# PART : PHYSICS

## Single Choice Type

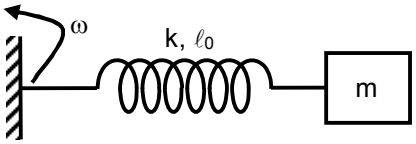
This section contains **20 Single choice questions.** Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

**1.** A block of mass m is connected at one end of spring fixed at other end having natural length $\ell_0$ and spring constant K. The block is rotated with constant angular speed ($\omega$) in gravity free space. The elongation in spring is–

(1) $\frac{\ell_0 m\omega^2}{k - m\omega^2}$ (2) $\frac{\ell_0 m\omega^2}{k + m\omega^2}$ (3) $\frac{\ell_0 m\omega^2}{k - m\omega}$ (4) $\frac{\ell_0 m\omega^2}{k + m\omega}$

**Ans.** **(1)**

**Sol.**

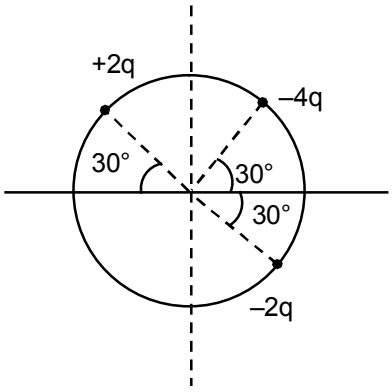



$m\omega^2 (\ell_0 + x) = kx$

$\left(\frac{\ell_0}{x} + 1\right) = \frac{k}{m\omega^2}$

$x = \frac{\ell_0 m\omega^2}{k - m\omega^2}$

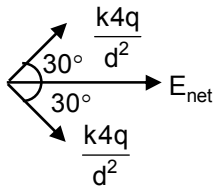
**2.** 3 charges are placed on circumference of a circle of radius 'd' as shown in figure. The electric field along x-axis at centre of circle is:




(1) $\frac{q}{4\pi\varepsilon_0 d^2}$ (2) $\frac{q\sqrt{3}}{4\pi\varepsilon_0 d^2}$ (3) $\frac{q\sqrt{3}}{\pi\varepsilon_0 d^2}$ (4) $\frac{q\sqrt{3}}{2\pi\varepsilon_0 d^2}$

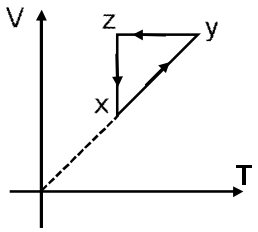
Ans. (3)

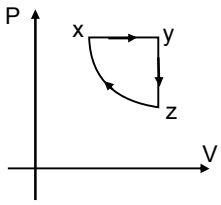
**Sol.**

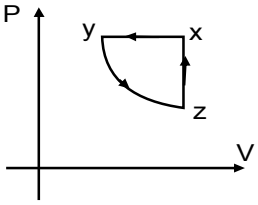


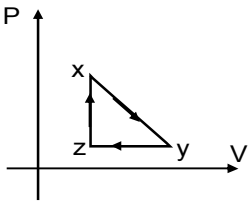

$$E_{net} = \frac{4kq}{d^2} \times 2\cos 30° = \frac{q\sqrt{3}}{\pi\varepsilon_0 d^2}$$

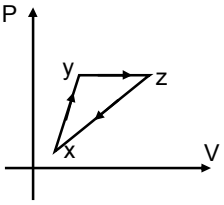
**3.** Choose the correct P-V graph of ideal gas for given V-T graph.




(1) 

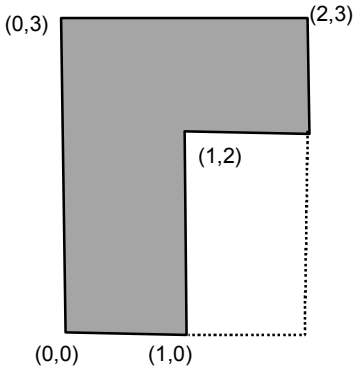

(2) 


(3) 


(4) 


**Ans.** (1)

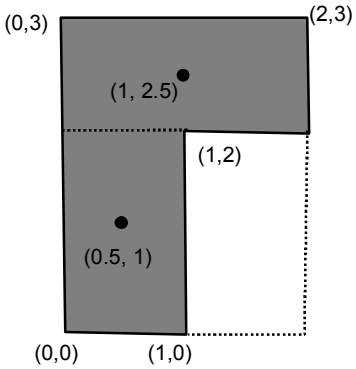
**4.** Find the co-ordinates of centre of mass of the lamina, shown in figure.




