

## Section 2: Physics

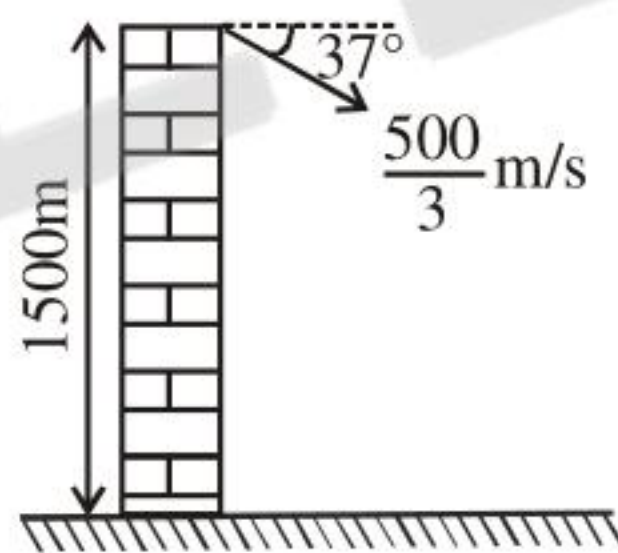
16. The dimensions of  $\frac{a}{b}$  in the equation  $P = \frac{a - t^2}{bx}$  where  $P$  is pressure,  $x$  is distance and  $t$  is time are

- (a)  $[M^2LT^{-3}]$                       (b)  $[MT^{-2}]$                       (c)  $[ML^3T^{-1}]$                       (d)  $[LT^{-3}]$

17. The coordinates of a particle moving at any time  $t$  is given by  $x = 2At^2$  and  $y = 2Bt^2$  where  $A$  and  $B$  are constants. The speed of the particle is

- (a)  $4t(A + B)$  (b)  $4t\sqrt{A^2 + B^2}$   
(c)  $4t(A^2 + B^2)$  (d)  $2t\sqrt{A^2 + B^2}$

18. A particle is projected from a tower as shown in figure, then the distance from the foot of the tower where it will strike the ground will be (take  $g = 10 \text{ m/s}^2$ )



- (a) 4000/3 m                      (b) 5000/3 m
- (c) 2000 m                        (d) 3000 m

19. The force required to just move a body up the inclined plane is twice the force required to just prevent the body from sliding down the plane. If  $\mu$  is the coefficient of friction, the inclination of the plane to the horizontal is

- (a)  $\tan^{-1}\left(\frac{\mu}{2}\right)$

(c)  $\tan^{-1}(2\mu)$

(b)  $\tan^{-1}(\mu)$

(d)  $\tan^{-1}(3\mu)$

- 20.** A wind-powered generator converts wind energy into electric energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into electrical energy. For wind speed  $v$ , the electrical power output will be proportional to

- (a)  $v$ 
(b)  $v^2$ 
(c)  $v^3$ 
(d)  $v^4$



21. A sphere of mass  $m$  moving with a constant velocity  $u$  hits another stationary sphere of the same mass. If  $e$  is the coefficient of restitution, then the ratio of velocities of the two spheres after collision will be

(a)  $\left(\frac{1-e}{1+e}\right)$  (b)  $\left(\frac{1+e}{1-e}\right)$   
(c)  $\left(\frac{e+1}{e-1}\right)$  (d)  $\left(\frac{e-1}{e+1}\right)$

