Time : 3 Hours
Maximum Marks : 70

PHYSICS

CBSE
Sample Question Paper

Solutions of Question Paper (2020)

Section 'A'

1. Correct option : (b)

Explanation : According to Gauss's law of electrostatic field,

$$\oint \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0}$$

So, it does not contradict for electrostatic field as the electric field lines do not form continuous path.

According to Gauss's law of magnetic field,

$$\oint \vec{B}.\vec{ds} = 0$$

It is clear that it contradicts for magnetic field because there is magnetic field inside the solenoid, and no field outside the solenoid carrying current, but the magnetic field lines form the closed paths. **1**

2. Correct option : (b) **1**

3. Correct options : (b) and **(d)**

Explanation : Let E_2 and E_1 be the energy corresponding to $n = 2$ and $n = 1$, respectively. If radiation of energy,

$\Delta E = (E_2 - E_1) = h\nu$

incident on a sample where all the H-atoms are in the ground state, according to Bohr's model some of the atoms will move to the first excited state. As this energy is not sufficient for transition from $n = 1$ to $n = 3$, hence no atom will make a transition to the $n = 3$ state. **1**

4. Correct options : (a) and **(c)**

Explanation : In the direction of electric field (E), the potential energy (PE) or energy of E decreases. So, electrons always move opposite to direction *i.e.*, from lower energy level to higher energy level and holes move from higher energy level to lower energy level. In semiconductors, electrons are in conduction band and holes are in valence band. **1**

5. Correct option : (b)

Explanation :

Here, $I_{rms} = 5$ A, $\nu = 50$ Hz and $t = \frac{1}{300}$ s

$$I_0 = \text{Peak value} = \sqrt{2} I_{rms} = \sqrt{2} \times 5 = 5\sqrt{2} \text{ A}$$

Now, $I = I_0 \sin \omega t = 5\sqrt{2} \sin 2\pi\nu t$

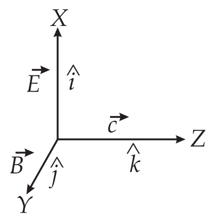
$$= 5\sqrt{2} \sin 2\pi \times 50 \times \frac{1}{300} = 5\sqrt{\frac{3}{2}} \text{ A}$$ **1**

6. Correct options : (a), (b), and **(c)**

Explanation : **(a)** The direction of propagation of an electromagnetic wave is always along the direction of vector product $\vec{E} \times \vec{B}$. Refer to figure.

(a) $\vec{B} = B\hat{j} = B(\hat{k} \times \hat{i}) = \frac{E}{c}(\hat{k} \times \hat{i})$ $\left(\text{as } \frac{E}{B} = c\right)$

$$= \frac{1}{c}(\hat{k} \times E\hat{i}) = \frac{1}{c}(\hat{k} \times \vec{E})$$



(b) $\vec{E} = E\hat{i} = cB(\hat{j} \times \hat{k}) = c(B\hat{j} \times \hat{k}) = c(\vec{B} \times \hat{k})$

(c) $\hat{k} \cdot \vec{E} = \hat{k} \cdot (E\hat{i}) = 0, \hat{k} \cdot \vec{B} = \hat{k} \cdot (B\hat{j}) = 0$

(d) $\hat{k} \times \vec{E} = \hat{k} \times (E\hat{i}) = E(\hat{k} \times \hat{i}) = E\hat{j}$

and $\hat{k} \times \vec{B} = \hat{k} \times (B\,\hat{j}) = B(\hat{k} \times \hat{j}) = -B\hat{i}$ **1**

7. Correct option : (d)

Explanation : Capacitor offers infinite resistance for DC circuit. So current from cell will not flow through branch of 4 μF and 10 Ω. So, current will flow through 2 ohm branch.

So, current flows through 2 Ω resistance from left to right is,

$$I = \frac{V}{(R+r)}$$

$$= \frac{2.5 \text{ V}}{(2+0.5)}$$

$= 1$ A

So, Potential Difference (PD) across 2 Ω resistance $V = RI = 2\times1 = 2$ Volt

Battery, capacitor and 2 Ω branches are in parallel. So PD will remain same across all three branches.

As current does not flow through capacitor branch so no potential drop will be across 10 Ω.

So PD across 4 μF capacitor = 2 Volt

$Q = CV = 4\ \mu\text{F}\times 2\text{ V} = 8\ \mu\text{C}$ **1**

Answering Tip

- Capacitor offers infinite resistance to DC current.