(1) 0.75, 1.75 (2) 0.75, 1.5 (3) 0.5, 1.75 (4) 0.5, 1.5

**Ans.** **(1)**

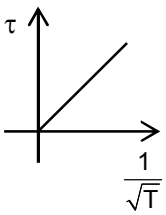
**Sol.**

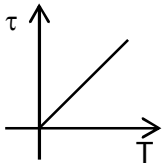


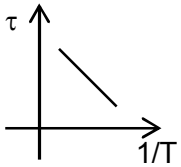

$$\vec{r}_{cm} = \frac{1\times\left(\frac{\hat{i}}{2}+\hat{j}\right)+1\times\left(\hat{i}+\frac{5\hat{j}}{2}\right)}{2}$$

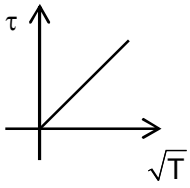
$$\vec{r}_{cm} = \frac{3}{4}\hat{i}+\frac{7}{4}\hat{j}$$

**5.** Which graph correctly represents variation between relaxation time ($\tau$) of gas molecules with absolute temperature (T) of gas.

(1) 


(2) 


(3) 


(4) 


**Ans.** **(1)**

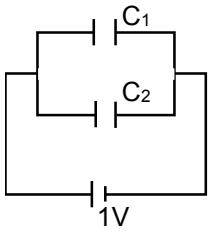
**Sol.** $\tau \propto \frac{1}{\sqrt{T}}$

**6.** If two capacitors $C_1$ & $C_2$ are connected in parallel then equivalent capacitance is 10μF. If both capacitance are connected across 1V battery then energy stored by $C_2$ is 4 times of $C_1$. Then the equivalent capacitance if they are connected in series is–

(1) 1.6μF (2) 16μF (3) 4μF (4) $\frac{1}{4}$ μF

**Ans.** **(1)**

**Sol.**




Given दिया है $C_1 + C_2 = 10\mu F$ …(i)

$$4\left(\frac{1}{2}C_1V^2\right) = \frac{1}{2}C_2V^2$$

$\Rightarrow$ $4C_1 = C_2$ …(ii)

from equation (i) & (ii)

$C_1 = 2\mu F$

$C_2 = 8\mu F$

If they are in series

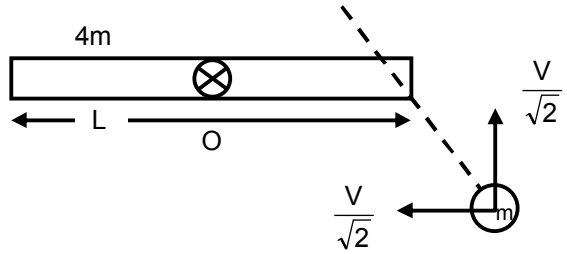
$$C_{eq.} = \frac{C_1C_2}{C_1 + C_2} = 1.6\mu F$$

**7.** A rod of mass 4m and length L is hinged at the mid point. A ball of mass 'm' moving with speed V in the plane of rod, strikes at the end at an angle of 45º and sticks to it. The angular velocity of system after collision is–

(1) $\frac{3\sqrt{2}V}{7L}$ (2) $\frac{\sqrt{2}V}{7L}$ (3) $\frac{\sqrt{2}V}{3L}$ (4) $\frac{3V}{7L}$

**Ans.** **(1)**

**Sol.**




$L_{oi} = L_{of}$

$$\frac{mV}{\sqrt{2}} \times \frac{1}{2} = \left[\frac{4mL^2}{12} + \frac{mL^2}{4}\right] \times \omega$$

$$\omega = \frac{6V}{7\sqrt{2}L} = \frac{3\sqrt{2}V}{7L}$$

**8.** Two photons of energy 4eV and 4.5 eV incident on two metals A and B respectively. Maximum kinetic energy for ejected electron is $T_A$ for A and $T_B = T_A - 1.5$ eV for metal B. Relation between de-Broglie wavelength of ejected electron of A and B are $\lambda_B = 2\lambda_A$. The work function of metal B is–

