PHYSICS - PART - I
TOPIC: MECHANICS

EXERCISE # 01

SECTION : (A) - Single Correct Options

1. The potential energy function for a particle executing simple harmonic motion is given by U(x) = $4+\frac{x^2}{4}$ joule. If the total energy of the particle is 5 J, then it would turn back from

(A) x = ±1m (B) x = ± 2 m (C) x = ± 3 m (D) x = ± 4 m

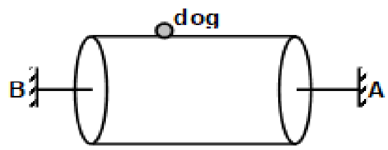
2. A solid cube is placed on a rough horizontal surface. What should be the maximum value of coefficient of friction between them such that when the cube is given a horizontal velocity, it does not topple on the surface?

(A) 0.5 (B) $\sqrt{0.5}$ (C) 0.25 (D) 0.33

3. A particle of mass 3m is projected in a vertical x – y plane with some initial velocity at t = 0. At t = 2 sec it explodes into two particles having mass ratio 1 : 2. At t = 3 sec, the smaller mass is observed having a velocity $\left(4\vec{i}-16\vec{j}\right)$ m/sec and that of bigger mass is $\left(\vec{i}-\vec{j}\right)$ m/s. Then projection velocity of the original mass at t = 0 is (Take g = 10 m/s²)

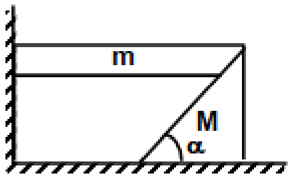
(A) $2\vec{i}+16\vec{j}$ m/s (B) $2\vec{i}-6\vec{j}$ m/s (C) $2\vec{i}+24\vec{j}$ m/s (D) $2\vec{i}+14\vec{j}$ m/s

4. A dog of mass 15 kg runs with a speed of 10 m/sec at surface of a circular drum of radius 2 m. The drum can rotate about its own axis AB freely as shown in the figure. The motion of the dog causes the rotation of drum. The speed of rotation is such that the relative position of the dog is unaltered. The kinetic energy of rotation of dog is



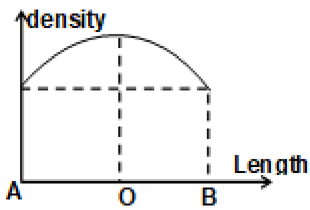
(A) 750 J (B) 37.5 J (C) 150 J (D) 60 J

5. A triangular wedge of mass M is placed on a smooth floor near a wall. A prism of mass m is kept as shown in figure. If the wall is also frictionless find the velocity of wedge as the prism falls through a height h.



(A) $\sqrt{\dfrac{2gh}{\tan^2\alpha+\dfrac{M}{m}}}$ (B) $\sqrt{\dfrac{2ghM}{m}}$ (C) $\sqrt{\dfrac{2ghM}{m\tan\alpha}}$ (D) $\sqrt{\dfrac{gh}{m}\tan\alpha}$

6. The density of a rod AB changes from A to B as shown in the figure. It's midpoint is O and its centre of mass is at C. Four axes pass through A, B, O and C, all perpendicular to the length of the rod. The moment of inertia of the rod about these axes are I_A, I_B, I_O and I_C respectively, then



(A) $I_A = I_B = I_O = I_C$ (B) $I_A = I_B > I_O = I_C$ (C) $I_A = I_B < I_O = I_C$ (D) $I_A < I_B < I_O = I_C$

7. A constant external force F is applied for a very small time interval Δt along a tangential direction of a small disc of m and radius r placed on a smooth horizontal surface, then

(A) the disc has pure translational motion

(B) the disc has pure rotational motion

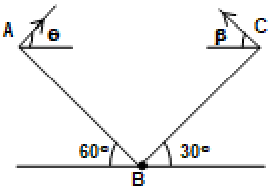
(C) the angular momentum of the disc will change by $Fr\,\Delta t$

(D) the kinetic energy of the disc will change by $\frac{2(Fr\Delta t)^2}{mr^2}$

8. A moving mass of 8 kg collides elastically with a stationary mass of 2 kg. If E be the initial kinetic energy of the moving mass, then the kinetic energy left with it after the collision will be

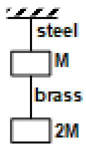
(A) 0.80E (B) 0.64E (C) 0.36E (D) 0.08E

9. Two inclined plane AB and BC are at inclination of 60° and 30° as shown in the figure. The two projectiles of same mass are thrown from A and C with speed 2 m/s & v_0 m/s respectively, such that each strikes at B with same speed. If length of AB is $\frac{1}{\sqrt{3}}$m and BC is 1 m. Find the value of v_0



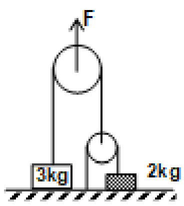
(A) 1/2 m/s (B) 1 m/s (C) 2 m/s (D) none of the above

10. If the ratio of lengths, radii and Young's Moduli of steel and brass wire in the figure are a, b and c respectively then the corresponding ratio of increase in their lengths is



(A) $2a^2c/b$ (B) $3a/2b^2c$ (C) $2ac/b^2$ (D) $3c/2ab^2$

11. What is the minimum value of applied force F so that both the block lifts up. Consider string to ideal & pulley to be massless & frictionless.



(A) 4g (B) 8g (C) 5g (D) 7g

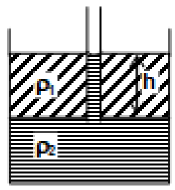
12. A block of mass m is resting on the rough horizontal ground. Minimum force required to move it is $\frac{4mg}{5}$. Then coefficient of friction is

(A) $\frac{1}{5}$ (B) $\frac{4}{5}$ (C) $\frac{1}{4}$ (D) $\frac{4}{3}$

13. A massless string of length ℓ, cross section area A & Young's modulus Y is tied up with a bob of mass m the bob is moving with constant angular speed ω in circular path of radius r as shown. Find elongation $\Delta\ell$ in the string assuming $\Delta\ell \ll \ell$.

(A) $\dfrac{mg\sqrt{\ell^2 - r^2}}{AY}$ (B) $\dfrac{mg}{AY}\dfrac{\ell^2}{\sqrt{\ell^2 - r^2}}$ (C) $\dfrac{mgr}{AY}$ (D) $\dfrac{mg}{AY}\dfrac{\ell^2}{r}$

14. A container contains two immiscible liquids of density ρ_1 & ρ_2 ($\rho_2 > \rho_1$). A capillary of radius r is inserted in the liquid so that its bottom reaches upto denser liquid. Denser liquid rises in capillary & attain height equal to h which is also equal to column length of lighter liquid. Assuming zero contact angle find surface tension of heaver liquid



(A) $\dfrac{r\rho_2 gh}{2}$ (B) $2\pi r\rho_2 gh$ (C) $\dfrac{r}{2}(\rho_2 - \rho_1)gh$ (D) $2\pi r(\rho_{2\cdot 1})gh$

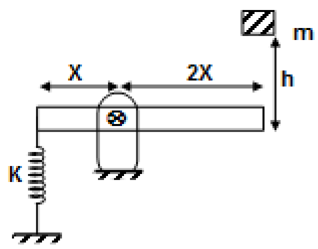
15. A ball is projected with a velocity 4 m/sec on the ground surface making an angle 30° with vertical. After collision with the ground, the velocity of ball becomes 2 m/sec and its direction is 60 with vertical, then the coefficient of friction between the ball and ground surface

(A) $\dfrac{(5\sqrt{3}-8)}{11}$ (B) $\dfrac{(5\sqrt{3}+8)}{11}$ (C) $\dfrac{(5\sqrt{3}+8\sqrt{2})}{11}$ (D) none of these

16. A car of mass 6 kg accelerates on a level road under the action of driving force 10N from a speed 4 m/sec to a higher speed V m/sec in a distance 8 m. If the engine develops a constant power output 38 J/sec, then the magnitude of V is

(A) 6 m/sec (B) 4 m/sec (C) 3 m/sec (D) 12 m/sec

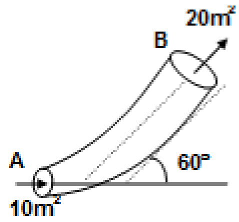
17. A crate of mass m falls from a height h onto the end of a platform, as shown in figure. The spring is initially unstretched and the mass of the plateform can be neglected. Assuming that there is no loss of energy, then the maximum elongation of spring is



(A) $\dfrac{2mg - \sqrt{4m^2g^2 + 2mghk}}{k}$ (B) $\dfrac{mg - \sqrt{m^2g^2 + 2mghk}}{k}$

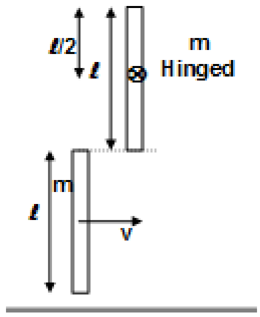
(C) $\dfrac{mg - \sqrt{m^2g^2 + 2mghk}}{k}$ (D) $\dfrac{2mg + \sqrt{4m^2g^2 + 2mghk}}{k}$

18. Liquid is flowing from A to B in the pipe and velocity of liquid at A is 40 m/sec and the pipe lie on a horizontal surface. If the specific gravity of the liquid is 4, then the force exerted by the pipe in Newton is



(A) $(\sqrt{3072}) \times 10^2$ (B) $(\sqrt{3072}) \times 10^3$ (C) $(\sqrt{3072}) \times 10$ (D) $(\sqrt{3072}) \times 10^{-2}$

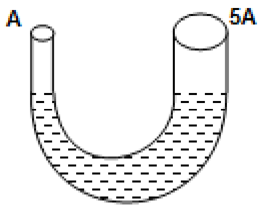
19. A bar of mass m and length ℓ is in pure translatory motion with its centre of mass moves with velocity v. It collides with a second identical bar which is initially at rest, and sticks to it the angular velocity of composite bar about hinged point will be



(A) $\frac{4}{3}\frac{v}{\ell}$ (B) $\frac{3}{4}\frac{v}{\ell}$

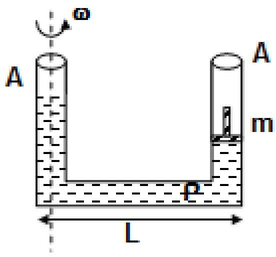
(C) $\frac{6}{7}\frac{v}{\ell}$ (D) $\frac{7}{6}\frac{v}{\ell}$

20. A U-tube contains m kg of a liquid of density ρ as shown in figure and is disturbed so that it oscillates back and forth from arm to arm. If we neglect friction, then the period of oscillation is



(A) $2\pi\sqrt{\frac{5m}{6\rho gA}}$ (B) $2\pi\sqrt{\frac{m}{6\rho gA}}$ (C) $2\pi\sqrt{\frac{m}{\rho gA}}$ (D) $2\pi\sqrt{\frac{6m}{5\rho gA}}$

21. Mass of the piston is m and its thickness is negligible and surface is frictionless. Then, find the angular velocity ω such that the level of liquid in both limb becomes equal. ($L \gg d$) d is the diameter of the limb



