Solved Paper

2022

ONLINE

25th July 2nd Shift

PHYSICS

SECTION-A (MULTIPLE CHOICE QUESTIONS)

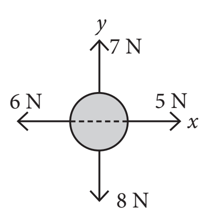
1. In AM modulation, a signal is modulated on a carrier wave such that maximum and minimum amplitudes are found to be 6 V and 2 V respectively. The modulation index is
(a) 100% (b) 80% (c) 60% (d) 50%

2. The electric current in a circular coil of 2 turns produces a magnetic induction B_1 at its centre. The coil is unwound and is rewound into a circular coil of 5 turns and the same current produces a magnetic induction B_2 at its centre. The ratio of $\frac{B_2}{B_1}$ is
(a) $\frac{5}{2}$ (b) $\frac{25}{4}$ (c) $\frac{5}{4}$ (d) $\frac{25}{2}$

3. A drop of liquid of density ρ is floating half immersed in a liquid of density σ and surface tension 7.5×10^{-4} N cm^{-1}. The radius of drop in cm will be
($g = 10$ m s^{-2})
(a) $\frac{15}{\sqrt{(2\rho - \sigma)}}$ (b) $\frac{15}{\sqrt{(\rho - \sigma)}}$
(c) $\frac{3}{2\sqrt{(\rho - \sigma)}}$ (d) $\frac{3}{20\sqrt{(2\rho - \sigma)}}$

4. Two billiard balls of mass 0.05 kg each moving in opposite directions with 10 m s^{-1} collide and rebound with the same speed. If the duration of contact is $t = 0.005$ s, then what is the force exerted on the ball due to each other?
(a) 100 N (b) 200 N (c) 300 N (d) 400 N

5. For a free body diagram shown in the figure, the four forces are applied in the 'x' and 'y' direction. What additional force must be applied and at what angle with positive x-axis so that the net acceleration of body is zero?



(a) $\sqrt{2}$ N, 45° (b) $\sqrt{2}$ N, 135°
(c) $\frac{2}{\sqrt{3}}$ N, 30° (d) 2 N, 45°

6. Capacitance of an isolated conducting sphere of radius R_1 becomes n times when it is enclosed by a concentric conducting sphere of radius R_2 connected to earth. The ratio of their radii $\left(\frac{R_2}{R_1}\right)$ is
(a) $\frac{n}{n-1}$ (b) $\frac{2n}{2n+1}$ (c) $\frac{n+1}{n}$ (d) $\frac{2n+1}{n}$

7. The ratio of wavelengths of proton and deuteron accelerated by potential V_p and V_d is $1:\sqrt{2}$. Then, the ratio of V_p to V_d will be
(a) 1 : 1 (b) $\sqrt{2}:1$ (c) 2 : 1 (d) 4 : 1

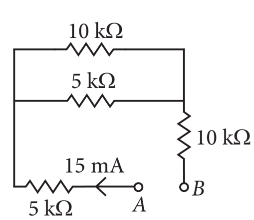
8. For an object placed at a distance 2.4 m from a lens, a sharp focused image is observed on a screen placed at a distance 12 cm form the lens. A glass plate of refractive index 1.5 and thickness 1 cm is introduced between lens and screen such that the glass plate faces parallel to the screen. By what distance should the object be shifted so that a sharp focused image is observed again on the screen?
(a) 0.8 m (b) 3.2 m (c) 1.2 m (d) 5.6 m

9. Light wave traveling in air along x-direction is given by $E_y = 540\sin\pi \times 10^4(x - ct)$ V m^{-1}. Then, the peak value of magnetic field of wave will be (Given $c = 3 \times 10^8$ m s^{-1})
(a) 18×10^{-7} T (b) 54×10^{-7} T
(c) 54×10^{-8} T (d) 18×10^{-8} T

10. When you walk through a metal detector carrying a metal object in your pocket, it raises an alarm. This phenomenon works on
(a) Electromagnetic induction.
(b) Resonance in ac circuits.
(c) Mutual induction in ac circuits.
(d) Interference of electromagnetic waves.

