

6. (a) path will change

Explanation:

As magnetic force always act perpendicular to the direction of motion, so path or direction will change without any change in speed.

7.

- (d) relative position and orientation of the two coils

Explanation:

The mutual inductance of a pair of coils depends upon the relative position and orientation of the two coils.

8.

- (c) F

Explanation:

$$F \propto \frac{q_m q'_m}{r^2}$$

$$\text{Hence } \frac{F'}{F} = \left(\frac{2q_m 2q'_m}{4r^2} \right) / \frac{q_m q'_m}{r^2} = 1$$

or $F' = F$

9.

- (d) violet component of white light travels slower than the red component

Explanation:

The refractive index of a violet component of white light is greater than the refractive index of a red component. Hence, the speed of violet light is less than the speed of red light in glass. Hence, violet light travels slower than red light in a glass prism.

10.

- (c) 9000 Vm^{-1}

Explanation:

To find the electric field intensity due to a point charge, we use the formula: $E = \frac{k \cdot |Q|}{r^2}$ where E is the electric field intensity, k is Coulomb's constant ($8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$), Q is the charge, and r is the distance from the charge to the point where the field is being calculated.

- i. Calculate the distance r : The charge is located at $3\hat{i} + 4\hat{j}$ and the point of interest is at $9\hat{i} + 12\hat{j}$. The distance vector from the charge to the point is: $\Delta x = 9 - 3 = 6$ and $\Delta y = 12 - 4 = 8$. Thus, the distance r is:

$$r = \sqrt{(6)^2 + (8)^2} = \sqrt{36 + 64} = \sqrt{100} = 10 \text{ m}$$

- ii. Substitute values into the electric field formula: The charge $Q = 100 \mu\text{C} = 100 \times 10^{-6} \text{ C}$. Now substituting the values into the formula: $E = \frac{(8.99 \times 10^9) \cdot (100 \times 10^{-6})}{(10)^2}$. Calculating this gives: $E = \frac{(8.99 \times 10^9) \cdot (100 \times 10^{-6})}{100} = 8.99 \times 10^4 \text{ Vm}^{-1}$

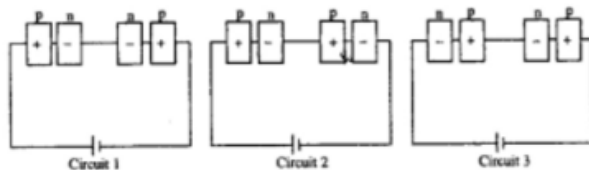
- iii. Convert to appropriate units: This value simplifies to 8990 Vm^{-1} , which rounds to . Thus, the calculated electric field intensity at the specified point is 9000 Vm^{-1} , confirming that the solution provided is correct.

11.

- (d) circuit 2 and 3

Explanation:

The potential drop across the two p-n junctions, connected in series, are equal in circuit 2 and circuit 3. These two circuits are either forward biased or reverse biased in terms of the p-n junctions.



In circuit 1, the two p-n junctions are such that one is forward biased and the other is reverse biased.

12.

- (b) $4f$

Explanation:

4f

13. (a) Both A and R are true and R is the correct explanation of A.

Explanation:

Photoelectrons produced by monochromatic light have different velocities and hence different energies. Actually all the electrons do not occupy the same level of energy. So, electrons coming out from different levels have different velocities and hence different energies. So, the assertion is true. The electrons coming out from inside the metal surface, face collisions with the other atoms in the metal. So, energies become different. Hence the reason is true and it explains the assertion.

14. (a) Both A and R are true and R is the correct explanation of A.

Explanation:

Both A and R are true and R is the correct explanation of A.

15.

- (c) A is true but R is false.

Explanation:

A is true but R is false.

16.

- (b) Both A and R are true but R is not the correct explanation of A.

Explanation:

Both A and R are true but R is not the correct explanation of A.