(A) $\left(\frac{4mg}{A\rho L^2}\right)^{1/2}$ (B) $\left(\frac{2mg}{A\rho L^2}\right)^{1/2}$ (C) $\left(\frac{mg}{A\rho L^2}\right)^{1/2}$ (D) $\left(\frac{4mg}{2A\rho L^2}\right)^{1/2}$

22. The breaking stress of aluminium 7.5×10^7 N/m². If the density of aluminium is 2.7 g/cc. Find the maximum length in km of the aluminium wire that could hang vertically without breaking (upto one decimal)
(A) 2.7 (B) 3.7 (C) 1.7 (D) 2.2

23. A car goes on a horizontal circular road of radius R, the speed increasing at a constant rate $\frac{dv}{dt} = a$. The friction coefficient between the road and tyre is μ. Then the speed at which the car will skid.
(A) $[(\mu^2 g^2 + a^2)R^2]^{1/2}$ (B) $[(3\mu^2 g^2 - a^2)R^2]^{1/4}$ (C) $[(\mu^2 g^2 + a^2)R^2]^{1/4}$ (D) $[(\mu^2 g^2 - a^2)R^2]^{1/4}$

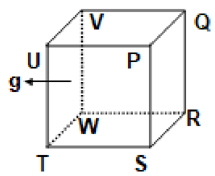
24. A particle moves in the x-y plane with constant acceleration a directed along the negative y-axis. The equation of path of the particle has the form $y = bx - cx^2$, where b and c are positive constant. Then, the velocity of the particle at the origin is
(A) $\sqrt{\frac{a}{2c}(1-b^2)}$ (B) $\sqrt{\frac{a}{2c}(1+b^2)}$ (C) $\sqrt{\frac{a}{c}(1+b^2)}$ (D) $\sqrt{\frac{2a}{c}(1-b^2)}$

25. The relation between length and radius of a cylinder of given mass and density so that its moment of inertia about an axis through its centre of mass and perpendicular to its length may be minimum.
(A) $\sqrt{\frac{2}{3}}$ (B) 1 (C) $\frac{4}{\sqrt{3}}$ (D) $\sqrt{\frac{3}{2}}$

SECTION : (B) - Multiple Correct Options

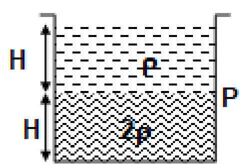
26. A satellite revolves round the earth with orbital velocity v_0. Then
(A) The escape velocity at the planet is $v_0\sqrt{2}$.
(B) The escape velocity at the planet is $2v_0$
(C) Particle is projected radially outward from the earth.
(D) Particle is projected in any direction

27. A closed hollow cube of side a is filled with a liquid of density ρ and it is accelerated with an acceleration g in the horizontal direction, then



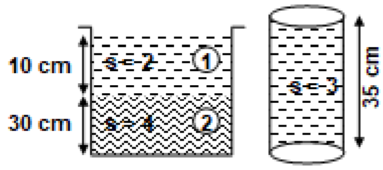
(A) Force exerted by surface PQRS is $\frac{a^3}{2}\rho g$. (B) Force exerted by surface PQRS is $\frac{3}{2}a^3\rho g$
(C) Force exerted by surface UTWV is $\frac{a^3}{2}\rho g$ (D) Torque about T is $\frac{\rho g a^4}{6}$

28. A tank is filled with two liquid of density 2ρ and ρ as shown in figure. A hole is punched in one of the walls, such that range becomes maximum, then



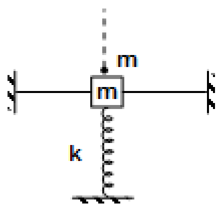
(A) The position of hole from P in 2ρ liquid is $\frac{H}{4}$ (B) The position of hole from P in 2ρ is $\frac{3H}{4}$
(C) The position of hole from P in ρ liquid is $\frac{H}{2}$ (D) The position of hole in ρ Liquid coincides with P

29. A tank is filled with two liquid of specific gravity s = 2 and s = 4 respectively as shown in figure. Then a solid cylinder of length 35 cm having specific gravity s = 3, dropped vertically in the liquid, then



(A) The length of cylinder immersed in liquid (2) is 21.5 cm.
(B) Then length of cylinder immersed in liquid (2) is 17.5 cm.
(C) The length of cylinder immersed in liquid (1) is 10 cm.
(D) The length of cylinder immersed in liquid (1) is 7.5 cm.

30. A particle of mass m is just placed on a block of mass m as shown in the figure. The block and particle stick firmly. Assume the oscillation are very small. So, that the strings of mass per unit length μ remains almost horizontal.



(A) The amplitude of small oscillation is mg/k

(B) Angular frequency of SHM is $\sqrt{\dfrac{k}{2m}}$

(C) Wavelength of the propagating wave in the string is $\dfrac{1}{2\pi}\sqrt{\dfrac{kT}{2\mu m}}$

(D) The oscillation of the string particles is forced oscillation

31. The schematic representations of the variation in acceleration vector for two particles P and Q during their motion from A to B are given as in figure I and figure II respectively
Choose the correct statement (s) [nature of variation of speed of A and B remains same throught the motion]

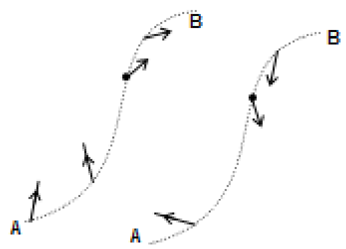


Fig-I Fig.-II

(A) speed of P increases with time
(B) speed of Q increases with time
(C) speed of P decreases with time
(D) speed of Q decreases with time

32. A satellite is revolving around the earth in a circular orbit. The universal gravitational constant suddenly becomes zero at time t = 0. Then
(A) The kinetic energy for t < 0 and t > 0 is same
(B) The angular momentum for t < 0 and t > 0 is same
(C) The angular momentum keeps changing for t < 0
(D) The angular momentum keeps changing for t > 0

33. A body is performing simple harmonic motion. Its:
(A) Average kinetic energy per cycle is equal to half of its maximum kinetic energy
(B) Root mean square velocity is $\frac{1}{\sqrt{2}}$ times of its maximum velocity.
(C) Mean velocity over a complete cycle is equal to $(2/\pi)$ times of its maximum velocity.
(D) Average acceleration for complete cycle is zero

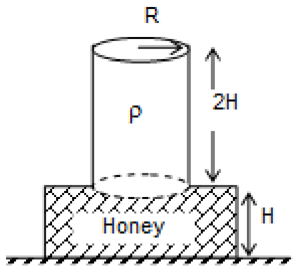
34. Choose the correct statements (s)
(A) Viscous force is a non conservative force
(B) A denser fluid is always more viscous than a less dense fluid
(C) Any object can not have a velocity more than its terminal velocity in a given fluid
(D) If a body is moving in a fluid then the viscous force on it is zero

35. A tank full of water has a small hole at its bottom. Let t_1 be the time taken to empty first half of the tank and t_2 be the time needed to empty the rest half of the tank then

(A) $t_2 > t_1$ (B) $t_1 = t_2$ (C) $t_1 = \frac{t_2}{\sqrt{2}}$ (D) $t_1 = 0.414\ t_2$

36. A hollow sphere and a solid sphere of same radius and same material fall through a liquid from same height (neglect viscous force). Then, the correct option(s) from the following is/are:
(A) The solid sphere reaches the ground earlier than the hollow sphere.
(B) The hollow sphere reaches the ground earlier than the solid sphere.
(C) Buoyant forces on both solid as well as hollow sphere are same.
(D) Buoyant forces on the solid and hollow spheres are different

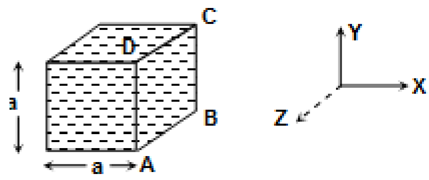
37. A bottle is kept on the ground as shown in the figure. The bottle can be modelled as having two cylindrical zones. The lower zone of the bottle has a cross-sectional radius of $R\sqrt{2}$ and is filled with honey of density 2ρ. The upper zone of the bottle is filled with the water of density ρ and has a cross-sectional radius R. The height of the lower zone is H while that of the upper zone is 2H. If now the honey and the water parts are mixed together to form a homogeneous solution (Assume that total volume does not change)



(A) The pressure inside the bottle at the base will remain unaltered.
(B) The normal reaction on the bottle from the ground will remain unaltered.
(C) The pressure inside the bottle at the base will increase by an amount $(1/2)\rho gH$
(D) The pressure inside the bottle at the base will decrease by an amount $(1/4)\ \rho gH$

38. A ball is dropped in a tunnel across the earth's diameter from a height h above the surface. (Assume h is small)
(A) Motion of the ball is simple harmonic.
(B) Motion is not simple harmonic.
(C) The period of motion is $4\sqrt{\frac{R}{g}}\sin^{-1}\left(\frac{R}{R+2h}\right)+4\sqrt{\frac{2h}{g}}$, (where R is the radius of earth)
(D) None of the above

39. Liquid is stored in a cubical box of side a. Now top face of the box is removed. The liquid has density ρ? (see figure)



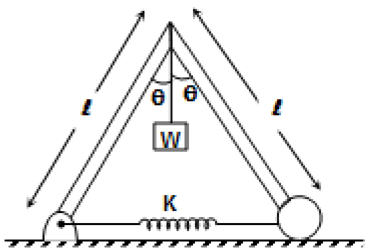
(A) The force exerted by a liquid on face ABCD is $\left(P_0 + \frac{\rho gh}{2}\right)a^2$

(B) The force exerted by a liquid on face ABCD is

(C) The force exerted by liquid on face ABCD will be along positive x-axis.

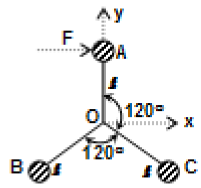
(D) The force exerted by liquid on face ABCD will be along negative x-axis.

40. Determine the values of θ for which the system will remain in equilibrium. Assume the rods to be massless and surface to be frictionless. Assume $W < 4k\ell$



(A) 0 (B) $\cos^{-1}\frac{W}{4k\ell}$ (C) $\sin^{-1}\frac{W}{2k\ell}$ (D) $\tan^{-1}\frac{W}{4k\ell}$

41. Each of the three balls of mass m and negligible radius is welded to a rigid frame of negligible mass and each rod having length ℓ. A force F is applied to one of the ball as shown in the figure. Then just at the instant of applying the force



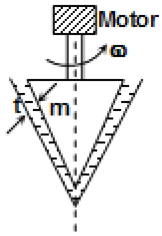
(A) net acceleration of point O is $\frac{F}{3m}\hat{i}$

(B) net acceleration of point A is $\frac{2F}{3m}\hat{i}$

(C) net acceleration of point B is $\frac{F}{6m}\hat{i} + \frac{F}{2\sqrt{3}m}\hat{j}$

(D) net acceleration of point C is $\frac{F}{6m}\hat{i} - \frac{F}{2\sqrt{3}m}\hat{j}$

42. The shown figure, there is a conical shaft rotating on a bearing of very small clearance t. The space between the conical shaft and the bearing, is filled with a viscous fluid having coefficient of viscosity η. The shaft is having radius R and height h. If the external torque applied by the motor is τ and the power delivered by the motor is P working in 100% efficiency to rotate the shaft with constant ω. Then



(A) $P = \frac{\pi\omega^2\eta R^3\sqrt{R^2+h^2}}{2t}$

(B) $\tau = \frac{\pi\omega\eta R^3\sqrt{R^2+h^2}}{2t}$

(C) $P = \frac{\pi\omega^2\eta R^3 h}{2t}$

(D) $\tau = \frac{\pi\omega\eta R^3 h^2}{2t\sqrt{R^2+h^2}}$

43. A metal wire of length L, area of cross section A and Young modulus Y is stretched by a variable force F such that F is always slightly greater than the elastic forces of resistance in the wire. When the longation of the wire is ℓ, then choose the correct option(s).