11. An electron with energy 0.1 keV moves at right angle to the earth's magnetic field of 1×10^{-4} Wb m^{-2}. The frequency of revolution of the electron will be
(Take mass of electron = 9.0×10^{-31} kg)
(a) 1.6×10^5 Hz (b) 5.6×10^5 Hz
(c) 2.8×10^6 Hz (d) 1.8×10^6 Hz

12. A current of 15 mA flows in the circuit as shown in figure. The value of potential difference between the points A and B will be



(a) 50 V (b) 75 V
(c) 150 V (d) 275 V

13. The length of a seconds pendulum at a height $h = 2R$ from earth surface will be
(Given R = Radius of earth and acceleration due to gravity at the surface of earth, $g = \pi^2$ m s^{-2})
(a) $\frac{2}{9}$ m (b) $\frac{4}{9}$ m (c) $\frac{8}{9}$ m (d) $\frac{1}{9}$ m

14. Sound travels in a mixture of two moles of helium and n moles of hydrogen. If rms speed of gas molecules in the mixture is $\sqrt{2}$ times the speed of sound, then the value of n will be
(a) 1 (b) 2 (c) 3 (d) 4

15. Let η_1 is the efficiency of an engine at T_1 = 447°C and T_2 = 147°C while η_2 is the efficiency at T_1 = 947°C and T_2 = 47°C. The ratio $\frac{\eta_1}{\eta_2}$ will be
(a) 0.41 (b) 0.56 (c) 0.73 (d) 0.70

16. An object is taken to a height above the surface of earth at a distance $\frac{5}{4}R$ from the centre of the earth. Where radius of earth, R = 6400 km. The percentage decrease in the weight of the object will be
(a) 36% (b) 50% (c) 64% (d) 25%

17. A bag of sand of mass 9.8 kg is suspended by a rope. A bullet of 200 g travelling with speed 10 m s^{-1} gets embedded in it, then loss of kinetic energy will be
(a) 4.9 J (b) 9.8 J (c) 14.7 J (d) 19.6 J

18. A ball is projected from the ground with a speed 15 m s^{-1} at an angle θ with horizontal so that its range and maximum height are equal, then 'tanθ' will be equal to
(a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) 2 (d) 4

19. The maximum error in the measurement of resistance, current and time for which current flows in an electrical circuit are 1%, 2% and 3% respectively. The maximum percentage error in the detection of the dissipated heat will be
(a) 2 (b) 4 (c) 6 (d) 8

20. Hydrogen atom from excited state comes to the ground state by emitting a photon of wavelength λ. The value of principal quantum number 'n' of the excited state will be (R : Rydberg constant)
(a) $\sqrt{\frac{\lambda R}{\lambda - 1}}$ (b) $\sqrt{\frac{\lambda R}{\lambda R - 1}}$
(c) $\sqrt{\frac{\lambda}{\lambda R - 1}}$ (d) $\sqrt{\frac{\lambda R^2}{\lambda R - 1}}$

SECTION-B (NUMERICAL VALUE TYPE)

Attempt any 5 questions out of 10.

21. A particle is moving in a straight line such that its velocity is increasing at 5 m s^{-1} per meter. The acceleration of the particle is ________ m s^{-2} at a point where its velocity is 20 m s^{-1}.

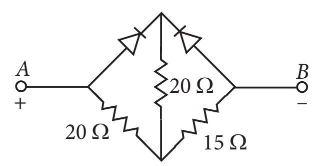
22. Three identical spheres each of mass M are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 3 m each. Taking point of intersection of mutually perpendicular sides as origin, the magnitude of position vector of centre of mass of the system will be $\sqrt{x}$ m. Then value of x is ________.

23. A block of ice of mass 120 g at temperature 0°C is put in 300 g of water at 25°C. The x g of ice melts as the temperature of the water reaches 0°C. The value of x is ________.
[Use specific heat capacity of water= 4200 J kg^{-1} K^{-1}, Latent heat of ice = 3.5×10^5 J kg^{-1}]

24. $\frac{x}{x+4}$ is the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its
(i) third permitted energy level to the second level and
(ii) the highest permitted energy level to the second permitted level.
The value of x will be ________.

