ISC Solved Paper 2020

Physics

Class-XII

(Maximum Marks : 80)

(Time allowed : Three hours)

All questions are compulsory.

This question paper is divided into 4 Sections, A, B, C and D as follows:

Section A

Question number 1 is of twelve marks. All parts of this question are compulsory.

Section B

Question numbers 2 to 12 carry 2 marks each with two questions having internal choice.

Section C

Question numbers 13 to 19 carry 3 marks each with two questions having internal choice.

Section D

Question numbers 20 to 22 are long-answer type questions and carry 5 marks each. Each question has an internal choice.
The intended marks for questions are given in brackets [ ].
All working, including rough work, should be done on the same sheet as and adjacent to the rest of the answer.
Answers to sub parts of the same question must be given in one place only. A list of useful physical constants is given at the end of this paper.
A simple scientific calculator without a programmable memory may be used for calculations.

SECTION-A

*Answer **all** questions.*

1. (A) Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below : 5×1

(i) A point charge 'q' is kept at each of the vertices of an equilateral triangle having each side 'a'. Total electrostatic potential energy of the system is :

(a) $\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{3q^2}{a^2}$

(b) $\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{3q}{a}$

(c) $\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{3q^2}{a}$

(d) $\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{3q}{a^2}$

(ii) Curie temperature is the temperature above which :

(a) a ferromagnetic substance behaves like a paramagnetic substance.

(b) a paramagnetic substance behaves like a diamagnetic substance.

(c) a ferromagnetic substance behaves like a diamagnetic substance.

(b) a paramagnetic substance behaves like a ferromagnetic substance.

(iii) In an Astronomical Telescope of Refracting type :

(a) Objective should have small focal length

(b) Objective should have large focal length

(c) Eyepiece should have large focal length

(d) Both objective and eyepiece should have large focal length

(iv) In photoelectric effect experiment, the slope of the graph of the stopping potential versus frequency gives the value of :

(a) $\frac{h}{e}$ **(b)** h

(c) $\frac{e}{h}$ **(d)** $\frac{hc}{e}$

(v) In a nuclear reactor, cadmium rods are used as :

(a) Control rods **(b)** Fuel rods

(c) Coolant **(d)** Moderator

(B) Answer the following questions briefly and to the point : 7 × 1

(i) State Gauss' theorem.

(ii) A metallic wire having a resistance of 20 Ω is bent in order to form a complete circle. Calculate the resistance between any two diametrically opposite points on the circle.

(iii) How can we convert a moving coil galvanometer into a voltmeter ?

(iv) Write Biot-Savart's law in vector form.

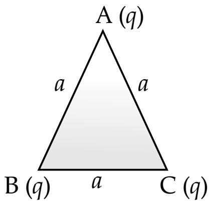
(v) What is the phase difference between any two points lying on the same wavefront?

(vi) Name the physical principle on which the optical fibres work.

(vii) What is Pair production ?

Ans. (A) (i) Option (c) is correct.

Explanation:



Total potential energy $= U = \frac{k.q.q}{a} \times 3$

$$= \frac{1}{4\pi\varepsilon_o} \times \frac{3q^2}{a}$$

(ii) Option (a) is correct.

(iii) Option (b) is correct.

(iv) Option (b) is correct.

Explanation:

$$h\nu_0 = \phi_0 + eV_0$$

or, $$\frac{h}{e}\nu_0 = \frac{\phi_0}{e} + V_0$$

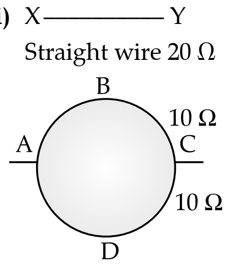
$\therefore$ $$\text{slope} = \frac{h}{e}$$

(v) Option (a) is correct.

(B) (i) Gauss Theorem : The theorem states, the total flux linked with a closed surface is $\frac{1}{\varepsilon_0}$ times the charge enclosed by the closed surface.

$$\oint E.ds = \frac{1}{\varepsilon_o} Q$$

(ii)



A straight wire XY (of resistance 20Ω) is transformed into a circle.