(1) 3 eV (2) 1.5 eV (3) 4.5 eV (4) 4 eV

**Ans.** **(4)**

**Sol.** Relation between De-Broglie wavelength and K.E. is

$$\lambda = \frac{h}{\sqrt{2(KE)m_e}} \Rightarrow \lambda \propto \frac{1}{\sqrt{KE}}$$

$$\frac{\lambda_A}{\lambda_B} = \frac{\sqrt{KE_B}}{\sqrt{KE_A}}$$

$$\Rightarrow \frac{1}{2} = \sqrt{\frac{T_A - 1.5}{T_A}}$$

$\Rightarrow T_A = 2$ eV

$\therefore KE_B = 2 - 1.5 = 0.5$ eV

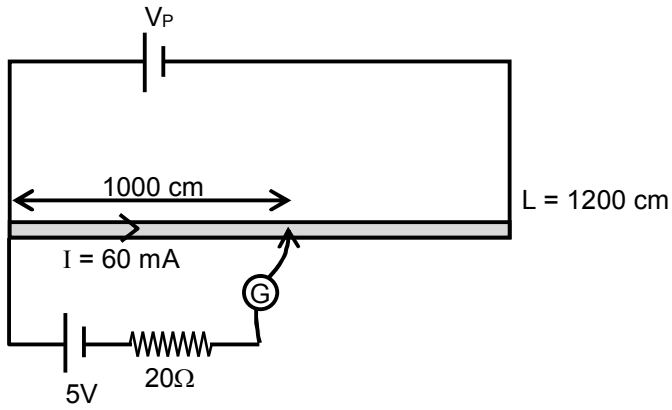
$\phi_B = 4.5 - 0.5 = 4$ eV

**9.** There is a potentiometer wire of length 1200 cm and 60 mA current is flowing in it. A battery of emf 5V and internal resistance of 20Ω is balanced on potentiometer wire with balancing length 1000 cm. The resistance of potentiometer wire is–

(1) 80 Ω (2) 100 Ω (3) 120 Ω (4) 60 Ω

**Ans.** **(2)**

**Sol.**




Potential gradient $= \frac{5}{1000} = \frac{V_P}{1200}$

$V_P = 6V$

and तथा $R_P = \frac{V_P}{I} = \frac{6}{60 \times 10^{-3}} = 100\Omega$

**10.** A telescope has magnification 5 and length of tube 60cm then the focal length of eye piece is–

(1) 10cm (2) 20cm (3) 30cm (4) 40cm

**Ans.** **(1)**

**Sol.** $m = \frac{f_o}{f_e}$

$5 = \frac{f_o}{f_e}$

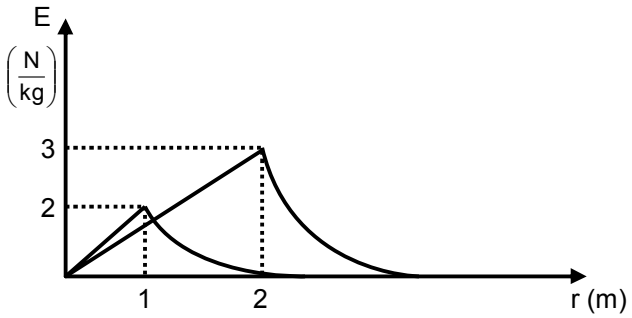
$f_o = 5f_e$

$f_o + f_e = 60$

$6f_e = 60$

$f_e = 10$

**11.** Two spherical bodies of mass $m_1$ & $m_2$ are having radius 1 m & 2 m respectively. The gravitational field of the two bodies with their radial distance is shown below. The value of $\frac{m_1}{m_2}$ is–




(1) $\frac{1}{6}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{1}{4}$

**Ans.** **(1)**

**Sol.** $3 = \frac{Gm_2}{2^2}$

$2 = \frac{Gm_1}{1^2}$

$\therefore \frac{3}{2} = \frac{1}{4}\frac{m_2}{m_1}$

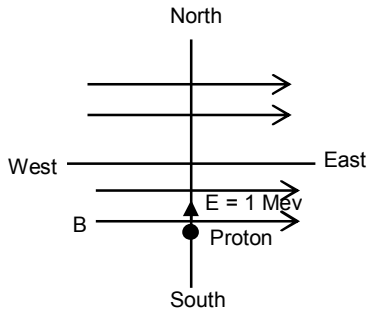
$\frac{m_1}{m_2} = \frac{1}{6}$

**12.** When proton of KE = 1.0 MeV moving in South to North direction enters the magnetic field (from West to East direction), it accelerates with a = $10^{12}$ m/s$^2$. The magnitude of magnetic field is–

