Physics
JEE-MAIN (July-Attempt)
25 July (Shift-1) Paper Solution

SECTION - A

1. If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is:

(A) $[P\ A^{-1}\ T^{0}]$ (B) $[P\ A\ T^{-1}]$ (C) $[P\ A^{-1}\ T]$ (D) $[P\ A^{-1}\ T^{-1}]$

Sol. **A**

$\eta \propto P^a A^b T^c$

$[\eta] = [P]^a [A]^b [T]^c$

$[ML^{-1}T^{-1}] = [MLT^{-1}]^a [L^2]^b [T]^C$

$[M^1 L^{-1} T^{-1}] = [M^a L^{a+2b} T^{-a+c}]$

a = 1, a + 2b = - 1, -a + c = - 1

b = -1 & C = 0

$\eta \propto P^1 A^{-1} T^0$

2. Which of the following physical quantities have the same dimensions?

(A) Electric displacement $(\vec{D})$ and surface charge density (σ)

(B) Displacement current and electric field

(C) Current density and surface charge density

(D) Electric potential and energy

Sol. **A**

Electric displacement – $D = \varepsilon E$

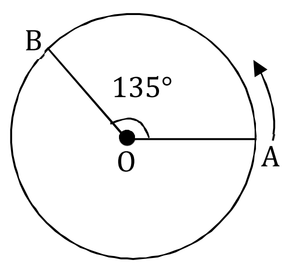
$[D] = [\varepsilon][E] \left[[E] = \frac{[\sigma]}{[\varepsilon_0]} \right]$

$\therefore [D] = [\sigma]$

Electric displacement have same dimension as surface charge density

3. A person moved from A to B on a circular path as shown in figure. If the distance travelled by him is 60m, then the magnitude of displacement would be:

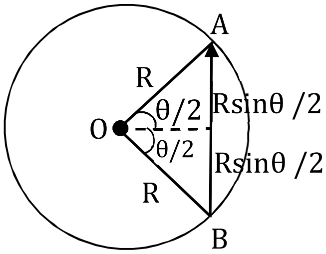
(Given cos 135° = –0.7)



(A) 42 m (B) 47 m (C) 19 m (D) 40 m

Sol. **B**

Distance travelled S = Rθ (R = radius)



$R = \frac{S}{\theta} \Rightarrow R = \frac{60}{\frac{3\pi}{4}} \Rightarrow R = \frac{80}{\pi} m$

Displacement $|\Delta\vec{r}| = 2R\sin\frac{\theta}{2}$

$|\Delta\vec{r}| = R\sqrt{2(1-cos\theta)}$

$= \frac{80}{\pi}\sqrt{2(1+0.7)}$ $\begin{Bmatrix} \theta = 135° \\ cos135° = -0.7\ (given) \end{Bmatrix}$

Given cos 135° = – 0.7

≈ 47 m

4. A body of mass 0.5 kg travels on straight line path with velocity v = ($3x^2$ + 4) m/s. The net work done by the force during its displacement from x = 0 to x = 2 m is:

(A) 64 J (B) 60 J (C) 120 J (D) 128 J

Sol. **B**

Using work energy theorem

w = ΔK

$w = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

v = $3x^2$ + 4

At x = 0, v_1 = 4 m/s

At x = 2m, v_2 = 3 × 4 + 4 ⇒ V_2 = 16 m/s^2

$w = \frac{1}{2}(0.5)(16^2 - 4^2)$ {m = 0.5 kg}

W = 60 J

5. A solid cylinder and a solid sphere, having same mass M and radius R, roll down the same inclined plane from top without slipping they start from rest. The ratio of velocity of the solid cylinder to that of the solid sphere, with which they reach the ground, will be:

(A) $\sqrt{\frac{5}{3}}$ (B) $\sqrt{\frac{5}{4}}$ (C) $\sqrt{\frac{3}{5}}$ (D) $\sqrt{\frac{14}{15}}$