Diameter of the circle is AC.

Half circle ABC has resistance 10Ω and half circle ADC has resistance 10 Ω.

These two resistors are in parallel. So the equivalent resistance is 5 Ω.

(iii) By connecting a very high resistance in series the moving coil galvanometer can be converted into a voltmeter.

(iv) Biot Savart law in vector form : The law states, the magnetic field, due to a current element vector $\vec{dl}$ carrying current I, at a point P with position vector $\vec{r}$ is given

$$\vec{dB} = \frac{\mu_0}{4\pi} \times I \times \left[\frac{\vec{dl} \times \vec{r}}{r^3}\right]$$

(v) Phase difference = 0

(vi) The principle is Total Internal reflection.

(vii) Pair production is the conversion of a radiation quantum into an electron and a positron.

It is a direct conversion of radiant energy into matter.

SECTION-B

*Answer **all** questions.*

2. (a) A uniform copper wire having a cross sectional area of 1 mm^2 carries a current of 5 A. Calculate the drift speed of free electrons in it.

(Free electron number density of copper = 2×10^{28}/m^3.) **2**

OR

(b) An electric bulb is rated as 250V, 750W. Calculate the :

(i) Electric current flowing through it, when it is operated on a 250V supply.

(ii) Resistance of its filament.

Ans. (a) area = a = 1mm^2 = 1×10^{-6} m^2

current = i = 5A

free electron number density = n

= 2×10^{28} m^{-3}

Using the equation:

$$i = n \times e \times a \times V_d$$

where e = charge of an electron

= 1.6×10^{-19} C

Drift speed = V_d

$$V_d = \frac{i}{n \times e \times a}$$

$$= \frac{5}{2 \times 10^{28} \times 1.6 \times 10^{-19} \times 1 \times 10^{-6}}$$

= 1.56×10^{-3} m/s

OR

(b) (i) Power = $P = VI$

$$\therefore \quad I = \frac{P}{V} = \frac{750}{250} = 3\text{A}$$

(ii) $V = IR$

$$\therefore \quad R = \frac{V}{I} = \frac{250}{3} = 83.3\ \Omega$$

3. Write an expression for force per unit length between two long current carrying wires,kept parallel to each other, in vacuum and based on that define an ampere, the SI unit of current. **2**

Ans. Force per unit length = $\dfrac{F}{l} = \dfrac{2\mu_0 i_1 i_2}{2\pi d}$

Where i_1 = current through one conductor

i_2 = current through other conductor

d = distance between the two conductors

Putting $i_1 = i_2 = 1, d = 1, \mu_0 = 4\pi \times 10^{-7}$

we find $\dfrac{F}{l} = 2 \times 10^{-7}$

1A is the value of that steady current which when maintained in each of the two parallel, infinitely long conductors, of negligible cross section, placed at 1m apart from each other in vacuum and produce on each other a force 2×10^{-7} N.

4. *(i) Define *angle of dip.* **2**

(ii) State the relation between magnetic susceptibility (χ) and relative permeability (μ_r) of a magnetic substance.

Ans. (ii) Relation between magnetic susceptibility (χ) and relative permeability (μ_r) : $\mu_r = 1 + \chi$

5. (a) *Figure 1* below shows a metallic rod MN of length l = 80 cm, kept in a uniform magnetic field of flux density B – 0.5T, on two parallel metallic rails P and Q. Calculate the emf that will be induced between its two ends, when it is moved towards right with a constant velocity v = 36 km/hr. **2**

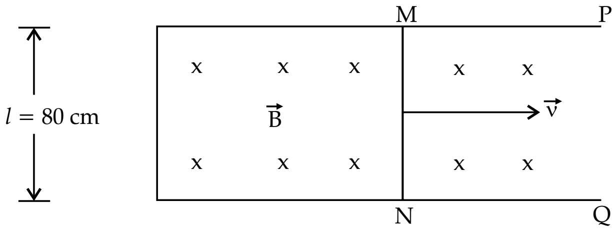


Figure 1

OR

(b) When current flowing through one coil changes from 0 Amp to 15 Amp in 0.2 s, an emf of 750 V is induced in an adjacent coil. Calculate the coefficient of mutual inductance of the two coils.

