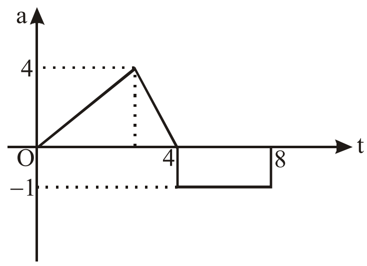
SINGLE CHOICE

Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

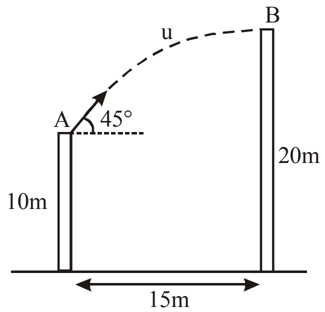
Kinematics

1. The acceleration time graph of a particle is shown in the figure. What is the velocity of particle at t = 8s, if initial velocity of particle is 3 m/s?



(A) 4 m/s (B) 5 m/s
(C) 6 m/s (D) 7 m/s

2. Find the value of 'u' so that the ball reaches at point B. (Take g = 10 m/s^2)



(A) 20 m/s (B) 40 m/s
(C) $15\sqrt{2}$ m/s (D) 50 m/s

3. Velocity of a particle at any instant is given by the equation $\vec{v} = \left(2t\hat{i} + 3t^2\hat{j}\right)$ m/s, and radius of the curvature of the path is 2m. Centripetal acceleration of the particle at t = 2 s is

(A) 80 m/s^2 (B) 160 m/s^2
(C) 40 m/s^2 (D) 100 m/s^2

4. A particle has an initial velocity of $3\hat{i} + 4\hat{j}$ and an acceleration of $0.4\hat{i} + 0.3\hat{j}$. Distance moved by the particle in 10 s is :

(A) 10 units (B) 7 units
(C) $7\sqrt{2}$ units (D) 8.5 units

5. A particle moving in the positive x–direction has initial velocity v_0. The particle undergoes retardation kv^2, where v is its instantaneous velocity. The velocity of the particle as a function of time is given by

(A) $v = v_0/(1 + kv_0t)$ (B) $v = \dfrac{2v_0}{1+kt}$

(C) $v = \dfrac{v_0}{kt}$ (D) $v = \dfrac{v_0}{\left(1+k^2v_0^2t\right)}$

6. In an imaginary atmosphere, the air exerts a small force F on any particle in the direction of the particle's motion. A particle of mass 'm' projected upward takes a time t_1 in reaching the maximum height and t_2 in the return journey to the original point then
(A) $t_1 < t_2$
(B) $t_1 > t_2$
(C) $t_1 = t_2$
(D) The relation between t_1 and t_2 depends on the mass of the particle

7. An aeroplane flying at a constant velocity releases a bomb. As the bomb drops down from the aeroplane,
(A) it will always be vertically below the aeroplane
(B) it will always be vertically below the aeroplane only if the aeroplane is flying horizontally
(C) it will always be vertically below the aeroplane only if the aeroplane is flying at an angle of 45° to the horizontal
(D) it will gradually fall behind the aeroplane if the aeroplane is flying horizontally

8. A particle is thrown with a speed u at an angle θ to the horizontal. When the particle makes an angle ϕ with the horizontal, its speed is
(A) $\upsilon = u \cos\theta$
(B) $\upsilon = u \cos\theta . \cos\phi$
(C) $\upsilon = u \cos\theta . \sec\phi$
(D) $\upsilon = u \sec\theta . \cos\theta$

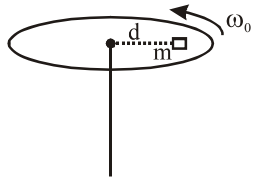
9. For a particle moving along a straight line, the displacement x depends on time t as $x = \alpha t^3 + \beta t^2 + \gamma t + \delta$. The ratio of its initial acceleration to its initial velocity depends
(A) only on α and β
(B) only on β and γ
(C) only on α and γ
(D) only on α

10. Wind is blowing at constant velocity $\vec{V}$ towards west. A man initially at rest starts moving with constant acceleration $\vec{a}$ towards north. Then the moment of time at which direction of wind appears south west to him is
(A) $\frac{\vec{V}}{\vec{a}}$
(B) $\frac{2\vec{V}}{\vec{a}}$
(C) $\frac{|\vec{V}|}{|\vec{a}|}$
(D) none of these

Laws of Motion

11. A rope of mass 'm' is looped in a circle of radius R and rotated with a constant angular velocity ω_0 about its axis in gravity free space. Find the tension in the rope ?
(A) $T = mR\omega_0^2$
(B) $2 \text{ m R } \pi\omega^2$
(C) $T = \frac{mR\omega_0^2}{2\pi}$
(D) $4mR\pi\omega_0^2$

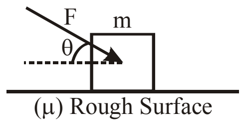
12. A small block of mass 'm' is placed on a rough rotating table. Find maximum angular velocity (ω_0) that canbe given to the table so that the particle does not slip on the table. It is given that the coefficient of friction between the block and the table is (μ).



(A) $\sqrt{\frac{2\mu g}{d}}$ (B) $\sqrt{\frac{3\mu g}{d}}$

(C) $\sqrt{\frac{\mu g}{d}}$ (D) $2\sqrt{\frac{\mu g}{d}}$

13. Find minimum value of the angle θ so that block of mass m does not move on rough surface. The coefficient of static friction between the block and surface whatever may be the value of applied force F.



(A) $\tan^{-1}(\mu)$ (B) $\frac{1}{2}\tan^{-1}(\mu)$

(C) $\cot^{-1}(\mu)$ (D) $\frac{1}{2}\cot^{-1}(\mu)$

14. A particle thrown up vertically reaches its highest point in time t_1 and returns to the ground in a further time t_2. The air resistance exerts a constant force on the particle opposite to its direction of motion
(A) $t_1 > t_2$
(B) $t_1 = t_2$
(C) $t_1 < t_2$
(D) may be (A) or (C) depending on the ratio of the force of air resistance to the weight of the particle.

15. A railway track is banked for a speed v, by making the height of the outer rail 'h' higher than that of the inner rail. The horizontal separation between the rails is d. The radius of curvature of the track is 'r' : then which of the following relation is true?

(A) $\frac{h}{d} = \frac{v^2}{rg}$ (B) $\tan\left(\sin^{-1}\frac{h}{d}\right) = \frac{v^2}{rg}$

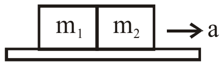
(C) $\tan^{-1}\left(\frac{h}{d}\right) = \frac{v^2}{rg}$ (D) $\frac{h}{r} = \frac{v^2}{dg}$

16. A person wants to drive on the vertical surface of a large cylindrical wooden 'well' commonly known as 'deathwell' in a circus. The radius of the 'well' is 2 meter, and the coefficient of friction between the tyres of the motorcycle and the wall of the well is 0.2 The minimum speed the motorcyclist must have in order to prevent slipping should be (take $g = 10\ m/s^2$)
(A) 10 m/s (B) 15 m/s
(C) 20 m/s (D) 25 m/s

17. Blocks A and B have masses of 2 kg and 3 kg respectively. The ground is smooth. P is an external force of 10 N. The force exerted by B on A is

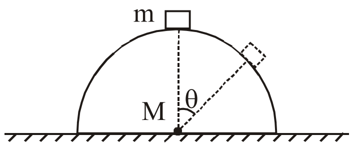
(A) 4 N
(B) 6 N
(C) 8 N
(D) 10 N

18. Two blocks of masses m_1 and m_2 are placed in contact with each other on a horizontal platform. The coefficient of friction between the platform and the two block is the same. The platform moves with an acceleration. The force of interaction between the blocks is



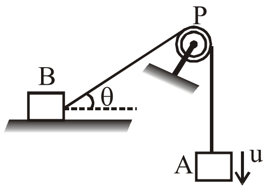
(A) zero in all cases
(B) zero only if $m_1 = m_2$
(C) nonzero only if $m_1 > m_2$
(D) nonzero only if $m_1 < m_2$

19. A particle of mass m is placed on the top of a smooth hemisphere of mass M. The hemisphere is placed on smooth ground. The particle is displaced gently. Then ratio of magnitude of normal reaction and pseudo force (seen from the hemisphere–frame) acting on the particle as a function of angle θ is given by (see figure). (Assume that the particle remains in contact with the hemisphere)



(A) $\dfrac{M}{m\sin\theta}$
(B) $\dfrac{m}{M\sin\theta}$
(C) $\dfrac{M}{m\cos\theta}$
(D) $\dfrac{M}{m\tan\theta}$

20. In the figure, the blocks are of equal mass. The pulley is fixed. In the position shown, A moves down with a speed u, and υ_B = the speed of B.



(A) the downward acceleration of A is equal in magnitude to the horizontal acceleration of B
(B) $\upsilon_B = u\cos\theta$
(C) $\upsilon_B = u/\cos\theta$
(D) none of these.

Work Energy and Power

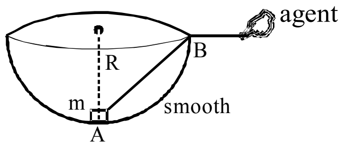
21. Given $\vec{F} = (xy^2)\hat{i} + (x^2y)\hat{j}$ newton. Find the work done by $\vec{F}$ when a particle is taken along the semicircular path OAB where O is origin and the co–ordinates of B are (4, 0).

(A) $\frac{65}{3}$ J
(B) $\frac{75}{2}$ J
(C) $\frac{73}{4}$ J
(D) 0 J

22. A chain of mass 10 kg and length 10 m is resting on a rough horizontal surface (μ = 0.2). A constant force of 20 newton is applied at one end. The tension in the mid point of the chain is

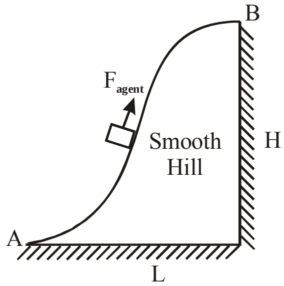
(A) 20 N
(B) 15 N
(C) 10 N
(D) 5 N

23. The minimum work done by the agent, in pulling a small particle of mass m from A to B as shown in figure, is



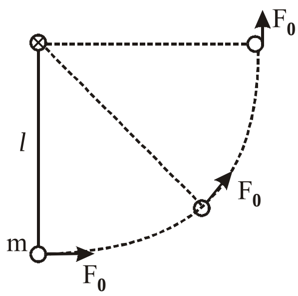
(A) 4 mgR (B) mgR
(C) 3mgR (D) 2mgR

24. An external agent moves the block m on slowly from A to B, along a smooth hill such that every time he applies the force tangentially. Find the work done by the agent in this interval.



