4}{9}\frac{GMm}{R^2} = \frac{4}{9} \times 81 = 36N$$

575 **(d)**

The acceleration due to gravity at a depth h below the surface of the earth is given by

$$g' = g\left(1 - \frac{h}{R}\right)$$

$$\text{If} \frac{h}{R} = \frac{1}{2} \text{ then } g' = g\left(1 - \frac{1}{2}\right) = \frac{g}{2}$$

$$\therefore \frac{g}{g'} = 2$$

576 **(b)**

Total energy, is zero at infinity. The force acting is attractive, hence the total energy is negative.

577 **(d)**

$$F = \frac{Gm_1 m_2}{r^2}$$

$\therefore F' = \frac{Gm_1m_2}{(3r)^2} = \frac{F}{9}$

$\therefore$ % decrease in $F' = \left(\frac{F-F'}{F}\right)100$

$= \frac{8}{9} \times 100 \approx 89\%$

578 **(a)**

Critical velocity of a satellite is independent of mass of a satellite

579 **(a)**

We know that, $F \propto m_1m_2$

$\therefore F \propto (xm) \times (1-x)m = xm^2(1-x)$

For maximum force, $\frac{dF}{dx} = 0$

$\therefore \frac{dF}{dx} = m^2 - 2xm^2 = 0$

$\Rightarrow x = \frac{1}{2}$

580 **(a)**

Angular momentum $L = mVr$

$= m\sqrt{\frac{GM}{r}}.r\left(V = \sqrt{\frac{GM}{r}}\right) = \sqrt{GMm^2r}$

581 **(d)**

$g = \frac{GM}{R^2}; g' = \frac{GM'}{R'^2}$

$\frac{g'}{g} = \frac{M'}{M}.\frac{R^2}{R'^2} = 1.5 \times \frac{1}{(1.5)^2} = \frac{1}{1.5}$

For seconds pendulum $T = 2$ s

$\therefore T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{l}{g'}}$

$\therefore \frac{l'}{g'} = \frac{l}{g}$ or $l' = \frac{g'}{g}.l$

$\therefore l' = \frac{1}{1.5} \times 1 = 0.67$ m

582 **(c)**

$F = \frac{G \times m \times m}{(2R)^2}$

$= \frac{G\left(\frac{4}{3}\pi R^3\rho\right)^2}{4R^2}$

$= \frac{4}{9}\pi^2\rho^2R^4$

$\therefore F \propto R^4$

583 **(c)**

On earth, $v_e = \sqrt{\frac{2GM}{R}} = 11.2$km/s

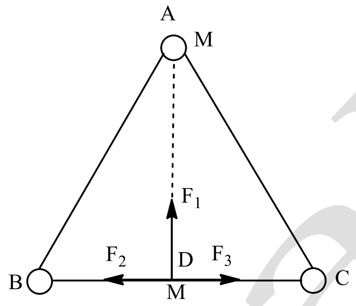
On moon, $v_m = \sqrt{\frac{2GM\times4}{81\times R}} = \frac{2}{9}\sqrt{\frac{2GM}{R}}$

$= \frac{2}{9} \times 11.2 = 2.5$ km/s

586 **(b)**

(i) Gravitational force on the particle placed at mid-point D of side BC of length a is

$F = F_1 + F_2 + F_3$



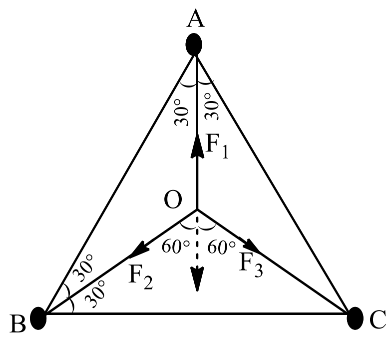
Here, $F_2 = -F_3$

$\Rightarrow F_2 + F_3 = 0$

$\therefore F = F_1 + 0 = F_1$

or $F = F_1 = \frac{GMM}{(AD)^2} = \frac{GM^2}{(3a^2/4)} = \frac{4GM^2}{3a^2}$

(ii) The given situation is shown below. Mass m is placed at the centre (O) of equilateral triangle.



Resolving all the forces F_1, F_2 and F_3 in vertical direction.

