Solution

PHYSICS

Class 12 - Physics

Section A

1.

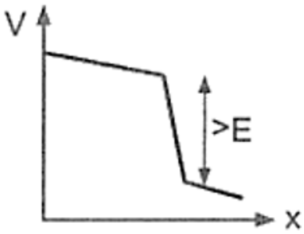
(d) 0 K

Explanation:

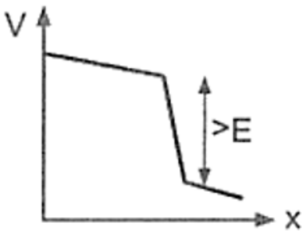
At very low temperatures, electrons cannot jump from the valence band to the conduction band.

2.

(c)



Explanation:



3.

(d) convergent lens of focal length 3.5 R

Explanation:

$\frac{1}{f}=(\frac{\mu_2}{\mu_1}-1)(\frac{1}{R_1}-\frac{1}{R_2})$

R_1 = -R and R_2 = R, hence,

$\frac{1}{f}=\left(\frac{1.5}{1.75}-1\right)\left(\frac{1}{-R}-\frac{1}{R}\right)=\left(\frac{1.5-1.75}{1.75}\right)\left(\frac{-2}{R}\right)=\frac{0.5}{1.75R}=\frac{1}{3.5R}$

or f = 3.5 R

Since focal length is positive, the lens acts as a converging lens.

4.

(b) $\frac{2}{3}\mathrm{Am}^{-1}$

Explanation:

On increasing the temperature magnetic susceptibility of paramagnetic material decreases or vice versa . According to Curie law, we can deduce a formula for the relation between magnetic field induction, temperature and magnetisation.

i.e., I (magnetization) $\propto \frac{B(\text{ magnetic field induction })}{t(\text{ temperature in kelvin })} \Rightarrow \frac{I_2}{I_1}=\frac{B_2}{B_1}\times\frac{t_1}{t_2}$

Let us suppose, here I_1 = 8 Am^{-1}

B_1 = 0.6 T, t_1 = 4 K

B_2 = 0.2 T, t_2 = 16 K

$\Rightarrow \frac{0.2}{0.6}\times\frac{4}{16}=\frac{I_2}{8}$

$\Rightarrow I_2=8\times\frac{1}{12}=\frac{2}{3}\mathrm{Am}^{-1}$

5. **(a)** 90 kW

Explanation:

$P=\frac{W}{t}=\frac{\frac{1}{2}CV^2}{t}=\frac{\frac{1}{2}\times(40\times10^{-6})\times(3000)^2}{2\times10^{-3}}$ W

= 9 $\times$ 10^4 W = 90 kW

6.

(d) 5 mA

Explanation:

5 mA

7.

(c) Electromagnetic induction

Explanation:

Electromagnetic induction, the electric dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through Faraday's law of induction.

8. **(a)** 0.126 V

Explanation:

$\varepsilon=Blv$

$=4\times10^{-5}\times35\times90$

$=126\times10^{-3}$ V = 0.126 V

9.

(d) $\frac{(2n+1)\lambda}{2}$

Explanation:

For destructive interference, the path difference should be an odd multiple of $\frac{\lambda}{2}$.

10.

(d) $\frac{q}{\epsilon_o}$

Explanation:

Since the charge q is placed at the center of the cube, so the electric flux lines move out equally from all sides of the cube. , so by Gauss theorem, the total flux through the cube is $\phi=\frac{q}{\varepsilon_0}$

11.

(c) 5 Ω

Explanation:

Voltage drop across diode, V_d = 0.5 V

Power rate of diode, P_d = 100 mW = 0.1 W

Resistance of the diode,

R_d = $\frac{V_d^2}{P_d}=\frac{(0.5)^2}{0.1}=2.5\Omega$

Maximum current through the diode,

I_d = $\frac{V_d}{R_d}=\frac{0.5}{2.5}$ = 0.2 A

Applied voltage, V = 1.5 V

Required total resistance of the circuit,

R' = $\frac{V}{I_d}=\frac{1.5}{0.2}=7.5\Omega$

Value of the series resistor, R = R' - R_d = 7.5 - 2.5 = 5Ω

12. **(a)** 4f

Explanation:

4f

13.