Ans. (a) emf induced = $e = Blv$

B = flux density = 0.5T

l = length = 80 cm = 0.8 m

***Out of Syllabus**

v = velocity = 36 km/h

$= 36 \times \frac{5}{18} = 10$ m/s

$e = Blv$

$\therefore \quad e = 0.5 \times 0.8 \times 10 = 4$ V

OR

(b) Change in current = 15 A

Time = 0.2 s

Induced emf = e = 750 V

$$e = M\frac{dI}{dt}$$

$$750 = M \times \frac{15}{0.2}$$

$$\therefore \quad M = 750 \times \frac{0.2}{15} = 10 \text{ H}$$

6. (i) State any one use of infrared radiations. 2

(ii) State any one source of ultraviolet radiations.

Ans. (i) Use of infrared radiation: In night vision camera, in remote controls.

(ii) Source of Ultraviolet radiation : Sun, UV lamps, arc welding, mercury vapour lamp etc.

7. Where will you keep an object in front of a:

(i) Convex lens in order to get a virtual and magnified image?

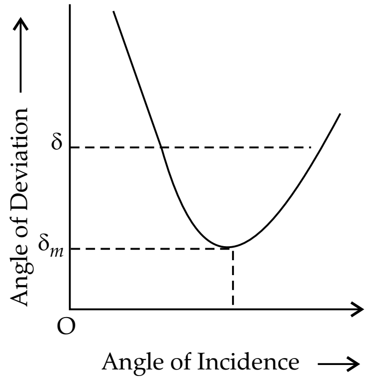
(ii) Concave mirror to get a real and diminished image?

Ans. (i) The object is to be placed between optical centre and focus.

(ii) Object is to be placed beyond centre of curvature.

8. Draw a labelled graph of angle of deviation (δ) versus angle of incidence (i) for a prism. 2

Ans. Angle of deviation vs, angle of incidence graph of a prism :



9. *(i) State de Broglie hypothesis. 2

(ii) What conclusion can be drawn from Davisson and Germer's experiment ?

Ans. (i) de Broglie's Hypothesis : De Broglie hypothesis says that all matter has both particle and wave nature. The wave nature of a particle is quantified by de Broglie wavelength defined as $\lambda = \frac{h}{P}$ where p is the momentum of the particle, h = Planck's constant.

10. Calculate binding energy of oxygen nucleus $\left({}^{16}_{8}\text{O}\right)$ from the data given below :

Mass of proton = 1.007825 u

Mass of neutron = 1.008665 u

Mass of $\left({}^{16}_{8}\text{O}\right)$ = 15.994915 u

Ans. Mass defect $= \Delta m$

$= [Zm_p + (A - Z)m_n - M_n]$

$\Delta m = [8 \times 1.007825 + (8 \times 1.008665) - 15.994915]$

$= 0.137005$ *amu*

So, Binding energy $= \Delta m \times 931.5$

$= 0.137005 \times 931.5$

$= 127.62$ MeV

***11. For a radioactive substance, write the relation between : 2**

(i) Half life (T) and disintegration constant (λ).

(ii) Mean life (τ) and disintegration constant (λ).

***12. With reference to communication systems, what is meant by :**

(i) modulation?

(ii) demodulation?

SECTION-C

*Answer **all** questions.*

13. Show that intensity of electric field E at a point in broadside on position is given by : 3

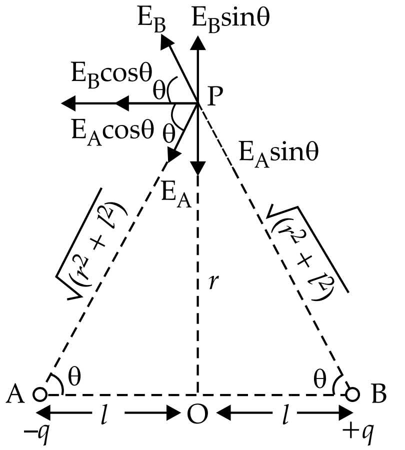
$$E = \left(\frac{1}{4\pi \epsilon_0}\right)\frac{p}{(r^2 + l^2)^{3/2}}$$

where the terms have their usual meaning.