Section B

17. Here it is given that, $\nu = 5 \times 10^{19}$ Hz

Now, we know that the wavelength is given by:

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{5 \times 10^{19}} = 6 \times 10^{-12} \text{ m}$$

This wavelength corresponds to either gamma rays or X-rays. These are used:

- For causing certain nuclear reactions, and
- For treatment of cancer

18. Here, $B = 0.3 \text{ T}$, $\theta = 30^\circ$, $\tau = 0.06 \text{ N-m}$, $M = ?$

$$\text{As } \tau = MB \sin \theta, M = \frac{\tau}{B \sin \theta} = \frac{0.06}{0.3 \sin 30^\circ} = 0.4 \text{ Am}^2$$

OR

When a magnet is placed in such a way that its north pole points towards the south, the neutral point is obtained at the axis of the magnet and as the point is said to be a neutral point, the magnitude of earth's magnetic field is equal to the magnetic field of the magnet.

therefore, we have, $B_{\text{magnet}} = B_H$

The magnetic field of the magnet at an axial point is given as

$$B_{\text{magnet}} = \frac{\mu_0}{4\pi} \frac{2Md}{(d^2 - l^2)^2} \text{ where } M \text{ is the magnetic moment.}$$

Given: $d = 30 \text{ cm} = 0.3 \text{ m}$, $2l = 30 \text{ cm} \rightarrow l = 0.15 \text{ m}$ and $B_H = 0.34 \text{ G} = 0.34 \times 10^{-4} \text{ T}$.

Let us substitute these values and find the magnetic moment.

$$\begin{aligned} M &= \left(B_{\text{magnet}} \right) \left(\frac{4\pi}{\mu_0} \right) \left(\frac{(d^2 - l^2)^2}{2d} \right) \\ \Rightarrow M &= (B_H) \left(\frac{4\pi}{\mu_0} \right) \left(\frac{(d^2 - l^2)^2}{2d} \right) \\ \Rightarrow M &= (0.34 \times 10^{-4}) \left(\frac{1}{10^{-7}} \right) \left(\frac{(0.3^2 - 0.15^2)^2}{2 \times 0.3} \right) \\ \Rightarrow M &= 2.582 \text{ Am}^2 \end{aligned}$$

So, pole strength of the magnet will be,

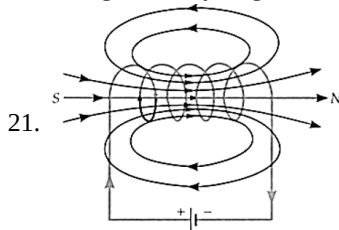
$$\therefore m = \frac{M}{2l} = \frac{2.582}{0.3} = 8.607 \text{ Am}$$

Therefore, the magnetic pole strength of the given magnet is 8.6 Am.

19. a. Since $I_e = I_b + I_c$
 $= 40 \mu\text{A} + 6 \text{ mA}$
 $= 6.04 \text{ mA}$

b. $\beta = \frac{I_c}{I_b}$
 $= \frac{6 \times 10^{-3}}{40 \times 10^{-6}} = 150$

20. Hydrogen nuclei (or protons) are much lighter than α -particles. So α -particles are not scattered by solid hydrogen. They pass through solid hydrogen almost undeflected from their paths.



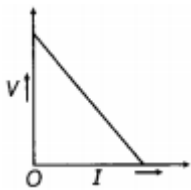
- i. The magnetic lines of force of a solenoid form closed loops while the electric lines of force of an electric dipole start from the positive charge and end at the negative charge.
 ii. Such curves are called magnetic lines of force. No two such lines of force can intersect. If they do so, then there will be two tangents and hence two directions of the magnetic field at the point of intersection which is impossible.

Section C

22. Internal resistance usually means the electrical resistance inside batteries and power supplies that can limit the potential difference that can be supplied to an external load.

We know that, $V = E - Ir$

The plot between V and I is a straight line of positive intercept and negative slope as shown in figure below.



The value of potential difference corresponding to zero current gives emf of the cell.