(A) the work done by F is $\frac{1}{2}\frac{YA}{L}\ell^2$
(B) the elastic potential energy stored in the wire is $\frac{1}{2}\frac{YA}{L}\ell^2$
(C) no heat is produced during the elongation
(D) the work done by F is $\frac{YA}{L}\ell^2$

44. A particle is moving on a path whose trajectory is given by

$$x - a = A\sin(pt)$$
$$y - b = A\cos(pt)$$

where x and y represents the co-ordinates of the particle at any instant t and a, b and A are positive constants, then
(A) Speed of the particle is constant and is equal to pA
(B) The particle must be moving in clockwise sense.
(C) At $t = \frac{3\pi}{2p}$, net acceleration of the particle is p^2A towards positive x-axis.
(D) At $t = \frac{\pi}{p}$, velocity of the particle is pA towards positive x-axis

45. The potential energy of a particle of mass 2 kg, moving along the x-axis is given by $U = 16(x^2 - 2x)$J, where x is in metres. Its speed at x = 1m is 2 m/s
(A) The motion of the particle is uniformly acceleration.
(B) The motion of the particle is oscillatory force x = 0.5 m to x = 1.5 m
(C) The motion of the particle is simple harmonic.
(D) The period of oscillation of the particle is $\pi/2$ s.

46. Let v, T, L K and r denote the speed period, angular momentum, kinetic energy and radius of satellite in a circular orbit, then
(A) $v \propto r^{-1}$
(B) $L \propto r^{1/2}$
(C) $T \propto r^{3/2}$
(D) $K \propto r^{-4}$

47. A linear harmonic oscillator of force constant 2×10^6 N/m and amplitude 0.01 m has a total mechanical energy of 160 J. Its maximum
(A) P.E. is 100 J
(B) PE is 160 J
(C) KE is 100 J
(D) PE is OJ

48. When a bullet is fired horizontally into a stationary block, kept on a rough horizontal surface, then,
(A) linear momentum of the system may remain approximately conserved
(B) angular momentum of the system remains conserved about any point on the base of the block
(C) Energy of the system will not be conserved even if we neglect losses.
(D) all of the above

49. A body moves on a horizontal circular road of radius r with a tangential acceleration a_r. The coefficient of friction between the body and the road surface is μ. It begins to slip when its speed is v. then

(A) $v^2 = \mu gr$
(B) $\mu g = \frac{v^2}{r} + a_T$
(C) $\mu^2 g^2 = \frac{v^4}{r^2} + a_T^2$
(D) The force of friction makes an angle $\tan^{-1}\left(\frac{V^2}{a_T r}\right)$ with the direction of motion at the point of slipping.

50. When a capillary is tube dipped in a liquid the liquid, rises to height h in the tube. The free liquid surface in side the tube is hemispherical in shape. The tube is now pushed down so that the height of the tube outside the liquid is less than h
(A) The liquid will come out of the tube like a small fountain
(B) The liquid will come out of the tube slowly.
(C) The liquid will fill the tube but not come out of its upper end
(D) The free liquid surface inside the tube will not be hemispherical.

51. A solid sphere of mass m is given initial linear speed v and angular speed ω as shown and kept on a rough incline. As soon as the sphere is kept on the incline, then the frictional force

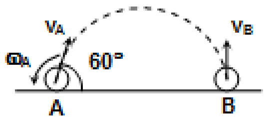
(A) acts up the incline
(B) acts down the incline
(C) is equal to $\mu mg \cos\theta$
(D) is equal to $mg \sin\theta$

52. There is a solid sphere of radius R & mass M the gravitational field g & potential V due to the sphere at a distance 'r' from its centre
(A) g & V both increases for $r < R$
(B) g increases & V decreases for $r < R$
(C) g & V both decreases, for $R < r < \infty$
(D) g decreases & V increases for $R < r < \infty$

53. A solid sphere of mass m and radius R is rolling on a rough surface. The work done by friction
(A) can never be positive (B) may be positive (C) may be negative (D) may be zero

54. The function $x = A \sin \omega t + B$ represents an SHM for
(A) $B = 0, A \neq 0$
(B) any real values of A and B
(C) $A > 0, B \neq 0$
(D) $A > 0, B = 0$

55. A small rubber ball of radius R is thrown against a rough floor with a velocity $\vec{v}_A$ of magnitude v_0 and angular velocity $\vec{\omega}_A$ of magnitude ω_0. It is observed that ball bounce at B in vertically upward direction and zero angular velocity. Take collision is elastic then

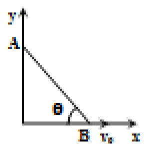


(A) $\omega_0 = \frac{5}{4}\frac{v_0}{R}$
(B) $\omega_0 = \frac{4}{5}\frac{v_0}{R}$
(C) $H_{max} = \frac{3}{8}\frac{v_0^2}{g}$
(D) $H_{max} = \frac{3}{2}\frac{v_0^2}{g}$

where H_{max} is maximum height attained by ball after first collision.

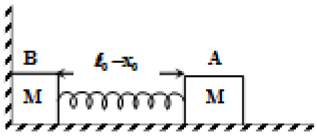
56. In a one dimensional collision between two identical particles B is stationary and A has momentum P before impact. During impact, A gives impulse J to B. Then
(A) The total momentum of A plus B system is P before and after the impact and (P-J) during the impact.
(B) during the impact B gives impulse J to A.
(C) the co-efficient of restitution is $[(2J/P) - 1]$
(D) the co-efficient of restitution is $[(2J/P) + 1]$

57. The end B of the rod AB which makes angle θ with the floor is being pulled with a constant velocity v_0 as shown. The length of the rod is ℓ at the instant when $\theta = 37°$



(A) velocity of end A is $\frac{4}{3}v_0$ downward
(B) Angular velocity rod is $\frac{5}{3}\frac{v_0}{\ell}$
(C) Angular velocity of rod is constant.
(D) velocity of end A is constant

58. If two block spring system is compressed towards rigid wall by x_0 as shown, over smooth surface and released. If spring constant is K. Then choose correct alternatives.

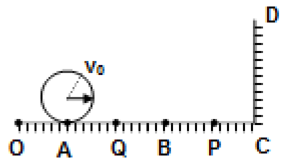


(A) Net force on the system till spring comes to natural length is kx_0
(B) Net force on the system if B leaves contact with wall is zero.
(C) Time when B leaves contact with wall is $\frac{\pi}{4}\sqrt{\frac{m}{K}}$.
(D) Time period of spring block system after B leaves contact is $2\pi\sqrt{\frac{M}{2k}}$

SECTION : (C) -Passage Type Questions

PASSAGE 01:

There is a frictionless wall CD on a horizontal surface OC. The surface OB has a friction coefficient 0.1 and the surface BC is frictionless. A sphere of uniform volume density of mass 0.14 kg and radius 4 m is kept at point A as shown in the figure. A sharp impulse is given to the sphere which provides a linear velocity v_0 = 14 m/s to the centre of mass of the sphere. If AQ = BQ = BP = PC = 192 m and collision with sphere and wall is perfectly elastic. Read the above passage carefully and answer the following questions. [Take g = 10 m/s^2]



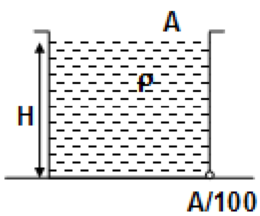
59. The sphere starts rolling without slipping at
(A) part Q (B) part B (C) part P (D) Any other point

60. The number of revolutions made by sphere during the times interval during its motion with rolling without slipping till just before collision is (approximately)
(A) 28.64 (B) 20.68 (C) 24.80 (D) none of these

61. The work done by the friction during the whole motion of sphere is
(A) 13.72 Joule (B) 1.8 Joule (C) 9.8 Joule (D) 11.92 Joule

PASSAGE 02:

A tank is placed on a frictionless surface having cross sectional area A and height H and the density of liquid is ρ. A hole is punched in one of the walls as shown in figure having area A/100, then



62. The time when height of liquid column becomes H/2.
(A) $100(\sqrt{2}-1)\sqrt{\frac{H}{g}}$ (B) $100(\sqrt{2}+1)\sqrt{\frac{H}{g}}$ (C) $200(\sqrt{2}-1)\sqrt{\frac{H}{g}}$ (D) $50(\sqrt{2}-1)\sqrt{\frac{H}{g}}$

63. The distance travelled by tank when height of the liquid column becomes zero.
(A) 200 H (B) 100 H (C) 400 H (D) 50 H

64. The acceleration of tank is
(A) g/5 (B) g/100 (C) g/50 (D) none of these

PASSAGE 3:

A vertical spring carries a 5 kg body and is hanging in equilibrium. An additional force is applied so that the spring is further stretched. When released from this position it performs 50 complete oscillation in 25 seconds, with an amplitude of 5 cm, then

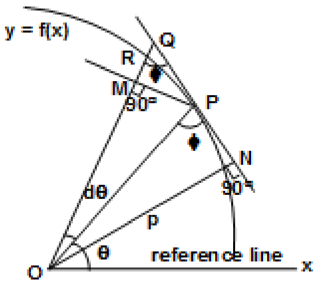
65. The value of the additional force applied (upto one decimal) in Newton is
(A) 39.5 (B) 38.5 (C) 31. 4 (D) 32.5

66. Force exerted by the spring on the body when it is at the lowest point in Newton (upto one decimal)
(A) 86.9 (B) 80.9 (C) 8 (D) 47.4

67. Force exerted by the spring on the body when it is at the middle point in Newton (upto one decimal)
(A) 86.9 (B) 80.9 (C) 8 (D) 47.4

PASSAGE 4:

If a point P moves in plane along a given curve y = f(x), the angular velocity of point P about a fixed point O in the plane is the rate of change of the angle that OP line makes with a fixed direction $[OX - \text{line}]$ in the plane



Let OP = r at t = t sec

PM = r$d\theta$ = PQ sinϕ, But if $d\theta$ is very small then. $PQ \cong \widehat{PR} = ds$ (arc length)

