TOPPER SAMPLE PAPER I
Class XII - Physics
Solutions

A1.Its magnitude is 2qa and the direction is from –q to +q. (1)

A2.Electric flux: V.m; Electric field : V/m.(1)

A3. The input power is equal to the output power if 100% efficiency is assumed. So the power at the secondary will be 1kW. (1)

A4. X-ray, infrared, visible, microwaves (1)

A5. Frequency (1)

A.6 It affects the stopping potential but not the saturation current.(1)

A7. Because hole concentration is more in the p-region as compared to n-region.(1)

A8. Noise refers to any unwanted signals that tend to disturb the transmission and processing of message signals in a communication system.(1)

A9.
deBroglie wavelength,
$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}.$$
For the same kinetic energy de Broglie wavelength depends on the mass of the particle. (1)
As alpha particle is the most massive its de Broglie wavelength will be the shortest. (1)

A 10. Yes, because the potentiometer does not draw any current from the circuit but it still measures the potential difference. (1)
An ideal voltmeter has infinite resistance and hence it does not draw any current from the circuit.(1)

A.11 The refractive index of the liquid must be equal to 1.47 for the lens to disappear. (1)
Now the focal length of the lens is 1/f =0 or f tends to infinity. In other words , the lens in the liquid acts like a plane sheet of glass. (1)

A12.

$\tau = mB\sin\theta$ (1/2mark)

$5\times10^2 = (m)(1.0T)\sin 60^0$

$m = \frac{5\times10^2}{(1.0T)\sin 60^0} = \frac{1000}{\sqrt{3}} A.m^2$ $(1\frac{1}{2}\text{mark})$

A 13. The random thermal motion is reduced at low temperatures so the tendency to disturb the alignment of dipoles is reduced at lower temperatures.(1)
However, in a diamagnetic sample the alignment is opposite to the magnetizing field so temperature does not affect diamagnetism. (1)

A14. Power factor is $\cos\phi$ where P = VI$\cos\phi$. (1)
If power factor is small, the current has to be increased to maintain the same power. This leads to greater I^2R losses in transmission.(1)

A15. Resolving power = $\frac{2n\sin\theta}{\lambda}$

i) The resolving power increases on decreasing the wavelength of light.(1)
ii) It does not change on decreasing the diameter of the objective. (1)

A16.
Energy of electrons

$E = 30keV = 30\times10^3\times1.6\times10^{-19}$ joule

From Einstein equation,

$E = h\nu$

$\nu = \frac{E}{h} = \frac{30\times10^3\times1.6\times10^{-19}}{6.6\times10^{-34}} = 7.27\times10^{18}Hz$ (1)

$\lambda = \frac{v}{\nu} = 0.413nm$ (1)

A17. Nuclear density for iron will be $2.3\text{x}10^{17}$ kg/ m^3. (1)
Nuclear density is independent of mass number A so iron also has the same nuclear density as hydrogen.(1)

A18. TV signals has a frequency between 100 and 200MHz so they are not reflected by the ionosphere. Thus their transmission via sky waves is not possible.(1)
The range can be increased by using i) taller antenna and ii) geostationary satellites.(1)

A 19. Electrostatic potential at a point is defined as the amount of work done in bringing a unit positive charge from infinity to that point.(1)

At a far off point lying on the axial line the electric potential is $V = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$

So $V \propto \frac{1}{r^2}$.(1)

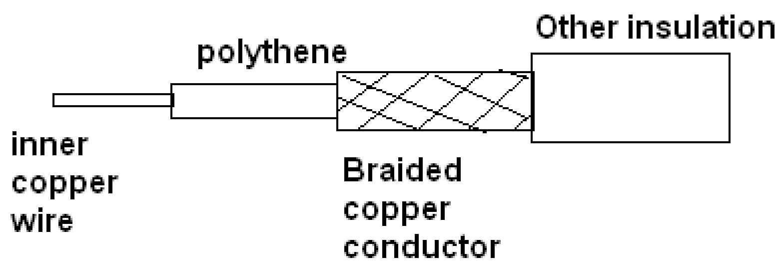
On the equatorial plane V = 0 everywhere. (1)