***Out of Syllabus**

Ans. Consider an electric dipole AB consists of charge $+q$ and $-q$ separated by a distance $2l$.

P is a point at a distance r from the centre O of the dipole .



Electric field at P due to charge at point A

$$= E_A = \frac{1}{4\pi\varepsilon_0} \times \frac{-q}{r^2+l^2}$$

Electric field at P due to charge at point B

$$= E_B = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2+l^2}$$

Y-component of E_A and E_B at P cancels out each other.

The resultant magnitude X-component of E_A and E_B at P is E

$$E = \left[\frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2+l^2} + \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2+l^2}\right] \cos\theta$$

$$E = 2 \times \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2+l^2} \cos\theta$$

In Δ OPB,

$$\cos\theta = \frac{OB}{PB} = \frac{1}{\sqrt{(r^2+l^2)}}$$

Replacing $\cos\theta$ in the expression of E,

$$E = 2 \times \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2+l^2} \times \frac{l}{\sqrt{(r^2+l^2)}}$$

$$E = \frac{1}{4\pi\varepsilon_0} \times \frac{p}{\left(r^2+l^2\right)^{\frac{3}{2}}}$$

(where $p = q \times 2l$ = electric dipole moment)

14. A parallel plate capacitor is charged by a battery, which is then disconnected.

A dielectric slab having dielectric constant (relative permittivity) K, is now introduced between its two plates in order to occupy the space completely. State in terms of K its effect on the following:

(i) The capacitance of the capacitor.

(ii) The potential difference between its plates.

(iii) The energy stored in the capacitor.

Ans. (i) $$C_{NEW} = KC$$

So, the capacitance will increase and will become K times of earlier capacitance.

(ii) $$V_{NEW} = \frac{V}{K}$$

So, the potential will decrease and will become $\frac{1}{K}$ times of the earlier potential.

(iii) Potential energy $= U = \dfrac{Q^2}{2C}$

Q remains constant.

$$\therefore \quad U_{NEW} = \frac{Q^2}{2C_{New}} = \frac{Q^2}{2KC} = \frac{1}{K}U$$

So, the potential energy will decrease and will become $\frac{1}{K}$ times of the earlier potential energy.

15. (a) E_1 and E_2 are two batteries having emfs of 3V and 4V and internal resistances of 2Ω and 1Ω respectively. They are connected as shown in Figure 2. Using Kirchhoff's Laws of electrical circuits, calculate the currents I_1 and I_2.

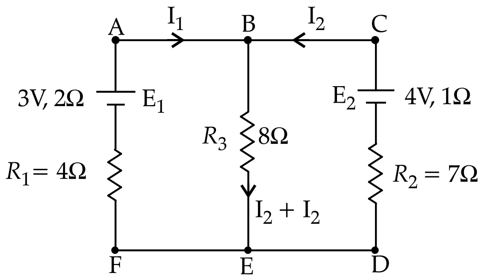
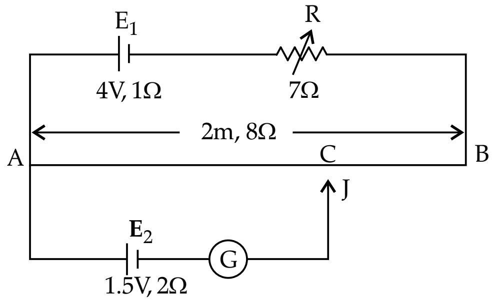


Figure 2

OR

(b) A potentiometer circuit is shown in Figure 3. AB is a uniform metallic wire having length of 2 m and resistance of 8Ω. The batteries E_1 and E_2 have emfs of 4V and 1.5V and their internal resistance are 1Ω and 2Ω respectively.