8. Correct options : (a) and (d)

Explanation : The Alexander's dark band lies between the primary and secondary rainbows, formed due to light scattered into this region interfere destructively. The primary rainbows subtend an angle nearly 41°– 42° at observer's eye, whereas secondary rainbows subtends an angle nearly 51°–54° at observer's eye with respect to incident light ray.

So, the scattered rays with respect to the incident light of the sun lies between approximately 42° and 50°. **1**

9. Correct options : (b) and (c)

Explanation : Applying the Ampere's circuital law, we have $\oint_c \vec{B}.\vec{dl} = \mu_0 (I - I) = 0$.

Hence, option (a) is wrong.

Also, $\oint_c \vec{B}.\vec{dl} = 0$, so, $\oint \vec{B}.\vec{dl}$ is independent of sense of C. Therefore, option (b) is correct.

Again there will be a point of loop C, lying at the axis of two loops A and B, hence, $\vec{B}$ and $\vec{dl}$ are perpendicular to each other. So, option **(c)** is correct.

Here, option **(d)** is wrong because value of $\vec{B}$ does not vanish on various points of C. **1**

10. Correct option : (a)

Explanation : The wave associated with moving particle is called matter wave or de-Broglie wave and it propagates in the form of wave packets with group velocity. According to de Broglie theory, the wavelength of de-Broglie wave is given by

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

As initial velocity of the electron is $v_0\hat{i}$, the initial de-Broglie wavelength of electron,

$$\lambda = \frac{h}{mv_0} \qquad \text{...(i)}$$

Electrostatic force on electron in electric field is,

$$\vec{F}_e = -e\vec{E} = -e\left[-E_0\hat{i}\right] = eE_0\hat{i}$$

Acceleration of electron, $\vec{a} = \frac{\vec{F}}{m} = \frac{eE_0\hat{i}}{m}$

Velocity of the electron after time t,

$$\vec{v} = v_0\hat{i} + \left(\frac{eE_0\hat{i}}{m}\right)t = \left(v_0 + \frac{eE_0}{m}t\right)\hat{i}$$

$$\Rightarrow \quad \vec{v} = v_0\left(1 + \frac{eE_0}{mv_0}\right)\hat{i}$$

de-Broglie wavelength associated with electron at time t is $\lambda = \frac{h}{mv}$

$$\Rightarrow \quad \lambda = \frac{h}{m\left[v_0\left(1+\frac{eE_0}{mv_0}t\right)\right]} = \frac{\frac{h}{mv_0}}{\left(1+\frac{eE_0}{mv_0}t\right)}$$

$$\Rightarrow \quad \lambda = \frac{\lambda_0}{\left[1+\frac{eE_0}{mv_0}t\right]} \qquad \left[As\ \lambda_0 = \frac{h}{mv_0}\right]$$

1

11. $c = \frac{1}{\sqrt{\mu\varepsilon}}$ **1**

OR

Ultra violet rays/Laser **1**

12. imaginary **1**

13. Cylindrical wave front **1**

14. 1.12eV, 0.75eV **1**

15. B.E. = $ZM_p + (A - Z)\ M - M] \times c^2 = \Delta Mc^2$ **1**

16. The energy gap of germanium is 0.72 eV whereas for silicon is 1.1 eV. Thus, the low band gap of germanium makes it as a perfect choice for making semiconductor devices. **1**

17. From the lens maker's formula, it is clear that n_{21} decreases then focal length increases. ½

$$\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \left(\because n_{21} = \frac{n_2}{n_1}\right)$$

Here refractive index of the glass with respect to surrounding material decreases. Hence, focal length increases which will also increase the image distance. ½

Commonly Made Error

- Many candidates write the correct lens maker's formula but could not relate that $(n_{21} - 1)$ is still negative, so the nature of lens changes.

Answering Tip

- Solve a few problems based on lens maker's formula and learn what happens when the lens is immersed in **(a)** rarer medium **(b)** a denser medium.