A 20. Each free electron accelerates due to the force that acts on it. This increases its drift speed until it collides with a positive ion of the metal. It loses some energy after each collision but it again accelerates and then collides and once again loses some energy. This sequence of events continues. (1)

On an average, the electrons hence acquire only a drift speed but they are not able to accelerate. (1)

In the presence of an electric field the path of the electrons is generally curved, rather than straight. (1)

A.21



(1)

A coaxial cable is as shown in the figure. It consists of an inner conductor that is made up of a copper wire and the outer conductor can be either a solid or braided mesh of fine wires. The outer conductor is externally covered with a polymer jacket for protection. (1)

Upper limit of the frequency that can be used is 20MHz. (1)

A22. A is a capacitor and B is an inductor.(1)

On decreasing the frequency of the applied voltage the inductive reactance decreases so the current through the inductor will increase.(1)

For this change in the frequency the capacitive reactance increases so the current through the capacitor decreases.(1)

A 23.

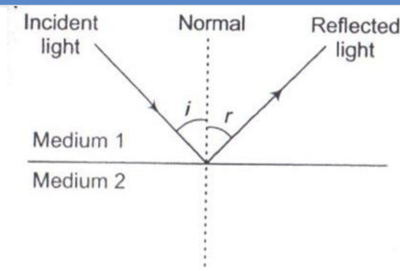
(a) The interesting matter is that the king of darkness, so called thief, got afraid with a simple light reflection and lost his control over the pole and fell down in the pond. (1)

(b) When light rays are incident on the surface of the transparent media by making an angle with the normal called angle of incidence, it reflects back by making same angle with the normal, called angle of reflection. (1)

Laws of Reflection

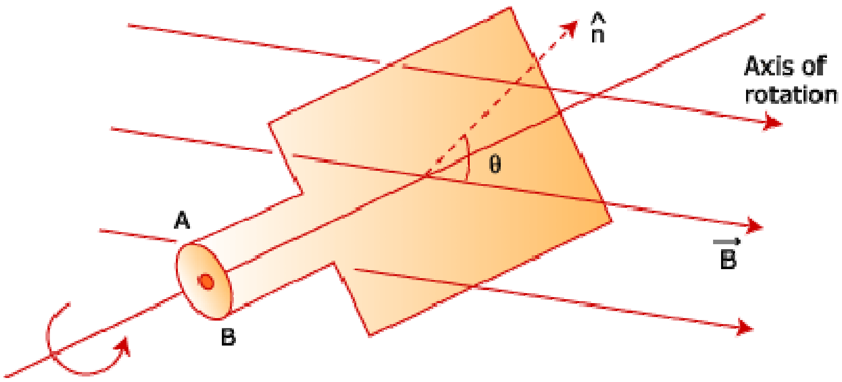
(i) Angle of reflection is equal to the angle of incidence. (1/2)

(ii) Incident light, reflected light and the normal are in the same plane



(1/2)

A 24. A wire loop of area A is free to rotate about an axis which is perpendicular to a uniformed magnetic field B.



(1)

If the normal to the loop $\hat{n}$ makes an angle θ with $\vec{B}$, then, flux through the loop $\Phi = BA\cos\theta$.

If this loop rotates with a constant angular velocity $\omega = \frac{d\theta}{dt}$ (By an external mechanical agency),

The flux through it changes at the rate

$$\frac{d\Phi}{dt} = -BA\sin\theta\frac{d\theta}{dt} = -BA\,\omega\sin(\omega t + Co)$$

where C_o is a constant (1)

$\therefore$ emf is induced between ends A and B given by:

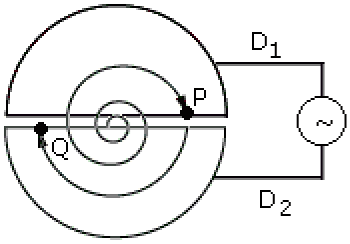
$$\varepsilon = BA\,\omega\sin(\omega t + Co)$$

$$\varepsilon = V_m\sin(\omega t + Co)$$

$V_m = BA\omega =$ Peak value of emf generated. (1)

A25:

Principle: A beam of charged particles describes a circular path when subjected to a uniform magnetic field directed perpendicular to their plane of motion. The beam can be accelerated time and again by a high frequency electric field of correctly adjusted frequency applied between two dees. (1)



(1)

Construction: It consists of a two semi circular disc like hollow metal containers D_1 and D_2 connected to high frequency alternating voltage.
A magnetic field is applied perpendicular to the plane of the dees. (1)

A 26.

$$E = E_0 \sin \omega t$$

$$E - L\frac{dI}{dt} = 0 \qquad (1)$$

$$\frac{dI}{dt} = \frac{E}{L} = \frac{E_0}{L}\sin \omega t$$

$$I = \frac{E_0}{L}\int \sin \omega t \qquad (1/2)$$

$$= -(\frac{E_0}{\omega L})\cos\omega t = -I_0 \cos\omega t \quad (1/2)$$

$$\text{where } I_0 = \frac{E_0}{\omega L}$$

$$\text{or, } \quad I = I_0 \sin(\omega t - \frac{\pi}{2}) \qquad (1)$$

Hence current lags behind the voltage by a phase angle of $\frac{\pi}{2}$.

A27:
Given: $n_i = 2 \times 10^8$ /m^3
On doping $n_h = 4 \times 10^{10}$ /m^3

(i) On doping hole concentration will increase, hence, it is p-type semiconductor. (1)

(ii) Since ${n^2}_i = n_e n_h$

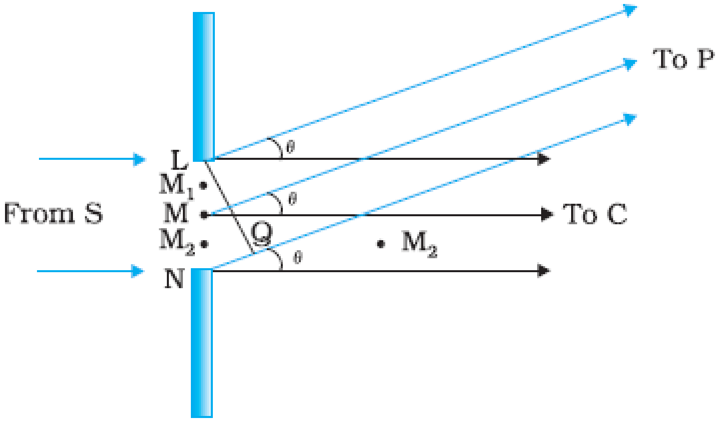
$$n_e = \frac{{n^2}_i}{n_h} = \frac{(2\times10^8)^2}{4\times10^{10}}$$

$$\Rightarrow n_e = 10^6 \text{ m}^{-3}$$

(1)

(iii) Energy gap decreases with doping because acceptor level gets created between the valance band and conduction band. (1)

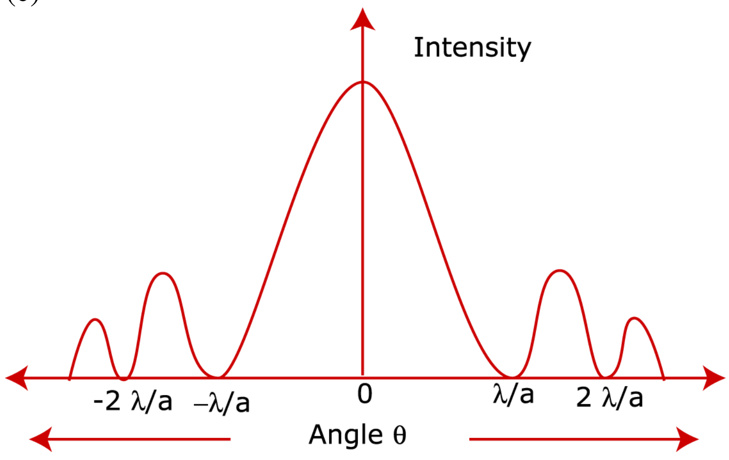
A 28:
a. Condition: Size of the obstacle or aperture should be comparable with the wave length of the incident light. (1)
b. Let a plane wave front to be incident slit on LM of width ‘a’. To consider diffraction effects at any point P, directed an angle θ to the incident rays, the wave front is divided into a number of parts, with each part treated as a secondary wave front. (1)