(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.

14.

(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.

15.

(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.

16.

(c) A is true but R is false.

Explanation:

As P = VI, so for the transmission of same power, high voltage implies low current. At high voltages, heat losses (H = I^2Rt) are substantially reduced.

Section B

17. a. Matter waves

(i) Matter waves are associated with moving particle

(ii) They travel with a speed less than the speed of light

(iii) **E** and **B** are not associated with these waves

Electromagnetic waves

(i) They are produced by accelerated charged particles

(ii) They travel with the speed of light

(iii) **E** and **B** are associated with these waves

b. $\lambda = \frac{h}{\sqrt{2mE_k}}$

Alternatively,

$\lambda \propto \frac{1}{\sqrt{E_k}}$

$\frac{\lambda_2}{\lambda_1} = \sqrt{\frac{E_{k1}}{E_{k2}}} = \sqrt{\frac{E_{K1}}{\frac{E_{k1}}{4}}} = \sqrt{4}$ = 2

$\lambda_2 = 2\lambda_1$

So,de Broglie wavelength associated with it become two times.

18. Here m = $q_m \times 2l = 14.4 \times 0.25 = 3.6$ Am^2, θ = 60°, B = 0.25 T, r = 12 cm = 0.12 m

Torque, τ = Fr = mB sin θ

$\therefore$ F = $\frac{mB\sin\theta}{r} = \frac{3.6\times0.25\times\sin 60^\circ}{0.12}$

= $\frac{3.6\times0.25\times0.866}{0.12}$ = 6.5 N

When the force F is removed, the magnet aligns itself in the direction of field B.

19. **Intrinsic semiconductors:** are pure semiconductors while extrinsic semiconductors are doped with either trivalent or pentavalent impurities.

Extrinsic semiconductor: maintains an overall charge neutrality as the charge of additional charge carriers is just equal and opposite to that of the ionised cores in the lattice.

20. a. When λ = 275nm = 275×10^{-9}m

$E = h\nu = \frac{hc}{\lambda} = \frac{6\cdot6\times10^{-34}\times3\times10^{8}}{275\times10^{-9}}$

$= \frac{19.8\times10^{-17}}{275\times1.6\times10^{-19}}\mathrm{eV} = 4.5\mathrm{eV}$

$\therefore$ Transition B will result in the emission of photon of λ = 275 nm

b. Maximum wavelength has minimum energy. Thus transition A corresponds to emission of radiation of maximum wavelength.

21. τ & = NIBA sin θ = 40 $\times$ 10 $\times$ 0.2 $\times$ 100 $\times$ 10^{-4} sin 90°

& = 0.8 Nm .

OR

Here N = 1, A = 5 $\times$ 10^{-2} m^2

B = 2 $\times$ 10^{-2} Wb m^{-2}, k = 4 $\times$ 10^{-9} Nm deg^{-1}

Current sensitivity

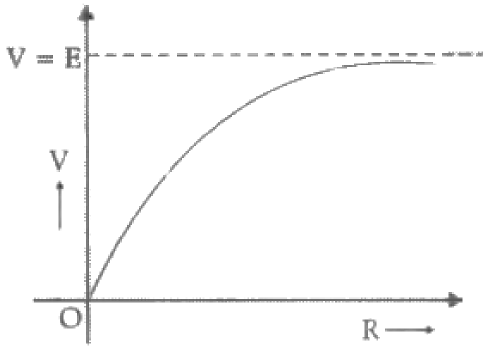
$= \frac{NBA}{k} = \frac{1\times2\times10^{-2}\times5\times10^{-2}}{4\times10^{-9}}$