18. **(i)** Nichrome ½

(ii) $R_{Ni} > R_{Cu}$ (or Resistivity$_{Ni}$ > Resistivity$_{Cu}$)

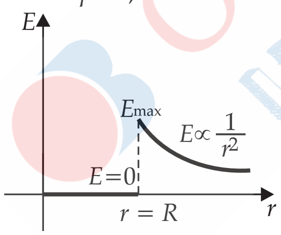
Justification : Conduction of electrons. ½

Two wires having similar length and radius, Nichrome wire gets heated up more as compared to Copper wire since resistivity of Nichrome is more than that of Copper. ½+½

19. The size of the dopant atom should be equivalent to the size of Si or Ge. So that the symmetry of pure Si or Ge, does not get disturbed and dopants can contribute to the charge carrier on forming covalent bonds with Si or Germanium atoms. Moreover, as the Si and Ge belong to XIV group, so similar size of atom will be in XIII and XV groups of Modern Periodic Table. 1

20. Field at an inside point $(r < R)$

As $q = 0$, $E = 0$.



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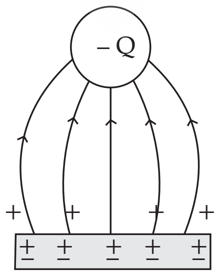
OR



1

[Note : (i) Deduct 1/2 mark, if arrows are not shown

(ii) do not deduct any mark, if charges on the plates are not shown]

Section 'B'

21. For hydrogen atom

The coulomb force provides the required centripetal force.

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} = \frac{mv^2}{r}$$

$$r = \frac{e^2}{4\pi\varepsilon_0 mv^2}$$ ½

Electron has kinetic energy

$$K = \frac{1}{2}mv^2$$

Putting the value of mv^2 in the above equation

$$K = \frac{e^2}{8\pi\varepsilon_0 r}$$ ½

P.E. of an electron $U = -\frac{1}{4\pi\varepsilon_0}\cdot\frac{e^2}{r}$ (negative sign shows that it is due to attraction force)

Total energy, $E = K + U$

$$E = \frac{e^2}{8\pi\varepsilon_0 r} + \left(-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\right)$$

$$= -\frac{e^2}{8\pi\varepsilon_0 r}$$ ½

The significance of total negative energy possessed by electron is bound to nucleus and revolve around it. This energy is known as binding energy of electron. ½

22. **(i)** Einstein's photoelectric equation,

K.E. of photoelectron = Incident energy of photons – Work function

or, $\quad$ K.E. $= h\nu - \phi_0$

or, $\quad$ K.E. $= h\nu - h\nu_0$

where, ν_0 is called threshold frequency.

(i) Threshold Frequency : For a given metal, there exists a certain minimum frequency of the incident radiation below which no emission of photoelectrons takes place. This frequency is called threshold frequency. It is denoted by ν_0. 1

(ii) Stopping Potential : It is that minimum negative potential given to anode in a photocell for which the photoelectric current becomes zero. It is denoted by V_0. It is independent of the intensity of the incident light. **1**

Commonly Made Errors

- A few student answer incorrectly as they did not know Einstein's photoelectric equation.
- Some students gave answer $h\nu = h\nu_0 + K_{max}$ or $W + K_{max}$ or other wrong statements.

23. We have : $B_P = B_Q = \dfrac{\mu_0 I}{2R}$ ½

B_P is directed in the vertically upward direction while B_Q is directed along the horizontal direction. ½

$$\therefore \quad B = \sqrt{B_P^2 + B_Q^2}$$

$$= \sqrt{2}B_P$$

$$= \sqrt{2}B_Q$$

$$\Rightarrow \quad B = \sqrt{2}\frac{\mu_0 I}{2R}$$

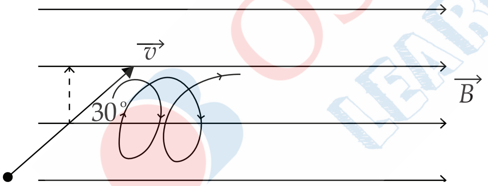
$$= \left(\frac{\mu_0 I}{\sqrt{2}R}\right) \quad ½$$

The net magnetic field is directed at an angle of 45° with either of the field. ½

OR

Drawing of trajectory **1**

Explanation **1**

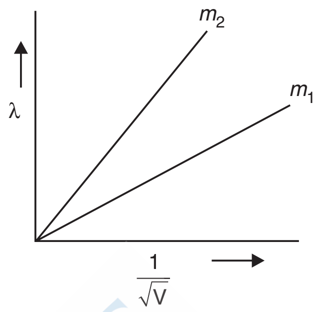


Two components of velocity vector $\vec{v}$ are responsible for the helical motion. Force on the charged particle due to the component normal to the magnetic field, acts perpendicular to the velocity and the magnetic field. This makes the particle to follow circular path. The component of to velocity which is along the magnetic field, does not cause any force on the particle hence particle continues to move in a straight line path due to this component. Hence resultant path will be helical.