Sol. **D**

$a = \frac{mg\sin\theta R^2}{(I+mR^2)}$

For solid cylinder $I = \frac{mR^2}{2}$

$a_c = \frac{2}{3} g\sin\theta$

For solid sphere $I = \frac{2}{5} mR^2$

$a_s = \frac{5}{7} g\sin\theta$

Velocity when they reach at – ground

$v^2 = 2as$ {u = 0}

$v = \sqrt{2as}$

$\frac{V_C}{V_S} = \sqrt{\frac{a_c}{a_s}}$ { S = Displacement of COM, S = same)

$\frac{V_C}{V_S} = \sqrt{\frac{14}{15}}$

6. Three identical particles A, B and C of mass 100 kg each are placed in a straight line with AB = BC = 13 m. The gravitational force on a fourth particle P of the same mass is F, when placed at a distance 13m from the particle B on the perpendicular bisector of the line AC. The value of F will be approximately:

(A) 21G (B) 100G (C) 59G (D) 42G

Sol. **B**

d = 13 m

$F_0 = \frac{Gm^2}{d^2}$

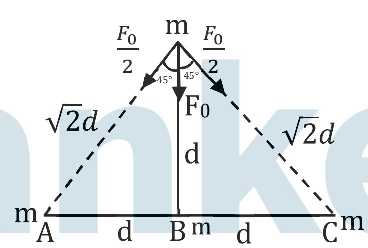
$F = F_0 + 2\frac{F_0}{2}\cos 45°$

$F = F_0\left(1 + \frac{1}{\sqrt{2}}\right)$

$F = \frac{Gm^2}{d^2}\left(1 + \frac{1}{\sqrt{2}}\right)$

$F = \frac{G(100)^2}{(13)^2}\left(1 + \frac{1}{\sqrt{2}}\right)$

$F \approx 100\,G$



7. A certain amount of gas of volume V at 27°C temperature and pressure 2×10^7 Nm^{-2} expands isothermally until its volume gets doubled. Later it expands adiabatically until its volume gets redoubled. The final pressure of the gas will be (Use $\gamma = 1.5$)

(A) 3.536×10^5 Pa (B) 3.536×10^6 Pa (C) 1.25×10^6 Pa (D) 1.25×10^5 Pa

Sol. **B**

For isothermal process

$P_1V_1 = P_2V_2$

$2 \times 10^7 V = P_2 (2V)$

$P_2 = 1 \times 10^7$ N/m²

For adiabatic process

$P_2V_2^{\gamma} = P_3V_3^{\gamma}$

$1 \times 10^7(2V)^{1.5} = P_3(4V)^{1.5}$ (Volume further doubled)

$P_3 = \frac{10^7}{2^{3/2}} \Rightarrow P_3 = 3.536 \times 10^6$ N/m²

8. Following statements are given:

(A) The average kinetic energy of a gas molecule decreases when the temperature is reduced.

(B) The average kinetic energy of a gas molecule increases with increase in pressure at constant temperature.

(C) The average kinetic energy of a gas molecule decreases with increase in volume.

(D) Pressure of a gas increases with increase in temperature at constant pressure.

(E) The volume of gas decreases with increase in temperature.

Choose the correct answer from the options given below:

(A) (A) and (D) only (B) (A), (B) and (D)only

(B) (B) and (D)only (D) (A), (B) and (E) only

Sol. Average kinetic energy of a gas molecule

$k.E_{avg} = \frac{f}{2}kT$ { f = degree of freedom}

(A) T ↓ ⇒ K. E_{avg} ↓

(B) T = constant ⇒ K. E_{avg} = constant

(C) Not necessary

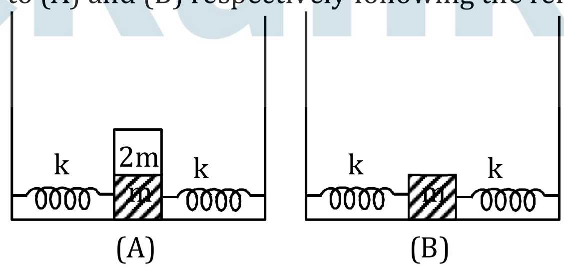
(D) Pressure is constant given

(E) Not necessary

Only (A) is correct (not in any option)

Ans. Given A (A and D) only

9. In figure (A), mass '2m' is fixed on mass 'm' which is attached to two springs of spring constant k. In figure (B), mass 'm' is attached to two springs of spring constant 'k' and '2k'. If mass 'm' in (A) and in (B) are displaced by distance 'x' horizontally and then released, then time period T_1 and T_2 corresponding to (A) and (B) respectively following the relation.