= 0.25 $\times$ 10^6 deg A^{-1}

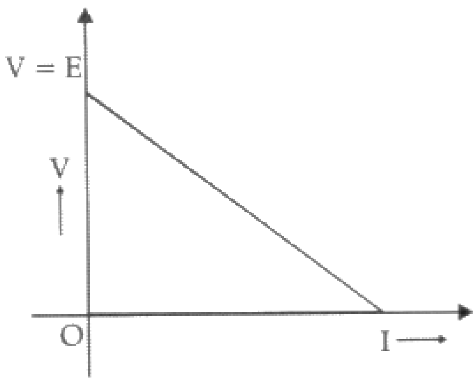
= 0.25 deg μ A^{-1}

Section C

22. i.



ii.



$I = \frac{E}{R+r}$ (V=E-Ir and V=IR)

$I = \frac{E}{4+r}$

$\Rightarrow$ E = 4 + r ...(i)

0.5 = $\frac{E}{9+r}$

Also E = 4.5 + 0.5r ...(ii)

From equation (i) and (ii),

4 + r = 4.5 + 0.5r

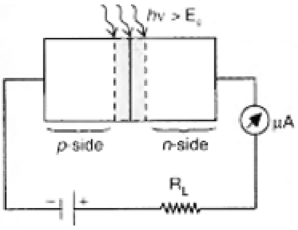
$\therefore$ r = 1 Ω (internal resistance)

Using this value of r, we get,

E = 5V

23. i. When you heat the semiconductor the resistance in the circuit will decrease. On making current fixed, we have to increase the resistance in the circuit to keep the reading of ammeter A constant.

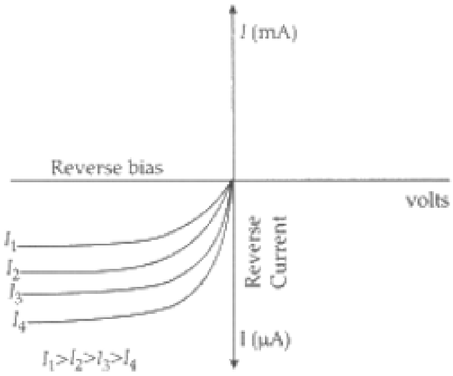
ii. Photodiode diagram



When the photodiode is illuminated with light (photons) (with energy (hν) greater than the energy gap (E_g) of the semiconductor), then electron-hole pairs are generated due to the absorption of photons. Due to the junction field, electrons and holes are separated before they recombine. Electrons are collected on n-side and holes are collected on p-side giving rise to an emf.

When an external load is connected, current flows

I-V Characteristics of the diode:



24. a. Einstein's photoelectric equation is

$eV_0 = K_{max} = h\nu - \phi_0$

Important features of this equation are given below

i. Photoemission occurs when frequency of incident radiation is more than the threshold frequency, $\nu_o = \frac{\phi_0}{h}$

ii. Energy of emitted photoelectron is proportional to energy of incident photon.

iii. Photoelectric emission is an instantaneous process.

b. The threshold frequency of surface P is greater than 10^{15} Hz, and that is the reason no photoemission takes place.

For surface Q, the threshold frequency is equal to 10^{15} Hz. So, photoemission takes place but photoelectrons have zero kinetic energy.

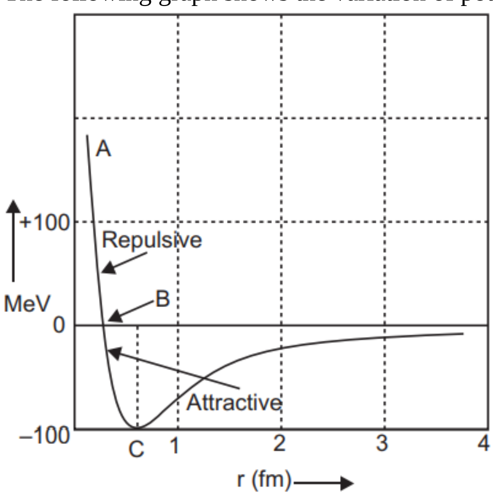
If the kinetic energy of the electrons emitted from surface B has to be increased then, the wavelength of the incident radiation has to be decreased.