24. As $\lambda = \dfrac{h}{\sqrt{2mqV}}$

As the charge of two particles is same, therefore,

$$\frac{\lambda}{\left(\frac{1}{\sqrt{V}}\right)} \propto \frac{1}{\sqrt{m}} \quad i.e., \text{ slope} \propto \frac{1}{\sqrt{m}}$$



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Hence, particle with lower mass (m_2) will have greater slope.

Commonly Made Errors

- Most of the students couldn't relate the slope values.
- Some students even couldn't draw the graph.

25. Yes, the ammeter will show a momentary deflection. ½

The momentary deflection is due to the flow of electrons in the circuit during the charging process. During this process, the electric field between the capacitor plates is changing and hence a displacement current flows in the gap. Hence, we can say that there is a continuity of current in the circuit. **1**

Expression : $I_D = \varepsilon_0 \dfrac{d\phi_E}{dt}$ ½

OR

Ampere's circuital law,

$$\oint \vec{B}.\vec{dl} = \mu_0 I \quad ½$$

between the plates of capacitor,

$$I = 0$$

$$\therefore \quad \oint \vec{B}.\vec{dl} = 0 \quad ½$$

which is impossible, as there is magnetic field.

Modified ampere circuital law,

$$\oint \vec{B}.\vec{dl} = \mu_0(I_C + I_D) \quad ½$$

where, I_D = Displacement current = $\varepsilon_0 \dfrac{d\phi_E}{dt}$. ½

26. (i) Using the formula to obtain balance point :

$$\frac{R}{X} = \frac{rl}{r(100-l)} \qquad \left[\because r = \frac{\rho}{A}\right]$$

$$\therefore \quad \frac{R}{X} = \frac{l}{(100-l)}$$

If R and X gets doubled and their position interchanges, then the new balance length l' will be :

$$\frac{2X}{2R} = \frac{l'}{(100-l')}$$

So, $$\frac{X}{R} = \frac{l'}{(100-l')}$$ ½

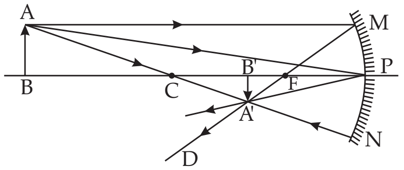
Hence, the new balance point position will be :

$$\frac{100-l}{l} = \frac{l'}{100-l'}$$

Hence, $$l' = (100-l)$$ ½

(ii) If the galvanometer and the battery gets interchanged, there will be no effect on the position of balance point since in null position there will be no flow of current in the circuit. **1**

27. (i)



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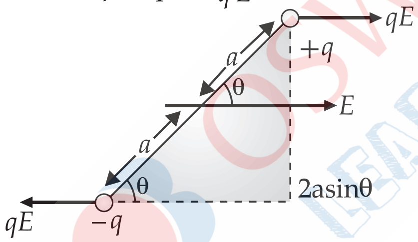
(ii) The position of image will remain same/unchanged, but the intensity of the image will decrease. **1**

Section 'C'

28. (i) Force on $+q$, $\vec{F} = q\vec{E}$ ½

Force on $-q$, $\vec{F} = -q\vec{E}$ ½



Magnitude of torque $\vec{\tau} = qE \times 2a\sin\theta$ ½

$= 2qaE\sin\theta$

$\vec{\tau} = \vec{p} \times \vec{E}$ ½

(ii) If the electric field is non-uniform, the dipole experiences a translatory force as well as a torque. **1**

29. (i) Correct Choice of *R* ½

Reason ½

(ii) Circuit Diagram **1**

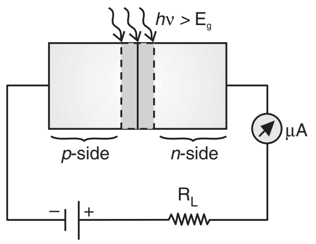
Working ½

***I-V* characteristics** ½

(i) *R* would be increased. ½

Resistance of S (a semiconductor) decreases on heating. ½

(ii) Photodiode diagram :