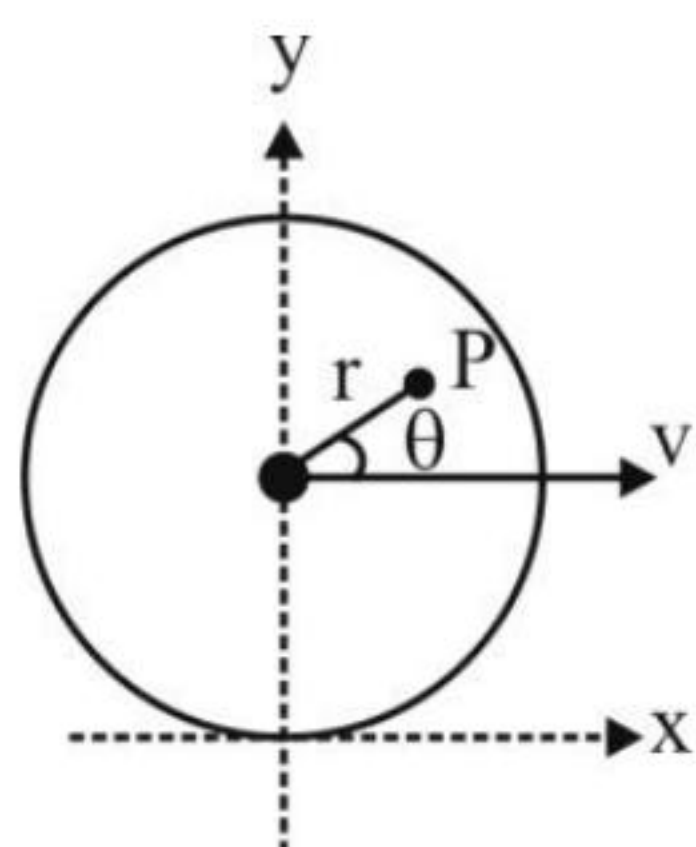
22. A pencil placed vertically on a table falls down. What will be the linear velocity of middle of pencil at the end of the fall if the pencil is 15 cm long?

(a) 1.05 m/s (b) 2.1 m/s  
(c) 3 m/s (d) 0.5 m/s

23. A billiard ball is hit by a cue at a height  $h$  above the centre. It acquires a linear velocity  $v_0$ . Mass of the ball is  $m$  and radius is  $r$ . The angular velocity  $\omega_0$  acquired by the ball is

(a)  $\frac{2v_0h}{5r^2}$  (b)  $\frac{5v_0h}{2r^2}$  (c)  $\frac{2v_0r^2}{5h}$  (d)  $\frac{5v_0r^2}{2h}$

24. A disc of radius  $R$  rolls without slipping at speed  $v$  along positive  $x$ -axis. Velocity of point  $P$  at the instant shown in figure is



(a)  $\vec{V}_P = \left(v + \frac{vr \sin \theta}{R}\right) \hat{i} + \frac{vr \cos \theta}{R} \hat{j}$  (b)  $\vec{V}_P = \left(v + \frac{vr \sin \theta}{R}\right) \hat{i} - \frac{vr \cos \theta}{R} \hat{j}$   
(c)  $\vec{V}_P = \frac{vr \sin \theta}{R} \hat{i} + \frac{vr \cos \theta}{R} \hat{j}$  (d)  $\vec{V}_P = \frac{vr \sin \theta}{R} \hat{i} - \frac{vr \cos \theta}{R} \hat{j}$



25. Two particles of mass  $m$  and  $M$  are initially at rest and infinitely separated from each other. Due to mutual interaction they approach each other. Their relative velocity of approach at a distance of separation  $d$  between them is

(a)  $2 G \left( \frac{d}{M+m} \right)$  (b)  $\sqrt{\left[ \frac{2 G(M+m)}{d} \right]}$   
 (c)  $\sqrt{\left[ \frac{2 G(M-m)}{d} \right]}$  (d)  $\sqrt{\left( \frac{2 G d}{M+m} \right)}$