Maximum current is drawn when terminal voltage is zero, so

$$V = E - Ir$$

$$\Rightarrow 0 = E - I_{\max}r \Rightarrow r = \frac{E}{I_{\max}}$$

Internal resistances within power supplies are normally constant and independent of use unless the power supply gets hot as a result of short circuits or low resistance loads. In that case, the internal resistance is likely to increase slightly.

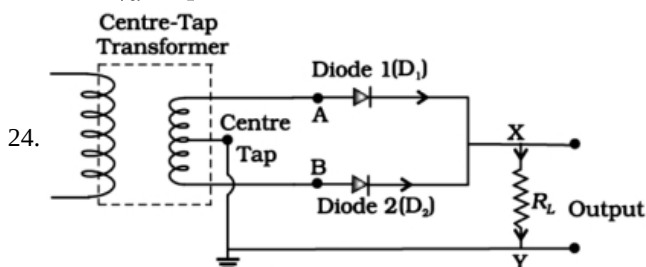
23. a. Purpose of Davisson Germer Experiment was to verify the wave nature of electron. It confirms the de Broglie relations for matter waves / Diffraction effect of electron beams from crystal

- b. de Broglie wavelength

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

$$\therefore \frac{h}{\sqrt{2 m_p e V_p}} = \frac{h}{\sqrt{2 m_\alpha e V_\alpha}}$$

$$\therefore \frac{V_p}{V_\alpha} = \frac{8}{1}$$

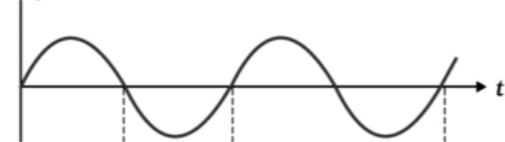


The circuit diagram of full wave rectifier is as shown above. During first half cycle of the input a.c. signal, only diode 1 is forward biased and conducts.

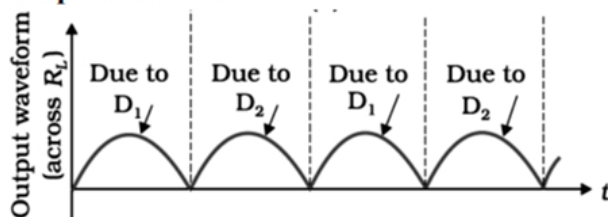
During the 2nd half cycle of the input ac signal only diode 2 is forward biased and conducts.

However, due to the use of the centre tapped transformer, the current in the load flows in the same direction during both these half cycles. The current through the load is therefore unidirectional.

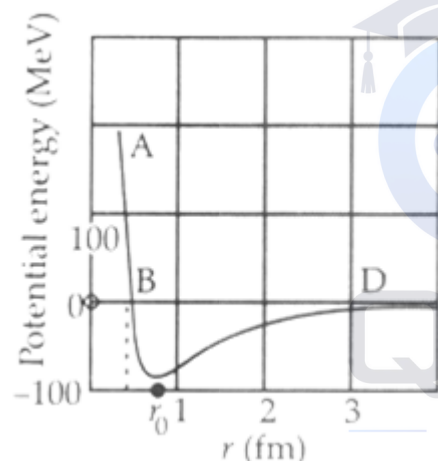
Input waveform



Output waveform



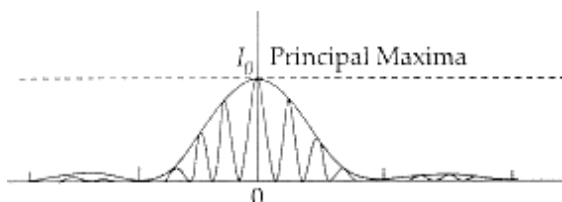
25. There are two types of forces: Coulomb force and nuclear force which are acting between protons in the nucleus. The gravitational force between two protons is very weak. Between these two forces, nuclear force is stronger as compared to Coulomb force but it is a very short-range force. Coulomb force is repulsive in nature for two protons dominant over nuclear force when the distance between two protons increases more than a few femtometer. As the nuclear size is in the order of the femtometer, hence in the nucleus, nuclear force between protons dominates over the Coulombian force. It is attractive in nature and binds together. Moreover, neutrons in nucleus also act as glue to held protons together as there is no Coulomb force between protons and neutrons but there is an attractive nuclear force between them.