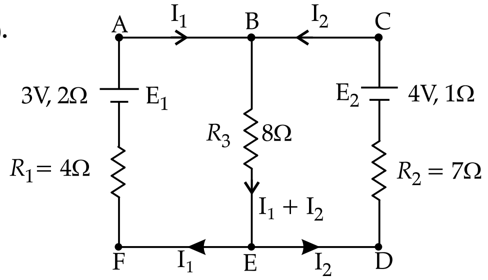
(i) When the jockey J does not touch the wire AB, calculate :

(a) the current flowing through the potentiometer wire AB.

(b) the potential gradient across the wire AB.

(ii) If, the jockey J is made to touch the wire AB at a point C such that the galvanometer (G) shows no deflection. Calculate the length AC.

Ans. **(a).**



Applying Kirchhoff's law in the mesh ABEF

$4I_1 + 2I_1 + 8 \times (I_1 + I_2) = 3$

$\therefore \quad 14I_1 + 8I_2 = 3 \quad ...(1)$

Applying Kirchhoff's law in mesh BCDE

$7I_2 + 1 \times I_2 + 8 \times (I_1 + I_2) = 4$

or, $\quad 8I_1 + 16I_2 = 4$

$\therefore 2I_1 + 4I_2 = 1 \quad ...(2)$

Multiplying eqn (2) by 7 and subtracting from eqn (1)

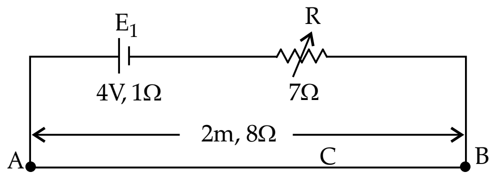
$$I_2 = \frac{4}{20} = 0.2\text{A}$$

Putting the value of I_2 in eqn(2)

$$I_1 = \frac{1}{10} = 0.1 \text{ A}$$

OR

Ans. (b) (i) When the J does not touch the wire AB, the circuit is as below :



Total resistance of the circuit $= 1 + 7 + 8 = 16\Omega$

Current in the circuit $= \frac{4}{16} = \frac{1}{4}\text{A}$

$= 0.25\text{A}$

(a) So the current through AB is 0.25A

(b) Potential across $AB = 0.25A \times 8\Omega = 2\text{V}$

$\therefore$ Potential gradient $= \frac{2\text{V}}{2\text{m}} = 1 \text{ V/m}$

(ii) Now the j is made to touch AB. Galvanometer shows no current means no current flow.

So, $\quad E_2 = \text{Potential gradient} \times AC$

Or, $\quad 1.5 = 1 \times AC$

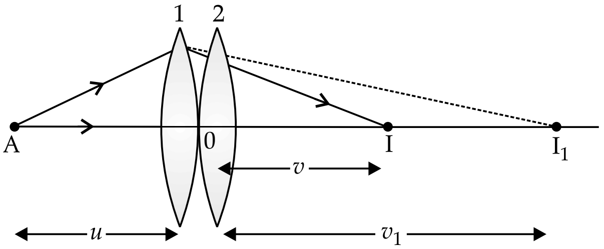
$\therefore \quad AC = 1.5\text{m}$

16. For two thin lenses kept in contact with each other, show that : **3**

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

where the terms have their usual meaning.

Ans.



Two lens are in contact.

An object is placed at point A.

The lens 1 produces an image at I_1 which serves as a virtual object for lens B

Lens 2 produces final image at I.

We consider that the lens are so thin that their optical centres coincide and it is at O.

For lens 1,

Using the lens formula

$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1} \quad ...(1)$$

For lens 2,

Using the lens formula

$$\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2} \quad ...(2)$$

Adding equations (1) and (2),

$$\frac{1}{v_1} - \frac{1}{u} + \frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$-\frac{1}{u}+\frac{1}{v}=\frac{1}{f_1}+\frac{1}{f_2}$$

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$$

(where F is the focal length of the equivalent lens which produces the image I for the object placed at A)

17. (a) A compound microscope consists of two convex lenses having focal length of 1.5 cm and 5 cm. When an object is kept at distance of 1.6 cm from the objective, the final image is virtual and lies at a distance of 25 cm from the eyepiece. Calculate magnifying power of the compound microscope in this set-up.