(1) 0.71 mT (2) 7.1 mT (3) 71 mT (4) 710 mT

**Ans.** **(1)**

**Sol.**




$\because$ K.E. = $1.6 \times 10^{-13} = \frac{1}{2} \times 1.6 \times 10^{-27} V^2$

$V = \sqrt{2} \times 10^7$

$\therefore$ Bqv = ma

$$B = \frac{1.6 \times 10^{-27} \times 10^{12}}{1.6 \times 10^{-19} \times \sqrt{2} \times 10^7}$$

$= 0.71 \times 10^{-3}$ T

so 0.71 mT

**13.** If electric field around a surface is given by $\left|\vec{E}\right| = \frac{Q_{in}}{\varepsilon_o |A|}$ where 'A' is the normal area of surface and $Q_{in}$ is the charge enclosed by the surface. This relation of gauss's law is valid when

(1) Surface is equipotential
(2) Magnitude of electric field is constant
(3) Magnitude of electric field is constant & the surface is equipotential
(4) For all Gaussian surfaces.

**Ans.** **(3)**

**Sol.** Magnitude of electric field is constant & the surface is equipotential

**14.** Stopping potential depends on planks constant (h), current (I), universal gravitational constant (G) and speed of light (C) choose the correct option for the dimension of stopping potential (V)

(1) $hI^{-1}G^{1}C^{5}$ (2) $h^{-1}I^{1}G^{-1}C^{6}$ (3) $h^{0}I^{1}G^{1}C^{6}$ (4) $h^{0}I^{-1}G^{-1}C^{5}$

**Ans.** (4)

**Sol.** $V = K (h)^a (I)^b (G)^c (C)^d$ (V is voltage)

we know $[h] = ML^2T^{-1}$

$[I] = A$

$[G] = M^{-1} L^3 T^{-2}$

$[C] = L T^{-1}$

$[V] = M L^2 T^{-3} A^{-1}$

$M L^2 T^{-3} A^{-1} = (M L^2 T^{-1})^a (A)^b (M^{-1}L^3T^{-2})^c (LT^{-1})^d$

$ML^2T^{-3}A^{-1} = M^{a-c} L^{2a+3c+d} T^{-a-2c-d} A^b$

$a - c = 1$……(1)

$2a + 3c + d = 2$……(2)

$-a -2c -d = -3$ ……(3)

$b = -1$……(4)

on solving

$c = -1$

$a = 0$

$d = 5, b = -1$

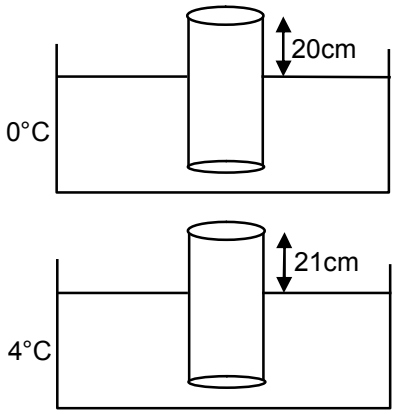
$V = K (h)^\circ (I)^{-1}(G)^{-1}(C)^5$

**15.** A cylinder of height 1m is floating in water at 0°C with 20 cm height in air. Now temperature of water is raised to 4°C, height of cylinder in air becomes 21cm. The ratio of density of water at 4°C to density of water at 0°C is– (Consider expansion of cylinder is negligible)

(1) 1.01 (2) 1.03 (3) 2.01 (4) 1.04

**Ans.** **(1)**

Sol.



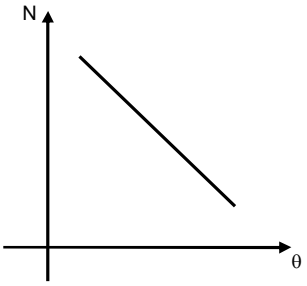

$mg = A(80)\ \rho_{0°C}\ g$

$mg = A(79)\ \rho_{4°C}\ g$

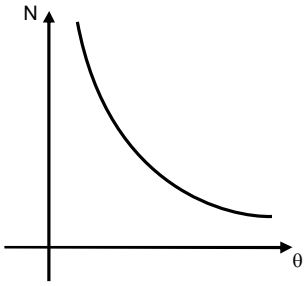
$\frac{\rho_{4°C}}{\rho_{0°C}} = \frac{80}{79} = 1.01$

**16.** Number of the $\alpha$-particle deflected in Rutherford's $\alpha$-scattering experiment varies with the angle of deflection. Then the graph between the two is best represented by.