It is clear from the graph, as the nucleons come closer under attractive nuclear force, the potential energy decreases and PE becomes more and more negative. When the distance between two nucleons falls below 10^{-15} m, the nuclear force becomes repulsive and potential energy increases rapidly. Hence negative PE shows that force between nucleons is attractive.

The characteristic properties of nuclear force:

- i. The nuclear force is short-range force.
 - ii. The nuclear force is independent of electric charge.
26. a. The quantised electron orbits and energy state are due to wave nature of the electron and only resonant standing waves can persist. Ace. De Broglie Apotheosis.
- $$2\pi r = n\lambda$$
- $$= \frac{nh}{mv}$$
- $$mvr = \left(\frac{nh}{2\pi}\right)$$
- b. Lyman series
- transition from $n = 4$ to $n = 1$ will have shortest wavelength.
27. The diagram, given here, shows several fringes, due to double-slit interference, 'contained' in a broad diffraction peak. When the separation between the slits is large compared to their width, the diffraction pattern becomes very flat and we observe the two-slit interference pattern.



Basic features that distinguish the interference pattern from those seen in a coherently illuminated single slit.:

- i. The interference pattern has a number of equally spaced bright and dark bands while the diffraction pattern has a central bright maxima which is twice as wide as the other maxima.
 - ii. Interference pattern is the superposition of two waves originating from two narrow slits. The diffraction pattern is a superposition of a continuous family of waves originating from each point on a single slit.
 - iii. For a single slit of width 'a' the first null of diffraction pattern occurs at an angle of $\frac{\lambda}{a}$. At the same angle of $\frac{\lambda}{a}$, we get a maximum for two narrow slits separated by a distance a.
28. i. Let RS moves with speed v rightward and also RS is at distances x_1 and x_2 from PQ at instants t_1 and t_2 , respectively.

Change in flux, $d\phi = \phi_2 - \phi_1 = Bl(x_2 - x_1)$ [$\because$ magnetic flux, $\phi = \vec{B} \cdot \vec{A} = BA \cos 0^\circ = Blx$]

$$\Rightarrow d\phi = Bldx \Rightarrow \frac{d\phi}{dt} = Bl \frac{dx}{dt} = Blv \quad \left[\because v = \frac{dx}{dt} \right]$$

If resistance of loop is R, then $I = \frac{vBl}{R}$

ii. Magnetic force = $BIl \sin 90^\circ$

$$= \left(\frac{vBl}{R} \right) Bl = \frac{vB^2 l^2}{R}$$

Now, External force must be equal to magnetic force

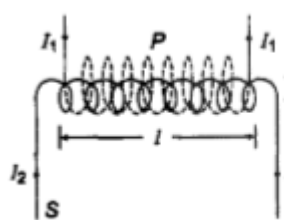
$$\therefore \text{External force} = \frac{vB^2 l^2}{R}$$

iii. As, $P = I^2 R = \left(\frac{vBl}{R} \right)^2 \times R = \frac{v^2 B^2 l^2}{R^2} \times R$

$$\therefore P = \frac{v^2 B^2 l^2}{R}$$

OR

Let coaxial solenoid P is wound over an another solenoid.