25. In a potentiometer arrangement, a cell of emf 1.20 V gives a balance point at 36 cm length of wire. This cell is now replaced by another cell of emf 1.80 V. The difference in balancing length of potentiometer wire in above conditions will be ________ cm.

26. Two ideal diodes are connected in the network as shown in figure. The equivalent resistance between A and B is ________ Ω.



27. Two waves executing simple harmonic motions travelling in the same direction with same amplitude and frequency are superimposed. The resultant amplitude is equal to the $\sqrt{3}$ times of amplitude of individual motions. The phase difference between the two motions is ________ (degree).

28. Two parallel plate capacitors of capacity C and $3C$ are connected in parallel combination and charged to a potential difference 18 V. The battery is then disconnected and the space between the plates of the capacitor of capacity C is completely filled with a material of dielectric constant 9. The final potential difference across the combination of capacitors will be ________ V.

29. A convex lens of focal length 20 cm is placed in front of a convex mirror with principal axis coinciding each other. The distance between the lens and mirror is 10 cm. A point object is placed on principal axis at a distance of 60 cm from the convex lens. The image formed by combination coincides the object itself. The focal length of the convex mirror is ________ cm.

30. Magnetic flux (in weber) in a closed circuit of resistance 20 Ω varies with time t(s) as $\phi = 8t^2 - 9t + 5$. The magnitude of the induced current at t = 0.25 s will be ________ mA.

HINTS & EXPLANATIONS

1. (d) : $A_{max} = 6$ V, $A_{min} = 2$ V

Modulation index, $\mu = \dfrac{A_{max} - A_{min}}{A_{max} + A_{min}}$

$\mu = \dfrac{6-2}{6+2} = \dfrac{4}{8} = \dfrac{1}{2} = 50\%$

2. (b) : Let the radius of coils is R_1 and R_2

$2 \times 2\pi R_1 = 5 \times 2\pi R_2$

$2R_1 = 5R_2$ ...(i)

$B_1 = 2 \times \dfrac{\mu_0 I}{2R_1}, \quad B_2 = \dfrac{5\mu_0 I}{2R_2}$; $\dfrac{B_2}{B_1} = \dfrac{5}{2}\dfrac{R_1}{R_2} = \dfrac{5}{2} \times \dfrac{5}{2}$ (from (i))

$\dfrac{B_2}{B_1} = \dfrac{25}{4}$

3. (a) : Density of liquid drop = ρ

Density of liquid = σ

Surface tension, $T = 7.5 \times 10^{-4}$ N/cm $= 7.5 \times 10^{-2}$ N/m

In equilibrium condition, (Let the radius is r)

Weight of drop = Buoyant force + force due to surface tension

$\rho \cdot \dfrac{4}{3}\pi r^3 g = \dfrac{4}{3}\dfrac{\pi r^3 \times \sigma}{2} g + T \times 2\pi r$

$\rho \times 4\pi r^3 g - 2\pi r^3 \sigma g = 6T\pi r$

$2\pi r^3 g(2\rho - \sigma) = 6\pi \times 7.5 \times 10^{-2} \times r$

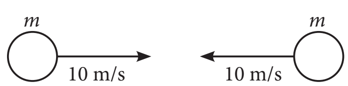
$r^2 g\,(2\rho - \sigma) = 22.5 \times 10^{-2}$

$r^2 = \dfrac{22.5 \times 10^{-3}}{2\rho - \sigma} = \dfrac{225 \times 10^{-4}}{2\rho - \sigma}$

$r = \dfrac{15}{\sqrt{2\rho - \sigma}} \times 10^{-2}$ m ; $r = \dfrac{15}{\sqrt{2\rho - \sigma}}$ cm