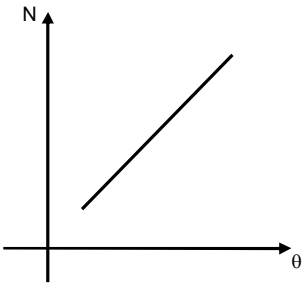
(1)



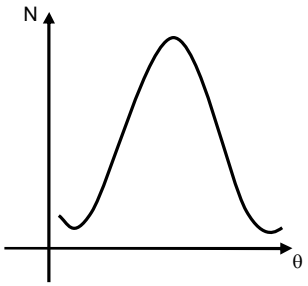

(2)




(3)




(4)




**Ans.** **(2)**

**Sol.** $N \propto \frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$

**17.** If relative permittivity and relative permeability of a medium are 3 and $\frac{4}{3}$ respectively. The critical angle for this medium is.

4

(1) 45º (2) 60º (3) 30º (4) 15º

**Ans.** **(3)**

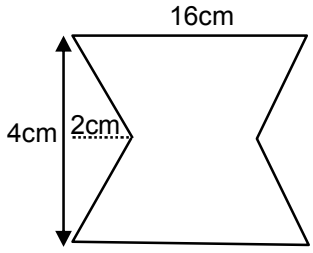
**Sol.** $V = \frac{1}{\sqrt{\mu\varepsilon}}$

$n = \sqrt{\mu_r \varepsilon_r}$ = 2

$\sin c = \frac{1}{2}$

c = 30º

**18.** The given loop is kept in a uniform magnetic field perpendicular to plane of loop. The field changes from 1000G to 500G in 5seconds. The average induced emf in loop is–




(1) 56 $\mu$V (2) 28 $\mu$V (3) 30 $\mu$V (4) 48 $\mu$V

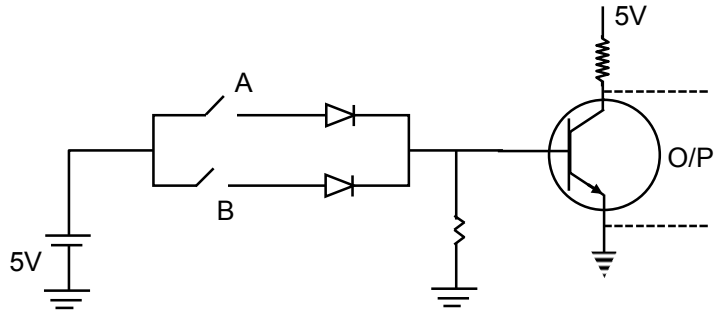
**Ans.** **(1)**

**Sol.** $\varepsilon = \left|-\frac{d\varphi}{dt}\right| = \left|-\frac{AdB}{dt}\right|$

$= .(16 \times 4 - 4 \times 2)\frac{(1000-500)}{5} \times 10^{-4} \times 10^{-4}$

$= 56 \times \frac{500}{5} \times 10^{-8} = 56 \times 10^{-6}$ V

**19.** Choose the correct Boolean expression for the given circuit diagram:




(1) A . B (2) $\bar{A}+\bar{B}$ (3) A + B (4) $\bar{A}\,.\,\bar{B}$

**Ans.** **(4)**

**Sol.** First part of figure shown OR gate and

Second part of figure shown NOT gate

so $Y_p$ = OR + NOT = NOR gate

$Y = \overline{A+B} = \bar{A}\,.\,\bar{B}$

**20.** A Solid sphere of density $\rho = \rho_0\left(1-\frac{r^2}{R^2}\right)$, $0 < r \le R$ just floats in a liquid then density of liquid is– (r is distance from centre of sphere)

(1) $\frac{2}{5}\rho_0$ (2) $\frac{5}{2}\rho_0$ (3) $\frac{3}{5}\rho_0$ (4) $\rho_0$ s

**Sol.** $\rho = \rho_0\left(1-\frac{r^2}{R^2}\right)$ $0 < r \le R$

mg = B

$$\int \rho\left(4\pi r^2 dr\right) = \rho_L \frac{4}{3}\pi R^3$$

$$\int \rho_0\left(1-\frac{r^2}{R^2}\right)4\pi r^2 dr = \rho_L \frac{4}{3}\pi R^3$$

$$\int_0^R \rho_0 4\pi\left(r^2-\frac{r^4}{R^2}\right)dr = \rho_0 4\pi\left(\frac{r^3}{3}-\frac{r^5}{5R^2}\right)_0^R = \rho_L \frac{4}{3}\pi R^3$$

$$\frac{2}{5}\rho_0 = \rho_L$$

**Numerical Value Type**

This section contains **5 Numerical value type questions.**

**21.** Two masses each with mass 0.10kg are moving with velocities 3m/s along x axis and 5m/s along y-axis respectively. After an elastic collision one of the mass moves with a velocity $4\hat{i}+4\hat{j}$. The energy of other mass after collision is $\frac{x}{10}$ then x is.