Let l = length of both solenoid

r_1 and r_2 = radii of P and S

$$A_2 = \pi r_2^2 \text{ [area of secondary coil, S]}$$

Magnetic induction in solenoid, P

$$B_1 = \mu_0 n_1 I_1$$

$$\text{where, } n_1 = \frac{N_1}{l}$$

$\therefore$ Total flux linked with solenoid S,

$$\phi_2 = B_1 A_2 N_2$$

$$\Rightarrow \phi_2 = B_1 (\pi r_2^2) N_2 = (\mu_0 n_1 I_1) \pi r_2^2 N_2$$

$$\phi_2 = \left(\mu_0 \frac{N_1}{l} I_1 \right) \pi r_2^2 N_2$$

$$\Rightarrow \phi_2 = \frac{\mu_0 \pi I_1 N_1 N_2 r_2^2}{l} \dots (i)$$

$$\text{But } \phi_2 = MI_1$$

where, M = coefficient of mutual induction

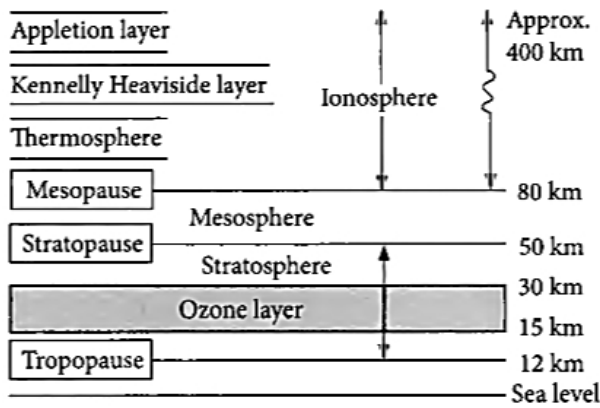
$$\Rightarrow MI_1 = \frac{\mu_0 \pi N_1 N_2 r_2^2}{l} I_1 \Rightarrow M = \frac{\mu_0 \pi N_1 N_2 r_2^2}{l}$$

Section D

29. Read the text carefully and answer the questions:

Radio waves are produced by the accelerated motion of charges in conducting wires. Microwaves are produced by special vacuum tubes. Infrared waves are produced by hot bodies and molecules also known as heat waves. UV rays are produced by special

lamps and very hot bodies like Sun.



- (i) (d) Option (i)

Explanation:

transverse electromagnetic wave

- (ii) (c) Infrared rays

Explanation:

Greenhouse effect is due to infrared rays.

- (iii) (b) it stops ultraviolet rays

Explanation:

Ozone layer absorbs the harmful ultraviolet radiations coming from the sun.

OR

- (d) infrared

Explanation:

The atmosphere of earth is richest in infrared radiation.

- (iv) (c) stratosphere

Explanation:

Ozone layer lies in stratosphere.

30. i. From, $q = ne$, $n = \frac{q}{e} = \frac{3.2 \times 10^{-18}}{1.6 \times 10^{-19}} = 20$

Hence, the number of electrons on the body is 20.

- ii. Charge on the body is $q = ne$

$\therefore$ No. of electrons present on the body is $n = \frac{q}{e} = \frac{1 \times 10^{-9} \text{ C}}{1.6 \times 10^{-19} \text{ C}} = 6.25 \times 10^9$

- iii. Here, $n = 10^9$ electrons per second

The charge given per second, $q = ne = 10^9 \times 1.6 \times 10^{-19} \text{ C}$

$q = 1.6 \times 10^{-10} \text{ C}$

Total charge, $Q = 1 \text{ C}$...(given)

$\therefore$ Time required = $\frac{Q}{q} = \frac{1}{1.6 \times 10^{-10}} \text{ s} = 6.25 \times 10^9 \text{ s}$

$\therefore \frac{6.25 \times 10^9}{3600 \times 24 \times 365} \text{ year} = 198.19 \text{ years}$

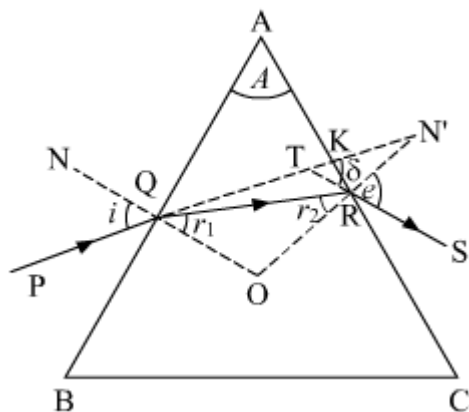
iv. As $q = ne$, $n = \frac{3.2 \times 10^{-7}}{1.6 \times 10^{-19}}$

$\Rightarrow n = 2 \times 10^{12} \text{ electrons}$

$\therefore$ the number of electrons transferred will be 2×10^{12}

Section E

31. a. The figure below shows the passage of light through a triangular prism ABC.