OR

(b) In Young's double slit experiment, the screen is kept at a distance of 1.2 m from the plane of the slits. The two slits are separated by 5 mm and illuminated with monochromatic light having wavelength 60 nm. Calculate :

(i) Fringe width i.e., fringe separation of the interference pattern.

(ii) Distance of 10th bright fringe from the centre of the pattern.

Ans. (a) For objective lens :

$$\frac{1}{v_0}-\frac{1}{u_0}=\frac{1}{f_0}$$

u_0 = Object distance = 1.6 cm

f_0 = focal length of the objective = 1.5 cm

Putting in the above equation

$$\frac{1}{v_0}-\frac{1}{-1.6}=\frac{1}{1.5}$$

Or, $$\frac{1}{v_0}=\frac{1}{-1.6}+\frac{1}{1.5}$$

Or, $$\frac{1}{v_0}=\frac{10}{240}$$

$\therefore$ $v_0 = 24$ cm

Magnifying power= $\boldsymbol{m} = -\frac{v_0}{u_0}\left[1+\frac{D}{f_E}\right]$

Where D = image distance = 25 cm

f_E = focal length of the eyepiece = 5 cm

$$\therefore \quad m=-\left(\frac{24}{1.6}\right)\times\left(1+\frac{25}{5}\right)=-90$$

–ve sign indicates that the final image is inverted.

OR

(b) (i) Fringe width = $\beta = \frac{\lambda D}{d}$

Wavelength= λ = 600 nm = 600×10^{-9} m

Distance = D = 1.2 m

Separation of slits= d = 5 mm = 5×10^{-3} m

Putting the values in the above equation

$$\beta=\frac{600\times10^{-9}\times1.2}{5\times10^{-3}}$$

$= 144 \times 10^{-6}$ m

$= 0.144$ mm

(ii) Distance of 10th bright fringe from the centre = $10\beta = 10 \times 0.144 = 1.44$ mm

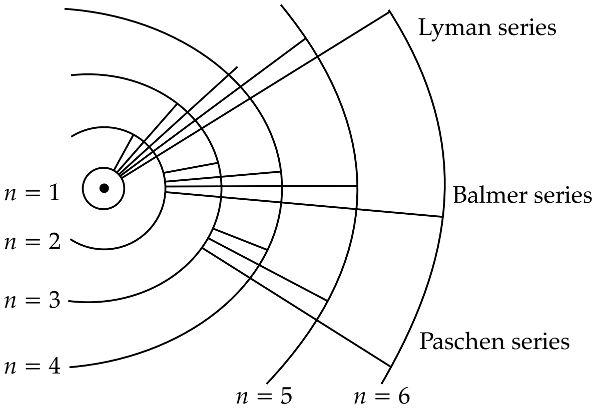
18. Draw the energy level diagram of hydrogen atom and show the transitions responsible for : 3

(i) absorption lines of Lyman series.

(ii) emission lines of Balmer series.

Ans. When a hydrogen atom absorbs a photon, electron jumps to a higher energy level.

When a photon is emitted by a hydrogen atom, the electron falls from a higher energy level to a lower. During this transition there is the transmission of light.



(a) Absorption lines of Lyman series : Absorption lines of Lyman series involves transition of electrons starting from $n = 1$ and ending at n = 2, 3, 4 .....

(b) Emission lines of Balmer series : Emission of Balmer series involves transition of electrons ending at $n = 2$ starting from n = 3, 4, 5 ......

19. (i) State any one difference between energy band diagram of conductors and that of insulators.

***(ii) Give a relation between α and β for a transistor. (Derivation is not required)**

***Out of Syllabus**

(iii) What is the advantage of an LED bulb over the filament electric bulb ?