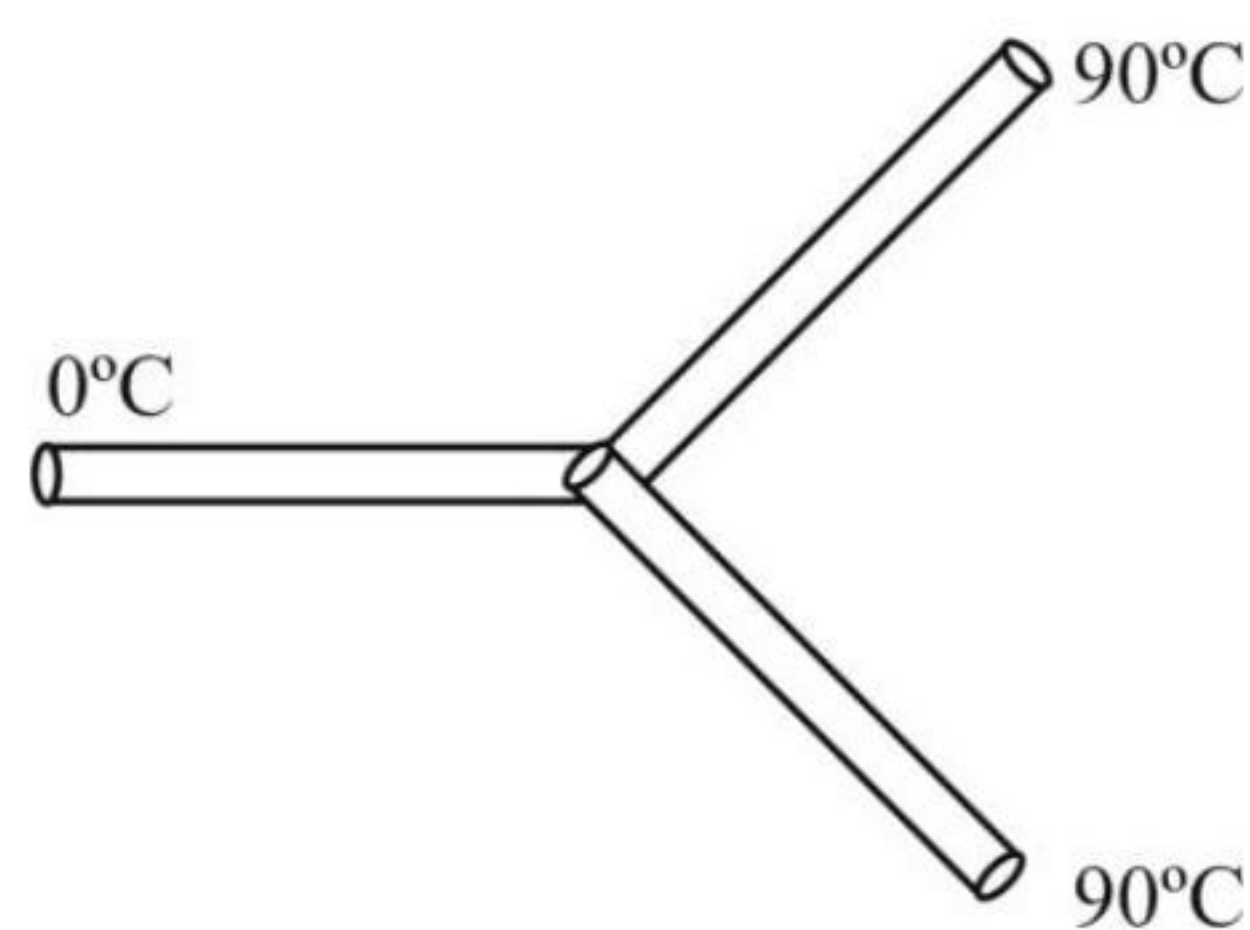
26. A cylinder of mass  $m$  and density  $\rho$  hanging from a string is lowered into a vessel of cross-sectional area  $s$  containing a liquid of density  $\sigma$  ( $\sigma < \rho$ ) until it is fully immersed. The increase in pressure at the bottom of the vessel is

(a)  $\frac{m\rho g}{\sigma s}$  (b)  $\frac{mg}{s}$  (c)  $\frac{m\sigma g}{\rho s}$  (d) zero