**Ans.** **1**

Sol. For elastic collision $KE_i = KE_f$

$$\frac{1}{2}m\times 25+\frac{1}{2}\times m\times 9=\frac{1}{2}m\times 32+\frac{1}{2}mv^2$$

$34 = 32 + v^2$

$$KE = \frac{1}{2}\times 0.1\times 2 = 0.1J = \frac{1}{10}$$

$x = 1$

**22.** A plano convex lens of radius of curvature 30 cm and refractive index 1.5 is kept in air. Find its focal length (in cm).

**Ans.** 60 cm

**Sol.** $$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$R_1 = \infty$

$R_2 = -30$ cm

$$\frac{1}{f}=(1.5-1)\left(\frac{1}{\infty}-\frac{1}{-30}\right)$$

$$\frac{1}{f}=\frac{0.5}{30}$$

$f = 60$ cm

**23.** Position of two particles A and B as a function of time are given by $X_A = -3t^2 + 8t + c$ and $Y_B = 10 - 8t^3$. The velocity of B with respect to A at t = 1 is $\sqrt{v}$ . Find v.

**Ans.** 580

**Sol.** $X_A = -3t^2 + 8t + c$

$\vec{v}_A = (-6t + 8)\hat{i}$

$= 2\hat{i}$

$Y_B = 10 - 8t^3$

$\vec{v}_B = -24t^2\hat{j}$

$\sqrt{v} = |\vec{v}_B - \vec{v}_A| = |-24\hat{j} - 2\hat{i}|$

$\sqrt{v} = \sqrt{24^2 + 2^2}$

v = 580

**24.** An open organ pipe of length 1m contains a gas whose density is twice the density of atmosphere at STP. Find the difference between fundamental and second harmonic frequencies if speed of sound in atmosphere is 300 m/s.

**Ans.** **105.75 Hz**

**Sol.** $V = \sqrt{\frac{B}{\rho}}$

$$\frac{V_{pipe}}{V_{air}} = \frac{\sqrt{\frac{B}{2\rho}}}{\sqrt{\frac{B}{\rho}}} = \frac{1}{\sqrt{2}}$$

$$V_{pipe} = \frac{V_{air}}{\sqrt{2}}$$

$$f_n = \frac{(n+1)V_{pipe}}{2\ell}$$

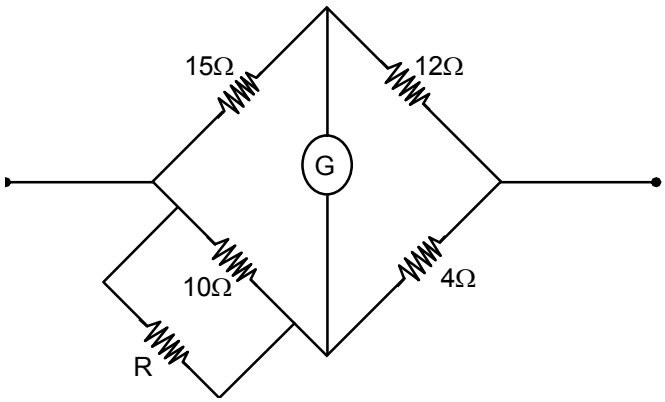
$$f_1 - f_0 = \frac{V_{pipe}}{2\ell} = \frac{300}{2\sqrt{2}} = 105.75 \text{ Hz (If } \sqrt{2} = 1.41)$$

$$= 106.05 \text{ Hz (If } \sqrt{2} = 1.414)$$

**25.** Four resistors of 15Ω, 12Ω, 4Ω and 10Ω given in cyclic order to form a wheat stone bridge. What resistance (in Ω) should be connected in parallel across the 10Ω resistor to balance the wheat stone bridge.

**Ans.** **10**

**Sol.**




$$\frac{10R}{10+R} \times 12 = 15 \times 4$$

on solving

$R = 10\Omega$