(A) $\frac{T_1}{T_2} = \frac{3}{\sqrt{2}}$ (B) $\frac{T_1}{T_2} = \sqrt{\frac{3}{2}}$ (C) $\frac{T_1}{T_2} = \sqrt{\frac{2}{3}}$ (D) $\frac{T_1}{T_2} = \frac{\sqrt{2}}{3}$

Sol. **A**

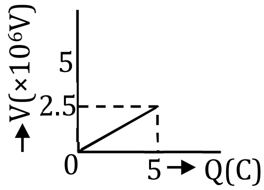
$T = 2\pi\sqrt{\frac{3m}{k_{eq}}}$ $\{k_{eq} = 2k\}$

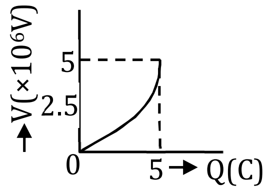
$T_1 = 2\pi\sqrt{\frac{3m}{2k}}$

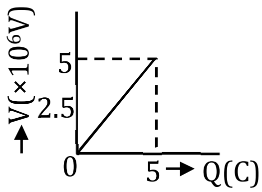
$T_2 = 2\pi\sqrt{\frac{m}{3k}}$

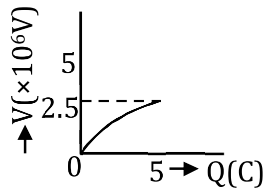
$\therefore \frac{T_1}{T_2} = \sqrt{\frac{9}{2}} \Rightarrow \frac{T_1}{T_2} = \frac{3}{\sqrt{2}}$

10. A condenser of 2 μF capacitance is charged steadily from 0 to 5 C. which of the following graph represents correctly the variation of potential difference (V) across it's plates with respect to the charge (Q) on the condenser?

(A)


(B)


(C)


(D)


Sol. **A**

Charge Q is 0 to 5C steadily

Potential difference $V = \frac{Q}{C}$

$V_{\max} = \frac{5}{2\times10^{-6}} \Rightarrow V_{max} = 2.5 \times 10^{6}$ volt

$V \propto Q$

{Q is steadily so V is also steadily}

11. Two charged particles, having same kinetic energy, are allowed to pass through a uniform magnetic field perpendicular to the direction of motion. If the ratio of radii of their circular paths is 6 : 5 and their respective masses ratio is 9 : 4. Then, the ratio of their charges will be:

(A) 8 : 5 (B) 5 : 4 (C) 5 : 3 (D) 8 : 7

Sol. **B**

$R = \frac{mv}{qB}$

$R = \frac{\sqrt{2mk}}{qB}$ {k = same, B = same}

$\frac{q_1}{q_2} = \left(\sqrt{\frac{m_1}{m_2}}\right)\left(\frac{R_2}{R_1}\right)$

$\frac{q_1}{q_2} = \left(\sqrt{\frac{9}{4}}\right)\left(\frac{5}{6}\right)$

$\frac{q_1}{q_2} = \frac{5}{4}$

12. To increase the resonant frequency in series LCR circuit,

(A) source frequency should be increased

(B) another resistance should be added in series with the first resistance

(C) another capacitor should be added in series with the first capacitor

(D) the source frequency should be decreased

Sol. **C**

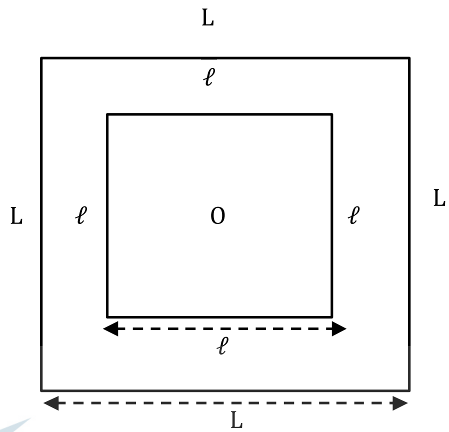
Resonant frequency $F_r = \frac{1}{2\pi\sqrt{LC}}$

By adding a capacitor in series

equivalent capacitance decreases

Hence resonant frequency increases.