Energy of incident photon is less than work function of P but just equal to that of Q.

For Q, Work function,

$\phi_0 = \frac{h\nu}{e}(eV) = \frac{6.6\times10^{-34}\times10^{15}}{1.6\times10^{-19}} = 4.1\text{eV}$

25. The following graph shows the variation of potential energy with the separation of nucleons



1. Part BC of the graph shows the attractive force.
2. Part AB of the graph shows the repulsive force.

The characterstic features of the nuclear force are as under:

1. Nuclear forces are attractive and stronger than the electrostatic force.
2. Nuclear forces are charge-independent and short range forces.

26. Number of a-particles scattered at an angle θ ,
$N \propto \frac{1}{\sin^4(\theta/2)}$ i.e; $N = \frac{K}{\sin^4(\theta/2)}$
where K is a proportionality constant
$\therefore \quad \frac{N_{90^\circ}}{N_{60^\circ}} = \frac{\sin^4(60^\circ/2)}{\sin^4(90^\circ/2)}$
or $N_{90^\circ} = \frac{\sin^4 30^\circ}{\sin^4 45^\circ} \times N_{60^\circ} = \left[\frac{1/2}{1/\sqrt{2}}\right]^4 \times 100$
$= \frac{100}{4} =$ particles min^{-1}.

27. a. fringe width $\beta = \frac{D\lambda}{d}$
so as d increases β decrease so fringes will not be resolved and observable. (they do not appear separate)
b. Conditions:-
- Two sources produce waves of same frequency.
- Two sources produce waves of constant phase difference.

c. $\beta = \frac{D\lambda}{d}$
so if λ changes by 1.5λ
β, fringe width increases, so more brighter will be the fringes.

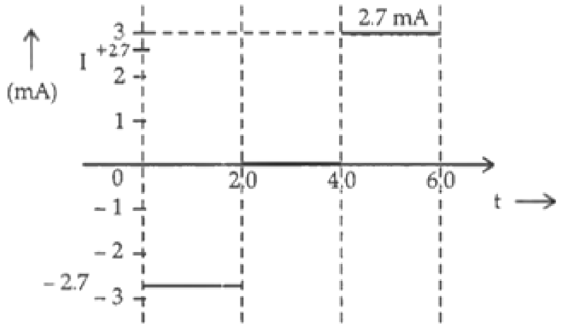
28. i. Suppose a rod of length 'l' moves with velocity v inward in the region having uniform magnetic field B.
Initial magnetic flux enclosed in the rectangular space is $\phi = |B|lx$
As the rod moves with velocity $-v = \frac{dx}{dt}$
Using Lenz's law,
$\varepsilon = -\frac{d\phi}{dt} = -\frac{d}{dt}(Blx) = Bl\left(-\frac{dx}{dt}\right)$
$\therefore \quad \varepsilon = Blv$
ii. Suppose any arbitrary charge 'q' in the conductor of length 'l' moving inward in the field as shown in figure, the change q also moves with velocity v in the magnetic field B.
The Lorentz force on the charge 'q' is F = qvB and its direction is downwards.
So, work done in moving the charge 'q' along the conductor of length l
W = F.l
W = qvBl
Since emf is the work done per unit charge
$\therefore \quad \varepsilon = \frac{W}{q} = Blv$
This equation gives emf induced across the rod.