The angles of incidence and refraction at first face AB are $\angle i$ and $\angle r_1$

The angles of incidence at the second face AC is $\angle r_2$ and the angle of emergence $\angle e$

δ is the angle between the emergent ray RS and incident ray PQ and is called the angle of deviation.

Here, $\angle PQN = i$, $\angle SRN' = e$, $\angle RQO = r_1$, $\angle QRO = r_2$, $\angle KTS = \delta$

$\therefore \angle TQO = i$ and $\angle RQO = r_1$, we have

$$\angle TQR = i - r_1$$

$$\angle TRO = e \text{ and } \angle QRO = r_2$$

$$\angle TRQ = e - r_2$$

In triangle TQR, the side QT has been produced outwards. Therefore, the exterior angle δ should be equal to the sum of the interior opposite angles.

$$\text{i.e., } \delta = \angle TQR + \angle TRQ = (i - r_1) + (e - r_2)$$

$$\delta = (i + e) - (r_1 + r_2) \dots (i)$$

In triangle QRO,

$$r_1 + r_2 + \angle ROQ = 180^\circ \dots (ii)$$

From quadrilateral AROQ, we have the sum of angles ($\angle AQO + \angle ARO = 180^\circ$) This means that the sum of the remaining two angles should be 180° .

$$\text{i.e., } \angle A + \angle QOR = 180^\circ [\angle A \text{ is called the angle of prism}]$$

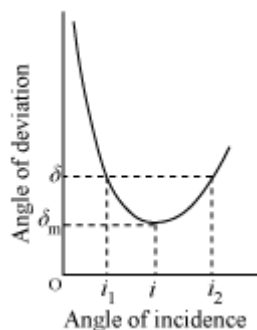
From equations (i) and (ii),

$$r_1 + r_2 = A \dots (iii)$$

Substituting (iii) in (i), we obtain,

$$\delta = (i + e) - A$$

$$A + \delta = i + e$$



If the angle of incidence is increased gradually, then the angle of deviation first decreases, attains a minimum value (δ_m), and then again starts increasing.

When angle of deviation is minimum, the prism is said to be placed in the minimum deviation position.

There is only one angle of incidence for which the angle of deviation is minimum.

When

$$\delta = \delta_m \text{ [prism in minimum deviation position],}$$

$$e = i \text{ and } r_2 = r_1 = r \dots (iv)$$

$$\therefore r_1 + r_2 = A$$

From equation (iv), $r + r = A$

$$r = \frac{A}{2}$$

Also, we have

$$A + \delta = i + e$$

Setting,

$$\delta = \delta_m \text{ and } e = i$$

$$A + \delta_m = i + i$$

$$i = \frac{(A + \delta_m)}{2}$$

$$\therefore \mu = \frac{\sin i}{\sin r}$$

$$\therefore \mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

- b. The incident ray travelling from denser medium to rarer medium grazes along the surface of the separation of the medium only when the light ray incident at the surface at an angle called critical angle (C) such that the angle of reflection is 90° .

Therefore, following Snell's law, we can write

$$\frac{\mu_1}{\mu_2} = \frac{\sin 90}{\sin C}$$

$$\frac{\mu_1}{\mu_2} = \frac{1}{\sin C}$$

$$\frac{\mu_2}{\mu_1} = \frac{1}{\sin C}$$

$$\frac{\sqrt{2}}{1} = \frac{1}{\sin C}$$

$$\sin C = \frac{1}{\sqrt{2}}$$

$$C = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$$

$$\therefore \text{Critical angle} = \text{Angle of incidence} = 45^\circ$$

OR

S.No	Interference	Diffraction
1.	The width of central maxima is the same as that of the other fringes.	The width of central maxima is more than of the other fringes.
2.	All bright fringes are of equal intensity.	The intensity of secondary maxima keeps on decreasing.
3.	A large number of fringes.	Only a small number of fringes.