(1)

Path difference between secondary wave front from L and M = $a\sin\theta$
For minima, $a\sin\theta = n\lambda$ (1/2 mark)
For maxima, $a\sin\theta = (2n+1)\dfrac{\lambda}{2}$ (1/2 mark)

(c)



(1)

OR

a. Coherent Sources of light: Two sources with same frequencies having a (time independent) stable phase difference or zero phase difference. (1)
If phase difference is variable, the interference term averages to zero. In case of stable phase difference between coherent sources, intensity at each point will vary and so

sustained interference will be observed. (1)

Difference between interference and diffraction pattern formed due to a single slit:

Interference	Diffraction
All bright and dark fringes are of equal width.	Width of secondary maxima keeps on decreasing.
At $\theta = \lambda / a$, a bright fringe is formed.	At $\theta = \lambda / a$, a dark fringe is formed.
Pattern is formed due to superposition of two different wave fronts.	Pattern is formed due to superposition of wavelets of the same wave front.

(Each point: 1 mark)

A29. According to the Biot-Savart law, the magnetic field dB due to an element dl carrying a steady current I at a point P at a distance r from the current element is

$$dB = \frac{\mu_0}{4\pi} I \frac{d\ell \times r}{r^3} \quad (1)$$

By taking a circuit element we can write down the magnetic field due to this segment. Then integrate to find the magnetic field due to the circular current loop, which comes out to be

$$B = \frac{\mu_0}{4\pi} \frac{2\pi N I a^2}{(a^2 + x^2)^{3/2}} \quad (2)$$

The magnetic field at the centre of the coil is found by putting x = 0

$$B_1 = \frac{\mu_0 I}{2a} \quad (1)$$

Magnetic field at an axial point for $x = \sqrt{3}a$ is

$$B_2 = \frac{\mu_0 I}{16a}$$

$$\frac{B_1}{B_2} = 8:1 \quad (1)$$

OR

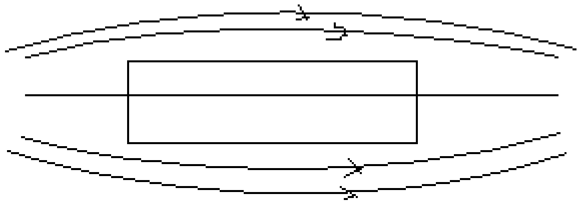
Diamagnetic substances have small and negative susceptibility.
Their magnetic permeability is less than 1
Their coercivity is very high. (1)

Paramagnetic substance have positive but small values of susceptibility.
Their magnetic permeability is greater than 1.

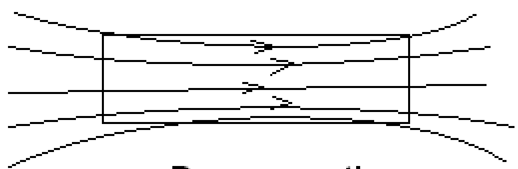
Their coercivity is low. (1)

Ferromagnetic substances have large and positive values of susceptibility.
Their magnetic permeability is very large.
Their coercivity is very low. (1)

Example of diamagnetic is bismuth
Example of paramagnetic is aluminium
Example of ferromagnetic is iron. (1)



Diamagnetic



Paramagnetic

(1)

A 30:

(a) $\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2\text{ mA}}{20\,\mu\text{A}} = 100$ (1)

(b) The input resistance $R_{BE} = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{20\text{ mV}}{20\,\mu\text{A}} = 1\text{ k}\Omega$ (1)

(c) Transconductance $= \frac{\Delta I_C}{\Delta V_{BE}} = \frac{2\text{ mA}}{20\,mV} = 0.1\text{ mho}$ (1)

(d) The change in input voltage is $R_L \Delta I_C = (5\,k\Omega)(2\text{ mA}) = 10\text{ V}$ (1)

The applied signal voltage = 20 mV

Thus, the voltage gain is,

$$= \frac{10\text{ V}}{20\text{ mV}} = 500$$ (1)