Ans. (i) In conductors, Conduction band and valence band overlap each other. In insulators, conduction band and valence band are well separated from each other (generally more than 6*e*V).

(iii) LED bulb is highly energy efficient (energy saving may be more than 90%) and has a very long life time (about 50000 hours ideally).

SECTION-D

*Answer **all** questions.*

20. (a) (i) A 400Ω resistor, a 3H inductor and a 5μF capacitor are connected in series to a 220V, 50Hz ac source. Calculate the :

(1) Impedance of the circuit.

(2) Current flowing through the circuit.

(ii) Draw a labelled graph showing the variation of impedance (Z) of a series LCR circuit versus frequency (*f*) of the ac supply.

OR

(b) (i) When an alternating emf e = 310 sin (100πt) V is applied to a series LCR circuit, current flowing through the circuit can be given by i = 5 sin (100πt + π/3) A.

(1) What is the phase difference between the current and the emf ?

(2) Calculate the average power consumed by the circuit.

(ii) Obtain an expression for the resonant frequency (f_o) of a series LCR circuit.

Ans. (a) (i) (1) When the components are connected in series, then

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

$$L = 3\text{H}$$

$$C = 5\mu\text{F} = 5 \times 10^{-6}\ \text{F}$$

$$\omega = 2 \times \pi \times 50\ \text{rad}$$

$$X_L = \omega L = 2\pi \times 50 \times 3 = 942\ \Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 50 \times 5 \times 10^{-6}}$$

$$= 636.9\Omega$$

Putting in the expression of Z.

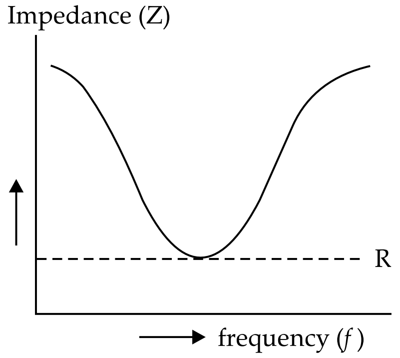
$$Z = \sqrt{(942 - 636.7)^2 + 400^2}$$

$$= 503\ \Omega$$

(2) Current through the circuit

$$= \frac{V}{Z} = \frac{220}{503} = 0.44\ \text{A}$$

(ii) Frequency vs. impedance graph :



OR

(b) (i) Alternating emf $= e = 310 \sin(100\pi t)$ V

Current flowing $= i = 5 \sin\left(100\pi t + \frac{\pi}{3}\right)$ A

(1) Phase difference between emf and current is $\frac{\pi}{3}$.

(2) Average Power $= P_{AV} = \frac{e_0}{\sqrt{2}} \times \frac{i_0}{\sqrt{2}} \times \cos\phi$

(where ϕ is the phase difference)

$$\therefore \quad P_{AV} = \frac{310}{\sqrt{2}} \times \frac{5}{\sqrt{2}} \cos\frac{\pi}{3}$$

$$= 387.5\ \text{W}$$

(ii) For resonance $X_L = X_C$

or, $\omega_0 L = \frac{1}{\omega_0 C}$

or, $\omega_0{}^2 = \frac{1}{LC}$

or, $\omega_0 = \frac{1}{\sqrt{LC}}$

or, $2\pi f_0 = \frac{1}{\sqrt{LC}}$

(where f_0 is the resonant frequency)

$\therefore \qquad f_0 = \dfrac{1}{2\pi\sqrt{LC}}$

21. (a) (i) Derive an expression for refraction at a single (convex) spherical surface, i.e. a relation between u,v, R, n_1 (rarer medium) and n_2 (denser medium), where the terms have their usual meaning. 5