4. (b) : Mass of ball, $m = 0.05$ kg

$t = 0.005$ s



Initial momentum of each ball, $p_i = 0.05 \times 10 = 0.5$ kg m/s

Final momentum of each ball, $p_f = -0.05 \times 10 = -0.5$ kg m/s

Change in momentum of each ball $= |p_f - p_i| = |-0.5 - 0.5|$
$= 1$ kg m/s

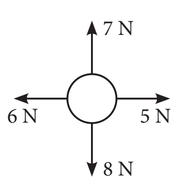
$\text{Force} = \dfrac{\text{Change in momentum of each ball}}{\text{Time}}$

$F = \dfrac{1}{0.005} = 200$ N

5. (a) : $F_x = -6 + 5 = -1$ N

$F_y = -8 + 7 = -1$ N

$F_{net} = \sqrt{F_x^2 + F_y^2} = \sqrt{1+1} = \sqrt{2}$ N



$\tan\theta = \dfrac{F_y}{F_x} = \dfrac{-1}{-1}$; $\theta = 180° + 45° = 225°$

So, the force must be applied in opposite direction of F_{net} and as of same magnitude of F_{net}.

$F' = \sqrt{2}$ N, at 45°

6. (a) : Capacitance of isolated sphere of radius R_1 is $C_1 = 4\pi\varepsilon_0 R_1$

Capacitance of spherical shell of radius R_1 and R_2 is, $C_2 = \dfrac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}$

According to question, $nC_1 = C_2$

$n \times 4\pi\varepsilon_0 R_1 = 4\pi\varepsilon_0 \left(\dfrac{R_1 R_2}{R_2 - R_1}\right)$; $nR_2 - nR_1 = R_2$

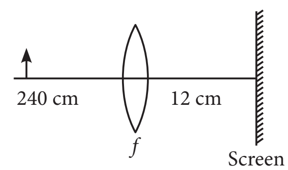
$\dfrac{R_2}{R_1} = \dfrac{n}{n-1}$

7. (d) : The wavelength is given by, $\lambda = \dfrac{h}{\sqrt{2mqV}}$

$\Rightarrow \dfrac{\lambda_p}{\lambda_d} = \sqrt{\dfrac{2m_d q_d V_d}{2m_p q_p \cdot V_p}} \Rightarrow \dfrac{1}{\sqrt{2}} = \sqrt{\dfrac{2m_p \times q \cdot V_d}{m_p \times q \times V_p}}$

$\Rightarrow \dfrac{1}{2} = 2 \cdot \dfrac{V_d}{V_p} \Rightarrow \dfrac{V_p}{V_d} = \dfrac{4}{1}$

8. (b) : Let the focal length is f.



$\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$

$\dfrac{1}{f} = \dfrac{1}{12} + \dfrac{1}{240} = \dfrac{20+1}{240} = \dfrac{21}{240} = \dfrac{7}{80}$

$\Rightarrow f = \dfrac{80}{7}$ cm

Now sheet is introduced.

Normal shift, $t' = t\left(1 - \dfrac{1}{\mu}\right)$; $t' = 1\left(1 - \dfrac{1 \times 2}{3}\right) = \dfrac{1}{3}$ cm

So, $v' = 12 - \dfrac{1}{3} = \dfrac{35}{3}$ cm As, $\dfrac{1}{f} = \dfrac{1}{v'} - \dfrac{1}{u'}$

or $\dfrac{7}{80} = \dfrac{3}{35} - \dfrac{1}{u'} \Rightarrow \dfrac{1}{u'} = \dfrac{-1}{560}$; $u' = -5.6$ m

Shift $= |u'| - |u| = 5.6$ m $- 2.4$ m $= 3.2$ m

9. (a) : $E_y = 540 \sin\pi \times 10^4 (x - ct)$ V/m; $E_0 = 540$ V/m

So, $B_0 = \dfrac{E_0}{c} = \dfrac{540}{3 \times 10^8} = 180 \times 10^{-8}$

$B_0 = 1.8 \times 10^{-6} = 18 \times 10^{-7}$ T

10. (b) : The metal detector works on the phenomenon of resonance in ac circuit. When we walk through a metal detector, we are in fact walking through a coil of many turns. The coil is connected to a capacitor tuned so that the circuit is in resonance. When we walk with metal in pocket through metal detector, the impedance of the circuit changes that changes the current in the circuit. This change in current is detected and causes a sound to be emitted as an alarm.