$F_1 - F_2\cos 60° - F_3\cos 60° = 0$

$\Rightarrow F_1 - \frac{F_2}{2} - \frac{F_3}{2} = 0$

$\Rightarrow F_1 = \frac{F_2 + F_3}{2}$

Since, OA = OB = OC

Hence, $|F_1| = |F_2| = |F_3| = F$

$\Rightarrow F = \frac{F + F}{2}$

$\Rightarrow$ F = F

[from Eq. (i)] Hence, resultant force of F_2 and F_3 is equal to F_1 in magnitude but direction is opposite. So, net force on the mass m at centre (O) will be zero.

587 **(a)**

1. According to Kepler's law, $T^2 \propto r^3$

$T^2 = kr^3$

Differentiating it, we have $2T\Delta T = 3kr^2\Delta r$

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{2T\Delta T}{T^2} = \frac{3kr^2\Delta r}{kr^3}$$

$$\Rightarrow \Delta T = \frac{3}{2}T\frac{\Delta r}{r}$$

594 **(d)**

$$g_d = g\left(1 - \frac{d}{R}\right)$$

$$\frac{g}{n} = g\left(1 - \frac{d}{R}\right)$$

$$\frac{d}{R} = 1 - \frac{1}{n} = \frac{n-1}{n}$$

$$d = R\left(\frac{n-1}{n}\right)$$

595 **(a)**

$$V_e = \sqrt{\frac{2GM}{R}}$$

$$\therefore \frac{V'_e}{V_e} = \sqrt{\frac{M'}{M}\frac{R}{R'}} = \sqrt{6 \times \frac{1}{2}} = \sqrt{3}$$

$$V'_e = \sqrt{3}V_e$$

597 **(c)**

$$g = \frac{GM}{R^2} \text{ and } M = \frac{4}{3}\pi R^3 \times \rho$$

$$\therefore g = \frac{4}{3}\frac{\pi R^3 \times G\rho}{R^2}$$

$$\therefore \rho = \frac{3g}{4\pi RG}$$

598 **(b)**

$$g' = g\left(1 - \frac{d}{R}\right)$$

$$g' = 0.6g$$

$$\therefore 0.6 = 1 - \frac{d}{R}$$

$$\therefore \frac{d}{R} = 1 - 0.6 = 0.4 = \frac{2}{5}$$

$$\therefore d = \frac{2}{5}R$$

599 **(d)**

For circular motion of planet

Gravitational force = Centripetal force

$$\frac{GMm}{R^n} = mR\omega^2$$

$$\omega^2 = \frac{GM}{R^{n+1}}$$

$$\therefore \omega = \frac{\sqrt{GM}}{R^{\frac{n+1}{n}}} = \frac{2\pi}{T}$$

$$\therefore T = 2\pi\frac{R^{\frac{n+1}{n}}}{\sqrt{GM}}$$

$$\therefore T \propto R^{\frac{n+1}{2}}$$

603 **(c)**

Acceleration due to gravity is given by

$$g' = \frac{GM}{r^2} = \frac{GM}{(R+h)^2} = \frac{GM}{(2R)^2} = \frac{GM}{4R^2} = \frac{g}{4}$$

604 **(a)**

$$\frac{\rho_1}{\rho_2} = \frac{2}{3}, \frac{R_1}{R_2} = \frac{1}{2}$$

$g \propto \rho R \Rightarrow g_1 \propto \rho_1 R_1$ and $g_2 \propto \rho_2 R_2$

$$\therefore \frac{g_1}{g_2} = \frac{\rho_1}{\rho_2} \times \frac{R_1}{R_2} = \frac{2}{3} \times \frac{1}{2} = \frac{1}{3}$$

605 **(d)**

Period of the satellite depends on the radius of the orbit and not on the mass of satellite

$T^2 \propto r^3$

$$\therefore \frac{T_2^2}{T_1^2} = \frac{r_2^3}{r_1^3} = (2)^3 = 8$$

$$\therefore \frac{T_2}{T_1} = \sqrt{8} = 2\sqrt{2}$$

608 **(d)**

Mass m is the quantity of matter contained in a body which is constant everywhere. Wright, however, is the force experienced by a body and is given by mg.

609 **(c)**

Angular momentum of the satellite L = mvr

Putting $v = \sqrt{\frac{Gm}{r}}$

We get

$L = \sqrt{GMm^2r}$

610 **(b)**

$R_m = \frac{R_e}{4}, \rho_m = \frac{2}{3}\rho_e$

Energy spent $= mg_eh_e = mg_mh_m$

$\therefore h_m = g_eh_e/g_m$

$\therefore h_m = \frac{\left(\frac{4}{3}\pi R_e\rho_e G\right) \times h_e}{\frac{4}{3}\pi R_m\rho_m G}$

$\therefore h_m = \frac{R_e}{R_m} \times \frac{\rho_e}{\rho_m} \times h_e = \frac{3}{2} \times \frac{4}{1} \times 0.5 = 3m$

612 **(d)**

The weight of a body will become equal to zero. If the centrifugal acceleration becomes equal to acceleration due to gravity.