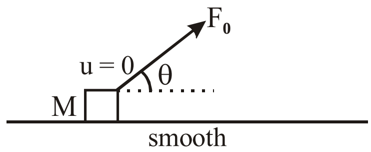
(A) $\frac{m^2g^2H^2}{L}$ (B) $\frac{mgH^2}{L}$
(C) mg (H + L) (D) mgH

25. An agent applies force of constant magnitude F_0 always in the tangential direction as shown in the figure. Find the speed of the bob when string becomes horizontal, assuming that it is at rest at its lowest point.



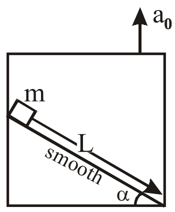
(A) $\sqrt{\frac{l}{m}(\pi F_0 - 2mg)}$ (B) $\sqrt{lg}$
(C) $\sqrt{\frac{l}{m}(\pi F_0 - 4mg)}$ (D) $\sqrt{\frac{l}{m}F_0}$

26. Find the speed of the block when it covers a horizontal distance 'l'. It is given that the block never loses contact with the smooth horizontal surface, and the force always acts at an angle θ with the horizontal.



(A) $\sqrt{\frac{lF_0\cos\theta}{m}}$ (B) $\frac{2lF_0\cos\theta}{m}$
(C) $\sqrt{\frac{2l}{m}F_0\cos\theta}$ (D) $\frac{lF_0\cos\theta}{m}$

27. A body of mass 'm' is released from rest on an inclined plane in an elevator (moving up with acceleration a_0). Find the time taken by the body to reach the bottom of the inclined plane.

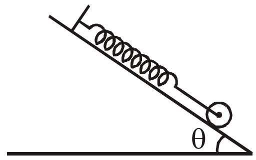


(A) $\sqrt{\frac{L}{(a_0+g)\sin\alpha}}$ (B) $t = \sqrt{\frac{2L}{(a_0+g)\sin\alpha}}$
(C) $\sqrt{\frac{3L}{(a_0+g)\sin\alpha}}$ (D) $2\sqrt{\frac{L}{(a_0+g)\sin\alpha}}$

28. A projectile is projected in the earth's gravitational with initial kinetic energy E. The horizontal of the projectile range is R. If the mass of the projectile is 1 kg then the angle of projection of the projectile will be equal to

(A) $\sin^{-1}(gR/2E)$ (B) $2\sin^{-1}(gR/2E)$
(C) $0.5\sin^{-1}(gR/2E)$ (D) $4\sin^{-1}(gR/2E)$

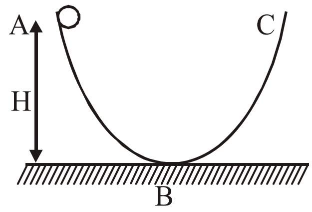
29. A sphere of mass m, attached at its center to a spring on incline as shown in figure, is held in unstretched position of spring. Suddenly the sphere is set free, the maximum extension of spring is (friction is enough to prevent slipping)



(A) $\frac{2mg}{k}$ (B) $\frac{2mg\cos\theta}{k}$

(C) $\frac{2mg\sin\theta}{k}$ (D) $\frac{mg\sin\theta}{k}$

30. A sphere of mass m and radius r is released from rest at point A on a track in vertical plane. The track is rough enough to support rolling between A and B and from B onwards it is smooth. The maximum height attained by sphere from ground on its journey from B onwards is

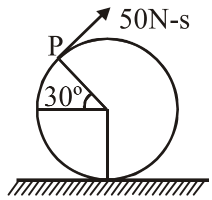


(A) H (B) $\frac{5}{7}H$

(C) $\frac{2}{5}H$ (D) $\frac{2}{7}H$

Conservation of Linear Momentum

31. A solid ball of radius 0.2m and mass 1kg lying at rest on a smooth horizontal surface is given an instantaneous impulse of 50 N–s at point P as shown. The number of rotations made by the ball about its diameter before hitting the ground is



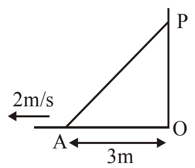
(A) $\frac{625\sqrt{3}}{2\pi}$ (B) $\frac{2500\sqrt{3}}{2\pi}$

(C) $\frac{3125\sqrt{3}}{2\pi}$ (D) $\frac{1250\sqrt{3}}{2\pi}$

32. A small ball strikes at one end of a stationary uniform frictionless rod of mass m and length ℓ which is free to rotate, in gravity–free space. The impact is elastic. Instantaneous axis of rotation of the rod will pass through

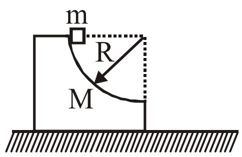
(A) its center of mass.
(B) the center of mass of rod plus ball.
(C) the point of impact of the ball on the rod.
(D) the point which is at a distance $2\ell/3$ from the striking end.

33. The end A of a ladder AP of length 5 m, kept inclined to a vertical wall is slipping over a horizontal surface with velocity of 2 m/s, when A is at a distance of 3m from the wall. Velocity of C.M. at this moment is



(A) 1.25 m/s (B) 0 m/s
(C) 1 m/s (D) 2 m/s

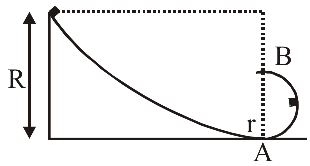
34. A small cube of mass m slides down a circular path of radius R cut into a larger block of mass M, as shown in the figure. M rests on a table, and both blocks move without friction. The blocks are initially at rest, and m starts from the top of the path. The velocity v of the cube as it leaves the block is



(A) $\sqrt{\frac{2mgR}{M}}$ (B) $\sqrt{2gR}$

(C) $\sqrt{\frac{2mgR}{m+M}}$ (D) $\sqrt{\frac{2MgR}{m+M}}$

35. A small block of mass m slides along a frictionless loop inside loop track as shown in figure. The minimum value of the ratio R/r so that the block may not lose contact at the highest point the inner loop is



(A) $\frac{7}{2}$ (B) 2

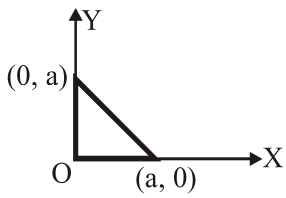
(C) $\frac{5}{2}$ (D) 3

36. A projectile is moving at 60 m/s at its highest point, where it breaks into two equal parts due to an internal explosion. One part moves vertically up at 50 m/s with respect to the ground. The other part will move at

(A) 110 m/s (B) 120 m/s

(C) 130 m/s (D) $10\sqrt{61}$ m/s

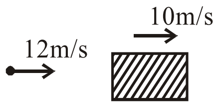
37. Three rods of the same mass are placed as shown in the figure. What will be the co–ordinates of the center of mass of the system?



(A) (a/2, a/2) (B) $(a/\sqrt{2}, a/\sqrt{2})$

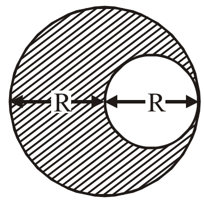
(C) $\left(\frac{\sqrt{2}a}{3}, \frac{\sqrt{2}a}{3}\right)$ (D) $\left(\frac{a}{3}, \frac{a}{3}\right)$

38. A light particle moving horizontally with a speed of 12 m/s strikes a very heavy block moving in the same direction at 10 m/s. The collision is one–dimensional and elastic. After the collision, the particle will



(A) move at 2 m/s in its original direction
(B) move at 8 m/s in its original direction
(C) move at 8 m/s opposite to in its original direction
(D) move at 12 m/s opposite to in its original direction

39. A circular disc of radius R has uniform thickness. A circular hole of diameter equal to the radius of the disc has been cut out from the disc as shown in figure. The centre of mass of the remaining portion of the disc lies on the diameter of the disc at a distance x to the left of the centre of the original disc. The value of x is



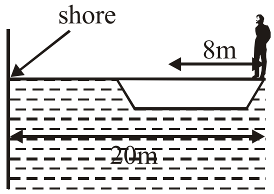
(A) R

(B) $\frac{R}{2}$

(C) $\frac{R}{4}$

(D) $\frac{R}{6}$.

40. A boy weighing 30 kg is standing on a flat boat so that his distance from the shore is 20 m. He walks 8 m towards the shore on the boat and then stops. If the boat weighs 120 kg, then the boy's distance from the shore is



(A) 20 m

(B) 8 m

(C) $\left(20+8+\frac{8}{5}\right)$m

(D) $\left(20-8+\frac{8}{5}\right)$m.

Rotational Mechanism

41. At time t = 0, a horizontal disc starts rotating with angular acceleration 1 rad/sec^2 about an axis perpendicular to its plane and passing though its center. A small block is lying on this disc at a distance 0.5 m from center, coefficient of friction between surface of block and disc is 0.255. The block will start slipping on the disc at time t, is approximately equal to

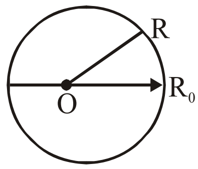
(A) $2\sqrt{3}$ s

(B) $2\sqrt{2}$ s

(C) 6 s

(D) $\sqrt{5}$ s

42. A particle is rotating about a vertical axis in the horizontal plane such that the angular velocity of the particle about the axis is constant and is equal to 1 rad/s. Distance of the particle from axis is given by $R = R_0 - \beta t$, where t stands for time. The speed of the particle as a function of time is



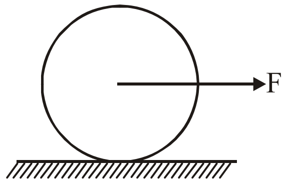
(A) $\sqrt{\beta^2+1}$

(B) $(R_0-\beta t)$

(C) $\sqrt{\beta^2+(R_0-\beta t)^2}$

(D) β

43. A solid sphere of mass m is lying at rest on a rough horizontal surface. The coefficient of friction between ground and sphere is μ. The maximum value of F, so that sphere will not slip, is equal to



(A) $\frac{7}{5}\mu mg$

(B) $\frac{4}{7}\mu mg$

(C) $\frac{5}{7}\mu mg$

(D) $\frac{7}{2}\mu mg$

44. A rectangular block has a square base measuring a × a, and its height is h. It moves on a horizontal surface in a direction perpendicular to one of the edges of the base. The coefficient of friction is μ. It will topple if (choose the most appropriate option)

(A) $\mu > a/2h$

(B) $\mu > 2a/h$

(C) $\mu > a/h$

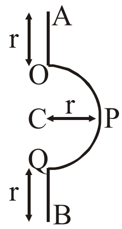
(D) $\mu > h/a$

45. The radius of gyration of a solid sphere of radius r about a certain axis is r. The distance of this axis from the centre of the sphere is