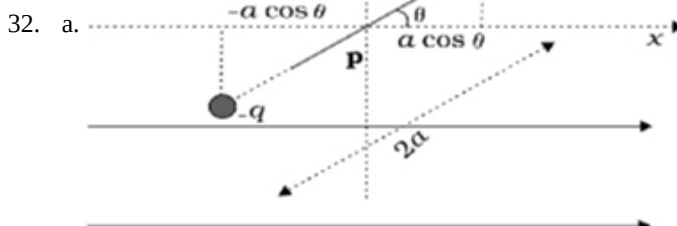
- ii. $y_n = \frac{n\lambda D}{d}$, $\lambda = 500 \times 10^{-9}$ m, $D = 1$ m, and $y_n = 2.5 \times 10^{-3}$ m thus the width of the slit is given by:-

$$\Rightarrow d = \frac{n\lambda D}{y_n}$$

$$\therefore d = \frac{1 \times 500 \times 10^{-9} \times 1}{2.5 \times 10^{-3}} \text{ m}$$

$$d = 2 \times 10^{-4} \text{ m} = 0.2 \text{ mm}$$

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Since torque acting on dipole

$$\vec{\tau} = \vec{p} \times \vec{E}$$

$$\vec{\tau} = pE \sin \theta \cdot \hat{n}$$

$$\text{work done } d\omega = \tau \cdot d\theta$$

$$= pE \sin \theta d\theta$$

$$w = \int_{\theta_1}^{\theta_2} dw = pE \int_{\theta_1}^{\theta_2} \sin \theta d\theta$$

$$w = pE [-\cos \theta]_{\theta_1}^{\theta_2}$$

$$= pE [\cos \theta_1 - \cos \theta_2]$$

$$\text{if } \theta_1 = 0, \theta_2 = \theta$$

$$w = pE (1 - \cos \theta)$$

Conditions-

For stable equilibrium - When electric dipole is parallel to electric field.

For unstable equilibrium - Anti Parallel to electric field.

b. No.

Inside equipotential surface

OR

a. During charging of the capacitor, work is done by the battery which is stored in the form of potential energy inside the capacitor.

Consider a capacitor which is to be charged by charge Q with the help of a battery. Let at any instant charge on the capacitor is q and the potential difference between the two plates of the capacitor is V .

We know that,

$$q = CV \Rightarrow V = q/C$$

Now small work done to charge the capacitor by small charge dq ,

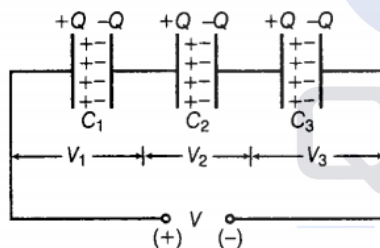
$$dW = Vdq = \frac{q}{C} dq$$

where, q = instantaneous charge, C = capacitance and V = voltage

$\therefore$ Total work done in storing charge from 0 to Q (total charge) is given by

$$\Rightarrow W = \int_0^Q \frac{q}{C} dq = \frac{Q^2}{2C}$$

b. In a series combination of capacitors, the same charge lie on each capacitor for any value of capacitances.