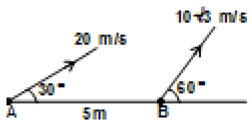
$\Rightarrow$ rd = ds sin ϕ

$$\Rightarrow \frac{d\theta}{dt} = \frac{1}{r}\frac{ds}{dt}\sin\phi = \frac{v\sin\phi}{r} = \frac{\text{Magnitude of component of velocity of point perpendicular to radius vector}}{\text{Magnitude of radius vector}}$$

$$\Rightarrow \frac{d\theta}{dt} = \frac{vp}{r^2}$$

68. $r^2\frac{d\theta}{dt}$ represents
(A) rate at which radius vector sweeps out area (B) angular momentum
(C) moment of velocity about origin (D) rate of increase of sectional area as P moves along curve

69. If two particles A and B are having speed 10√3 m/s and 20 m/s at a particular instant as shown in the figure, then the angular velocity of A with respect to B at the same instant is



(A) 1 rad/s clockwise (B) 1 rad/s anticlockwise
(C) 2 rad/s clockwise (D) 2 rad/s anticlockwise

70. If point P moves on parabolic path $y^2 = 4(x + 1)$, where x and y are in meter with constant speed 2 m/s. Its angular velocity about focus at an instant when it makes angle 60° at focus with x-axis is [all angles are measured in anticlockwise direction with positive x-axis]

(A) 0.25 rad/s (B) 0.50 rad/s (C) 0.12 rad/s (D) none of the above

PASSAGE 05

If the container filled with liquid gets accelerated horizontally or vertically, pressure in liquid gets changed. In case of horizontally accelerated liquid (a_x), the free surface has the slope $\frac{a_x}{g}$. In case of vertically accelerated liquid (a_y) for calculation of pressure, effective g is used. A closed box with horizontal base 6m by 6m and a height 2m is half filled with liquid. It is given a constant horizontal acceleration g/2 and vertical downward acceleration g/2.

71. The angle of the free surface with the horizontal is equal to -

(A) 30° (B) $\tan^{-1}\frac{2}{3}$ (C) $\tan^{-1}\frac{1}{3}$ (D) 45°

72. Length of exposed portion of top of box is equal to-

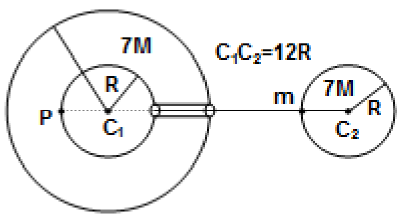
(A) 2m (B) 3m (C) 4m (D) 2.5 m

73. What is the value of vertical acceleration of box for given horizontal acceleration (g/2), so that no part of bottom of box is exposed :

(A) g/2 upward (B) g/4 downward (C) g/4 upward (D) not possible

PASSAGE 06:

Two planets having radii R and 2R with equal mass 7M respectively. The bigger planet has concentric cavity of radius R. A narrow hole is drilled through the bigger planet as shown in the figure [Assume that the process of drilling does not change the mass of bigger planet] A point mass of mass m is given a velocity v_0 from point Q at smaller planet so that it will reach to point P of bigger planet, assume there is no other force in the space except their mutual attraction of gravity



74. The distance of point of journey of particle of mass m from c_1 where it will experiences no force is

(A) 6 R (B) 8 R (C) 4 R (D) none of the above

75. The minimum value of v_0 so that it will reach to point P

(A) $\sqrt{\frac{35}{33}\left(\frac{GM}{R}\right)}$ (B) $\sqrt{\frac{211}{33}\left(\frac{GM}{R}\right)}$ (C) $\sqrt{\frac{350}{33}\left(\frac{GM}{R}\right)}$ (D) $\sqrt{\frac{21}{33}\left(\frac{GM}{R}\right)}$

76. Potential at P due to hollow sphere only

(A) $\frac{-GM}{2R}$ (B) $\frac{-7GM}{R}$ (C) $\frac{-9GM}{2R}$ (D) none of the above

PASSAGE 07:

One of the ways to approach gravitational behaviour of light follows from the observation that, although a photon has no rest mass, it nevertheless interacts with electrons as through it has the inertial mass given by

$$m = p/v \qquad \ldots \text{(i)}$$

where p is the momentum of the photon and v, its velocity. According to the principle of equivalence, gravitational mass is always equal to inertial mass, so a photon of frequency ν ought to act gravitationally like a particle of mass given by equation (i).

Gravitational behaviour of light can be demonstrated in the laboratory. When we drop a stone of mass m from a height H near the earth's surface, it gains an energy mgH on the way to ground, and its final speed becomes $\sqrt{2gH}$.

All photons travel with the speed of light so can not go any faster. However a photon that falls through a height H can manifest the increase of mgH in its energy by an increase in its frequency from ν to ν'. Because the frequency change is extremely small on a laboratory scale experiment, we can neglect the corresponding change in photon's 'mass'. An interesting astronomical effect is suggested by the gravitational behaviour of light. If the frequency associated with a photon moving towards the earth increases, then the frequency of a photon moving away from it should decrease. Suppose a star of mass M and radius R emits a photon of frequency ν, then we can express the total energy of the photon as the summation of its quantum energy ($h\nu$) and its gravitational potential energy ($-\frac{GMm}{R}$) as $h\nu - \frac{GMm}{R}$ where m can be written as $m = \frac{h\nu}{c^2}$.

Using the energy conservation, we can find its frequency (ν') as the photon escapes to infinity from the surface of the star. It must be noted that a photon will be able to escape to infinity only if its total energy is positive. If the photon is not able to escape to infinity it means its total energy is negative, we have what are known as 'black hole stars'. The phenomenon of reduction of frequencies of photons emitted from the star is quantified by a term called gravitational red shift.(GRS). We define GRS = $\Delta\nu/\nu = (\nu - \nu')/\nu$ where ν' is the frequency of the escaped photon and ν is the frequency of emitted photon.

Now answer the following questions:

77. If ν' is the frequency of a photon which escapes to ∞ from a star and ν is its frequency when it was emitted from the surface of star of radius R then

(A) $\frac{\nu}{\nu'} = 1 + \frac{GM}{c^2R}$ (B) $\frac{\nu'}{\nu} = 1 - \frac{GM}{c^2R}$ (C) $\frac{\nu'}{\nu} = 1 - \sqrt{\frac{GM}{c^2R}}$ (D) $\frac{\nu'}{\nu} = 1 - \left(\frac{GM}{c^2R}\right)^2$

78. According to the passage the Gravitational red shift of a photon escaped to ∞ from a star's surface is

(A) $\sqrt{\frac{GM}{c^2R}}$ (B) $\frac{G^2M^2}{c^4R^2}$ (C) $\frac{GM}{c^2R}$ (D) $\frac{c^2R}{GM}$

79. As suggested by the passage, for a black hole:

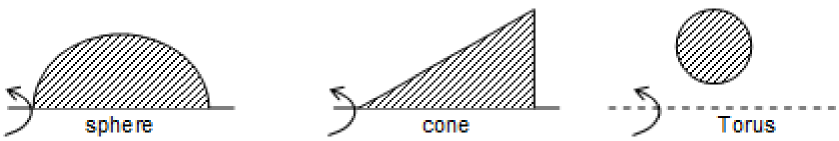
(A) $\frac{GM}{c^2R} > \sqrt{2}$ (B) $\frac{GM}{c^2R} > 1$ (C) $\frac{c^2R}{GM} < \frac{1}{2}$ (D) $\frac{GM}{c^2R} < 1$

PASSAGE 8

THEOREMS OF PAPPUS-GULDINUS

These theorems, which were first formulated by the Greek Geometer Pappus during the third century A.D. and later related by the Swiss mathematician Guldinus, or Guldin, (1577-1643) deal with the surfaces and bodies of revolutions. A surface of revolution is a surface which can be generated by rotating a plane curve about a fixed axis. For example the surface of a sphere can be generated by rotating a semicircular arc about its diameter. Similarly, a cone can be generated by rotating a line segment about an axis passing through one of its end points. The surface of a torus of a ring can be generated by rotating the circumference of a circle about a non - intersecting axis.

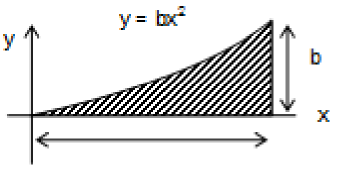
A body of revolution is a body which can be generated by rotating a plane area about a fixed axis. As shown in the figure, a sphere, a cone and a torus can each be generated by rotating the appropriate shape about the indicated axis



Now we shall state the two theorems of Pappus Guldinus.

Theorem – 1
The area of a surface of revolution is equal to the length of the generating curve times the distance travelled by the centroid centre of mass of the curve if the curve is made of a material of uniform linear density) of the curve while the surface is being generated.
Theorem – 2
The volume of a body of revolution is equal to the generating area times the distance travelled by the centroid of the area while the body is being generated. Now answer the following questions.

80. The below figure shows an area (known as parabolic spandrel). The location of centre of mass of the spandrel is

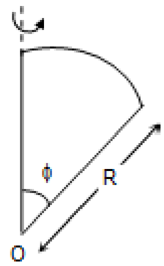


(A) $\left(\frac{3}{5}, \frac{3}{10}b\right)$ (B) $\left(\frac{3}{4}, \frac{1}{3}b\right)$ (C) $\left(\frac{3}{4}, \frac{3}{10}b\right)$ (D) $\left(\frac{4}{5}, \frac{1}{3}b\right)$

81. If the spandrel in the previous question was given a turn of 360° about y axis, the volume of the body thus generated will be

(A) $\frac{\pi b}{3}$ (B) $\frac{\pi b}{2}$ (C) $\frac{\pi b^2}{2}$ (D) $\frac{\pi b}{\sqrt{2}}$

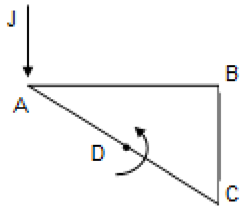
82. It is known that volume of revolution of a sector of a circle about the shown axis is $(4/3)\pi R^3 \sin^2(\phi/2)$. The distance of the centre of mass of the sector from point O must be



(A) $\frac{4R}{3\phi}\sin^2\phi$ (B) $\frac{4R}{3\phi}\sin^2(\phi/2)$ (C) $\frac{R}{3\phi}\sin^2(\phi/2)$ (D) $\frac{2R}{3\phi}\sin^2(\phi/2)$

PASSAGE 09

The figure shows the top view of a uniform solid prism. The sides of the prism are AB = 4 cm, BC = 3 cm and AC = 5 cm. the thickness of the prism (perpendicular to the plane of the paper) is t = 1 cm. The prism is mounted on a frictionless axis passing through D (which is the mid point of AC) and perpendicular to the plane of the paper. An impulse J = 1 Ns is imparted at point A of the prism, perpendicular to the edge AB of the prism. (The impulse vector lies in the plane of the paper). It was found that after the impulse was imparted, the prism took 1 second to undergo one complete rotation about the axis.