(A) r (B) 0.5 r

(C) $\sqrt{0.6}$ r (B) $\sqrt{0.4}$ r

46. A wire frame AOPQB, lying in the horizontal plane, is free to rotate about a vertical axis passing through center C of the same circle and ⊥ to plane of AOPQB. The mass M of the frame is uniformly distributed over its whole length. The moment of inertia of the frame about this axis, is (OA = QB = r and CP = r the radius of semicircular part)



(A) $Mr^2\left(\frac{14+3\pi}{3\pi+6}\right)$ (B) $Mr^2\left(\frac{\pi+r}{\pi+2r}\right)$

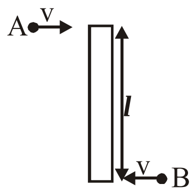
(C) $Mr^2\left(\frac{3}{4}\pi\right)$ (D) $\frac{1}{2}Mr^2$

47. An external device, e.g., an electric motor, supplies constant power to a rotating system, e.g., a flywheel, through a torque τ. The angular velocity of the system is ω. Both τ and ω are variable

(A) $\omega \propto \tau$ (B) $\omega \propto \frac{1}{\tau}$

(C) $\omega \propto \sqrt{\tau}$ (D) $\omega \propto \frac{1}{\sqrt{\tau}}$

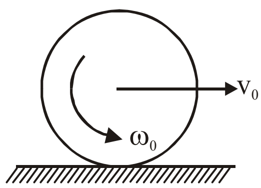
48. Two particles A and B of mass m each and moving with velocity v, hit the ends of a rigid bar of the same mass m and length l simultaneously and stick to the bar as shown in the figure. The bar is kept on a smooth horizontal plane. The linear and angular speed of the system (bar + particle) after the collision are



(A) $v_{cm} = 0, \omega = \frac{12}{7}\frac{v}{\ell}$ (B) $v_{cm} = 0, \omega = \frac{4v}{\ell}$

(C) $v_{cm} = 0, \omega = \frac{5v}{\ell}$ (D) $v_{cm} = 0, \omega = \frac{v}{5\ell}$

49. A disc of radius R is spun to an angular speed ω_0 about its axis and then imparted a horizontal velocity of magnitude $\frac{\omega_0 R}{4}$ (at t = 0) with its plane remaining vertical. The coefficient of friction between the disc and the plane is μ. The sense of rotation and direction of its linear speed are shown in the figure. Choose the correct statement. The disc will return to its initial position



(A) if the value of μ < 0.5. (B) irrespective of the value of μ (μ > 0).

(C) if the value of 0.5 < μ < 1. (D) if μ > 1.

50. A uniform rod of mass m and length ℓ starts rotating with constant angular acceleration α in a horizontal plane about a fixed vertical axis passing through one end. The horizontal

component of the net force exerted on the rod by the axis when it has rotated by an angle $\pi/2$, is

(A) $m\alpha\frac{\ell}{2}$ (B) $m\alpha\frac{\ell}{2}\sqrt{1+\pi^2}$

(C) $\frac{m\pi\alpha\ell}{2}$ (D) none of these

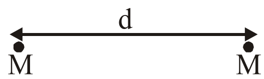
Gravitation

51. The binding energy of a particle of mass m with a planet, when it is on the planets surface, is $\frac{1}{2}mv_0^2$. A tunnel is dug along a diameter of the planet and the particle is dropped into it from the surface, when the body reaches the centre of the planet, its speed is

(A) v_0 (B) $\frac{v_0}{\sqrt{2}}$

(C) Zero (D) $\frac{v_0}{2}$

52. Consider the two identical particles shown in the given figure. They are released from rest and can move forwards each other under the influence of their mutual gravitation forces.



Speed of each particle, when the separation reduces to half of initial value equals

(A) $\sqrt{\frac{GM}{d}}$ (B) $\sqrt{\frac{2GM}{d}}$

(C) $\sqrt{\frac{GM}{2d}}$ (D) none of these

53. At the center of a non–uniform ring of radius R, made up of two uniform halves of mass 2M and M (G : Newton's gravitational constant)

(A) field and potential both are zero

(B) field is zero but potential is $\frac{-3GM}{R}$

(C) field is zero but potential is $-\frac{GM}{R}$

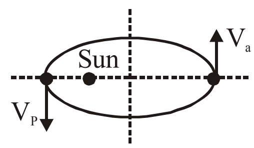
(D) magnitude of field is $\frac{2GM}{\pi R^2}$ and potential is $-\frac{3GM}{R}$

54. For a satellite of mass m orbiting the earth very close to earth's surface (mass of earth = M, radius of earth = R) total energy is

(A) zero (B) greater than zero

(C) $\frac{GMm}{R}$ (D) $-\frac{GMm}{2R}$

55. A planet moves around Sun in an elliptical orbit of eccentricity e. The ratio of the velocity at perigee V_P and at apogee V_a is given by



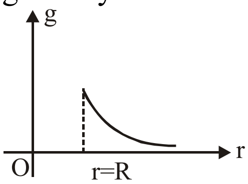
(A) $\frac{V_P}{V_a} = \frac{1+e}{1-e}$

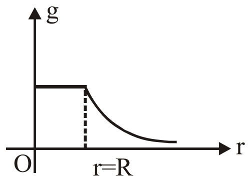
(B) $\frac{V_P}{V_a} = \frac{1-e}{1+e}$

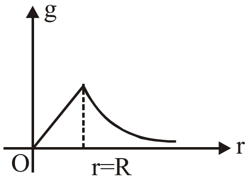
(C) $\frac{V_P}{V_a} = \sqrt{\frac{1+e}{1-e}}$

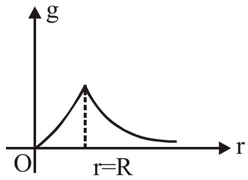
(D) $\frac{V_P}{V_a} = \sqrt{\frac{1-e}{1+e}}$

56. The variation of gravitational intensity g for a uniform solid sphere of mass M and radius R is given by

(A) 

(B) 

(C) 

(D) 

57. Assume that the escape velocity for a body projected vertically upward from the earth's surface is 11 km/s. If the body is projected at an angle of 45° with the vertical the escape velocity will be (assume that the earth is not rotating and there is no air resistance)

(A) $\frac{11}{\sqrt{2}}$ km/s

(B) $11\sqrt{2}$ km/s

(C) $\frac{11}{2}$ km/s

(D) 11 km/s

58. A comet moves around the sun in an elliptical orbit. It is closest to the sun at a distance d_1 and its corresponding velocity is v_1, and if it is farthest from the sun at a distance d_2, then the corresponding velocity is

(A) $\frac{v_1}{d_1} \cdot d_2$

(B) $v_1 \cdot \frac{d_1}{d_2}$

(C) $v_1 \cdot \sqrt{\frac{d_2}{d_1}}$

(D) $v_1 \cdot \sqrt{\frac{d_1}{d_2}}$.

59. Three stars each of mass m, rotate in a circle of radius r with uniform angular speed under their mutual gravitational attraction. The angular speed of each star is

(A) $\sqrt{\frac{3Gm}{r^3}}$

(B) $\sqrt{\frac{Gm}{3r^3}}$

(C) $\sqrt{\frac{Gm}{\sqrt{3}r^3}}$

(D) $\sqrt{\frac{\sqrt{3}Gm}{r^3}}$

60. A body is projected vertically upwards from the earth's surface to reach a height 7R, where R is the radius of earth. The velocity required to do so is

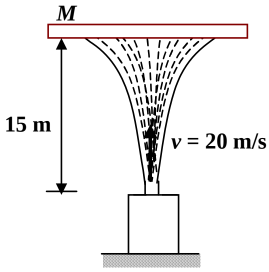
(A) $\sqrt{\frac{7GM}{8R}}$

(B) $\sqrt{\frac{7GM}{4R}}$

(C) $\sqrt{\frac{8GM}{3R}}$

(D) $\sqrt{\frac{20}{11}\frac{GM}{R}}$.

61. A vertical jet of water coming out of a nozzle with velocity 20 m/s supports a plate of mass M stationary at a height h = 15m, as shown in the figure. If the rate of water flow is 1 litre per second, the mass of the plate is (Assume the collision to be inelastic).



(A) 1 kg
(B) 1.414 kg
(C) 2 kg
(D) 10 kg

62. The density ρ of a liquid varies with depth h from the free surface as ρ = kh. A small body of density ρ_1 is released from the surface of liquid. The body will

(A) come to a momentary rest at a depth $\frac{2\rho_1}{k}$ from the free surface

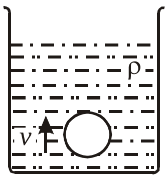
(B) execute simple harmonic motion about a point at a depth $\frac{\rho_1}{k}$ from the surface

(C) execute simple harmonic motion of amplitude $\frac{\rho_1}{k}$

(D) all of the above

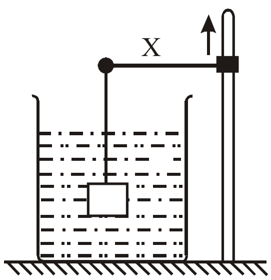
63. An air bubble of radius r rises steadily through a liquid of density ρ at the rate of v. Neglecting density of air, the coefficient of viscosity of liquid is

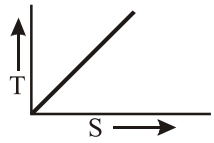
(A) $\frac{2}{9}\frac{r^2\rho g}{v}$
(B) $\frac{1}{3}\frac{r^2\rho g}{v}$
(C) $\frac{1}{9}\frac{r^2\rho g}{v}$
(D) $\frac{2}{9}\frac{r^2\rho g}{v}$

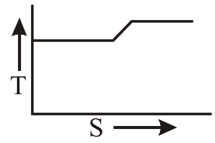


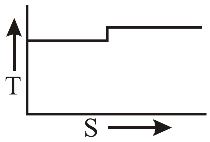
64. The reading of a barometer containing some air above the mercury column is 73cm while that of a correct one is 76 cm. If the tube of the faulty barometer is pushed down into mercury until volume of air in it is reduced to half, the reading shown by it will be
(A) 70 cm
(B) 72 cm
(C) 74 cm
(D) 76 cm

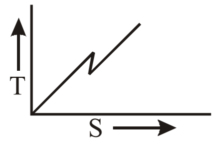
65. A metallic plate having shape of square is suspended as shown in figure. The plate is made to dip in water such that level of water is well above that of the plate. The point X is then slowly raised at constant velocity then curve between tension T in string and displacement S of point X is given by



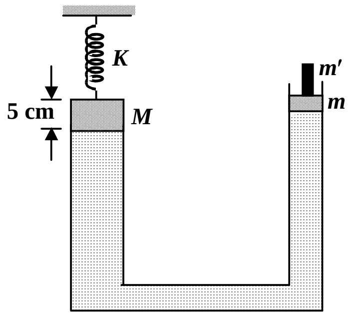
(A) 

(B) 

(C) 

(D) 

66. For the system shown in the figure, the cylinder on left has a mass (M) of 25 kg and cross–sectional area 20 cm^2 and is connected to a spring of spring constant 1400 N/m. The piston on the right has mass m (= 5 kg) and cross–sectional area 4 cm^2. The minimum mass m′ to be kept on m so that water spills out from the left is ($g = 10\ m/s^2$) (initially water level in both limbs is same).