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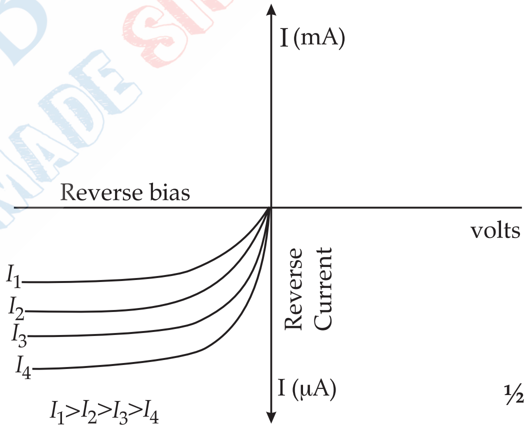
When the photodiode is illuminated with light (photons) (with energy ($h\nu$) greater than the energy gap (E_g) of the semiconductor), then electron-hole pairs are generated due to the absorption of photons. Due to junction field, electrons and holes are separated before they recombine. Electrons are collected on *n*-side and holes are collected on *p*-side giving rise to an emf. ½

When an external load is connected, current flows.

***I-V* Characteristics of the diode :**



½

30. The current leads the voltage in phase

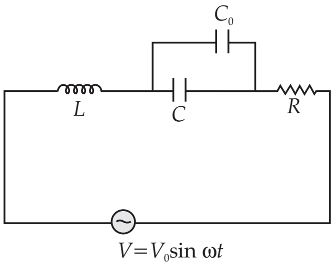
Hence, $X_C > X_L$

For resonance, we must have ½

New value of $X_C = X_L$

We, therefore, need to decrease $X_C = \left(\frac{1}{\omega C}\right)$. This requires an increase in the value of C. Hence, capacitor C_0 should be connected in parallel across C. ½

The diagram of the modified circuit is as shown.



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For resonance, we have ½

$$\frac{1}{\omega\,(C+C_0)} = \omega L$$

$$\therefore \quad C_0 = \left[\frac{1}{\omega^2 L} - C\right]$$ ½

31. (a) Frequency range for :

1. **Radar** — microwaves : $10^{12} - 10^{10}$ Hz
2. **Eye surgery** — UV radiations : $10^{17} - 10^{15}$ Hz

½+½+ ½+ ½

(b) From Maxwell's equations, magnitude of electric and magnetic fields in an electromagnetic wave are related as

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

Velocity, $v = \dfrac{1}{\sqrt{\mu\varepsilon}}$

Where, μ = magnetic permeability

ε = permittivity of material medium

$$\therefore c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$$

In a region of free space with electric field E,

energy density = $\varepsilon_0 \dfrac{E_0^2}{2}$

Magnetic energy density associated with magnetic field = $\dfrac{B_0^2}{2\mu_0}$

Using $B_0 = \dfrac{E_0}{c}$ in above equation given

magnetic energy density = $\dfrac{E_0^2}{c^2 \times 2\mu_0} = \dfrac{1}{2}\varepsilon_0 E_0^2$

The two energy densities are equal. 1

32. In circuit **(a)**,

Total emf = 15 V

Total Resistance = 2 Ω

Current, i = (15/2) A = 7.5 A ½

Potential difference between the terminals of 6 V battery

$$V = E - ir$$
$$= [6 - (7.5\times1)] \text{ V}$$
$$V = -1.5 \text{ V}$$

In circuit **(b)**,

Effective emf = (9 – 6) V 1

= 3 V

Total resistance = 2 Ω

Current, $i = \left(\dfrac{3}{2}\right)$ A = 1.5 A ½

Potential difference across 6 V cell

$$V = E + ir$$
$$= 6 + 1.5 \times 1$$
$$= 7.5 \text{ V}$$ 1

OR

(i) Let the original potential difference be V volts with heat generated as H.

Now, heat generated will be :

$$H = \frac{V^2 t}{R} \quad \text{...(1)}$$ ½

Take the new potential difference as V' and change in heat produced be H', so,

Change in heat produced :

$$H' = \frac{V'^2 t}{R} \quad \text{...(2)}$$

But from the question, if the heat is produced by a factor of 9, so

$$H' = 9H$$

So, $$\frac{V'^2 t}{R} = 9 \times \frac{V^2 t}{R}$$

$$V'^2 = 9V^2$$

$$V' = 3V$$ ½

Hence, it is clear that the applied potential difference increases by factor 3.