83. The moment of Inertia of the prism about the given axis is:

(A) $\frac{10^{-2}}{\pi}\text{kgm}^2$ (B) $\frac{10^{-2}}{2\pi}\text{kgm}^2$ (C) $\frac{2\times10^{-2}}{\pi}\text{kgm}^2$ (D) $\frac{\sqrt{2}\times10^{-2}}{\pi}\text{kgm}^2$

84. The mass of the prism is

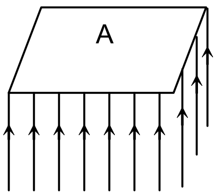
(A) $\frac{96}{\pi}$kg (B) $\frac{48}{\pi}$kg (C) $\frac{24}{\pi}$kg (D) $\frac{12}{\pi}$kg

85. If all the dimension of the prism were doubled while maintaining the same material ($\therefore$ AB = 8 cm, BC = 6 cm and AC = 10 cm, t = 2 cm) and an impulse of 1 Ns is applied at the point A once again. The time taken by the prism to complete one full rotation will be:

(A) 8 s (B) 32 s (C) 16 s (D) 64 s

PASSAGE 10:

A small metallic plate of area A and mass m is held in mid-air by striking a water jet from beneath. ρ is the density of water and v is the speed with which the water jet strikes the plate. Assume that the water jet strikes the plate normally.



86. If the water particles come to rest after colliding with the plate then the values of v for which the plate remains is equilibrium is

(A) $\sqrt{\frac{mg}{2\rho A}}$ (B) $\sqrt{\frac{mg}{\rho A}}$ (C) $\frac{1}{2}\sqrt{\frac{mg}{\rho A}}$ (D) $\sqrt{\frac{2mg}{\rho A}}$

87. What would be the value of v for the plate to be a equilibrium if after striking the plate water particles rebound with the same speed?

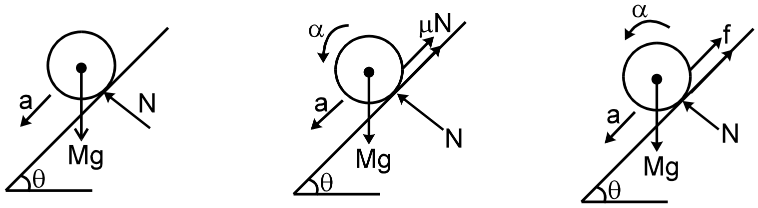
(A) $\sqrt{\frac{mg}{2\rho A}}$ (B) $\sqrt{\frac{mg}{\rho A}}$ (C) $\frac{1}{2}\sqrt{\frac{mg}{\rho A}}$ (D) $\sqrt{\frac{2mg}{\rho A}}$

88. The plate is held in equilibrium by striking the water jet. The plate is now given a sharp impulse at the centre of the plate in the downward direction

(A) The plate will perform SHM.
(B) The plate will perform oscillatory motion.
(C) The plate will keep moving in the downward direction.
(D) The plate will start rotating.

PASSAGE 11:

In this passage a brief idea is given of the motion of the rolling bodies on an inclined plane.
We will consider three cases : Objects are released on an incline plane
Case A : which is smooth. ;
Case B : where friction is insufficient to provide pure rolling.
Case C : where friction is sufficient to provide pure rolling.
Force diagram for three cases are as follows : (where symbols have their usual meanings)



Case (A) $\alpha = 0$

Case (B) $a \neq \alpha R$

Case (C) $a = \alpha R$

Equations for case (C) :

$Mg\sin\theta - f = Ma$
$fR = (Mk^2)\alpha$; where k = radius of gyration and f is force of friction.
$a = \alpha R$
on solving the above equations we will get

$$a = \frac{g\sin\theta}{\left(1+\frac{k^2}{R^2}\right)}$$

Object	Ring	Disc	Hollow sphere	Solid sphere
k	R	$\frac{R}{\sqrt{2}}$	$\sqrt{\frac{2}{3}}R$	$\sqrt{\frac{2}{5}}R$

To decide the minimum friction coefficient to provide pure rolling put
$f = \mu\, Mg\cos\theta$

And we will get $\mu_{min} = \dfrac{\tan\theta\left(\frac{k^2}{R^2}\right)}{\left(1+\frac{k^2}{R^2}\right)}$

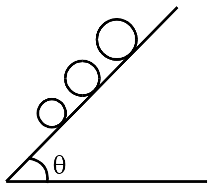
Equations for case (B) :

$Mg\sin\theta - \mu N = Ma$
$\mu NR = Mk^2\alpha$
$N = Mg\cos\theta$

The K.E. of a rolling body can be expressed as :

$$K.E. = \frac{1}{2}MV_{CM}^2 + \frac{1}{2}I_{CM}\omega^2$$

89. Three solid uniform spheres are released on an inclined plane as shown. The distance between the spheres remains constant during motion in :



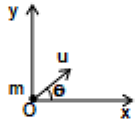
(A) all three cases
(B) case 'A' & 'B'
(C) case 'C'
(D) depends on the mass of the spheres.

90. We have four objects : a solid sphere, a hollow sphere, a ring & a disc, all of same radius. When these are released on an inclined plane, it may happen that all of them do not perform pure rolling. But from the information of pure rolling, if one object can be confirmed to be purely rolling then it can be said that rest all will perform pure rolling. This object whose pure rolling confirms pure rolling of all other objects is :
(A) Hollow sphere (B) solid sphere (C) ring (D) disc

91. If the four objects given in the above question are of same mass, same radius having the same friction coefficient & are released from the same height, then at the bottom the object which will have least K.E. for case 'B' will be the :
(A) Hollow sphere (B) solid sphere (C) ring (D) disc

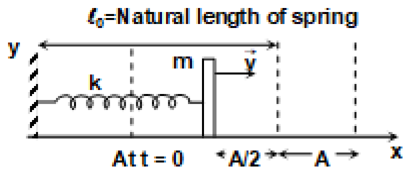
SECTION : (D) - Matrix Match

92. A particle of mass m is projected from origin at angle θ to x-axis with initial speed u as shown in the figure.



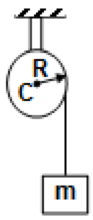
Column A	**Column B**
(A) Distance travel by particle in the time interval t_1 to t_2	(i) positive
(B) Instantaneous power at time t	(ii) negative
(C) Average power developed by gravity in the time interval t_1 to t_2	(iii) Zero
(D) $\dfrac{\text{Work done by gravity in time interval } t_1 \text{ to } t_2}{t_2 - t_1}$	(iv) $mg\left[\frac{1}{2}g(t_2+t_1) - u\sin\theta\right]$

93. A spring mass-system perform simple harmonic motion as shown in the figure, where $\vec{v}$, ℓ_0 and A are the velocity of particle natural length of spring and amplitude of motion respectively. If $\vec{x}$ and $\vec{a}$ represents displacement of particle from mean position and acceleration of particle respectively. [Assume x = A sin (ωt + ϕ)]



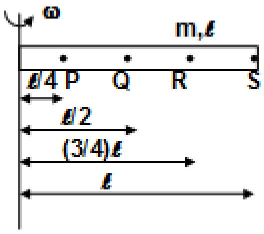
(A) Initial phase of motion	(i) Negative
(B) Phase of particle of motion when particle is at mean position first time.	(ii) $\dfrac{11\pi}{6}$
(C) $\vec{x} \times \vec{a}$ for the motion at time t = t sec is	(iii) $\vec{a} \times \vec{v}$
(D) $\vec{a} \cdot \vec{x}$ for the motion at time t = t sec is	(iv) zero

94. The string is wrapped on the given cylinder and the cylinder can rotate about the horizontal axis. Then, match the acceleration of the block in list II with list I



List I	**List II**
(A) Cylinder is solid of mass m and there is sufficient friction between rope and cylinder.	(i) g
(B) Cylinder is hollow of mass m and there is no friction between the rope and cylinder	(ii) (2/3)g
(C) Cylinder is massless	(iii) g/3
(D) Cylinder is hollow and mass of the cylinder is m and there is sufficient friction between the block and the cylinder	(iv) g/2

95. A rod of mass m and length ℓ is rotating about a vertical axis with a constant angular velocity ω. Then, match the following:



List I	**List II**
(A) Tension at P	(i) $\frac{3m\omega^2\ell}{8}$
(B) Tension at Q	(ii) $\frac{7m\omega^2\ell}{32}$
(C) Tension at R	(iii) zero
(D) Tension at S	(iv) $\frac{15m\omega^2\ell}{32}$

96. A particle is moving according to the displacement time relation $x = 3t^2 - \frac{t^3}{2}$ (where x is in meters and t is in seconds). Match the condition of column I with time interval and instant of column II

Column A	**Column B**
(A) Velocity and acceleration will be in same direction	(i) At t = 0 and t = 6 sec
(B) particle will be at origin	(ii) 0 < t < 2 sec and t > 4 sec
(C) particle will retard	(iii) at t = 0 and t = 4 sec
(D) velocity is zero	(iv) 2 < t < 4

97. A bob is attached to a string of length ℓ whose other end is fixed and is given horizontal velocity at the lowest point of the circle so that the bob moves in a vertical plane. Match the velocity given at the lowest point of circle in column I with tension and velocity at the highest point of the circle corresponding to velocity of column I of column II

Column A	**Column B**
(A) $\sqrt{2g\ell}$	(i) V = 0 and $T \neq 0$
(B) $\sqrt{g\ell}$	(ii) T = 0 and $v \neq 0$
(C) $\sqrt{3g\ell}$	(iii) T = 0 and $v = \sqrt{g\ell}$
(D) $\sqrt{5g\ell}$	(iv) T = 0 and v = 0

98. If the position vector of a particle at point P moving in space and distance traveled from a fixed point on the path are given by $\vec{r}$ and s respectively. Three vectors are defined as follows

$\vec{N} = \frac{d\vec{r}}{ds}$, $\vec{T} = R\frac{d\vec{N}}{ds}$ and $\vec{B} = \vec{N} \times \vec{T}$ where R is the radius of curvature at point P and $\vec{r}$ is a non-zero vector. Now match the following on the basis of above concept

Column A	**Column B**
(A) $\vec{T}$	(i) Unit vector
(B) $\vec{N}$	(ii) Zero
(C) $\vec{N} \cdot \vec{T}$	(iii) $\hat{v}$ (unit vector along the direction of velocity)
(D) $\vec{B}$	(iv) $\frac{v\vec{a} - \vec{v}\, a_T}{\lvert\vec{v} \times \vec{a}\rvert}$ where $\vec{a}$ and a_T are acceleration and magnitude of tangential acceleration of particle P

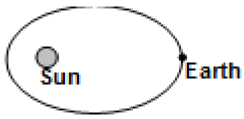
99. In this question $\vec{r}$ represents the position vector of a particle and and a are some constants. Now match the appropriate options: (constant magnitude includes a zero magnitude)

Column I	**Column II**
(A) $\vec{r} = \cos\omega t\hat{i} + \sin\omega t\hat{j} + at\hat{k}$	(1) Constant speed
(B) $\vec{r} = 5\cos\omega t\hat{i} + 5(\sin\omega t + t)\hat{j}$	(2) Helical motion
(C) $\vec{r} = 5at^2\hat{i} + 2at\hat{j}$	(3) Constant magnitude of tangential acceleration.
(D) $\vec{r} = 5[(\cos\omega t^2)\hat{i} + (\sin\omega t^2)\hat{j}]$	(4) Constant magnitude of total acceleration

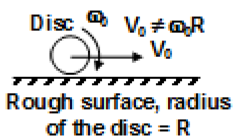
100. Choose the right choice.