$\therefore R\omega^2 = g \text{ or } \omega^2 = \frac{g}{R} \text{or } \omega = \sqrt{\frac{g}{R}}$

$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{R}{g}} = 2 \times 3.14\sqrt{\frac{6400 \times 10^3}{10}}$

$= 2 \times 3.14 \times 800 \text{ second} = \frac{2 \times 3.14 \times 800}{3600} \text{hour}$

$= 1.4 \text{ h}$

613 **(b)**

Kinetic and potential energies vary with position of earth w.r.t. sun. Angular momentum remains constant everywhere

614 **(b)**

$P.E_1 = 0$

$P.E_2 = -\frac{GmM}{2R}$

$\therefore \text{Change in P.E.} = GmM\left[\frac{1}{R} - \frac{1}{2R}\right] = \frac{GmM}{2R}$

$= \frac{Gm}{R^2} \times \frac{mR}{2} = \frac{1}{2}mgR$

617 **(d)**

$\frac{g'}{g} = \frac{R^2}{(R')^2} = \left(\frac{R}{2R}\right)^2 = \frac{1}{4}$

$\therefore g' = \frac{g}{4}$

618 **(b)**

The period or frequency of revolution of a satellite does not depend on its mass. Hence it is same for both.

620 **(a)**

$g' = g\left(\frac{R}{R+h}\right)^2$

when $g' = \frac{g}{4}$ then,

$\frac{g}{4} = g \times \left(\frac{R}{R+h}\right)^2 \Longrightarrow \frac{1}{2} = \frac{R}{R+h}$

$\therefore 2R = R + h \Longrightarrow R = h$

621 **(a)**

Angular momentum,

$L = 2m\frac{\Delta A}{\Delta t} \Rightarrow \frac{\Delta A}{\Delta t} = \frac{L}{2m}$

622 **(b)**

For $r < R, I = \frac{GMr}{R^3} \Rightarrow I \propto r$

For $r = R, I = \frac{GM}{R^2} \Rightarrow I \propto \frac{1}{R^2}$

For $r > R, I = \frac{GM}{r^2} \Rightarrow I \propto \frac{1}{r^2}$

So, the variation of I with r is correctly shown in option (b).

623 **(c)**

$v_1 = \sqrt{\frac{GM}{R+h}}, v_2 = \sqrt{\frac{GM}{R}}$

$\therefore \frac{v_1}{v_2} = \sqrt{\frac{R}{R+h}} = \sqrt{\frac{R}{R+7R}} = \frac{1}{2\sqrt{2}}$

$\therefore v_1 = \frac{v}{2\sqrt{2}}$

624 **(d)**

The minimum velocity with which a body is projected in the atmosphere, so as to enable it to just overcome the gravitational pull, is known as escape velocity.

Initial $KE = \frac{1}{2}mv^2 = \frac{1}{2} \times m(4 \times 11.2)^2$

$= 16 \times \frac{1}{2}mv_e^2$ (where , $v_e = 11.2kms^{-1}$)

As, $\frac{1}{2}mv_e^2$ energy is used up in coming out from the gravitational pull of the earth, so final KE should be $15 \times \frac{1}{2}mv_e^2$.

Hence, $\frac{1}{2}mv'^2 = 15 \times \frac{1}{2}mv_e^2$

$\Rightarrow v'^2 = 15v_e^2$

or $v' = \sqrt{15}v_\theta$

$= \sqrt{15} \times 11.2kms^{-1}$

626 **(c)**

U = Loss in gravitational energy

= gain in K.E.

So, $U = \frac{1}{2}mv^2 \Rightarrow m = \frac{2U}{v^2}$

627 **(c)**

$T^2 \propto r^3$

$T \propto r^{3/2}$

629 **(d)**

Total energy of the planet remains constant. When it moves close to the sun, its potential energy decreases and kinetic energy increases. Hence it will have maximum kinetic energy at C.