OR

$\varepsilon = -\frac{d\phi}{dt}$
$= -\pi R^2 \times \frac{dB}{dt}$
$= -\frac{22}{7} \times (0.12)^2 \times \frac{1}{2}$
ε = -0.023 V,
I = $\frac{\varepsilon}{R}$
= - 2.7 mA for 0 < t < 2s.
Similarly,

	0 < t < 2s	2 < t < 4 s	4 < t < 6 s
ε(V)	-0.023	0	+0.023
I (mA)	-2.7	0	+2.7

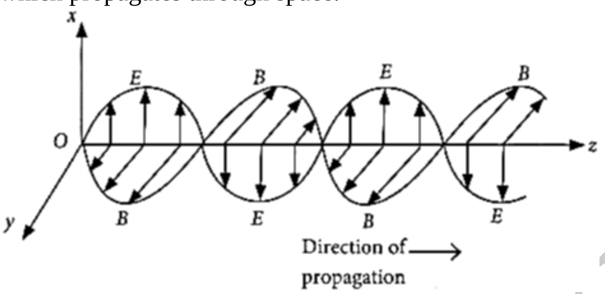
The graphical variation of induced current with time is shown in fig. From t = 0 to t = 2s, magnetic field is increasing. Therefore, induced current opposes the increase. From t = 2s to t = 4s induced current is zero. From t = 4s to t = 6s magnetic field is decreasing. Therefore, induced current opposes the decrease and flow in the same direction.



Section D

29. **Read the text carefully and answer the questions:**

A stationary charge produces only an electrostatic field while a charge in uniform motion produces a magnetic field, that does not change with time. An oscillating charge is an example of accelerating charge. It produces an oscillating magnetic field, which in turn produces an oscillating electric fields and so on. The oscillating electric and magnetic fields regenerate each other as a wave which propagates through space.



(i) **(a)** $\vec{E}$ = B_0c sin (kx + ωt) $\hat{k}$ V/m

Explanation:

Given : $\vec{B}$ = B_0 sin (kx + ωt)$\hat{j}$T

The relation between electric and magnetic field is, c = $\frac{E}{B}$ or E = cB

The electric field component is perpendicular to the direction of propagation and the direction of magnetic field.

Therefore, the electric field component along z-axis is obtained as $\vec{E}$ = cB_0 sin (kx + ωt) $\hat{k}$ V/m

(ii) **(b)** $\frac{2E_0}{c}$ $\hat{j}$ sin kz sin ωt

Explanation:

$\frac{dE}{dz} = -\frac{dB}{dt}$

$\frac{dE}{dz}$ = -2 E_0k sin kz cos ωt = $-\frac{dB}{dt}$

dB = +2 E_0k sin kz cos ωt dt

B = +2 E_0k sin kz $\int$ cos ωt dt = +2 E_0 $\frac{k}{\omega}$ sin kz sin ωt

$\frac{E_0}{B_0} = \frac{\omega}{k} = c$

B = $\frac{2E_0}{c}$ sin kz sin ωt $\therefore$ $\vec{B}$ = $\frac{2E_0}{c}$ sin kz sin ωt $\hat{j}$

E is along y-direction and the wave propagates along x-axis.

$\therefore$ B should be in a direction perpendicular to both x-and y-axis.

(iii) **(c)** 0.021 μT

Explanation:

Here, E = 6.3 $\hat{j}$; c = 3 $\times$ 10^8 m/s

The magnitude of B is

B_z = $\frac{E}{c}$ = $\frac{6.3}{3\times10^8}$ = 2.1 $\times$ 10^{-8} T = 0.021 μ T

OR

(a) 3.1 $\times$ 10^{-8} T

Explanation:

At a particular point, E = 9.3 V m^{-1}

$\therefore$ Magnetic field at the same point = $\frac{9.3}{3\times10^8}$

= 3.1×10^{-8} T

(iv) **(b)** $E_y = 66 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_z = 2.2 \times 10^{-7} \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

Explanation:

Here : E_0 = 66 V m^{-1}, $E_y = 66 \cos \omega\left(t - \frac{x}{c}\right)$,

λ = 3 mm = 3×10^{-3} m, k = $\frac{2\pi}{\lambda}$

$\frac{\omega}{k}$ = c $\Rightarrow \omega$ = ck = $3 \times 10^{8} \times \frac{2\pi}{3\times10^{-3}}$

or $\omega = 2\pi \times 10^{11}$

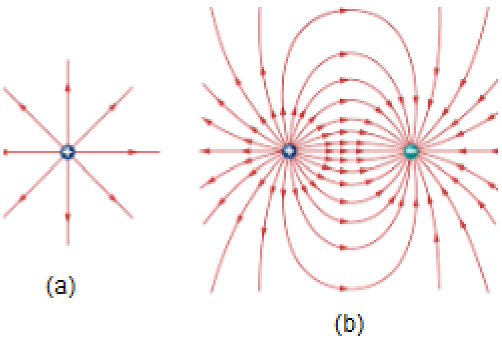
$\therefore E_y = 66 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