System | **Conservation principle**

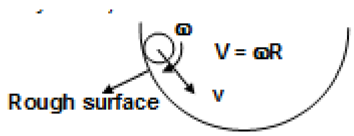
(A) Earth moving in an elliptical orbit (Only earth in system) direction



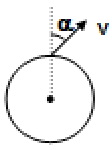
(B) A disc having translation and rotation motion both (with slipping) on a rough surface. (only disc in system along a specific direction



(C) A sphere rolling without slipping on a curved surface (Only the sphere in system) in the space



(D) Projection of a particle from the surface of earth. (Only particle in system)



(i) Conservation of linear momentum along any

(ii) Conservation of linear momentum

(iii) conservation of angular momentum about any point

(iv) Conservation of angular momentum about a specific point in the space

(v) Conservation of mechanical energy.

101. In list I the axes of rotation of rotation of circular disc of mass m and radius R are stated. Match these with the corresponding expressions of moment of inertia given in

(A) Through its centre and normal to its plane	(i) $\frac{5}{4}MR^2$
(B) Through any diameter.	(ii) $\frac{1}{4}MR^2$
(C) Through tangent in the plane of the disc	(iii) $\frac{3}{2}MR^2$
(D) Through tangent perpendicular to the plane of the disc.	(iv) $\frac{1}{2}MR^2$

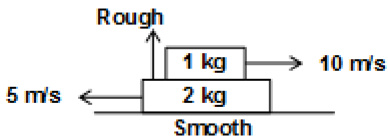
102. Match the following, considering R to be radius of earth, M mass of earth and G as universal gravitational constant

List – I	List – II
(A) Orbital velocity at height R from earth's surface	(i) $\sqrt{\frac{2GM}{R}}$
(B) Orbital velocity at near earth's surface	(ii) $\sqrt{\frac{GM}{R}}$
(C) Escape velocity from earth's surface	(iii) $\sqrt{\frac{2GM}{3R}}$
(D) Orbital velocity in a particular orbit	(iv) $\sqrt{\frac{GM}{2R}}$

103. For a particle of mass m moving in straight line, match the following

List – I	List - II
(A) Acceleration and velocity	(i) May be equal at all time
(B)Instantaneous speed and magnitude of instantaneous velocity	(ii) Must be equal at all time
(C) Magnitude of displacement and distant	(iii) Must be along the same line at all time
(D) Displacement and velocity	(iv) May be along the same line at all time

104. In a two block system shown in the figure. Match the following. (Assume 2 kg block is long enough)



List – I	List – II
A.Velocity of centre of mass	(i) Keep on changing all the time
B.Momentum of centre of mass	(ii) First decrease then become constant
C.Momentum of 1 kg block	(iii)Zero
D.Kinetic energy of 2 kg block	(iv)Constant

105. Density of a planet is two times the density of earth. Radius of this planet is half. Match the following (As compared to earth)

List – I	List – II
(A) Acceleration due to gravity on this planets surface	(i) Half
(B) Gravitational potential on the surface	(ii) Same
(C) Gravitational potential at centre	(iii) Two times
(D) Gravitational field strength at centre	(iv) Four times

106. There is hemisphere of radius 'R' & Mass M with base in x–z plane then match the following

List – I	List – II
(A) Moment of inertia about XX' of solid hemisphere.	(i) $\frac{2}{5}MR^2$
(B) Moment of inertia about YY' solid hemisphere	(ii) $\frac{1}{5}MR^2$
(C) Moment of inertia about CM parallel to XX' of hollow hemisphere	(iii) $\frac{5}{12}MR^2$
(D) Moment of inertia about ax is passing through centre of mass of solid hemisphere parallel to XX'.	(iv) $\left(\frac{83}{320}\right)MR^2$

107. **List – I**

(A) Area under the curve a-x
(B) Total work done per unit mass
(C) Area under the net force verses time (R)
(D) Slope of line joining two points on velocity verses time graph

List – II

(i) Instaneous velocity
(ii) Change in kinetic energy per mass
(iii) Average acceleration.
(iv) Change in momentum.

108. **List – I**

(A) Equation of continuity (ρAv = constant)
(B) Bernoulli's equation
(C) Velocity of a given point is constant with time
(D) Ideal flow

List – II

(i) non-viscous flow
(ii) Steady flow
(iii) incompressible flow
(iv) irrotational flow

109. Let there be two bodies with masses m_1 and m_2 moving with velocities u_1 and u_2 in same direction. They collide at an instant and acquire velocities v_1 and v_2. The coefficient of restitution of collision is e ($0 \le e \le 1$). Match the following

List – I

(A) $m_1 = m_2$, $u_1 > u_2$, $e = 1$
(B) $m_1 \ll m_2$, $u_1 < u_2$, $e = 1$
(C) $m_1 \gg m_2$, $u_1 > u_2$, $e = 1$
(D) If collision is perfectly inelastic

List – II

(i) $v_1 > v_2$
(ii) $v_1 < v_2$
(iii) $v_1 = v_2$
(iv) Total momentum of the system is conserved.

110. A particle of mass 1 kg has velocity $\vec{v}_1 = 2t\hat{i}$ and another particle of mass 2 kg has velocity $\vec{v}_2 = t^2\hat{j}$. Match the following

List – I

(A) Net force on centre of mass at t = 2 sec.
(B) Velocity of centre of mass at t = 2 sec.
(C) Displacement of centre of mass at t = 2 sec.
(D) Magnitude of linear momentum of centre of mass at t = 2 sec.

List – II

(i) 20/9 unit
(ii) $\sqrt{68}$ unit
(iii) $\sqrt{80}/3$ unit
(iv) $\sqrt{80}$ unit

111. A boy is experimenting in lab with simple pendulum. He denotes the four – physical quantities with $\vec{A}$, $\vec{B}$, $\vec{C}$ and $\vec{D}$. He knows that either of them denotes force, displacement, velocity and acceleration. He obtained few results from the above data: as

(1) $\vec{C}\cdot\vec{B}$ and $\vec{A}\cdot\vec{B}$ are always negative in an SHM.
(2) $\vec{A}\cdot\vec{C}$ is always positive in an SHM.
(3) $\vec{A}\times\vec{C}$, $\vec{D}\times\vec{B}$, $\vec{C}\times\vec{B}$ and $\vec{A}\times\vec{B}$ are always zero in an SHM.
(4) Average of all the quantities (individually) for one time-period in an SHM is zero.

Match the following

List – I

(A) $\vec{A}$
(B) $\vec{B}$
(C) $\vec{C}$
(D) $\vec{D}$

List – II

(i) displacement vector
(ii) velocity vector
(iii) acceleration vector
(iv) force vector

112. **List – I**

(A) The third significant digit in 14.745 after rounding it off to three significant digits is
(B) The third significant digit in 14.650 after rounding it off to there significant digits is
(C) The number of significant digits in 0.00023 is
(D) The number of significant digits in 1.0023 is

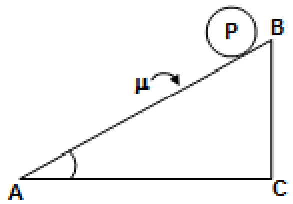
List – II

(i) 2
(ii) 5
(iii) 6
(iv) 7

113.

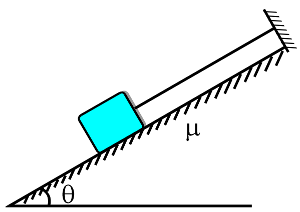
List – I	**List – II**
(A) Gravitational potential at the centre of a uniform solid sphere of radius R.	(i) Directly proportional to R
(B) Gravitational field at a distance R from the centre of a uniform solid sphere of radius 'a' (R < a)	(ii) Depends on 'a'
(C) Gravitational potential at a distance 'a' from the centre of a thin spherical shell of radius R(a<R)	(iii) Directly proportional to R^{-1}
(D) Gravitational potential at a distance R from the centre of a uniform solid sphere of radius a (R > a)	(iv) Increases as R increases

114. A body P is rolling without slipping on the rough inclined surface as shown in the figure. The frictional force acting on the body is listed in list II. Match the following lists

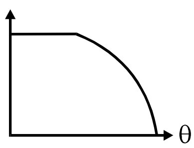


List – I	**List – II**
(A) For ring	(i) $mg \sin\theta \,(2/5)$
(B) For solid sphere	(ii) $\frac{mg \sin\theta}{3}$
(C) For solid cylinder	(iii) $(2/7)\, mg \sin\theta$
(D) For hollow sphere	(iv) $(mg \sin\theta)/2$

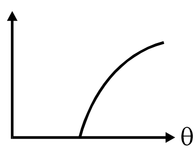
115. A block of mass m is put on a rough inclined plane of inclination θ, and is tied with a light thread shown. Inclination θ is increased gradually from $\theta = 0°$ to $\theta = 90°$. Match the column according to corresponding curve.



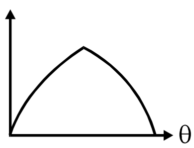
(i) Tension in the thread versus θ

(P) 

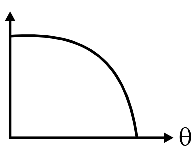
(ii) Normal reaction between the block and the incline versus θ

(Q) 

(iii) friction force between the block and the incline versus θ

(R) 

(iv) Net interaction force between the block and the incline versus θ

(S) 

116. The velocity of an aircraft as seen by the driver of a car is 5 m/s upwards. A passenger in a train simultaneously sees the car to move southwards with 5 m/s. The conductor of a bus feels that the train is moving north with a velocity of 10 m/s. A dacoit running towards the bus feels it moving 6 m/s eastwards. A police jeep chasing the dacoit feels him to be moving westwards with 3 m/s. A person standing on the ground sees the police jeep moving north-west with $15\sqrt{2}$ m/s.

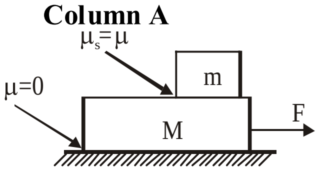
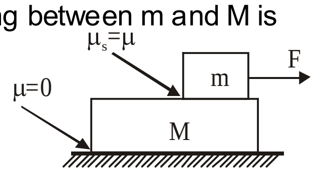
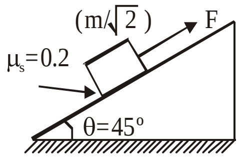
(a) Velocity of the aircraft as seen by the conductor — (P) $-3\hat{i}-5\hat{j}-5\hat{k}$

(b) Velocity of the conductor as seen by the police — (Q) $5\hat{j}+5\hat{k}$

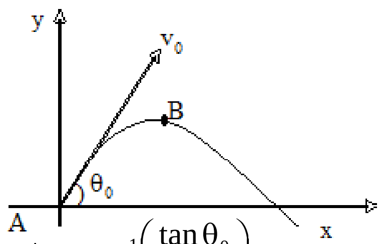
(c) Velocity of the aircraft — (R) $3\hat{i}$

(d) Velocity of police as seen by the pilot of aircraft — (S) $-12\hat{i}+20\hat{j}+5\hat{k}$

117.