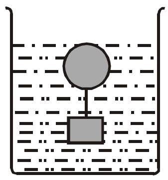
(A) 1 kg
(B) 1.4 kg
(C) 0.7 kg
(D) 2.5 kg

67. The rate of flow of glycerin of density ρ through conical section of a pipe, if the area of cross–sectional of its ends are A_1 and A_2 and pressure drop across its length be ΔP, is given by

(A) $A_1A_2\sqrt{\frac{\Delta P}{\rho\left(A_1^2-A_2^2\right)}}$
(B) $A_1A_2\sqrt{\frac{2\Delta P}{\rho\left(A_1^2-A_2^2\right)}}$
(C) $\sqrt{\frac{2\Delta P}{\rho\left(A_1^2-A_2^2\right)}}$
(D) $A_1A_2\sqrt{\frac{2\Delta P}{3\rho\left(A_1^2-A_2^2\right)}}$

68. Water rises in a vertical capillary tube to a height 2cm. In another capillary tube whose radius is one–third of it and which is inclined at 60° with the vertical, the water will occupy a length equal to
(A) 2 cm
(B) 6 cm
(C) 8 cm
(D) 12 cm

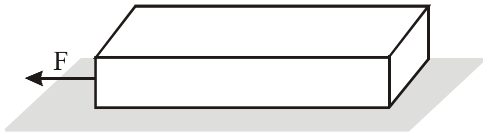
69. A body floats in a liquid contained in a beaker. The whole system shown in figure is falling under gravity. The upthrust on the body due to liquid is:



(A) zero
(B) equal to weight of liquid displaced
(C) equal to weight of the body in air
(D) equal to weight of the immersed body

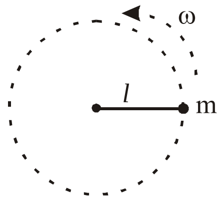
70. A liquid drop at temperature t, isolated from its surroundings, breaks into a number of droplets. The temperature of the droplets will be
(A) equal to t
(B) greater than t
(C) less than t
(D) either (A), (B) or (C) depending on the same surface tension of the liquid

71. A uniform bar of square cross–section is lying along a frictionless horizontal surface. A horizontal force is applied to pull it from one of its ends then



(A) The bar is under same stress throughout its length
(B) The bar is not under any stress because force has been applied only at one end
(C) The bar simply moves without any stress in it
(D) The stress developed reduces to zero at the end of the bar where no force is applied

72. A ball of mass m, attached to a light wire of length l, is rotated in a horizontal circle. The area of cross–section of the wire is A and its breaking stress is S then maximum angular velocity is



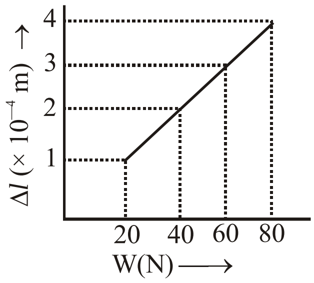
(A) $\sqrt{\frac{1}{2}\frac{AS}{ml}}$ rad s^{-1} (B) $\sqrt{\frac{AS}{ml}}$ rad s^{-1}
(C) $\sqrt{\frac{1}{4}\frac{AS}{ml}}$ rad s^{-1} (D) $\sqrt{\frac{2AS}{ml}}$ rad s^{-1}

73. A uniform plank of Young's modulus Y is moved over a smooth horizontal surface by a constant horizontal force F_0. The area of cross–section of the plank is A. The compressive strain on the plank in the direction of the force is
(A) $\frac{F_0}{AY}$ (B) $\frac{2F_0}{AY}$
(C) $\frac{F_0}{2AY}$ (D) $\frac{3F_0}{AY}$

74. A steel ring of radius r and cross–sectional area A is fitted on to a wooden disc of radius R(R > r). If Young's modulus be Y, then the force with which the steel ring is expanded is :
(A) $AY\frac{R}{r}$ (B) $AY\left(\frac{R-r}{r}\right)$
(C) $\frac{Y}{A}\frac{(R-r)}{r}$ (D) $\frac{Yr}{AR}$

75. The elongation of a freely hanging uniform steel rope, if its length is doubled, will increase in the ratio of
(A) 2 : 1 (B) 4 : 1
(C) 8 : 1 (D) 16 : 1

76. The graph shows the extension (Δl) of a wire of length 1 m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross–sectional area of the wire is 10^{-6} m^2, calculate the Young's modulus (i.e., Y) of the material of the wire is S.I. units



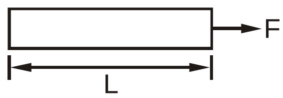
(A) 2×10^6 N/m^2
(B) 5×10^6 N/m^2
(C) 2×10^{11} N/m^2
(D) 5×10^{11} N/m^2

77. A steel wire of cross–sectional area 1×10^{-4} m^2 is clamped firmly at each end when its temperature is 25°C so that it cannot contract on cooling. The tension in the wire when it is cooled to 0°C is ($\alpha = 10^{-5}$ /°C, $Y = 2 \times 10^{11}$ N/m^2)
(A) 5000 N
(B) 7000 N
(C) 7400 N
(D) 4700 N

78. A uniform rod of length L, mass M and area of cross–section A is placed on rough horizontal surface. The rod is pulled with a force F (< friction force). The elongation produced in the rod is (Y = Young's modulus)
(A) $\frac{FL}{YA}$
(B) $\frac{FL}{2YA}$
(C) 0
(D) $\frac{2FL}{YA}$

79. A metallic rod hinged at one end is rotated in a horizontal plane. If the angular velocity of rotation is doubled
(A) there will be no elongation in rod in any case
(B) elongation in rod will be same
(C) elongation in rod becomes two times of initial value
(D) elongation in rod becomes four times of initial value

80. A rod of length L is pulled with a force F as shown on a smooth horizontal surface. If A is the area of cross–section and Y the Young's modulus of the material of the rod, the elastic potential energy stored in the rod is



(A) $\frac{F^2L}{3YA}$
(B) $\frac{F^2L}{2YA}$
(C) $\frac{F^2L}{6YA}$
(D) $\frac{F^2L}{YA}$

Simple Harmonic Motion

81. A particle A is attached to a spring and the time period for small oscillations is observed to be T; when an additional mass dm is added on, the time period becomes T + dT. The mass of particle A is

(A) $dm\left\{2\frac{dT}{T}+\left(\frac{dT}{T}\right)^2\right\}^{-1}$

(B) $dm\left\{2+2\frac{dT}{T}+\left(\frac{dT}{T}\right)^2\right\}^{-1}$

(C) $dm\left\{2\cdot\frac{dT}{T}\right\}^{-1}$

(D) none of these

82. One end of a spring of force constant k is fixed to a vertical wall and the other to a body of mass m resting on a smooth horizontal surface. There is another wall at a distance x_0 from the body. The spring is then compressed by $2x_0$ and released. The time taken to strike the wall is

(A) $\frac{\pi}{6}\sqrt{\frac{m}{k}}$

(B) $\sqrt{\frac{m}{k}}$

(C) $\frac{2\pi}{3}\sqrt{\frac{m}{k}}$

(D) $\frac{\pi}{4}\sqrt{\frac{m}{k}}$

83. A particle undergoes SHM with a time period of 2 seconds. In how much time will it travel from its mean position to a displacement equal to half of its amplitude ?

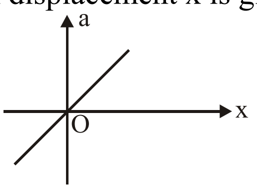
(A) $\frac{1}{2}$s

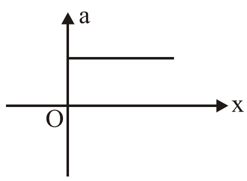
(B) $\frac{1}{3}$s

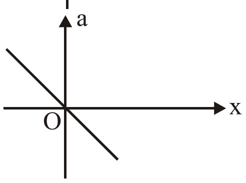
(C) $\frac{1}{4}$s

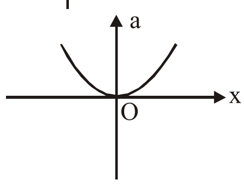
(D) $\frac{1}{6}$s

84. For a particle executing simple harmonic motion, the correct variation of acceleration a with displacement x is given by

(A) 

(B) 

(C) 

(D) 

85. The displacement y of a particle executing a certain periodic motion is given by $y = 4\cos^2\left(\frac{1}{2}t\right)\sin(1000\,t)$. This expression may be considered to be the superposition of n independent harmonic motions. Then, n is equal to

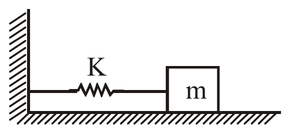
(A) 2

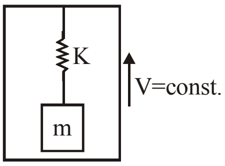
(B) 3

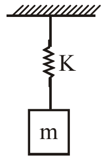
(C) 4

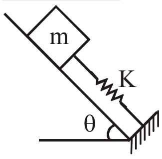
(D) 5

86. Identify a spring mass system which has a different time period compared to the system shown in figure



(A) 

(B) 

(C) 

(D) none of these

87. A uniform rod of length 2ℓ is suspended about one of its ends. The time period of oscillation for small angular displacements is

(A) $2\pi\sqrt{\frac{3\ell}{2g}}$ (B) $2\pi\sqrt{\frac{2\ell}{3g}}$

(C) $4\pi\sqrt{\frac{\ell}{3g}}$ (D) $\pi\sqrt{\frac{3\ell}{g}}$

88. The time period of a simple pendulum in air is T. The time period of the same simple pendulum in another medium which offers a Buoyant force on the bob, one third of its weight, is

(A) $\sqrt{\frac{3}{2}}\,T$ (B) $\sqrt{\frac{2}{3}}\,T$

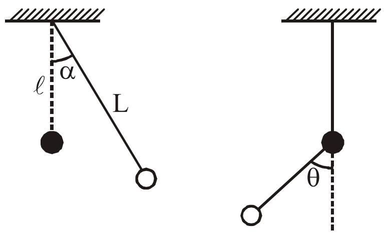
(C) $\frac{3}{2}T$ (D) $\frac{2}{3}T$

89. A simple pendulum rotates in a horizontal plane with an angular velocity of ω about a fixed point P in gravity–free space. There is a negative charge at P. The bob gradually emits photoelectrons (disregard the energy and momentum of the incident photons and emitted electrons). The total force acting on the bob is T

(A) T will decrease, ω will decrease (B) T will decrease, ω will remain constant

(C) T and ω will remain unchanged (D) none of these.