$B_z = \frac{E_y}{c} = \left(\frac{66}{3\times10^{8}}\right) \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

= $2.2 \times 10^{-7} \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

30. **Read the text carefully and answer the questions:**

Electric field lines as a path, straight or curved in an electric field such that tangent to it at any point gives the direction of electric field intensity at the point. Electric field lines are continuous curves they start from a positive charged body and end at the negatively charged body. (Refer image)



(i) **(d)** spherically symmetric

Explanation:

spherically symmetric

(ii) **(a)** N/C

Explanation:

N/C

(iii) **(b)** Electric field lines can intersect each other.

Explanation:

Electric field lines can intersect each other.

(iv) **(a)** path 'd'

Explanation:

path 'd'

OR

(c) All of these.

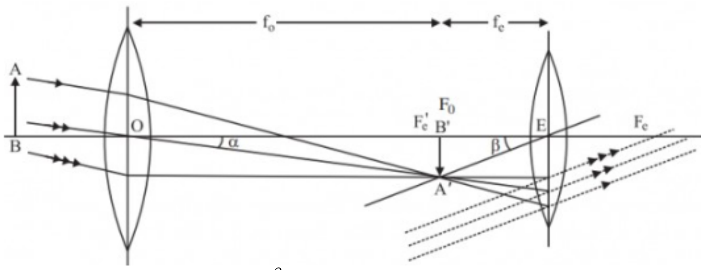
Explanation:

All of these.

Section E

31. i. Astronomical Telescope: Magnifying power of astronomical telescope in normal adjustment is defined as the ratio of the angle subtended at the eye by the final image to the angle subtended at the eye, by the object directly, when the final image and the

object both lie at infinite distance from the eye.



ii. Magnifying power, $m = \frac{\beta}{\alpha}$ ....(1)

As angles α and β are small, therefore, α ≈ tan α and β ≈ tan β

From equation (1),

$m = \frac{tan\beta}{tan\alpha}$ ....(2)

In $\Delta A'B'E$, $\tan\beta = \frac{A'B'}{EB'}$

In $\Delta A'B'O$, $\tan\alpha = \frac{A'B'}{OB'}$

Put in equation (2), we get,

$m = \frac{A'B'}{EB'} \times \frac{OB'}{A'B'} = \frac{OB'}{EB'}$

or $m = \frac{f_0}{-f_e}$

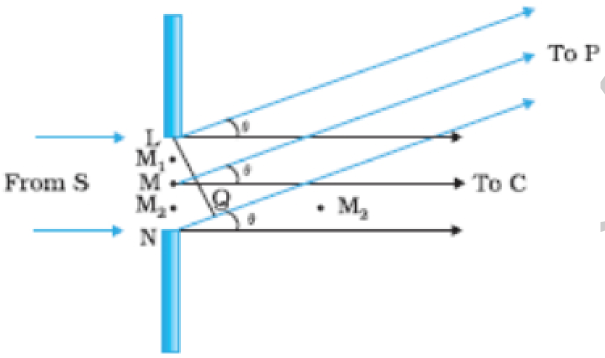
Where OB' = f_0 focal length of objective lens, EB' = $-f_e$ focal length of eye lens.

Negative sign of m indicates that final image is inverted.

The diameter of objective is kept large to increase (i) intensity of image, (ii) resolving power of telescope.

Telescope	Compound Microscope
Objective lens is of large focal length and eye lens is small focal length.	Both objective and eye lenses are of small focal length but focal length of eye lens is larger than that of objective lens.
Objective is of very large aperature.	Objective is of small aperture.