(ii) Ammeter Reading, $I = \dfrac{V}{R+r}$ ½

$$= \frac{12}{4+2} \text{ A} = 2 \text{ A}$$ ½

(iii) Voltmeter Reading, $V = E - Ir$ ½

$= [12 - (2 \times 2)]$ V = 8 V ½

(**Alternatively,** $V = iR$ = 2 × 4 V = 8 V)

33. (i) A_4 Mass Number : 172 ½

Atomic Number : 69 ½

A : Mass Number : 180 ½

Atomic Number : 72 ½

[**Alternatively :** Give full credit if student considers β^+ decay and find atomic and mass numbers accordingly.]

$$^{180}_{74}A \xrightarrow{\alpha} {}^{176}_{72}A_1 \xrightarrow{\beta^+} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{\gamma} {}^{172}_{69}A_4$$

Gives the values quoted above.

If the student takes β^+ decay

$$^{180}_{74}A \xrightarrow{\alpha} {}^{176}_{72}A_1 \xrightarrow{\beta^+} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{\gamma} {}^{172}_{69}A_4$$

This would give the answers :

(A_4 : 172, 69); (A 180, 74)] ½

(ii) Basic nuclear process for β^+ decay

$$p \rightarrow n + {}^{0}_{1}e + \nu$$

For β^- decay

$$n \rightarrow p + {}^{0}_{-1}e + \bar{\nu}$$ ½

[**Note :** Give full credit of this part, if student writes the processes as conversion of proton into neutron for β^+ decay and neutron into proton for β^- decay.]

34. **(i)** $|\varepsilon| = Bvl$

P is positive end

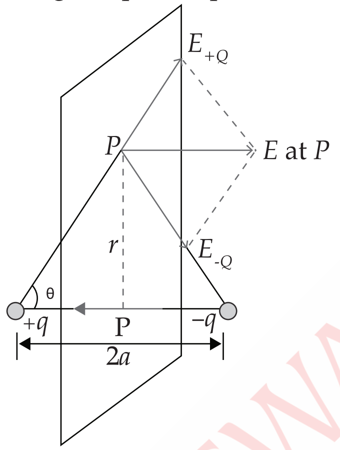
Q is negative end **1**

(ii) Magnetic force gets cancelled by electric force that generates due to extra charge of opposite sign at rod ends. **1**

(iii) Induced emf is zero as motion of rod is not cutting field lines **1**

Section 'D'

35. (a) The magnitude of the electric fields due to the two charges +q and –q are



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$$E_{+q} = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r^2+a^2)}$$ **½**

$$E_{-q} = \frac{1}{4\pi\varepsilon_0}\frac{q}{(r^2+a^2)}$$ **½**

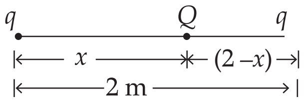
The components normal to the dipole axis cancel away and the components along the dipole axis add up.

Hence, total Electric field

$$= -(E_{+q} + E_{-q})\cos\theta\hat{p}$$ **½**

$$\vec{E} = \frac{2qa}{4\pi\varepsilon_0(r^2+a^2)^{\frac{3}{2}}}\hat{p}$$ **½**

(b)



½

System is in equilibrium therefore net force on each charge of system will be zero.

For the total force on 'Q' to be zero

$$\frac{1}{4\pi\varepsilon_0}\frac{qQ}{x^2} = \frac{1}{4\pi\varepsilon_0}\frac{qQ}{(2-x)^2}$$ **½**

$$x = 2 - x$$

$$2x = 2$$

$$x = 1 \text{ m}$$ **½**

(Give full credit of this part, if a student writes directly 1 m by observing the given condition)

For the equilibrium of charge "q" the nature of charge Q must be opposite to the nature of charge q. **½**

OR

(i)

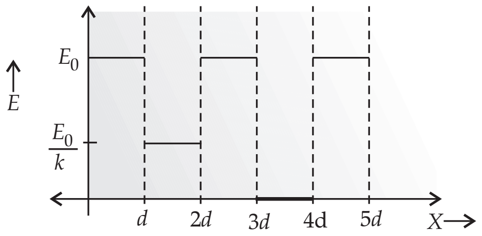
	Non-polar (O_2)	**Polar (H_2O)**
In absence of electric field		
Individual	No dipole moment exists.	Dipole moment exists.
Specimen	No dipole moment exists.	Dipoles are randomly oriented. Net $P=0$
In presence of electric field		
Individual	Dipole moment exists (molecules become polarised.)	Torque acts on the molecules to align them parallel to E.
Specimen	Dipole moment exists.	Net dipole moment exists parallel to E.