90. A simple pendulum consisting of a mass M attached to a string of length L is released from rest at an angle α. A pin is located at a distance ℓ below the pivot point. When the pendulum swings down, the string hits the pin as shown in the figure. The maximum angle θ which string makes with the vertical after hitting the pin is

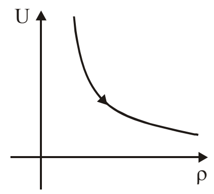


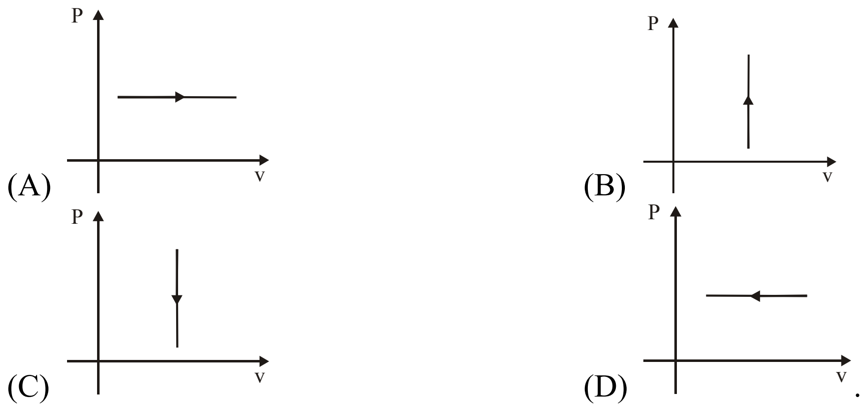
(A) $\cos^{-1}\left[\frac{L\cos\alpha+\ell}{L+\ell}\right]$ (B) $\cos^{-1}\left[\frac{L\cos\alpha+\ell}{L-\ell}\right]$

(C) $\cos^{-1}\left[\frac{L\cos\alpha-\ell}{L-\ell}\right]$ (D) $\cos^{-1}\left[\frac{L\cos\alpha-\ell}{L+\ell}\right]$

Heat and Thermodynamics

91. Variation of internal energy with density of one mole of monatomic gas is depicted in the adjoining figure, corresponding variation of pressure with volume can be depicted as (Assuming the curve is rectangular hyperbola)





92. A gas of adiabatic exponent γ is supplied heat at a constant pressure. What is the ratio between dQ, dW and dU in the process

(A) $\gamma : \gamma - 1 : \frac{1}{\gamma}$ (B) $1 : 1 : \gamma - 1$

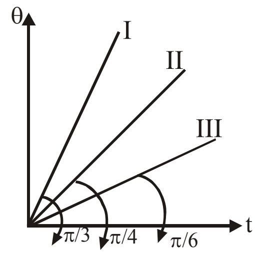
(C) $\gamma : \gamma - 1 : 1$ (D) $\gamma : 1 : \gamma - 1$

93. A body executes simple harmonic motion. The potential energy (PE), kinetic energy (KE) and total energy (TE) are measured as a function of displacement x. Which of the following statements is true?

(A) TE is zero when x = 0 (B) PE is maximum when x = 0

(C) KE is maximum when x = 0 (D) KE is maximum when x is maximum

94. Three bodies A, B and C of masses m, m and $\sqrt{3}$ m respectively are supplied heat at a constant rate. The change in temperature θ versus time t graph for A, B and C are shown by I, II and III respectively. If their specific heat capacities are S_A, S_B and S_C respectively then which of the following relation is correct? (Initial temperature of body is 0ºC)



(A) $S_A > S_B > S_C$ (B) $S_B = S_C < S_A$

(C) $S_A = S_B = S_C$ (D) $S_B = S_C > S_A$

95. 600 J of heat is added to a monatomic gas in a process in which the gas performs a work of 150 J. The molar heat capacity for the process is

(A) 3 R (B) 4 R

(C) 2 R (D) 6 R

96. The internal energy of a gas is given by U = 2PV. It expands from V_0 to $2V_0$ against a constant pressure P_0. The heat absorbed by the gas in the process is

(A) $2P_0V_0$ (B) $4P_0V_0$

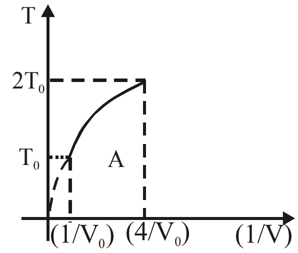
(C) $3P_0V_0$ (D) P_0V_0

97. A gas is found to obey the law P^2V = constant. The initial temperature and volume are T_0 and V_0. If the gas expands to a volume $3V_0$, then the final temperature becomes

(A) $\sqrt{3}\,T_0$ (B) $\sqrt{2}\,T_0$

(C) $\frac{T_0}{\sqrt{3}}$ (D) $\frac{T_0}{\sqrt{2}}$

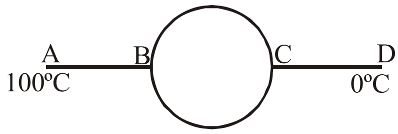
98. Figure shows a parabolic graph between T and $\frac{1}{V}$ for a mixture of a gas undergoing an adiabatic process. What is the ratio of v_{rms} and speed of sound in the mixture?



(A) $\sqrt{\frac{3}{2}}$ (B) $\sqrt{2}$

(C) $\sqrt{\frac{2}{3}}$ (D) $\sqrt{3}$

99. Two identical conducting rods AB and CD are connected to a circular conducting ring at two diametrically opposite points B and C. The radius of the ring is equal to the length of rods AB and CD. The area of cross–section, and thermal conductivity of the rod and ring are equal. Points A and D are maintained at temperatures of 100ºC and 0ºC. Temperature of point C will be



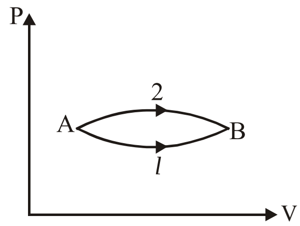
(A) 62ºC (B) 37ºC

(C) 28ºC (D) 45ºC

100. The figure shows two paths for the change of state of a gas from A to B. The ratio of molar heat capacities in path 1 and path 2 is

(A) < 1 (B) > 1

(C) 1 (D) data insufficient



Wave and Sound

101. The equation $y = a\cos^2(2\pi nt - 2\pi x/\lambda)$ represents a wave with

(A) amplitude a, frequency n and wavelength λ

(B) amplitude a, frequency 2n and wavelength 2λ

(C) amplitude a/2, frequency 2n and wavelength λ

(D) amplitude a/2, frequency 2n and wavelength λ/2

102. The displacement due to a wave moving in the positive x–direction is given by $y = \frac{1}{(1+x^2)}$ at time t = 0 and by $y = \frac{1}{[1+(x-1)^2]}$ at t = 2 seconds, where x and y are in metres. The velocity of the wave in m/s is

(A) 0.5 (B) 1

(C) 2 (D) 4

103. A car sounding its horn at 480 Hz moves towards a cliff at 20 m/s. The driver of the car hears (velocity of sound = 320 m/s)
(A) No beats
(B) beats at a frequency of 64 Hz
(C) beats at a frequency of 30 Hz
(D) beats at a frequency of 32 Hz.

104. A wave $y_1 = A\sin\left(2x - 4t + \frac{\pi}{3}\right)$ is superposed with a second waveform producing a standing wave with a node at x = 0. In the equation of the waveform, x is in metre and t is in second. The equation of the second waveform is
(A) $y_2 = A\sin(4t - 2x - \pi/3)$
(B) $y_2 = A\sin(2x + 4t + 5\pi/3)$
(C) $y_2 = A\sin(2x + 4t - 5\pi/3)$
(D) $y_2 = A\sin(-2x + 4t - \pi/3)$.

105. Two sound waves of wavelengths 98 cm and 100 cm arrive at the same point, from two different sources. The number of beats heard is (speed of sound is 392 m/s.)
(A) 4
(B) 8
(C) 16
(D) none of these

106. A plane transverse harmonic wave travels through a medium. The maximum particle velocity equals the wave velocity. Then
(A) $\lambda = 2\pi A$
(B) $\lambda = \pi A$
(C) $A = \lambda 2\pi$
(D) none of the above is true.

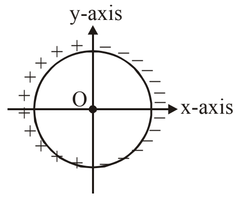
107. A wave represented by the equation y = a cos (kx – ωt) is superposed with another wave to form a stationary wave such that the point x = 0 is a node. The equation for the other wave is
(A) $a\sin(kx + \omega t)$
(B) $-a\cos(kx + \omega t)$
(C) $-a\cos(kx + \omega t)$
(D) $-a\sin(kx - \omega t)$

108. A metal string is fixed between rigid supports. It is initially at negligible tension. Its Young modulus is Y, density is ρ and coefficient of thermal expansion is α. If it is now cooled through a temperature = t, transverse waves will move along it with speed
(A) $Y\sqrt{\alpha t/\rho}$
(B) $\alpha t\sqrt{Y/\rho}$
(C) $\sqrt{Y\alpha t/\rho}$
(D) $t\sqrt{Y\alpha/\rho}$

109. To decrease the cut–off wave length of continuous X–ray by 25% the potential difference across the X–ray tube
(A) must be increased by $\frac{100}{3}$%
(B) must be decreased by $\frac{100}{3}$%
(C) must be increased by 25%
(D) must be decreased by 25%

110. Two identical strings are stretched at tensions T_A and T_B. A tuning fork is used to set them in vibration. A vibrates in its fundamental mode and B in its second harmonic mode
(A) $T_A = 2T_B$
(B) $T_A = 4T_B$
(C) $2T_A = T_B$
(D) $4T_A = T_B$

111. What is the direction of electric field at point O as shown in figure ?



(A) positive x–axis
(B) negative x–axis
(C) positive y–axis
(D) negative y–axis

112. Two particles, each of mass m carrying charge Q, are separated by some distance. If they are in equilibrium under mutual gravitational and electrostatic forces then Q/m (in C/kg) is of the order of

(A) 10^{-5}
(B) 10^{-10}
(C) 10^{-15}
(D) 10^{-20}

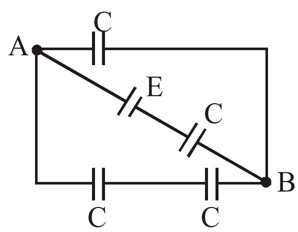
113. In a parallel plate capacitor of plate area A, plate separation d and charge Q, the force of attraction between the plates is F, then

(A) $F \propto Q^2$
(B) $F \propto \frac{1}{A^2}$
(C) $F \propto d$
(D) $F \propto \frac{1}{d}$

114. Charge Q is divided into two parts which are then kept some distance apart. The force between them will be maximum if eth two parts are