13. A small square loop of wire of side l is placed inside a large square loop of wire L (L >> l). Both loops are coplanar and their centres coincide at point O as shown in figure. The mutual inductance of the system is:



(A) $\frac{2\sqrt{2}\mu_0 L^2}{\pi l}$ (B) $\frac{\mu_0 l^2}{2\sqrt{2}\pi L}$ (C) $\frac{2\sqrt{2}\mu_0 l^2}{\pi L}$ (D) $\frac{\mu_0 L^2}{2\sqrt{2}\pi l}$

Sol. **C**

Magnetic field at centre

$B = 4\left(\frac{\mu_0 I}{4\pi\left(\frac{L}{2}\right)}\right)(2\sin 45°)$

$B = 2\sqrt{2}\frac{\mu_0 I}{\pi L}$

Magnetic flux in small loop

$\phi = B\ell^2$

$\phi = 2\sqrt{2}\frac{\mu_0 I}{\pi L}\ell^2$

Mutual Inductance $M = \frac{\phi_s}{I_p}$

$M = 2\sqrt{2}\frac{\mu_0 \ell^2}{\pi L}$

14. The rms value of conduction current in a parallel plate capacitor is 6.9 μ A. The capacity of this capacitor, if it is connected to 230 V ac supply with an angular frequency of 600 rad/ s will be

(A) 5pF (B) 50 pF (C) 100 pF (D) 200 pF

Sol. **B**

$I_{rms} = \frac{V_{rms}}{x_C}\left\{x_c = \frac{1}{\omega c}\right\}$

$I_{rms} = V_{rms}\,\omega c$

$C = \frac{I_{rms}}{\omega V_{rms}} \Rightarrow C = \frac{6.9\times10^{-6}}{600\times230}$

C = 50 pF

15. Which of the following statements is correct ?

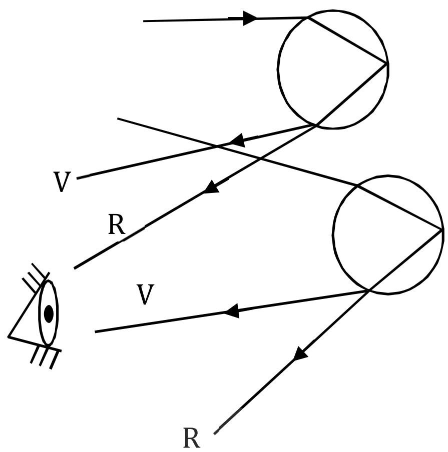
(A) In primary rainbow, observer sees red colour on the top and violet on the bottom

(B) In primary rainbow, observer sees violet colour on the top and red on the bottom

(C) In primary rainbow, light wave suffers total internal reflection twice before coming out of water drops.

(D) primary rainbow is less bright than secondary rainbow.

Sol. **A**



From the lower drop the red light will be below the line of sight and from upper drop violet light will be above the line of sight.

So red colour at the top and violet colour will on the bottom in primary rainbow.

16. Time taken by light to travel in two different material A and B of refractive indices μ_A and μ_B of same thickness is t_1 and t_2 respectively. If $t_2 - t_1 = 5 \times 10^{-10}$s and the ratio of μ_A to μ_B is 1 : 2. Then, the thickness of material, in meter is : (Given v_A and v_B are velocities of light in A and B materials respectively.)