3

(ii) (a) $V = E_0 d + \frac{E_0}{k}d + E_0 d + 0 + E_0 d$ **½**

$$V = 3E_0 d + \frac{E_0}{k}d$$ **½**

(b) Graph :



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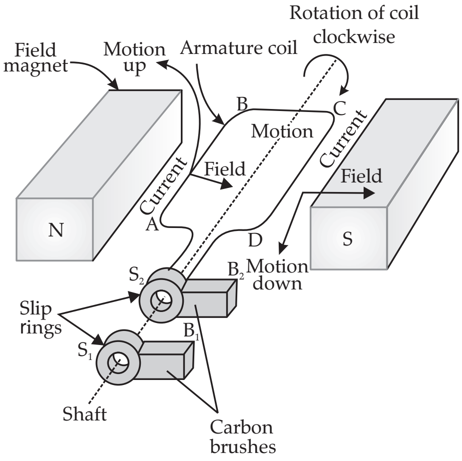
36. (i) AC generator

Basic elements of an AC generator :

- **Rectangular coil :** Also called as armature.
- **Strong permanent magnets :** Magnetic field is perpendicular of the axis of rotation of coil.
- Slip rings
- Brushes



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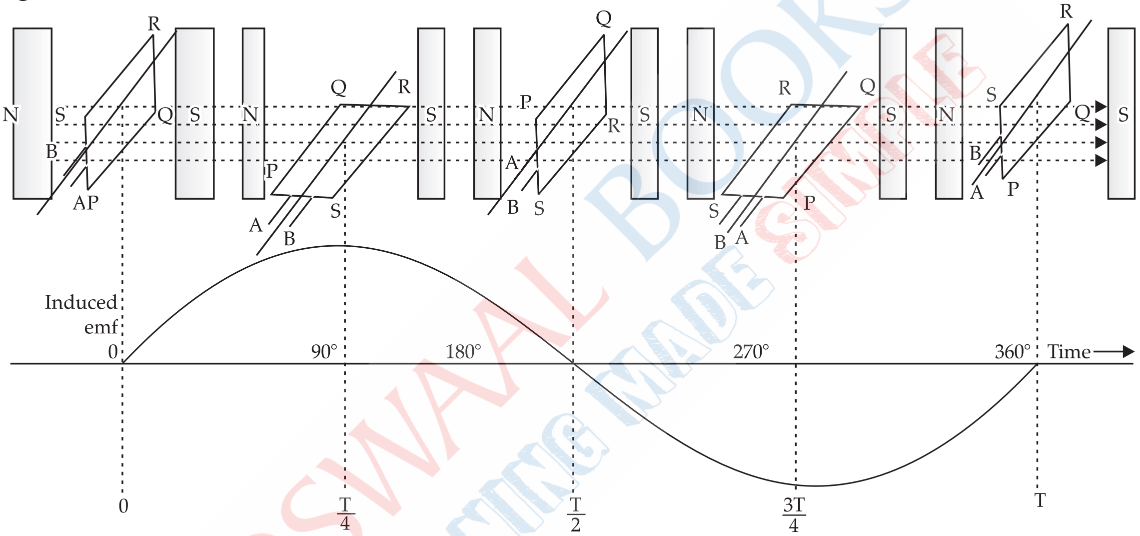
AC generator

Principle : It is based on the principle of electromagnetic induction. That is, when a coil is rotated about an axis perpendicular to the direction of uniform magnetic field, an induced emf is produced across it. **1**

Working of AC Generator



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(ii) **(a)** The capacitor stores energy in the form of electric field and the inductor stores energy in the form of magnetic field.

(b) Oscillations become damped due to : ½+½

- Resistance of the circuit ½
- Radiation in the form of EM waves ½

OR

(i) Curve *B* corresponds to inductive reactance and curve *C* corresponds to resistance. ½+½

(ii) At resonance,

$$X_L = X_C$$ **1**

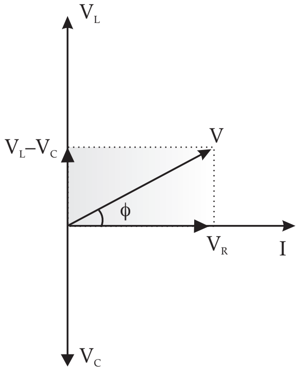
Therefore, impedance is given as :

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

$$Z = R$$

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

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



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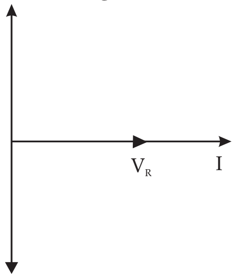
Here, ϕ is phase difference.