Column A	Column B
(A)  In the above case the condition of no slipping between m and M is	(P) $F \le \mu mg\left(1+\dfrac{m}{M}\right)$
(B)  In the above case the condition of no slipping between m & M is	(Q) $F \le \mu\,(m + M)\,g$
(C)  In the above case the condition no slipping is	(R) $F > 0.6\ mg$
(D)  Fixed In the above case the value of F so that the small block can move up the inclined plane is	(S) $F \le \mu\ mg$

118. In oblique projection of a particle:



(a) Radius of curvature at A — (p) $\dfrac{2g\cos\theta_0 \sin 2\theta}{v_0 \sin^2\theta_0}$

(b) Radius of curvature at B — (q) $\dfrac{g^2 \sin 2\phi}{v_0^2 \sin 2\theta_0}$, where $\phi = \tan^{-1}\left(\dfrac{\tan\theta_0}{2}\right)$

(c) ω_{BA} — (r) $\dfrac{v_0^2}{g\cos\theta_0}$

(d) α_{BA} — (s) $\dfrac{v_0^2 \cos^2\theta_0}{g}$

where ω_{BA} and α_{BA} are angular velocity and angular acceleration of the particle at the highest point B relative to the point of projection A.

119. (a) A man of mass m is seen holding a rope hanging from roof. The tension in the string can be(man is also in air) — (p) mg

(b) A projectile experiences an average force during its motion in air (neglecting air resistance) — (q) > mg

(c) A pendulum bob of mass m swings by an inextensible string when hanging from a fixed support.Tension in the string at the extreme position — (r) < mg

(d) When you jump from a building holding a bag of mass m, the reaction force of the bag on you is is — (s) zero

120. Match the enteries of Column I with the entries of Column II.

Column I	**Column II**
(a) Young's modulus	(p) Shear strain
(b)Modulus rigidity	(q) Normal strain
(c) Bulk modulus	(r) Transverse strain
(d) Poisson ratio	(s) Volumetric strain

121. The velocity of an aircraft as seen by the driver of a car is 5 m/s upwards. A passenger in a train simultaneously sees the car to move southwards with 5 m/s. The conductor of a bus feels that the train is moving north with a velocity of 10 m/s. A dacoit running towards the bus feels it moving 6 m/s eastwards. A police jeep chasing the dacoit feels him to be moving westwards with 3 m/s. A person standing on the ground sees the police jeep moving north-west with $15\sqrt{2}$ m/s.

(a) Velocity of the aircraft as seen by the conductor — (p) $-3\hat{i}-5\hat{j}-5\hat{k}$

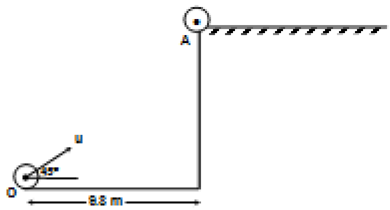
(b) Velocity of the conductor as seen by the police — (q) $5\hat{j}+5\hat{k}$

(c) Velocity of the aircraft — (r) $3\hat{i}$

(d) Velocity of police as seen by the pilot of aircraft — (s) $-12\hat{i}+20\hat{j}+5\hat{k}$

SECTION : (E) - Integer Type

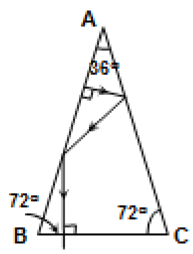
122. A uniform sphere is projected at an angle of 45° above horizontal from a point O behind 9.8 m from a rough horizontal elevated surface as shown in the figure. It is observed that the lowermost point of the sphere lands on the surface at A horizontally and the surface can sustain rolling without sliding. The ratio of the speed with which the sphere lands at A to the speed of sphere after pure rolling starts is X/Y. Find the value of |X-Y| (take g = 10 m/s^2)



123. A uniform spring of mass m = 0.0100 kg length L = 1.0000 m and spring constant K = 4.00 N/m is kept in a gravity free space. What will be the speed of longitudinal waves on the spring in m/s?

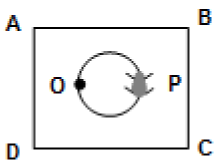
124. A thin ring has mass M = 4 kg and radius R = 1 m. Find its moment of inertia about an axis passing through its centre which makes an angle of exactly $\pi/4$ radians with the normal of the plane containing the ring.

125. A room is in the shape of a prism as shown in the figure. The front view of the room is as shown in the figure. A ball is projected normally from the wall ABFE and it strikes the floor normally after 2 reflection as shown in the figure. Gravitational force and friction are assumed to be absent. The coefficient of restitution between the ball and any wall is e. Find the value of e for which the ball will strike the floor normally

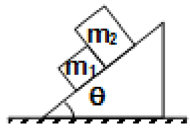


126. A uniform rod AB of mass 3m and length 2a has a small smooth ring of mass m attached at A. The ring is threaded on a horizontal fixed wire. Initially the rod is held horizontally alongside the wire and is released from rest from this position. Find the angular velocity (in rad/sec) of the rod when AB become vertical. (Assume the rod can rotate freely about A and g = 10m/s²).

127. A uniform square laminar plate ABCD having moment of inertia 250 π kgm² is placed on a horizontal smooth surface. The plate is having a circular groove of radius 2.5 m, whose centre is concentric to the centre of the plate. The plate is free to rotate about a point O on the groove fixed to the horizontal surface, as shown in the figure. A tortoise of mass 8 kg starts moving along the groove from a point P on the groove, which is diametrically opposite to O. The angle (in radian) upto one decimal place rotated by the plate ABCD is X/10, when the tortoise comes back to point P after a complete rotation on the groove. Find X (Assume that plate is much heavier than the tortoise. Such that the velocity of the plate is much smaller than the velocity of the tortoise)



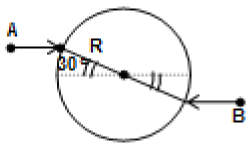
128. Two blocks of masses m_1 and m_2 are kept touching each other on an incline plane of inclination θ as shown in figure. If the coefficient of friction between the block m_1 and the plane is μ_1 and that between block m_2 and the plane is $\mu_2(<\mu_1)$.



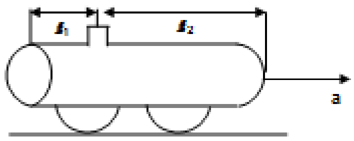
If minimum value of the inclination is θ at which the blocks just start sliding down the plane, then tan θ is $\frac{X}{Y}$.

Then |X-Y| is:
[given μ_1 = 0.3, μ = 0.2, m_1 = 30 kg, m_2 = 20 kg]

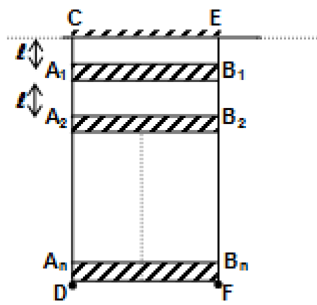
129. A uniform disc of mass m and radius 0.5 m is kept on a horizontal frictionless surface. Two point masses each of equal mass m and moving with speed of 30 m/s hit the disc as shown, and stick to it. The angular velocity (in rad/s) of the disc after collision is:



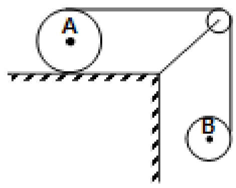
130. A closed cylindrical oil tanker filled with oil of density ρ = 800 kgm^{-3} has a stopper at the top. The acceleration a in horizontal direction at which the stopper will come out if it can support a pressure p = 0.05 atm is X/4 and the distance of the stopper is ℓ_1 = 0.1 m from one end ℓ_2 = 1m from the other end as shown in the figure. Find the value of X.



131. Two massless rods CD and EF are hinged at C and E respectively as shown. n rods, each of mass m and length are fixed to CD and EF at points A_1B_1 A_2B_2, …………, A_nB_n such that the separation between each rod is ℓ. The first rod A_1B_1 is at a distance ℓ from CE. The whole arrangement is at rest in the vertical equilibrium, Find the value of impulse (in Ns) to be given to the nth rod so that the complete system just reaches the horizontal level. (Impulse given is perpendicular to the rod and is horizontal).
Take: n = 7; g = 10 m/s²; ℓ = 25 cm; m = 1kg. The system is free to rotate about an axis passing through CE

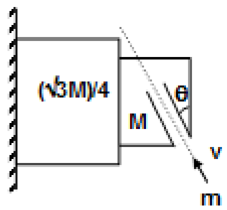


132. Two cylinder A&B of equal mass and radius, have an inextensible thread wound around them. The thread unwinds itself without slipping on the cylinders. Cylinder A is kept on a smooth horizontal surface. Cylinder B is hanging in the vertical plane. When the system is released, find the magnitude of acceleration (in m/s^2) of a point on the rim of the cylinder A when it is at the topmost point. Assume, frictionless pulley and sufficient length of string. (Take g = 10 m/s^2)



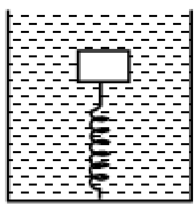
133. A particle moving with S.H.M on a straight line passes through two points A & B with same velocity. Time taken by particle to move from B to A is 1 sec & another 5 sec to return B from A. What is time period of S.H.M (in sec)

134. A block of mass M has a groove (see the figure) which gets 'n' particles per second each of mass 'm' moving with velocity v. The coefficient of friction between M and $\frac{\sqrt{3}}{4}$M is zero. Assume M $\gg$ m and each particle gets stuck after hitting. M is found to be at rest. The value of coefficient of friction between the wall and $\frac{\sqrt{3}}{4}$M so that the latter remains at rest is 1/X. The value of X is: [given θ = 60°]

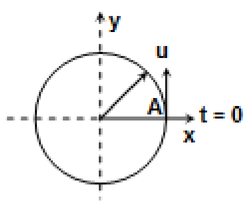


135. A block of density ρ_b and volume v is attached to a spring of spring constant k inside a liquid of density ρ_ℓ kept in a beaker is then accelerated by an acceleration a in vertical direction. The amplitude of oscillation ($\rho_b > \rho_\ell$)

[Given $\rho_b = 2\rho_\ell$-, va = $\frac{k}{500\rho_\ell}$] is (in mm)

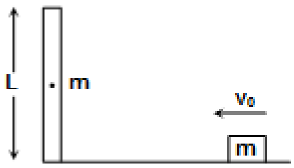


136. A particle is moving along a circular track of radius R_O = 1 m, the centre of which located at the origin of coordinate i.e. (0, 0). At time t = 0, the initial position of the particle is (1, 0). The speed of the particle at this instant is 4π m/s and the magnitude of tangential acceleration is 2π m/s^2. The speed of the particle at 2.5 sec is $n\pi$ m/sec, then the value of n is



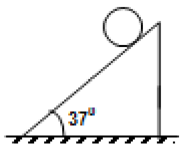
137. A satellite is revolving around a planet of mass M in an elliptic orbit such that the planet is at the focus and the maximum and minimum distance of the satellite from the planet are 450 km and 150 km. If the orbital speed v of the satellite when it is at a distance of 400 km from the planet is given by $v^2 = \frac{GM}{R}$ where R is constant and has dimensions of distance, then R = _______ km.