11. (c) : Magnetic field, $B = 10^{-4}$ Wb/m^2

$q = 1.6 \times 10^{-19}$ C, $m = 9 \times 10^{-31}$ kg

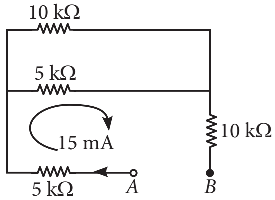
Frequency, $f = \dfrac{Bq}{2\pi m} = \dfrac{10^{-4} \times 1.6 \times 10^{-19} \times 7}{2 \times 22 \times 9 \times 10^{-31}}$

$f = 2.8 \times 10^6$ Hz

12. (d) : Let the current in 5 kΩ is i and in 10 kΩ is $(15 - i)$.

So, $i \times 5 = (15 - i) \times 10$

$i = 10$ mA



Using KVL in lower loop,

$V_A = 15 \times 5 - 10 \times 5 - 10 \times 15 - V_B = 0$

$V_A - V_B = 275$ V

13. (d) : Here, $h = 2R$

The time period of second's pendulum is 2 s on earth.

$$T = 2\pi\sqrt{\frac{l}{g}} \quad \ldots(i)$$

At $h = 2R$, $g' = g\left(\frac{R}{R+h}\right)^2 = g\left(\frac{R}{R+2R}\right)^2 = \frac{g}{9}$.

So, $$T = 2\pi\sqrt{\frac{l'}{g'}} \quad \ldots(ii)$$

From equation (i) and (ii), we get

$2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{l'}{g'}}$; $\frac{l}{g} = \frac{l'}{g'} \times 9$. As $l = 1$ m ; $l' = \frac{l}{9} = \frac{1}{9}$ m

14. (b) : Given: 2 moles Helium, n moles Hydrogen

$$v_{\text{rms}} = \sqrt{2}\, v \Rightarrow \sqrt{\frac{3RT}{M_{\text{mix}}}} = \sqrt{2}\sqrt{\frac{\gamma_{\text{mix}} RT}{M_{\text{mix}}}}$$

$$\Rightarrow \sqrt{3} = \sqrt{2}\sqrt{\gamma_{\text{mix}}} \Rightarrow 3 = 2\gamma_{\text{mix}} \quad \ldots(i)$$

As, $$\gamma_{\text{mix}} = \frac{n_1 C_{p1} + n_2 C_{p2}}{n_1 C_{v1} + n_2 C_{v2}}$$

$$\Rightarrow \frac{3}{2} = \frac{\frac{5}{2}\cdot R \times 2 + n \times \frac{7R}{2}}{2 \times \frac{3R}{2} + n \times \frac{5R}{2}} \quad \text{(Using (i))}$$

$$\Rightarrow \frac{3}{2} = \frac{10R + 7nR}{6R + 5nR} \Rightarrow 18R + 15nR = 20R + 14nR$$

$\Rightarrow nR = 2R$; $n = 2$

15. (b) : $\eta_1 : T_1 = 447°C = 720$ K

$T_2 = 147°C = 420$ K

$\eta_2 : T_1 = 947°C = 1220$ K

$T_2 = 47°C = 320$ K

$$\eta_1 = 1 - \frac{T_2}{T_1} = 1 - \frac{420}{720} = \frac{300}{720}$$

$$\eta_2 = 1 - \frac{T_2}{T_1} = 1 - \frac{320}{1220} = \frac{900}{1220} ; \frac{\eta_1}{\eta_2} = \frac{300}{720} \times \frac{1220}{900} = 0.56$$

16. (a) : $g_{\text{eff}} = \dfrac{g}{\left(1 + \frac{h}{R}\right)^2} = \dfrac{g}{\left(1 + \frac{1}{4}\right)^2}$; $g_{\text{eff}} = \dfrac{16g}{25}$

% change in weight $= \dfrac{g_{\text{eff}} - g}{g} \times 100 = \left(\dfrac{g_{\text{eff}}}{g} - 1\right)100$

$$= \left(\frac{16g}{25g} - 1\right)100 = 36\%$$

17. (b) : Mass of sand bag, $M = 9.8$ kg

Mass of bullet, $m = 200$ g $= 0.2$ kg

Speed of bullet, $u = 10$ m/s

Let the speed of (bag + bullet) is v after embedding.