(A) $5 \times 10^{-10}\ v_A$ m (B) 5×10^{-10} m (C) 1.5×10^{-10} m (D) $5 \times 10^{-10}\ v_A$ m

Sol. **A**

$t_2 - t_1 = 5 \times 10^{-10}$ sec

$\frac{d}{V_B} - \frac{d}{V_A} = 5 \times 10^{-10}$

$\frac{d}{V_A}\left(\frac{V_A}{V_B} - 1\right) = 5 \times 10^{-10}$

$\frac{d}{V_A}\left(\frac{\mu_B}{\mu_A} - 1\right) = 5\times 10^{-10}$

$\frac{d}{V_A}(2 - 1) = 5 \times 10^{-10}$

$d = 5 \times 10^{-10}\ V_A$

17. A metal exposed to light of wavelength 800 nm and emits photoelectrons with a certain kinetic energy. The maximum kinetic energy of photo-electron doubles when light wavelength 500 nm is used. The work function of the metal is : (Take hc = 1230 eV – nm)

(A) 1.537 eV (B) 2.46 eV (C) 0.615 eV (D) 1.23 eV

Sol. **C**

$KE_{\max_1} = \frac{hc}{\lambda_1} - \phi$

$KE_{\max_2} = \frac{hc}{\lambda_2} - \phi$ {λ_1 = 800 nm, λ_2 = 500 nm}

$K.E_{\max_2} = 2k.E_{\max_1}$

$\frac{hc}{\lambda_2} - \phi = 2\left(\frac{hc}{\lambda_1} - \phi\right)$

$\phi = hc(\frac{2}{\lambda_1} - \frac{1}{\lambda_2})$

$\phi = 1230\left(\frac{2}{800} - \frac{1}{500}\right)$

ϕ = 0.615 eV

18. The momentum of an electron revolving in nth orbit is given by :
(symbols have their usual meanings)

(A) $\frac{nh}{2\pi r}$ (B) $\frac{nh}{2r}$ (C) $\frac{nh}{2\pi}$ (D) $\frac{2\pi r}{nh}$

Sol. **A**

From Bohr IInd postulate

$mvr = \frac{nh}{2\pi}$

$mv = \frac{nh}{2\pi r}$

19. The magnetic moment of an electron (e) revolving in an orbit around nucleus with an orbital angular momentum is given by :

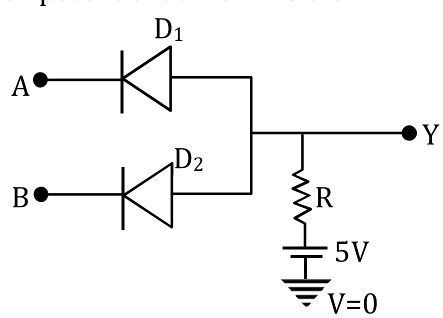
(A) $\vec{\mu}_L = \frac{e\vec{L}}{2m}$ (B) $\vec{\mu}_L = -\frac{e\vec{L}}{2m}$ (C) $\vec{\mu}_\ell = -\frac{e\vec{L}}{m}$ (D) $\vec{\mu}_\ell = -\frac{2e\vec{L}}{m}$

Sol. **B**

$\vec{\mu}_L = \frac{q}{2m}\vec{L}$ {q = as per sign}

$\vec{\mu}_L = \frac{-e}{2m}\vec{L}$

20. In the circuit, the logical value of A = 1 or B = 1 when potential at A or B is 5V and the logical value of A = 0 or B = 0 when potential at A or B is 0 V.



(A)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

(B)

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

(C)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	0

(D)

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

Sol. **A**

Given circuit is of And gate

y = A. B

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

21. A car is moving with speed of 150 km/h and after applying the break it will move 27 m before it stops. If the same car is moving with a speed of one third the reported speed then it will stop after travelling….. m distance

Sol. **3**

Using $V^2 = u^2 + 2a\Delta x$

$0 = (150)^2 - 2a(27)$

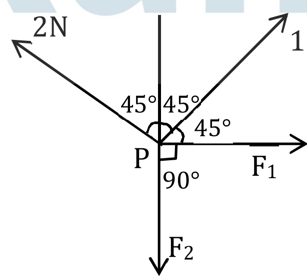
$(150)^2 = 2a(27)$ .... (1)

If the speed $= \frac{150}{3} = 50$ km /h

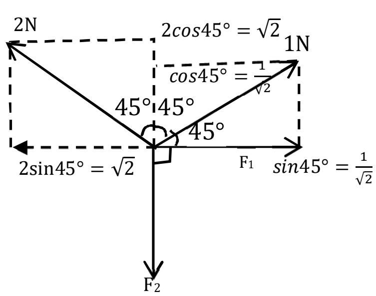
$(50)^2 = 2a(\Delta x)$ ... (2)

$9 = \frac{27}{\Delta x} \Rightarrow \Delta x = 3m$

22. Four forces are acting at a point P in equilibrium as shown in figure. the ratio of force F_1 to F_2 is 1 : x where x = …..