138. In the shown figure, a particle of mass m is moving with speed v_0 on a frictionless surface and collides with the uniform horizontal rod of length L and mass m. The collision is perfectly elastic. The rod rotates about its centre of mass. The rod deflects by angle $\theta(= /2)$ from initial position in time t. if t is $\frac{K\pi L}{24v_0}$, then the value of K is………………….

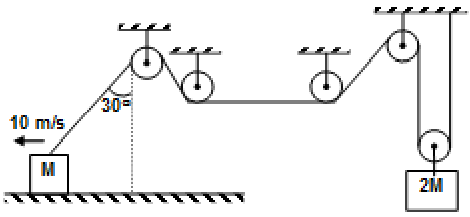


139. A solid sphere of mass 'm' and radius r is attached through a rod of mass 'm' and length ℓ and hinged at point 'P' vertical plane and a spring is attached as shown in the figure. The time period of oscillation (in second) is given $\ell = \left[\frac{\sqrt{g}}{\pi\left(\sqrt{\frac{142}{75}} + \sqrt{\frac{71}{165}}\right)}\right]^2$

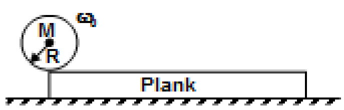
140. A solid metallic sphere of mass m and radius R is free to roll (without sliding) over inclined surface of wooden wedge of mass m. Wedge lies on a smooth horizontal floor. If the system is released from rest. The frictional force between sphere and wedge is $\frac{nmg}{9}$, then the value of n is …………



141. If at an instant, shown block B is moving towards left with speed of 10 m/s. The block of mass 2M is moving with speed V/2 m/s at that instant, then value of V is



142. A uniform solid spherical ball of mass m and radius R is given an angular velocity ω_0 in clockwise direction and placed gently on a plank of same mass M. The friction coefficient between plank and surface is zero and that of plank and ball is μ. The kinetic energy of the ball in Joule after infinite time is…………
[Assume plank is sufficiently long and M = 4.05 kg, R = 1m, ω_0 = 10 rad/s]

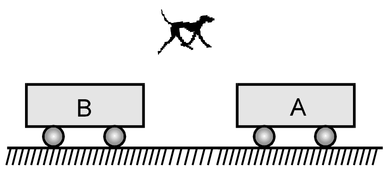


143. Two simple harmonic motions of the form $y = -\sqrt{669}\cos\left(\omega t - \frac{\pi}{6}\right)$m and $y = 2\sqrt{669}\sin\left(\omega t + \frac{2\pi}{3}\right)$m superimpose. The square of the resultant amplitude is ______m^2.

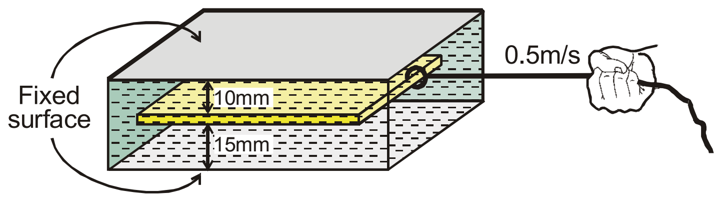
144. A liquid is filled in a large cylindrical vessel up to height 40 m and there are two identical holes, one at a depth 20 m from the free surface and other at the bottom of the vessel. The holes are initially plugged. At time t = 0 the first hole is unplugged and the liquid starts coming out. The second hole is unplugged when liquid reaches the height of the first hole. Area of the each hole is 2×10^{-3} m^2. Base area of the vessel is 6 m^2. The time taken to empty the tank is _________ minutes. [take g = 10 m/s^2]

145. An engineer works at a plant out of town. A car is sent for him from the plant every day that arrives at the railway station at the same time as the train he takes. One day the engineer arrived at the station half an hour before his usual time and without waiting for the car, started walking towards factory. On his way he met the car and reached his plant 20 minutes before the usual time. For how much time (in minute) did the engineer walk before he met the car ? The car moves with the same speed everyday.

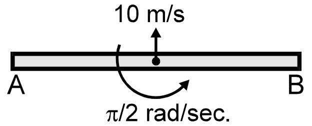
146. In a circus act, a 4 kg dog is trained to jump from B cart to A cart and then immediately back to the B cart. The carts each have a mass of 20 kg and they are initially at rest. In both cases the dog jumps at 6 m/s relative to the cart. If the cart moves along the same line with negligible friction, If the final magnitude of velocity of cart B with respect to the floor is X/36. Value of X is:



147. Glycerine is filled in 25 mm wide space between two large plane horizontal surfaces. Calculate the force required to drag a very thin plate 0.75 m^2 in area between the surfaces at a constant speed of 0.5m/s if it is at a distance of 10 mm from one of the surfaces in horizontal position ? Take coefficient of viscosity η = 0.5 Ns/m^2. Fill the value of X where X = 100 × force required to drag (in newton).

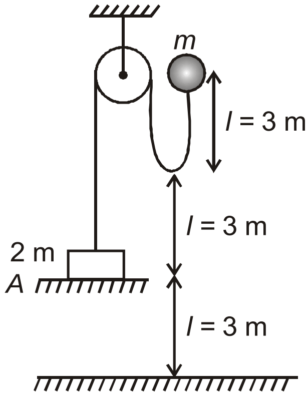


148. A uniform rod AB of length 4m and mass 12 kg is thrown such that just after the projection the centre of mass of the rod moves vertically upwards with a velocity 10 m/s and at the same time it is rotating with an angular velocity $\frac{\pi}{2}$ rad/sec about a horizontal axis passing through its mid point. Just after the rod is thrown it is horizontal and is as shown in the figure. Find the acceleration (in m/sec^2) of the point A in m/s^2 when the centre of mass is at the highest point. (Take g = 10m/s^2 and π^2 = 10)

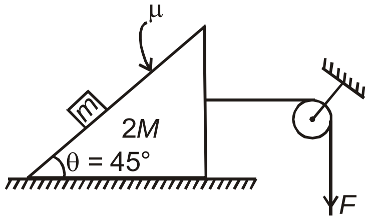


149. Two particles P and Q describe simple harmonic motions of same period, same amplitude along the same line about the same equilibrium position O. When P and Q are on opposite sides of O at the same distance from O they have the same speed of 1.2 m/s in the same direction, when their displacements are same they have the same speed of 1.6 m/s in opposite directions. Find the maximum velocity of P (in m/s).

150. A small ball having mass m is released as shown in figure. Find the maximum height attained by mass $2m$ (in metre) from the position A shown in figure.



151. In the figure shown, the contact surface of prism and ground is smooth. If the value of F is $10x$ N so that there will be no contact force between m and inclined plane, then find the value of x. Take $m = 1$ kg, $M = 2$ kg, $\mu = 0.5$ and $g = 10$ m/s^2.



Answer Key

Qs.	Ans.	Qs.	Ans.	Qs.	Ans.	Qs.	Ans.
1	B	51	AC	101	A-(iv),B-(ii),C-(i),D-(iii)	151	4
2	A	52	AD	102	A-(iv),B-(ii),C-(i),D-(ii,iii,iv)		
3	C	53	BCD	103	A-(iii),B-(ii),C-(i),D-(iv)		
4	A	54	ACD	104	A-(iii,iv),B-(iii,iv),C-(ii),D-(ii)		
5	A	55	AC	105	A-(ii),B-(i),C-(i),D-(ii)		
6	B	56	BC	106	A-(i),B-(i),C-(iii),D-(iv)		
7	C	57	AB	107	A-(ii),B-(ii),C-(iv),D-(iii)		
8	C	58	BCD	108	A-(i,ii,iii,iv),B-(i,ii,iii,iv),C-(ii),(i,ii,iii,iv)		
9	C	59	D	109	A-(ii,iv),B-(i,iv),C-(ii,iv),D-(iii,iv)		
10	B	60	A	110	A-(ii),B-(iii),C-(i),D-(iv)		
11	B	61	D	111	A-(iii,iv),B-(i),C-(iii,iv),D-(i,ii,iii,iv)		
12	D	62	A	112	A-(iv),B-(iii),C-(i),D-(ii)		
13	B	63	A	113	A-(iii,iv),B-(I,ii,iv),C-(iii,iv),D-(iii,iv)		
14	C	64	C	114	A-(iv),B-(iii),C-(ii),D-(i)		
15	A	65	A	115	A-(Q),B-(S),C-(R),D-(P)		
16	A	66	A	116	A-(Q),B-(R),C-(S),D-(P)		
17	D	67	D	117	A-(Q),B-(P),C-(S),D-(R)		
18	A	68	C	118	A-(R),B-(S),C-(P),D-(Q)		
19	C	69	D	119	A-(P,Q,R),B-(S),C-(R),D-(S)		
20	B	70	A	120	A-(Q),B-(P),C-(S),D-(R)		
21	A	71	D	121	A-(Q),B-(R),C-(S),D-(P)		
22	A	72	C	122	2		
23	D	73	A	123	20.0ms-1		
24	B	74	A	124	3kgm2		
25	D	75	C	125	1		
26	AD	76	C	126	2		
27	BCD	77	B	127	4		
28	AD	78	C	128	37		
29	AC	79	B	129	24		
30	ABD	80	C	130	25		
31	AD	81	B	131	20		
32	AB	82	B	132	5		
33	ABD	83	A	133	10		
34	ABC	84	B	134	4		
35	AD	85	C	135	2		
36	AC	86	B	136	9		
37	BCD	87	A	137	600		
38	BCD	88	C	138	5		
39	AC	89	A	139	1		
40	AB	90	C	140	2		
41	ABCD	91	C	141	5		
42	AB	92	A-(i),B-(I,ii,iii),C-(I,ii,iii,iv),D-(I,ii,iii,iv)	142	26		
43	ABC	93	A-(ii),B-(iv),C-(iii,iv),D-(I,iv)	143	2007		
44	ABC	94	A-(ii),B-(i),C-(i),D-(iv)	144	200		
45	BCD	95	A-(iv),B-(i),C-(ii),D-(iii)	145	20		
46	C	96	A-(ii),B-(i),C-(iv),D-(iii)	146	55		
47	BCD	97	A-(iv),B-(i),C-(ii),D-(ii,iii)	147	3125		
48	AB	98	A-(iv),B-(I,iii),C-(iii),D-(i)	148	5		
49	CD	99	A-(iv,v),B-(iv),C-(v),D-(iv,v)	149	2		
50	CD	100	A-(1,2,3,4),B-(4),C-(4),D-(3)	150	2		