630 **(b)**

$$g = \frac{GM}{R^2}$$

$$\therefore M = \frac{gR^2}{G} = \frac{9.8 \times (6 \times 10^6)^2}{6.67 \times 10^{-11}}$$

$$\therefore M = \frac{9.8 \times 36}{6.67} = 10^{23} = 25.89 \times 10^{23}\text{kg}$$

$$\therefore M \approx 5.3 \times 10^{24}\text{kg}$$

631 **(c)**

$$v_e = \sqrt{\frac{2GM}{R}}, v_e' = \sqrt{\frac{2GM}{R+h}}$$

As $R + h > R \Rightarrow v_e > v_e'$

632 **(d)**

$F = \frac{Gm_1m_2}{r^2}$ and $F' = \frac{Gm_1m_2}{(3r)^2} = \frac{F}{9} \therefore$ % decrease in $F = \left(\frac{F-F'}{F}\right) \times 100 = \frac{8}{9} \times 100 = 88.8\% \simeq 89\%$

Thus, attraction force between sun and earth will decrease by 89%.

633 **(d)**

$\rho_p = 2\rho_e, g_p = g_e$

$$g = \frac{4}{3}\pi\rho GR$$

$$\therefore \frac{R_p}{R_e} = \left(\frac{g_p}{g_e}\right)\left(\frac{\rho_e}{\rho_p}\right) = (1) \times \left(\frac{1}{2}\right)$$

$$\therefore R_p = \frac{R_e}{2} = \frac{R}{2}$$

634 **(b)**

1. At depth, $g' = g\left(1 - \frac{d}{R}\right)$

$$\frac{g'}{g} = \frac{1}{n} = \left(1 - \frac{d}{R}\right) \Rightarrow d = R\left(\frac{n-1}{n}\right)$$

635 **(d)**

New acceleration due to gravity g' is given by

$g' = g - R_\theta \omega^2 cos^2 \lambda$

$0 = 10 - 6.4 \times 10^6 \omega^2 cos^2 60°$

$$\Rightarrow \omega^2 = \frac{10}{6.4 \times 10^6 (0.5)^2}$$

$= 2.5 \times 10^{-3} rads^{-1}$

636 **(b)**

Surface àrea of Q is four times, therefore radius of Q is two times, volume is eight times and mass of Q is also eight times.

So, let $M_P = M$ and $R_P = r$

Then, $M_Q = 8M$ and $R_Q = 2r$

Now, mass of R is $(M_P + M_Q)$ or $9M$, therefore radius of R is $(9)^{1/3}r$. Now, escape velocity from the surface of a planet is given by

$$v = \sqrt{2\frac{GM}{r}} \quad (r \text{ radius of that planet})$$

$$\therefore v_P = \sqrt{\frac{2GM}{r}}, v_Q = \sqrt{\frac{2G(8M)}{(2r)}} \text{ and } v_R = \sqrt{\frac{2G(9M)}{(9)^{1/3}r}}$$

From here, we can see that, $\frac{v_P}{v_Q} = \frac{1}{2}$ and $v_R > v_Q > v_P$.

637 **(a)**

$$g' = g\left(1 - \frac{d}{R}\right)$$

$$\therefore \frac{g}{n} = g\left(1 - \frac{d}{R}\right)$$

$$\therefore \frac{1}{n} = \left(1 - \frac{d}{R}\right)$$

$$\therefore \frac{d}{R} = 1 - \frac{1}{n}$$

$$= \frac{n-1}{n}$$

$$\therefore d = \frac{R(n-1)}{n}$$

638 **(c)**

$$v = \sqrt{\frac{GM}{r}}$$

v is independent of mass of the satellite

$$\frac{v_1}{v_2} = \sqrt{\frac{r_2}{r_1}} \Rightarrow r_1 > r_2 \Rightarrow v_2 > v_1$$

Orbital speed of satellite does not depend upon the mass of the satellite

639 **(a)**

$$\frac{v_1}{v_2} = \sqrt{\frac{2g_1R_1}{2g_2R_2}} = \sqrt{k_1k_2}$$

640 **(b)**

The energy of artificial satellite at the surface of the earth,

$$E_1 = -\frac{GMm}{R}$$

When the satellite is intended to move in a circular orbit of radius $7R$, then energy of artificial satellite,

$$E_2 = -\frac{1}{2}\frac{GMm}{7R}$$

The minimum energy required,

$$E = E_1 - E_2 = -\frac{GMm}{R} + \frac{1}{2}\left(\frac{GMm}{7R}\right)$$

$$= \frac{-14GMm + GMm}{14R} = \frac{-13GMm}{14R}$$

641 **(c)**

As $g = \frac{GM}{R^2}$, if R decreases then g increases. Taking logarithm of both the sides, we get

$$log\ g = log\ G + log\ M - 2 log\ R$$

Differentiating it, we get

$\frac{dg}{g} = 0 + 0 - \frac{2dR}{R} = -2\left(\frac{-2}{100}\right) = \frac{4}{100}$ ∴ % increase in $g = \frac{dg}{g} \times 100 = \frac{4}{100} \times 100 = 4\%$