27. The frequency of a sonometer wire is  $f$ . When the weights producing the tensions are completely immersed in water the frequency becomes  $f/2$  and on immersing the weights in a certain liquid the frequency becomes  $f/3$ . The specific gravity of the liquid is

(a)  $\frac{4}{3}$  (b)  $\frac{16}{9}$  (c)  $\frac{15}{12}$  (d)  $\frac{32}{27}$

28. Three rods made of the same material and having the same cross-section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at  $0^\circ\text{C}$  and  $90^\circ\text{C}$  respectively. The temperature of junction of the three rods will be



(a)  $45^\circ\text{C}$  (b)  $60^\circ\text{C}$  (c)  $30^\circ\text{C}$  (d)  $20^\circ\text{C}$

29. The mean density of sea water is  $\rho$ , and bulk modulus is  $B$ . The change in density of sea water in going from the surface of water to a depth of  $h$  is

(a)  $\frac{B\rho^2}{gh}$  (b)  $B\rho gh$  (c)  $\frac{\rho^2 gh}{B}$  (d)  $\frac{\rho gh}{B}$



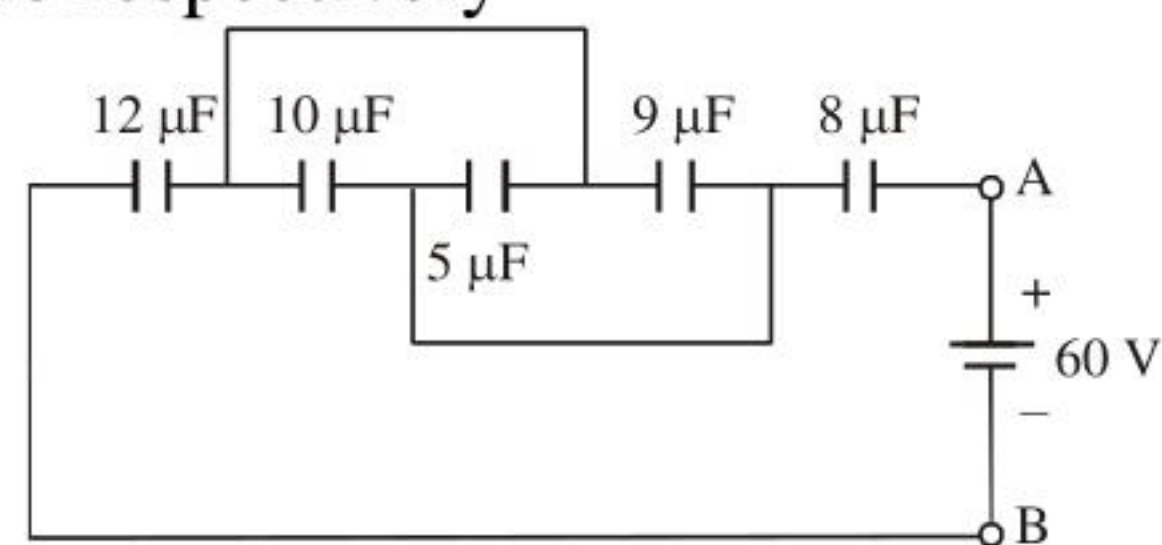
30. A uniform cylinder of length  $L$  and mass  $M$  having cross-sectional area  $A$  is suspended with its vertical length, from a fixed point by a massless spring, such that it is half-submerged in a liquid of density  $d$  at equilibrium position. When the cylinder is given a small downward push and released, it starts oscillating vertically with a small amplitude. If the force constant of the spring is  $K$ , the frequency of oscillation of the cylinder is