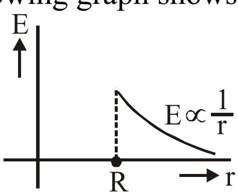
(A) Q/2 each
(B) Q/4 and 3Q/4
(C) Q/3 and 2Q/3
(D) e and (Q – e), where e = electronic charge

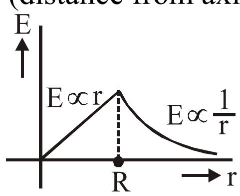
115. For the circuit shown, find the potential difference between A and B

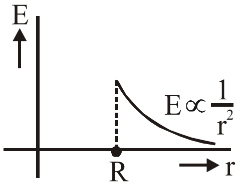


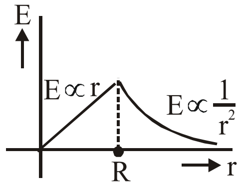
(A) E
(B) $\frac{2E}{3}$
(C) $\frac{2E}{5}$
(D) zero

116. For a uniformly charged conducting solid cylinder of infinite length, which of the following graph shows the variation of E with r ? (distance from axis)

(A)


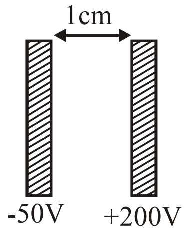
(B)


(C)


(D)


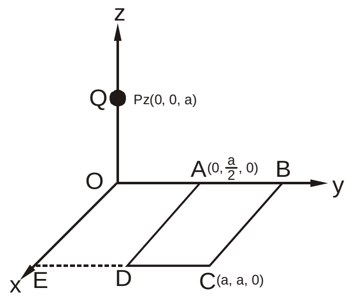
117. In the arrangement of a pair of parallel plates having separation 1 cm as shown. What is electric field in the region between the plates ?

(A) 15 kN/C towards right (B) 15 kN/C towards left
(C) 25 kN/C towards right (D) 25 kN/C towards left



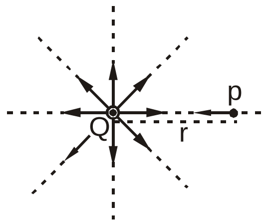
118. A charge Q is placed at P (0, 0, a). The coordinates of A and C of a square are $\left(0, \frac{a}{2}, 0\right)$ and (a, a, 0) respectively. The flux through ABCD is

(A) $\frac{Q}{16\varepsilon_o}$ (B) $\frac{Q}{24\varepsilon_o}$
(C) $\frac{Q}{48\varepsilon_o}$ (D) none of these



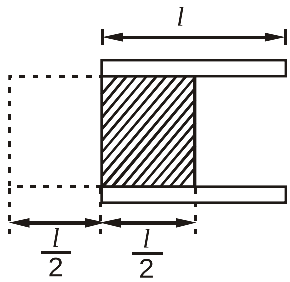
119. A dipole of dipole moment p is placed at a distance r from a point charge Q (as shown in figure). Choose the incorrect statement.

(A) Torque acting on the dipole is zero
(B) Force acting on the dipole due to the electric field produced by Q is zero.
(C) Potential energy of the dipole due to the point charge Q is $\frac{Qp}{4\pi\varepsilon_o r^2}$
(D) Force acting on the dipole due to the point charge Q is $\frac{Qp}{2\pi\varepsilon_o r^3}$



120. A capacitor of capacitance C is charged by a battery of emf V and then disconnected. The work done by an external agent to insert a dielectric of dielectric strength k of half the length of the capacitor is

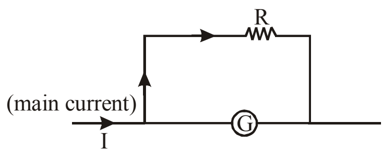
(A) $\frac{1}{2}CV^2\left(\frac{k-1}{k+1}\right)$ (B) $\frac{1}{2}CV^2\left(\frac{1-k}{k+1}\right)$
(C) $\frac{1}{4}CV^2(k-1)$ (D) $\frac{1}{4}CV^2(1-k)$



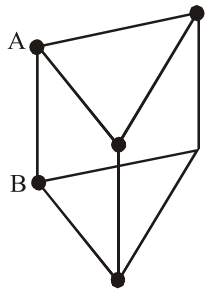
Current Electricity

121. The value of R for which 20 % of the main current passes through galvanometer of resistance 80 Ω is

(A) 10 Ω (B) 20
(C) 30 Ω (D) 40 Ω



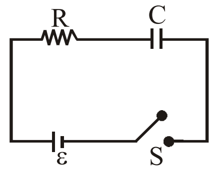
122. Nine similar resistors of resistance R are connected as shown in the figure. Equivalent resistance between points A and B is



(A) $\frac{3}{5}R$ (B) $\frac{4}{3}$R

(C) $\frac{9}{5}$R (D) R

123. If switch S is closed at t = 0 then the time at which power supplied by battery is equal to rate of energy storage in capacitor is



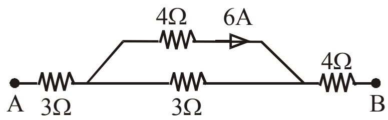
(A) t = 0

(B) t = 4RC

(C) t = 5RC

(D) It never happens (except $t \to \infty$) because resistor always consume energy

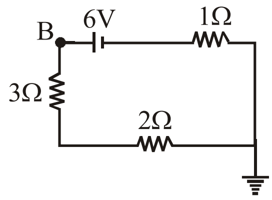
124. Potential difference between point A and B is



(A) 122 volt (B) 60 volt

(C) 100 volt (D) none.

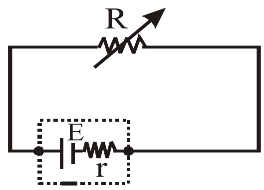
125. Potential of point B is



(A) 6 volt (B) 5 volt

(C) 4 volt (D) 3 volt

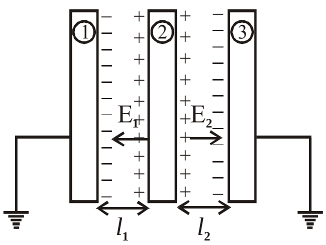
126. A battery having e.m.f. E is connected to a variable resistance R. Internal resistance of battery is r. As we increase R then potential difference across the terminals of battery



(A) Increases (B) Decreases

(C) First increase then decreases (D) None of the above

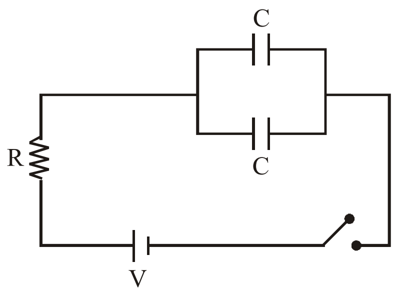
127. Suppose Electric field between plate (A) and (B) is E_1 and between (B) and (C) is E_2 then



(A) $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ (B) $\frac{E_1}{E_2} = \frac{l_2}{l_1}$

(C) $E_1 l_1 > E_2 l_2$ (D) none of these

128. If switch S closed at t = 0 then work done by battery upto time t is equal to



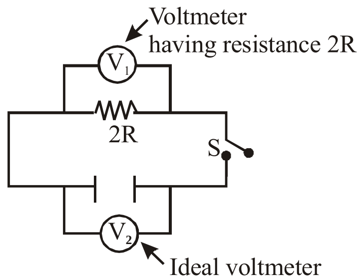
(A) $\frac{CV^2}{2}\left(1 - e^{\frac{-2t}{CR}}\right)$

(B) $CV^2\left(1 - e^{-\frac{t}{2CR}}\right)$

(C) $CV^2\left(1 - e^{-t/CR}\right)$

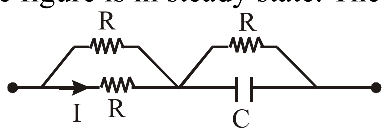
(D) None of the above

129. If switch is closed at t = 0 then the time at which reading of both voltmeters will be equal



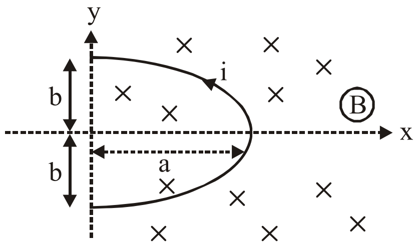
(A) t = 2RC (B) t = 3RC
(C) t = 4RC (D) All times

130. The capacitor shown in the figure is in steady state. The energy stored in the capacitor is



(A) CI^2R^2 (B) $2CI^2R^2$
(C) $4CI^2R^2$ (D) None of the above

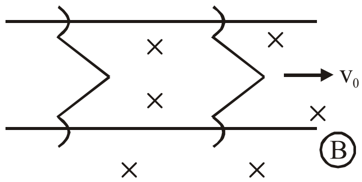
131. In the figure, there is a conducting wire having current i and which has a shape of half ellipse $\left[\frac{x^2}{a^2}+\frac{y^2}{b^2}=1\right]$ is kept in a uniform magnetic field B as shown. If the mass of wire is m, the acceleration of wire will be



(A) $\frac{2ibB}{m}$ (B) $\frac{2iaB}{m}$

(C) $\frac{ibB}{m}$ (D) $\frac{iaB}{m}$.

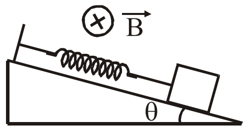
132. In figure there are two sliders and they can slide on two frictionless parallel wires in uniform magnetic field B, which is present everywhere. The mass of each slider is m, resistance R and initially these are at rest. Now if one slider is given a velocity v_0, the velocity of other slider after considerably long time will be (neglect the self induction)



(A) $\frac{v_0}{4}$ (B) $\frac{v_0}{2}$

(C) v_0 (D) Zero.

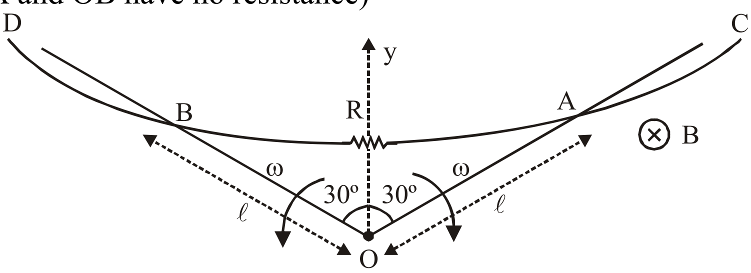
133. A small block of mass m, having charge q is placed on frictionless inclined plane making an angle θ with the horizontal. There exists a uniform magnetic field B parallel to the inclined plane but perpendicular to the length of spring. If m is slightly pulled on the inclined in downward direction, the time period of oscillation will be (assume that the block does not leave contact with the plane)



(A) $2\pi\sqrt{\frac{m}{K}}$ (B) $2\pi\sqrt{\frac{2m}{K}}$

(C) $2\pi\sqrt{\frac{qB}{K}}$ (D) $2\pi\sqrt{\frac{qB}{2K}}$.