642 **(b)**

Minimum value of kinetic energy required to escape from the gravitational influence of the earth is given by

$$k_e = \frac{GMm}{R}$$

∴ The kinetic energy of projection is

$$K = \frac{GMm}{2R}$$

At the highest point the kinetic energy become zero.

Loss of kinetic energy = Gain in potential energy

$$\frac{GMm}{2R} = \frac{GMm}{R} - \frac{GMm}{R+h}$$

$$\therefore \frac{1}{2R} = \frac{1}{R} - \frac{1}{R+h}$$

$$\therefore \frac{1}{R+h} = \frac{1}{R} - \frac{1}{2R} = \frac{1}{2R}$$

$$\therefore R + h = 2R$$

$$\therefore h = 2R - R = R$$

643 **(a)**

$T_A = 8\ T_B$

Using Kepler's third law, $\frac{T_A^2}{T_B^2} = \frac{r_A^3}{r_B^3}$

$$\therefore \frac{(8T_B)^2}{T_B^2} = \left(\frac{r_A}{r_B}\right)^3 \quad ...[\because T_A = 8T_B]$$

$$\left(\frac{r_A}{r_B}\right)^3 = (4)^3 \Rightarrow \frac{r_A}{r_B} = 4 \text{ or } r_A = 4r_B$$

644 **(d)**

The potential energy of the mass m at the mid-point is given by

$$P.E. = -\frac{GM_e m}{\left(\frac{D}{2}\right)} - \frac{GM_m m}{\left(\frac{D}{2}\right)}$$

$$= -\frac{2GM_e m}{D} - \frac{2GM_m m}{D}$$

$$= -\frac{2Gm}{D}(M_e + M_m)$$

If V is the velocity given to it, then kinetic energy

$$K.E. = \frac{1}{2}mv^2$$

To escape to infinity, the total energy should become zero.

$$\therefore \frac{1}{2}mv^2 - \frac{2Gm}{D}(M_e + M_m) = 0$$

$$\therefore \frac{1}{2}mv^2 = \frac{2Gm}{D}(M_e + M_m)$$

$$\therefore v^2 = \frac{4G}{D}(M_e + M_m)$$

$$\therefore v = 2\sqrt{\frac{G}{D}(M_e + M_m)}$$

646 **(a)**

$$g' = g - \omega^2 r \cos\lambda = g - \omega^2 r \quad [\lambda = 0]$$

$$\frac{3}{5}g = g - \omega^2 r$$

$$\omega^2 r = g - \frac{3}{5}g = \frac{2}{5}g = \frac{2}{5} \times 10 = 4$$

$$\omega^2 = \frac{4}{r} = \frac{4}{6400 \times 1000}$$

$$\omega = \frac{2}{8 \times 100 \times \sqrt{10}}$$

$\omega = \frac{1}{4} \times \frac{10\sqrt{10}}{10000} = 7.91 \times 10^{-4}$ c/S

647 **(c)**

$$v_e = \sqrt{\frac{2GM}{R}} = c$$

$$\Rightarrow R = \frac{2GM}{c^2} = \frac{2 \times 6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{(3 \times 10^8)^2}$$

$$= \frac{2 \times 6.67 \times 5.98}{9} \times 10^{-3}\text{m}$$

$$= 8.86 \times 10^{-3}\text{m} \approx 10^{-2}\text{m}$$

648 **(c)**

1. As, $\frac{g_m}{g_e} = \frac{G(M/8R_m^2)}{GM/R_e^2} = \frac{R_e^2}{8R_m^2}$

   Given, $\frac{mg_m}{mg_e} = \frac{1}{6} \Rightarrow \frac{g_m}{g_e} = \frac{1}{6}$

From Eqs. (i) and (ii), we get

$$\frac{R_e^2}{8R_m^2} = \frac{1}{6} \text{ or } R_e = R_m\sqrt{\frac{8}{6}}$$