(a)  $\frac{1}{2} \left( \frac{K - Adg}{M} \right)^{1/2}$  (b)  $\frac{1}{2\pi} \left( \frac{K + dgL}{M} \right)^{1/2}$   
 (c)  $\frac{1}{2\pi} \left( \frac{K + Adg}{M} \right)^{1/2}$  (d)  $\frac{1}{2\pi} \left( \frac{K - Adg}{Adg} \right)^{1/2}$

31. An open pipe of length  $\ell$  is sounded together with another open organ pipe of length  $\ell + x$  in their fundamental tones. Speed of sound in air is  $v$ . The beat frequency heard will be ( $x \ll \ell$ )

(a)  $\frac{vx}{4\ell^2}$  (b)  $\frac{v\ell^2}{2x}$   
 (c)  $\frac{vx}{2\ell^2}$  (d)  $\frac{vx^2}{2\ell}$

32. Five capacitors are connected as shown. The equivalent capacitance between terminals A and B and charge on  $5\mu\text{F}$  capacitor will be respectively



- (a)  $8\mu\text{F}$ ,  $100\mu\text{C}$  (b)  $4\mu\text{F}$ ,  $50\mu\text{C}$   
 (c)  $12\mu\text{F}$ ,  $150\mu\text{C}$  (d)  $16\mu\text{F}$ ,  $200\mu\text{C}$
33. A charge  $Q$  is distributed over two concentric hollow spheres of radii  $R$  and  $2R$  such that the surface densities are equal. The potential at the common centre is

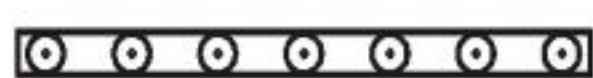
(a)  $\frac{2}{3} \cdot \frac{Q}{4\pi\epsilon_0 R}$  (b)  $\frac{3}{4} \cdot \frac{Q}{4\pi\epsilon_0 R}$   
 (c)  $\frac{2}{5} \cdot \frac{Q}{4\pi\epsilon_0 R}$  (d)  $\frac{3}{5} \cdot \frac{Q}{4\pi\epsilon_0 R}$



34. A particle of charge  $q$  and mass  $m$  starts moving from the origin under the action of an electric field  $\vec{E} = E_0 \hat{i}$  and  $\vec{B} = B_0 \hat{i}$  with a velocity  $\vec{v} = v_0 \hat{j}$ . The speed of the particle will become  $\frac{\sqrt{5}}{2} v_0$  after a time

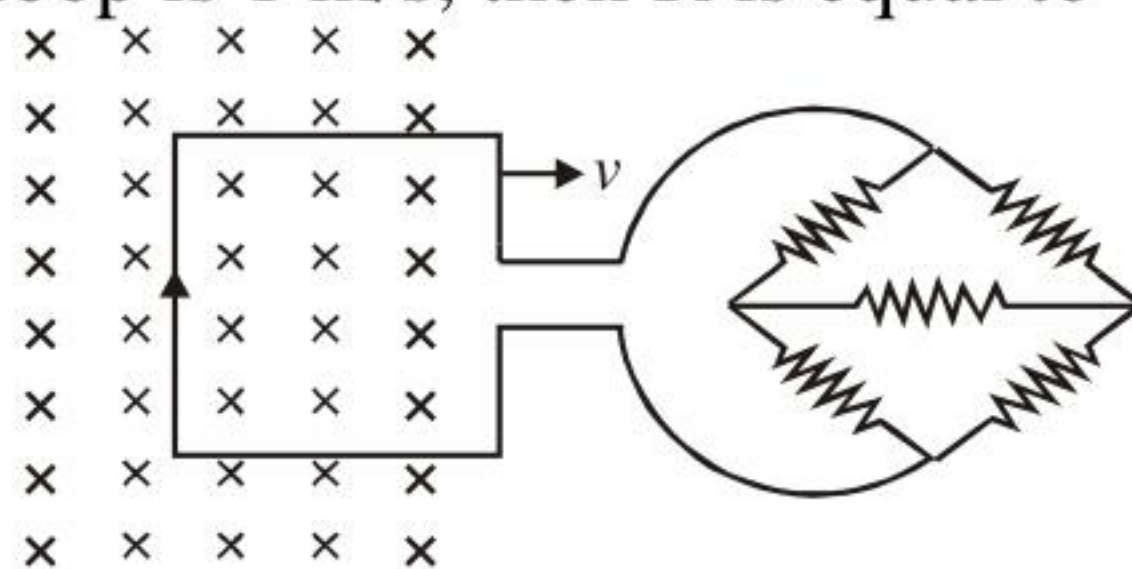
- (a)  $\frac{mv_0}{qE}$  (b)  $\frac{\sqrt{q}mv_0}{2qE}$   
 (c)  $\frac{mv_0}{2qE}$  (d)  $\frac{mv_0}{3qE}$