OR

a. 

From diagram path difference between the waves from L and N = a sinθ

When first minimum is obtained at P then path difference $= \lambda$

[imagine the slit be divided into two halves, for each wavelets from first half of the slit has a corresponding wavelet from second half of the slit differing by a path of $\frac{\lambda}{2}$ and cancel each other]

Condition for first minimum

$\therefore \lambda = \mathrm{a}\sin\theta$

b. $\beta_{\mathrm{cm}} = \frac{2\lambda\mathrm{D}}{\mathrm{d}}$

i. As we know that wave length (λ) of red light is more than yellow light.

$\therefore \lambda_{\text{red}} > \lambda_{\text{yellow}}$

So, $\therefore \beta_{\text{red}} > \beta_{\text{yellow}}$

Hence, the linear width of the central maximum will increase if monochromatic yellow light is replaced with the red light.

ii. If the distance between the slit and screen (d) is increased then also the linear width of the central maximum will increase.

c. $10\frac{\lambda}{\mathrm{d}} = 2\frac{\lambda}{a}$

$\mathrm{a} = \frac{\mathrm{d}}{5}$ = 0.2 mm

32. 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 ⇒ V = q/C

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

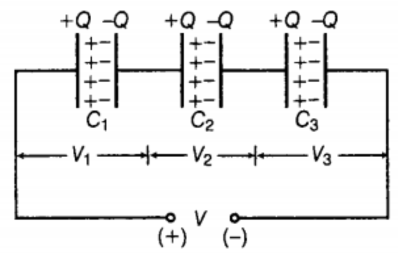
dW = Vdq = $\frac{q}{C}dq$

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

∴ 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

i.e. V = V_1 + V_2 + V_3 ....(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.

Again $q_1 = C_1V_1 \Rightarrow V_1 = \frac{q_1}{C_1}$

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

∴ Total potential difference [From Eq.(i)]

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

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

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

OR

Given,

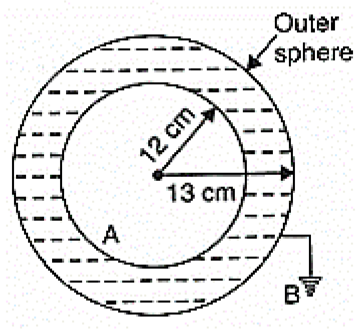
$r_1 = 12cm = 12 \times 10^{-2}m$

$r_2 = 13cm = 13 \times 10^{-2}m$

$q = 2.5\mu C = 2.5 \times 10^{-6}C$

k = 32

a. From formula,



$C = kC_0$

$C = k.4\pi\varepsilon_0\frac{r_1r_2}{r_2-r_1}$

$= \frac{32\times13\times10^{-2}\times12\times10^{-2}}{9\times10^9(13\times10^{-2}-12\times10^{-2})}\left[\therefore 4\pi\varepsilon_0 = \frac{1}{9\times10^9}\right]$

$= \frac{32\times13\times12}{9} \times 10^{-11} = \frac{1644}{3} \times 10^{-11}$

$= 5.54 \times 10^{-9}F$

b. Potential of inner sphere,

$V=\frac{q}{C}=\frac{2.5\times10^{-6}}{5.54\times10^{-9}}=4.5\times10^{2}V$

c. Capacitance of sphere

$=4\pi\varepsilon_0$

$=\frac{12\times10^{-2}}{9\times10^{9}}=1.33\times10^{-11}F$

Total potential in case of concentric spheres is distributed over two spheres and the potential difference between the two spheres becomes smaller that is why the capacitance of an isolated sphere is much small than that of concentric spheres. Since the capacitance is inversely proportional to the potential difference $\left(C=\frac{Q}{V}\right)$.