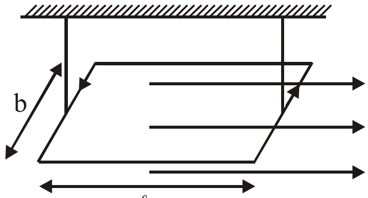
134. In figure there exists uniform magnetic field B into the plane of paper. Wire CD is in the shape of an arc and is fixed. OA and OB are the wires rotating with angular velocity ω as shown in figure in the same plane as that of the arc about point O. If at some instant OA = OB = ℓ and each wire makes angle θ = 30º with y–axis, the current through resistance R is (wires OA and OB have no resistance)



(A) Zero (B) $\frac{B\omega\ell^2}{R}$

(C) $\frac{B\omega\ell^2}{2R}$ (D) $\frac{B\omega\ell^2}{4R}$.

135. A uniform conducting rectangular loop of sides ℓ, b and mass m carrying current i is hanging horizontally with the help of two vertical strings. There exists a uniform horizontal magnetic field B which is parallel to the longer side of loop. The value of tension which is least is



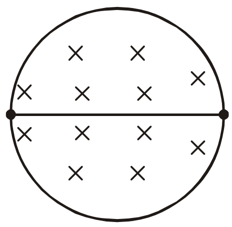
(A) $\frac{mg - Bb}{2}$ (B) $\frac{mg + Bb}{2}$

(C) $\frac{mg - 2iBb}{2}$ (D) $\frac{mg + 2Bb}{2}$.

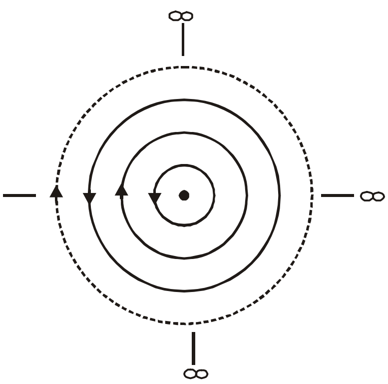
136. A cylindrical region of uniform magnetic field exists perpendicular to plane of paper which is increasing at a constant rate $\frac{dB}{dt} = \alpha$. The diameter of cylindrical region is ℓ. A non–conducting rigid rod of length ℓ having two charged particles is kept fixed on the diameter of cylindrical region w.r.t. inertial frame. If two charged particles having charges q each is kept fixed at the ends of the non–conducting rod. The net force on any one of the charge is

(A) $\frac{q\ell\alpha}{4}$ (B) $\frac{q\ell\alpha}{2}$

(C) Zero (D) $q\ell\alpha$.



137. In figure, infinite conducting rings each having current i in the direction shown are placed concentrically in the same plane as shown in the figure. The radius of rings are r, 2r, 2^2r, 2^3r …. ∞. The magnetic field at the centre of rings will be



(A) Zero (B) $\frac{\mu_0 i}{r}$

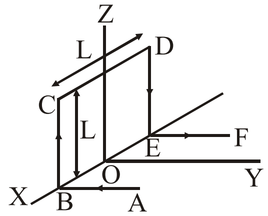
(C) $\frac{\mu_0 i}{2r}$ (D) $\frac{\mu_0 i}{3r}$.

138. A particle of specific charge $\frac{q}{m} = \pi$ C/kg is projected from the origin towards positive x–axis with a velocity of 10 m/s in a uniform magnetic field $\vec{B} = -2\hat{k}$ T. The velocity $\vec{v}$ of particle after time $t = \frac{1}{12}$ s will be (in m/s)

(A) $5[\hat{i} + \sqrt{3}\,\hat{j}]$ (B) $5(\sqrt{3}\,\hat{i} + \hat{j})$

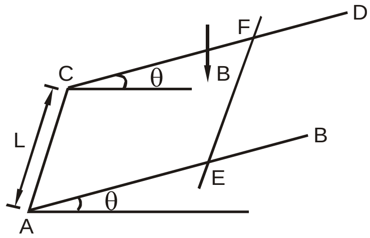
(C) $5[\sqrt{3}\hat{i}-\hat{j}]$ (D) $5[\hat{i}+\hat{j}]$

139. A conductor ABCDEF, with each side of length L, is bent as shown. It is carrying a current I in a uniform magnetic induction (field) B, parallel to the positive y–direction. The force experienced by the wire is



(A) BIL in the positive y–direction
(B) BIL in the positive z–direction
(C) 3BIL
(D) zero

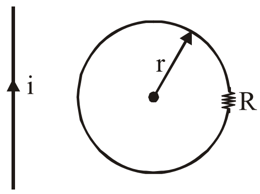
140. AB and CD are smooth parallel rails, separated by a distance l, and inclined to the horizontal at an angle θ. A uniform magnetic field of magnitude B, directed vertically downwards, exists in the region. EF is a conductor of mass m, carrying a current i. For EF to be in equilibrium,



(A) i must flow form E to F
(B) Bil = mg tan θ
(C) Bil = mg sin θ
(D) None of these.

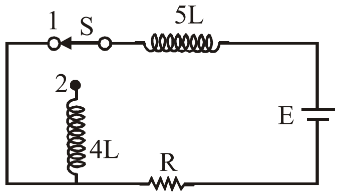
Electromagnetic Induction

141. In the given figure, the mutual inductance of coil and the very long straight wire is M, the coil has resistance R and the self inductance L. There is an infinite wire which lies in the same plane as that of the coil. The current in the wire varies according to the law i = at, where a is a constant and t is the time, the time dependence of current in the coil is



(A) $\frac{M}{aR}$ (B) $MaR\,e^{-Rt/L}$
(C) $\frac{M}{R}e^{-tR/L}$ (D) $\frac{Ma}{R}(1-e^{-tR/L})$.

142. In the circuit shown the switch S is shifted to position 2 from position 1 at t = 0, having been in position 1 for a long time. The current in the circuit just after shifting of switch will be (battery and both the inductors are ideal)



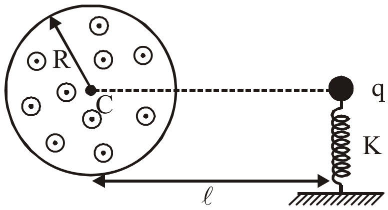
(A) $\frac{4}{5}.\frac{\varepsilon}{R}$ (B) $\frac{5}{4}.\frac{\varepsilon}{R}$
(C) $\frac{5}{9}\frac{\varepsilon}{R}$ (D) $\frac{\varepsilon}{R}$.

143. There is a conducting ring of radius R. Another ring having current i and radius r (r << R) is kept on the axis of bigger ring such that it's a centre lies on the axis of bigger ring at a distance x from the centre of bigger ring and its plane is perpendicular to that axis. The mutual inductance of bigger ring due to smaller ring

(A) $\frac{\mu_0 \pi R^2 r^2}{(R^2 + x^2)^{3/2}}$ (B) $\frac{\mu_0 \pi R^2 r^2}{4(R^2 + x^2)^{3/2}}$

(C) $\frac{\mu_0 \pi R^2 r^2}{16(R^2 + x^2)^{3/2}}$ (D) $\frac{\mu_0 \pi R^2 r^2}{2(R^2 + x^2)^{3/2}}$.

144. There is a horizontal cylindrical uniform but time varying magnetic field increasing at a constant rate $\frac{dB}{dt}$ as shown. A charged particle having charge q and mass m is kept in equilibrium, at the top of a spring of spring constant K in such a way that it is on the horizontal line passing through the center of the magnetic field as shown in figure. The compression in the spring will be



(A) $\frac{1}{K}\left[mg - \frac{qR^2}{2\ell}\frac{dB}{dt}\right]$ (B) $\frac{1}{K}\left[mg + \frac{qR^2}{\ell}\frac{dB}{dt}\right]$

(C) $\frac{1}{K}\left[mg + \frac{2qR^2}{\ell}\frac{dB}{dt}\right]$ (D) $\frac{1}{K}\left[mg + \frac{qR^2}{2\ell}\frac{dB}{dt}\right]$.

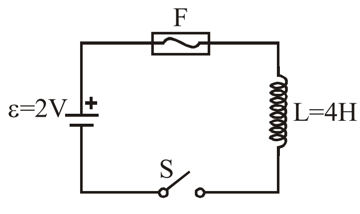
145. Three identical rings move with the same speed on a horizontal surface in a uniform horizontal magnetic field normal to the planes of the rings. The first (A) slips without rolling, the second (B) rolls without slipping, and the third rolls with slipping
(A) the same emf is induced in all three rings
(B) no emf is induced in any of the rings
(C) in each ring all points are at the same potential
(D) B develops the maximum induced emf, and A, the least

146. A long solenoid of N turns has a self–inductance L and area of cross–section A. When a current i flows through the solenoid, the magnetic field inside it has magnitude B. The current i is equal to

(A) $\frac{BAN}{L}$ (B) BANL

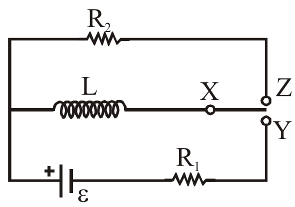
(C) $\frac{BN}{AL}$ (D) $\frac{B}{ANL}$

147. In the circuit shown, the cell is ideal. The coil has an inductance of 4 H and zero resistance. F is a fuse of zero resistance and will blow when the current through it reaches 5 A. The switch is closed at t = 0. The fuse will blow



(A) almost at once (B) after 2 s
(C) 5 s (D) after 10 s

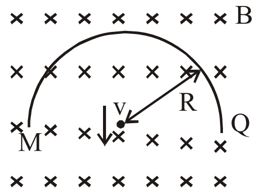
148. In the circuit shown, S is joined to Y for a long time, and then X is joined to Z. The total heat produced in R_2 is



(A) $\frac{L\varepsilon^2}{2R_1^2}$ (B) $\frac{L\varepsilon^2}{2R_2^2}$

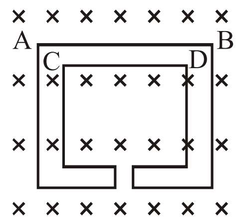
(C) $\frac{L\varepsilon^2}{2R_1^2R_2^2}$ (D) $\frac{L\varepsilon^2 R_2}{2R_1^3}$

149. A thin semicircular conducting ring of radius R is falling with its plane vertical in a horizontal magnetic induction $\vec{B}$. At the position MNQ, the speed of the ring is υ. The potential difference developed across the ring is



(A) zero
(B) $\frac{1}{2}B\upsilon\pi R^2$, and M is at a higher potential
(C) πRBυ, and Q is at a hither potential
(D) 2πRBυ, and Q is at a hither potential

150. A wire if bent to form the double loop shown in the figure. There is a uniform magnetic field directed into the plane of the loop. If the magnitude of this field is decreasing, current will flow from



(A) A to B and C to D
(B) B to A and D to C
(C) A to B and D to C
(D) B to A and C to D

Alternating Current

151. An electric current wave is given by i = (10 + 10 sin100πt) A. Its average value over one time period is given as
(A) 10 A (B) 5 A
(C) $\sqrt{50}$ A (D) Zero.