Sol. **3**



For equilibrium $\sum\vec{F} = \vec{0}$

$F_1 + \frac{1}{\sqrt{2}} = \sqrt{2} \Rightarrow F_1 = \frac{1}{\sqrt{2}}$

$F_2 = \sqrt{2} + \frac{1}{\sqrt{2}} \Rightarrow F_2 = \frac{3}{\sqrt{2}}$

$\frac{F_1}{F_2} = \frac{1}{3} \Rightarrow$ x = 3

23. A wire of length L and radius r is clamped rigidly at one end. when the other end of the wire is pulled by a force F, its length increases by 5 cm. Another wire of the same material of length 4L and radius 4r is pulled by a force 4F under same conditions. The increase in length of this wire is .... cm.

Sol. **5**

Stress = y × strain

$\frac{F}{\pi r^2} = \frac{y\Delta\ell}{L} \Rightarrow \Delta\ell = \frac{FL}{y\pi r^2}$

$\frac{\Delta\ell_1}{\Delta\ell_2} = \left(\frac{F}{4F}\right)\left(\frac{L}{4L}\right)\left(\frac{4r}{r}\right)^2$

$\frac{\Delta\ell_1}{\Delta\ell_2} = 1 \Rightarrow \Delta\ell_2 = \Delta\ell_1$

$\Delta\ell_2 = 5\ cm$

24. A unit scale is to be prepared whose length does not change with temperature and remains 20cm, using a bimetallic strip made of brass and iron each of different length. The length of both components would change in such a way that difference between their lengths remains constant. if length of brass is 40 cm and length of iron will be ..... cm.

($\alpha_{iron} = 1.2 \times 10^{-5}\ K^{-1}$ and $\alpha_{brass} = 1.8 \times 10^{-5}\ K^{-1}$).

Sol. **60**

Difference of their length

$\ell_2 - \ell_1 = const.$

$\Delta\ell_2 - \Delta\ell_1 = 0$

$\Delta\ell_2 = \Delta\ell_1$

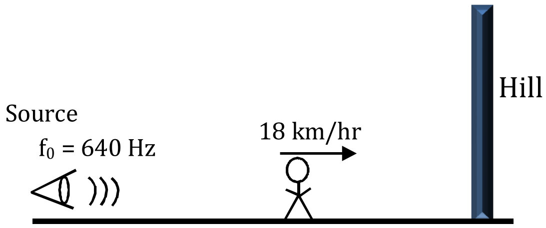
$\ell_2\alpha_2\Delta T = \ell_1\alpha_1\Delta T$

$40 \times 1.8 \times 10^{-5} = \ell_1(1.2 \times 10^{-5})$

$\ell_1 = 60$ cm

25. An observer is riding on a bicycle and moving towards a hill at 18 km h^{-1}. he hears a sound from a source at some distance behind him directly as well as after its reflection from the hill. If the original frequency of the sound as emitted by source is 640 Hz and velocity of the sound in air is 320 m/s, the beat frequency between the two sounds heard by observer will be.... Hz.