For $X_L = X_C$, $V_L = V_C$.

Therefore phasor diagram is :



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(iii) Series resonance *LCR* circuit is called an acceptor circuit. ½

They are widely used in the tuning mechanism of a radio or a TV. ½

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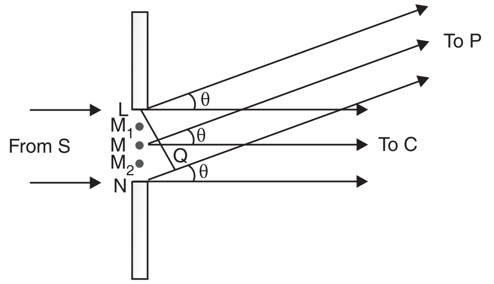


The diffraction pattern formed can be understood by adding the contributions from the different wavelets of the incident wavefront, with their proper phase differences. 1

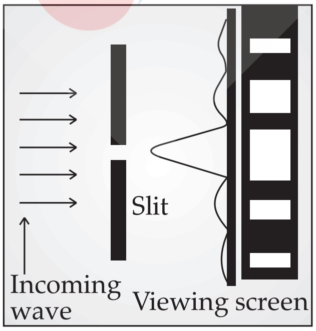
For the central point, we imagine the slit to be divided into two equal halves. The contribution of corresponding wavelets, in the two halves, are in phase with each other. Hence, we get a maxima at the central point. The entire incident wavefront contributes to this maxima. ½

All other points, for which $\theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{a}$,

get a net non zero contribution from all the wavelets. Hence, all such points are at the points of maxima. Points for which $\theta = \frac{n\lambda}{a}$,

the net contribution, from all the wavelets, is zero. Hence, these points are points of minima. ½

We, thus get a diffraction pattern on the screen, made up of points of maxima and minima. ½



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Secondary maxima keep on getting weaker in intensity, with increasing *n*. This is because, at the :

First secondary maxima, the net contribution is only from (effectively) $\frac{1}{3}$rd of the incident wavefront on the slit.

Second secondary maxima, the net contribution is only from (effectively) 1/5th of the incident wavefront on the slit and so on. 1

OR

(a) Definition of wavefront ½

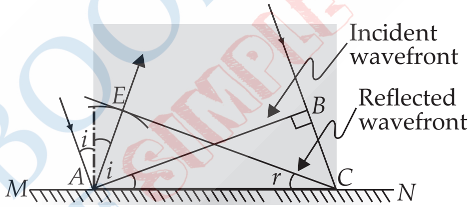
Verification of laws of reflection 2

(b) Explanation of the effect on the size and intensity of central maxima 1 + 1

(c) Explanation of the bright spot in the shadow of the obstacle ½

(a) The wavefront may be defined as a surface of constant phase. ½

[**Alternatively :** The wave front is the locii of all points that are in the same phase]



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Let speed of the wave in the medium be 'v'

Let the time taken by the wave front, to advance from point *B* to point *C* be 'τ' ½

Hence $BC = v\,\tau$

Let *CE* represent the reflected wave front

Distance $AE = v\,\tau = BC$

$\Delta\, AEC$ and $\Delta\, ABC$ are congruent

$$\angle BAC = \angle ECA \quad ½$$

$$\Rightarrow \quad \angle i = \angle r \quad ½$$

(b) Size of central maxima reduces to half, ½

($\therefore$ Size of central maxima = $2\frac{2\lambda D}{\alpha}$)

Intensity increases. ½

This is because the amount of light, entering the slit, has increased and the area, over which it falls, decreases. ½

(Also accept if the student just writes that the intensity becomes four fold)

(c) This is because of diffraction of light.

[**Alternatively :** Light gets diffracted by the tiny circular obstacle and reaches the centre of the shadow of the obstacle.] ½

[**Alternatively :** There is a maxima, at the centre of the obstacle, in the diffraction pattern produced by it.]

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