152. An ideal coil of 20 H is joined in series with a resistance 10Ω and an ideal battery of 10 V. After two seconds the current flowing (in ampere) in the circuit will be
(A) e (B) e^{-1}
(C) $(1 - e^{-1})$ (D) (1 – e).

153. An electric bulb consumes 55 W when operated at 110 volts AC. It is connected to a 220 V, 50 Hz line through an inductor (coil) in series. The inductance of the coil for which the device gets correct voltage is
(A) $0.7\sqrt{3}$ H (B) $7\sqrt{3}$ H
(C) $0.07\sqrt{3}$ H (D) $\sqrt{3}$ H

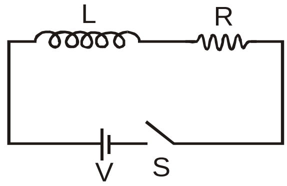
154. Average power delivered by an *AC* source when a resistor of resistance *R*, an inductor of inductance *L* and a capacitor of capacitance *C* are connected in series is (choose the most appropriate option)
(A) minimum when the frequency of the source is $\frac{1}{2\pi}\sqrt{\frac{1}{LC}}$.

(B) maximum when the frequency of the source is $\frac{1}{2\pi}\sqrt{\frac{1}{LC}}$.

(C) zero when there is no resistor in the circuit.

(D) both (B) & (C)

155. An inductor of inductance $L = \frac{\tau R}{2}$ and a resistor of resistance R is connected to a battery of emf V as shown in the figure. The potential difference across the resistance at a time, $t = \tau \ln 2$ after the switch S is closed is (τ is constant)



(A) $\frac{V}{4}$ (B) $\frac{3V}{4}$

(C) $\frac{V}{2}$ (D) $\frac{2V}{3}$

156. In a series LCR circuit the resistance $R = 24\Omega$ while the reactance corresponding to L and C are 2Ω and 28Ω respectively at a certain frequency. The total impedance, if the frequency is doubled, is

(A) 30Ω (B) 28.1Ω

(C) 34Ω (D) 26Ω.

157. A charged capacitor discharged through a resistance R with time constant τ. The two are now placed in series across an AC source of angular frequency $\omega = \frac{1}{\tau}$. The impedance of the circuit will be

(A) $\frac{R}{\sqrt{2}}$ (B) R

(C) $\sqrt{2}R$ (D) 2R

158. An electric lamp designed for operation on 110V AC is connected to a 220 V AC supply, through a choke coil of inductance 2H, for proper operation. The angular frequency of the AC is $100\sqrt{10}$ rad/s. If a capacitor is to be used in place of the choke coil, its capacitance must be

(A) 1 μF (B) 2 μF

(C) 5 μF (D) 10 μF

159. A resistance R draws P power when connected to an AC source. If an inductance is now placed in series with the resistance, such that the impedance of the circuit becomes Z, the power drawn will be

(A) $P\left(\frac{R}{Z}\right)^2$ (B) $P\left(\frac{R}{Z}\right)$

(C) $P\sqrt{\frac{R}{Z}}$ (D) P

160. An inductance L, a capacitance C and a resistance R may be connected to an AC source of angular frequency ω, in three different combinations of RC, RL and LC in series. Assume that $\omega L = \frac{1}{\omega C}$. The power drawn by the three combinations are P_1, P_2, P_3 respectively. then,

(A) $P_1 > P_2 > P_3$ (B) $P_1 = P_2 < P_3$

(C) $P_1 = P_2 > P_3$ (D) $P_1 = P_2 = P_3$

Optics (Geometrical and Wave)

161. A point source of light is placed inside a liquid of refractive index $\frac{2}{\sqrt{3}}$ at distance of 10m below the surface. The fraction of the emitted light that comes out of the liquid surface is

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$

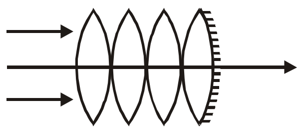
(C) $\frac{1}{8}$ (D) $\frac{1}{100}$.

162. P is a point on the axis of a concave mirror. The image of P, formed by the mirror, coincides with P. A rectangular glass slab of thickness t and refractive index μ is now introduced between P and the mirror. For the image of P to coincide with P again, the mirror must be moved

(A) towards P by $(\mu - 1)t$ (B) away from P by $(\mu - 1)t$

(C) towards P by $t(1 - 1/\mu)$ (D) away from P by $t(1 - 1/\mu)$

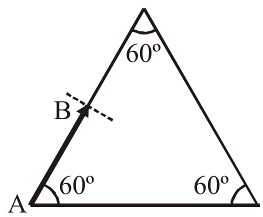
163. Four identical lenses are kept one beside the other on the same optical axis as shown in the figure. The right surface of rightmost lens is silvered. Focal length of lens is 20 cm and radius of silvered surface is 20 cm. The focal length of the combined system is



(A) 2 cm (B) – 2 cm

(C) 5 cm (D) – 5 cm.

164. An equilateral prism is made of a transparent material of refractive index 2. A ray of light AB incident on the prism as shown in the figure. The angle of deviation (angle between incident ray and emergent ray) is



(A) 60° (B) 90°

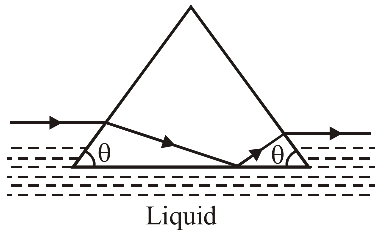
(C) 45° (D) 120°.

165. Ram moves at a velocity 10 m/s in a straight line forming an angle 30° with the plane of a plane mirror. The velocity V_{rel} at which he approaches his image is (assuming that the object and its image are symmetric relative to the plane of the mirror).

(A) 20 m/s (B) 10 m/s

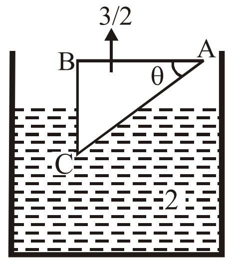
(C) 5 m/s (D) 15 m/s.

166. An iso–scale glass prism stands with its (horizontal) base in water as shown in the figure. An incident ray of light, above and parallel to the liquid surface and perpendicular to the prism's axis, is internally reflected at the glass–liquid interface and subsequently re–emerges into the air. Refractive index of glass is μ_g and liquid is μ_ℓ, then which relation holds good



(A) $\mu_g^2 - \mu_\ell^2 \geq \cos^2\theta(\mu_g^2 + 1 - 2\mu_\ell)$
(B) $\mu_g = \mu_\ell \cos\theta$
(C) $\mu_g^2 = \mu_\ell^2 \cos\theta$
(D) $\mu_g^2 - \mu_\ell^2 < \cos^2\theta(\mu_g^2 + 1 - 2\mu_\ell)$.

167. A glass prism of refractive index $\frac{3}{2}$ is immersed in a liquid of refractive index 2. The light beam incident normally on AB will undergo total internal reflection if



(A) $\sin\theta > \frac{2}{3}$
(B) $\sin\theta \geq \frac{8}{9}$
(C) $\frac{3}{2} < \sin\theta < \frac{8}{9}$
(D) none of these

168. A plane glass slab is placed over letter of varied colours. The letter which appears most elevated is
(A) violet
(B) yellow
(C) red
(D) green

169. An air bubble inside water behaves as a
(A) convergent lens
(B) divergent lens
(C) plane slab
(D) concave mirror

170. In an experiment similar to Young's experiment interference is observed using waves associated with moving electrons. Increase in accelerating voltage will
(A) increase fringe width
(B) decrease fringe width
(C) maintain fringed width
(D) double the width

Modern Physics

171. In a radioactive series, $^{238}_{92}U$ changes to $^{206}_{92}Pb$ through n_1 α–decay processed and n_2 β–decay processes.
(A) $n_1 = 8, n_2 = 8$
(B) $n_1 = 6, n_2 = 6$
(C) $n_1 = 8, n_2 = 6$
(D) $n_1 = 6, n_2 = 8$

172. An electron with kinetic energy = E eV collides with a hydrogen atom in the ground state. The collision will be elastic
(A) for all values of E
(B) for E < 10.2 eV
(C) for E < 13.6 eV
(D) only for E < 3.4 eV

173. When a hydrogen atom emits a photon in going from n = 5 to n = 1, its recoil speed is almost
(A) 10^{-4} m/s
(B) 2×10^{-2} m/s
(C) 4 m/s
(D) 8×10^{2} m/s

174. In a Coolidge tube, the potential difference across the tube is 20 kV and 10 mA current flows through the voltage supply. Only 0.5% of the energy carried by the electrons striking the target is converted into X–rays beam carries a power of
(A) 0.1 W
(B) 1 W
(C) 2 W
(D) 10 W

175. If a potential difference of 20000 volts is applied across an X–ray tube, the cut–off wavelength will be
(A) 6.21×10^{-10} m
(B) 6.21×10^{-11} m
(C) 6.21×10^{-12} m
(D) 3.1×10^{-11} m

176. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 12 eV fall on it is 8 eV. The stopping potential is
(A) 4 eV
(B) 8 eV
(C) 12 eV
(D) 2 eV

177. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$ where n_1 and n_2 are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible value of n_1 and n_2 are
(A) $n_1 = 6, n_2 = 2$
(B) $n_1 = 8, n_2 = 2$
(C) $n_1 = 8, n_2 = 1$
(D) $n_1 = 6, n_2 = 3$

178. The ratio of half life to the mean life of a radioactive sample is
(A) ln 2
(B) 1
(C) $\frac{1}{\ln 2}$
(D) $\frac{1}{2 \ln 2}$

179. When a metal of atomic number Z is used as the target in a Coolidge tube, let v be the frequency of the K_α line. Corresponding values of Z and v are known for a number of metals. Which of the following plots will give a straight line ?
(A) v against Z
(B) $\frac{1}{v}$ against Z
(C) $\sqrt{v}$ against Z
(D) v against $\sqrt{Z}$

180. The Kinetic Energy of the fastest photoelectron emitted using light of wavelength λ is $\in$; while the K.E. of the fastest photoelectron using light of wavelength λ' is $2\in$. The photocathode is the same in both the cases. Then,
(A) $\frac{\lambda}{\lambda'} = \frac{1}{2}$
(B) $1 > \frac{\lambda}{\lambda'} > \frac{1}{2}$
(C) $\frac{\lambda}{\lambda'} < \frac{1}{2}$
(D) $\frac{\lambda}{\lambda'} > 1$.