35. A large metal sheet carries an electric current along its surface. Current per unit length is  $\lambda$ . Magnetic field induction near the metal sheet is

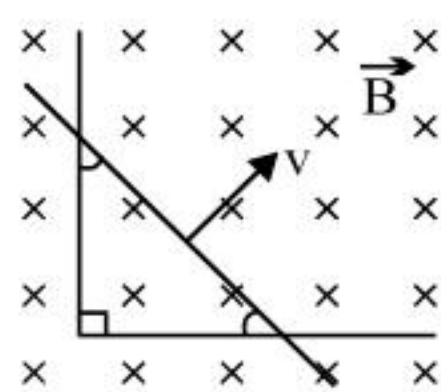


- (a)  $\lambda\mu_0$  (b)  $\frac{\lambda\mu_0}{2}$   
 (c)  $\frac{\lambda\mu_0}{2\pi}$  (d)  $\frac{\lambda}{\mu_0}$

36. A square metal loop of side 20 cm and resistance 2 ohm is moved with a constant velocity partly inside a uniform magnetic field of  $5 \text{ Wb/m}^2$ , directed into the paper, as shown in the figure. The loop is connected to a network of five resistors each of value  $R$ . If a steady current of 0.1 A flows in the loop, and the speed of the loop is 1 m/s, then  $R$  is equal to



- (a)  $2 \Omega$  (b)  $3 \Omega$   
 (c)  $8 \Omega$  (d)  $9 \Omega$
37. A conductor is bent in L-shape and another conductor is sliding with constant velocity  $v$  directed perpendicular to its length as shown in the figure. The sliding conductor always makes equal angle with the two arms of the bent conductor. If resistance per unit length of each conductor is  $r$  then current in the loop formed by conductors is



- (a)  $\frac{\sqrt{2}BV}{(\sqrt{2}+1)r}$  (b)  $\frac{\sqrt{2}BV}{(\sqrt{2}+2)r}$   
 (c)  $\frac{BV}{(\sqrt{2}+2)r}$  (d)  $\frac{BV}{(\sqrt{2}+1)r}$



38. In an ac circuit  $V = 100 \sin(100t)$  volt and  $I = 100 \sin(100t + \pi/3)$  mA. The power dissipated in the circuit is
- (a)  $10^4$  W (b) 10 W  
(c) 2.5 W (d) 5 W
39. A radioactive material has a mean life of 1620 years and 540 years for  $\alpha$  and  $\beta$  emission respectively. The time in which one half of the material remains undecayed emitting both these radiations is
- (a) 202.5 yrs (b) 280.7 yrs  
(c) 405 yrs (d) 1080 yrs
40. A hydrogen atom in its ground state absorbs 10.2 eV of energy. Its orbital angular momentum is increased by (given  $h = 6.6 \times 10^{-34}$  Js)
- (a)  $1.05 \times 10^{-34}$  Js (b)  $3.16 \times 10^{-34}$  Js  
(c)  $2.11 \times 10^{-34}$  Js (d)  $4.22 \times 10^{-34}$  Js