Capacitors in series combination

Also, the net potential difference across the combination is equal to the algebraic sum of potential differences across each capacitor

$$\text{i.e. } V = V_1 + V_2 + V_3 \dots \dots \dots (i)$$

where V_1, V_2, V_3 and V are the potential differences across C_1, C_2, C_3 and equivalent capacitor, respectively.

$$\text{Again } q_1 = C_1 V_1 \Rightarrow V_1 = \frac{q_1}{C_1}$$

$$\text{Similarly, } V_2 = \frac{q}{C_2} \text{ and } V_3 = \frac{q}{C_3}$$

$\therefore$ Total potential difference [From Eq.(i)]

$$\Rightarrow V = \frac{q}{C_1} + \frac{q}{C_2} + \frac{q}{C_3}$$

$$\Rightarrow \frac{V}{q} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \left[\frac{V}{q} = \frac{1}{C}, \text{ where } C \text{ is equivalent capacitance} \right]$$

33. Here, $L = 5.0 \text{ H}$, $R = 40 \Omega$

$$C = 80 \mu F = 80 \times 10^{-6} F$$

$$E_v = 230 \text{ volt}$$

$$E_0 = \sqrt{2} E_v = \sqrt{2} \times 230 V$$

i. Resonance angular frequency,

$$\omega_r = \frac{1}{\sqrt{LC}}$$

$$= \frac{1}{\sqrt{5 \times 80 \times 10^{-6}}} = \frac{1}{2 \times 10^{-7}} = 50 \text{ rad/sec}$$

ii. Impedance, $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

At resonance, $\omega L = \frac{1}{\omega C}$

$Z = \sqrt{R^2} = R = 40\Omega$

Amplitude of current at resonating frequency,

$I_0 = \frac{E_0}{Z} = \frac{\sqrt{2} \times 230}{40} = 8.13 \text{ A}$

$I_v = \frac{I_0}{\sqrt{2}} = \frac{8.13}{\sqrt{2}} = 5.75 \text{ A}$

iii. Potential drop across L,

$V_L = I_v \omega_r L = 5.75 \times 50 \times 5.0 = 1437.5 \text{ V}$

Potential drop across R,

$V_R = I_v \times R = 5.75 \times 40 = 230 \text{ V}$

Potential drop across C,

$V_C = I_v \left(\frac{1}{\omega_r C}\right)$

$= 5.75 \times \frac{1}{50 \times 80 \times 10^{-6}}$

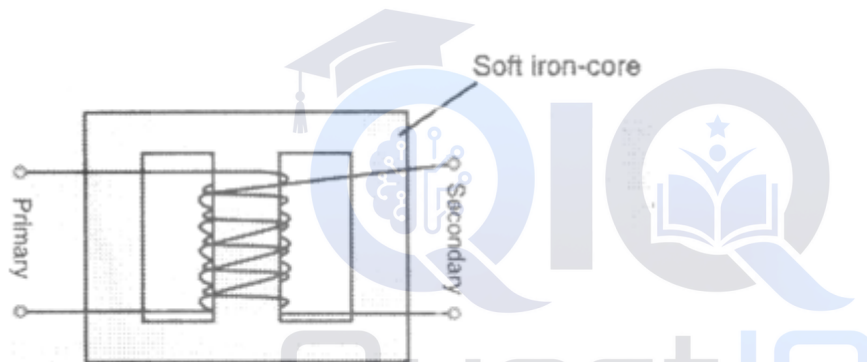
$= \frac{5.75}{4} \times 10^3 = 1437.5 \text{ V}$

Potential drop across LC circuit,

$V_{LC} = V_L - V_C = 0$

OR

i.



Whenever current in one coil changes an emf gets induced in the neighbouring coil (Principle of mutual induction)

Voltage across secondary

$V_s = e_s = -N_s \frac{d\phi}{dt}$

Voltage across primary

$V_p = e_p = -N_p \frac{d\phi}{dt}$

$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (here, $N_s > N_p$)

In an ideal transformer

Power Input = Power output

$I_p V_p = I_s V_s$

$\therefore \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$

ii. Calculation of the number of turns in the secondary:

No. of turns in primary coil $N_p = 3000$, $V_s = 220\text{V}$, $V_p = 2200\text{V}$

$\frac{N_s}{N_p} = \frac{V_s}{V_p}$

$\frac{N_s}{3000} = \frac{220}{2200}$

$\therefore N_s = 300$