By using conservation of momentum,

$M \times 0 + mu = (M + m)v$

$0 + 0.2 \times 10 = (9.8 + 0.2) \times v$; $2 = 10v$

$KE_i = \frac{1}{2} m \times u^2$, $KE_f = \frac{1}{2} mv^2$

Loss in energy, $\Delta K = K_i - K_f = \frac{1}{2} m\left[10^2 - 0.2^2\right]$

$\Delta K = \frac{1}{2} \times 0.2\left[100 - 0.04\right] = 9.96$ J

18. (d) : Range = Maximum height

$$\frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g} ; \frac{2\sin\theta\cos\theta}{1} = \frac{\sin^2\theta}{2}$$

$\therefore$ $\tan\theta = 4$

19. (d) : Percentage error in resistance = 1%

Percentage error in time = 3 %

Percentage error in current = 2 %

As, $H = I^2Rt$

Percentage error in heat,

$$\frac{\Delta H}{H} \times 100 = \frac{2\Delta I}{I} \times 100 + \frac{\Delta R}{R} \times 100 + \frac{\Delta t}{t} \times 100$$

$= 2 \times 2 + 1 + 3 = 8\%$

20. (b) : Wavelength emitted by photon during its transition $= \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$n_1 = 1$, $n_2 = n$

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{n^2}\right] ; \frac{1}{\lambda R} = 1 - \frac{1}{n^2} \quad \ldots(i)$$

$$\frac{1}{n^2} = 1 - \frac{1}{\lambda R} = \frac{\lambda R - 1}{\lambda R} ; n^2 = \frac{\lambda R}{\lambda R - 1} \therefore n = \sqrt{\frac{\lambda R}{\lambda R - 1}}$$

21. (100) : Given: Rate of change of velocity w.r.t. distance is $\frac{dv}{dx} = 5$ m/s per meter, $v = 20$ m/s

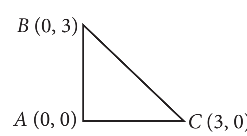
Acceleration of particle is, $a = v\frac{dv}{dx} = 20 \times 5 = 100$ m/s^2

22. (2) : $x_{\text{CM}} = \dfrac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

$$x_{\text{CM}} = \frac{M \times 0 + M \times 0 + M \times 3}{3M} = \frac{3M}{3M} = 1$$

$$y_{\text{CM}} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{M \times 0 + M \times 0 + M \times 3}{3M}$$

$$y_{\text{CM}} = \frac{3M}{3M} = 1$$



$$r = \sqrt{x_{\text{CM}}^2 + y_{\text{CM}}^2} = \sqrt{1^2 + 1^2} = \sqrt{2}$$

So, $x = 2$

23. (90) : $m_{\text{ice}} = 120$ g $= 0.12$ kg, $T_{\text{ice}} = 0°C$

$m_{\text{water}} = 300$ g $= 0.3$ kg, $T_w = 25°C$

$c_w = 4200$ J/kg/K, $L_{\text{ice}} = 3.5 \times 10^5$ J/kg

Heat lost by water

$H_1 = m_{water} \times c_w \times \Delta T = 0.3 \times 4200 \times (25 - 0)$; $H_1 = 31500$ J

Heat gained by x g ice

$$H_2 = \frac{x \times L}{1000} = \frac{x}{1000} \times 3.5 \times 10^5 = 350x$$

By calorimetry law total heat lost by the body is equal to

$31500 = 350x$

$\therefore$ Total heat gained by body, $x = 90$

24. (5) : $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For, third to second level, $\frac{1}{\lambda_1} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}$