Sol. **20**

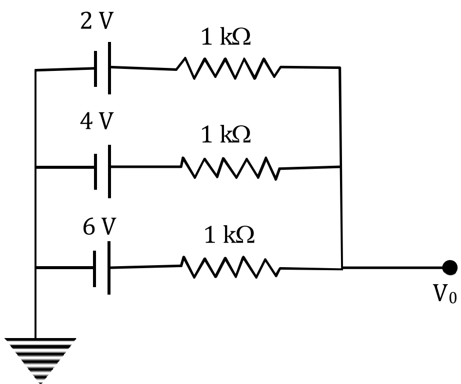


$V_{observer}$ = 18 km/hr
= 5 m/s
Frequency received by observer direct
$f_1 = \left(\frac{v-v_0}{v}\right) f_0 \Rightarrow f_1 = \left(\frac{320-5}{320}\right) f_0$
$f_1 = \frac{315}{320} \times 640 \Rightarrow f_1 = 630\ Hz$
Frequency received by hill as same
frequency of source = f_0
frequency received by observer after reflection from hill
$f_2 = \left(\frac{v+v_0}{v}\right) f_0 \Rightarrow f_2 = \left(\frac{320+5}{320}\right) 640$
f_2 = 650 Hz
Beats heard by observer = $f_2 - f_1$
= 650 – 630
= 20 Hz

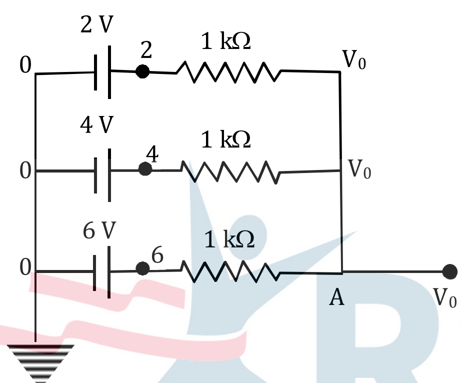
26. The volume charge density of a sphere of radius 6m is 2μ C cm^{-3}. The number of lines of force per unit surface area coming out from the surface of the sphere is ..... × 10^{10} NC^{-1}
[Given : Permittivity of vacuum $\in_0 = 8.85 \times 10^{-12}$ $C^2 N^{-1} - m^{-2}$)

Sol. **45**
Electric field at surface
$E = \frac{kQ}{R^2}$
$E = \frac{\rho R}{3\varepsilon_0} \left\{Q = \rho \frac{4}{3}\pi R^3\right\}$
Number of lines per unit area $\alpha|\vec{E}|$
Number using proportionality constant = 1
of lines per unit area = $|\vec{E}|$
= $\frac{\rho R}{3\varepsilon_0}$
= $\frac{\frac{2\times10^{-6}}{10^{-6}}\times 6}{3\times 8.85\times 10^{-12}}$
= $45 \times 10^{10} \frac{N}{C}$

27. In the given figure, the value of V_0 will be V



Sol. **4**



using KCL at A junction

$\frac{V_0-2}{1}+\frac{V_0-4}{1}+\frac{V_0-6}{1}=0$

$3V_0 = 12$

$V_0 = 4$ volt

28. Eight copper wire of length l and diameter d are joined in parallel to form a single composite conductor of resistance R. If a single copper wire of length 2l have the same resistance (R). then its diameter will be ...... d.

Sol. **4**

For each copper wire $r=\frac{4\rho\ell}{\pi d^2}$

$R=\frac{r}{8}\Rightarrow R=\frac{4\rho\ell}{8\pi d^2}$

$R=\frac{\rho\ell}{2\pi d^2}$

Single wire

$R=\frac{4\rho(2\ell)}{\pi D^2}$

$\frac{\rho\ell}{2\pi d^2}=\frac{8\rho\ell}{\pi D^2}\Rightarrow$ D = 4d

29. The energy band gap of semiconducting material to produce violet (wavelength = 4000 Å) LED is …. eV. (Round off to the nearest integer)

Sol. **3**

$\Delta E_g = \frac{hc}{\lambda}$

$\Delta E_g = \frac{12400}{4000}$

$\Delta E_g = 3.1\ eV$

30. The required height of a TV tower which can cover the population of 6.03 lakh is h. if the average population density is 100 per square km and the radius of earth is 6400 km, then value of h will be…. m

Sol. **150**

Coverage radius $d = \sqrt{2Rh}$

Area A = πd^2

$100 \times \pi d^2 = 6.03 \times 10^5$

$100 \times \pi(2Rh) = 6.03 \times 10^5$

$h = \frac{6.03 \times 10^5}{100 \times 2 \times 3.14 \times 6400}$

h = 0.15 km

h = 150 m