33. i. The figure shows the variation of resistance and reactance versus angular frequency, thus the Curve B corresponds to inductive reactance and curve C corresponds to resistance.

ii. At resonance,

$X_L = X_C$

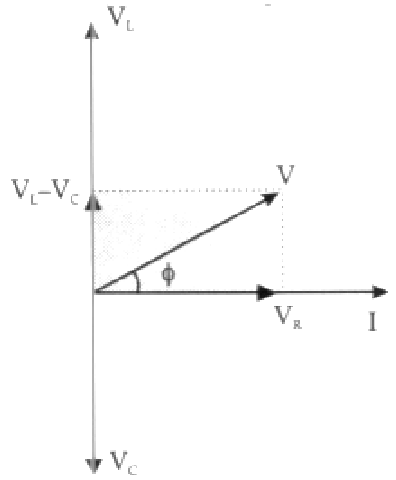
Therefore, impedance is given as:

Z = $\sqrt{R^2+(X_L-X_C)^2}$

Z = R

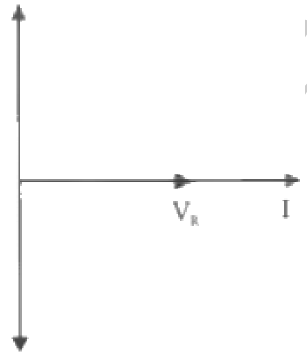
Thus, a series LCR circuit at resonance behaves as a purely resistive circuit.

Fr $X_L > X_C$, $V_L > V_C$. Therefore a phasor diagram is:



Here, ϕ is phase difference.

For $X_L = X_C$, $V_L = V_C$. Therefore phasor diagram is:

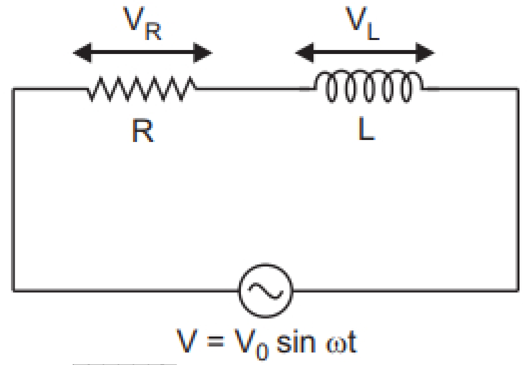


iii. A Series resonance LCR circuit is called an acceptor circuit.

They are widely used in the tuning mechanism of a radio or a TV.

OR

Let a circuit contain a resistor of resistance R and an inductor of inductance L connected in series. The applied voltage is V $=V_O\sin\omega t$. Suppose the voltage across resistor is V_R and that across inductor is V_L. The voltage V_R and current I are in the same phase, while the voltage V_L leads the current by an angle $\pi/2$ Thus, V_R and V_L are mutually perpendicular. The resultant of V_R and V_L is the applied voltage i.e.,



V = $\sqrt{V_R^2 + V_L^2}$

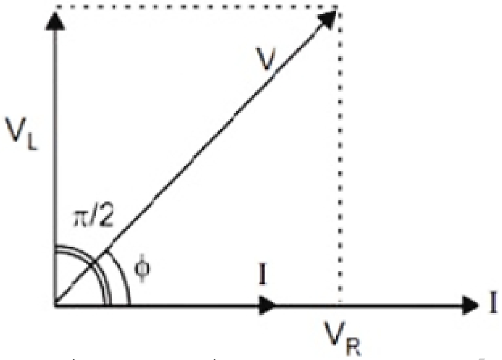
But V_R = Ri, V_L = X_L i = $\omega L i$

where X_L = ωL is inductive reactance

$\therefore$ V = $\sqrt{(Ri)^2 + (X_L i)^2}$

$\therefore$ Impedance, Z = $\frac{V}{i} = \sqrt{R^2 + X_L^2}$

$\Rightarrow$ Z = $\sqrt{R^2 + (\omega L)^2}$



P = $\frac{\mathrm{v_m i_m}}{2} \cos\phi$ = $\frac{\mathrm{v_m i_m}}{2} \cos\phi$

= VI cos ϕ

This can also be written as

P = I^2 Zcosϕ