For, highest to second level, $\frac{1}{\lambda_2} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = \frac{R}{4}$

$$\frac{E_1}{E_2} = \frac{hc \times \lambda_2}{\lambda_1 \times hc} = \frac{\frac{1}{\lambda_1}}{\frac{1}{\lambda_2}} = \frac{5R \times 4}{36R} = \frac{5}{9}$$

$$\frac{x}{x+4} = \frac{5}{9} \Rightarrow 9x = 5x + 20 \;\therefore\; x = 5$$

25. (18) : $E_1 = 1.2$ V, $l_1 = 36$ cm, $E_2 = 1.8$ V, $l_2 = ?$

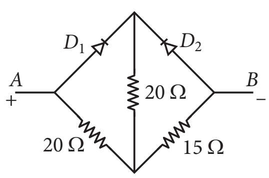
The balanced condition for potentiometer,

$$\frac{E_2}{E_1} = \frac{l_2}{l_1} \Rightarrow \frac{1.8}{1.2} = \frac{l_2}{36}$$

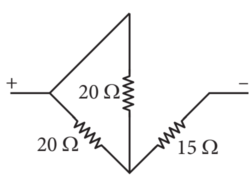
$\therefore$ $l_2 = 54$ cm

So, $l_2 - l_1 = 54 - 36 = 18$ cm

26. (25) : Here D_1 is in the forward bias and D_2 is in the reverse bias, so from the circuit 20 Ω and 20 Ω are in parallel



$$R_p = \frac{20 \times 20}{20 + 20} = 10\,\Omega$$



Now, R_p and 15 Ω is in series

So, $R_{eq} = 10 + 15 = 25\,\Omega$

27. (60) : $R = \sqrt{3}\,A$ (Given)

Let the amplitude is A and phase difference is ϕ

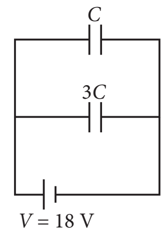
$$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi};\ \sqrt{3}\,A = \sqrt{A^2 + A^2 + 2A^2\cos\phi}$$

$3A^2 = 2A^2(1 + \cos\phi)$

$$\frac{3}{2} = 1 + \cos\phi \Rightarrow \cos\phi = \frac{1}{2}$$

$\therefore$ $\phi = 60°$

28. (6) : Charge on C is $q_1 = C \times 18 = 18C$



Charge on $3C$ is $q_2 = 3C \times 18 = 54C$

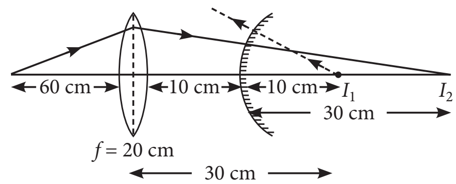
Now after disconnected

$C_1' = KC = 9C$

$C_2' = 3C$

$$V = \frac{q_1 + q_2}{C_1' + C_2'} = \frac{18C + 54C}{9C + 3C} = \frac{72C}{12C} = 6\text{ V}$$

29. (10) : Let the image distance is v from lens.



From lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\frac{1}{20} = \frac{1}{v} + \frac{1}{60} \Rightarrow \frac{1}{v} = \frac{1}{20} - \frac{1}{60} = \frac{3-1}{60} = \frac{1}{30};\ v = 30\text{ cm}$$

Image I_1, formed by the convex lens acts as an object for convex mirror. Since the mirror and lens are separated by 10 cm, distance between I_1 and mirror is 10 cm *i.e.* $u = 10$ cm

$R = 30 - 10 = 20$ cm ; $f = R/2 = 20/2 = 10$ cm

30. (250) : $\phi = 8t^2 - 9t + 5$, $R = 20\,\Omega$, $t = 0.25$ s

$$e = \left|\frac{d\phi}{dt}\right| = 16t - 9;\ i = \frac{e}{R} = \frac{16t - 9}{20}$$

$$i(t = 0.25\text{ s}) = \frac{(16 \times 0.25) - 9}{20} = \frac{-5}{20}$$

$$i = \frac{-5}{20} \times 1000\text{ mA} = -250\text{ mA}$$