***(ii) Name the phenomenon due to which the sun appears reddish at sunset.**

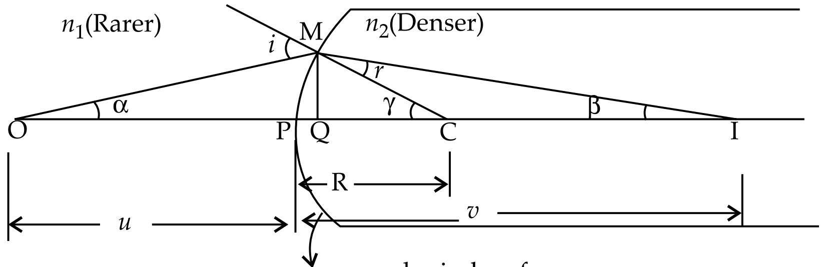
OR

(b) (i) Draw a labelled graph of intensity of diffracted light (I) versus angle (θ) in the Fraunhofer diffraction experiment for a single slit diffraction.

***(ii) State the law of Malus.**

***(iii) How will you distinguish experimentally between ordinary light and plane polarized light ?**

Ans.(a)(i)



O is the position of a point object,

$OP = u$ = Object Distance

P is the Pole, C is the centre of curvature,

$PC = R$ = Radius of curvature

I is the position of Image,

$PI = v$ = Image distance

n_1 = refractive index of rarer medium

n_2 = refractive index of denser medium

$${}_1n_2 = \frac{n_2}{n_1} = \frac{\sin i}{\sin r} = \frac{i}{r} \qquad ...(1)$$

(since I and r are very small angles, so considering $\sin i = i$ and $\sin r = r$)

In Δ MCO,

$$i = \alpha + \gamma \qquad ...(2)$$

In Δ MCI,

$$\gamma = r + \beta$$

$$\therefore \quad r = \gamma - \beta \qquad ...(3)$$

Replacing i and r in eqn (1) from eqn (2) and (3)

$$\frac{n_2}{n_1} = \frac{i}{r}$$

or, $\dfrac{n_2}{n_1} = \dfrac{\alpha+\gamma}{\gamma-\beta}$

Since α, β, γ are very small angles so, it can be written

or, $n_2(\gamma - \beta) = n_1(\alpha + \gamma)$

$$\therefore (n_2 - n_1)\gamma = n_1\alpha + n_2\beta \qquad ...(4)$$

$$\alpha = \tan\alpha = \frac{MQ}{OQ}$$

$$\beta = \tan\beta = MQ/IQ$$

$$\gamma = \tan\gamma = \frac{MQ}{QC}$$

Replacing α, β, γ in eqn (4)

$$(n_2 - n_1)\gamma = n_1\alpha + n_2\beta$$

or, $(n_2 - n_1)\dfrac{MQ}{QC} = n_1\dfrac{MQ}{OQ} + n_2\dfrac{MQ}{IQ} \qquad ...(5)$

Considering $OQ \simeq OP = u$

$QI \simeq PI = v$

$QC \simeq PC = R$

Putting the eqn (5)

$$(n_2 - n_1)\frac{MQ}{QC} = n_1\frac{MQ}{OQ} + n_2\frac{MQ}{IQ}$$

$$(n_2 - n_1)\frac{1}{R} = n_1\frac{1}{u} + n_2\frac{1}{v}$$

u is $-ve$, v is $+ve$, R is $+ve$

So, using proper sign convention, the above equation becomes

$$(n_2 - n_1)\frac{1}{R} = n_1\frac{(1)}{(-u)} + n_2\frac{1}{v}$$

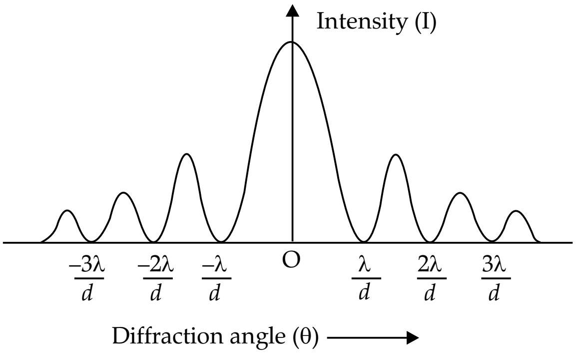
Or, $(n_2 - n_1)\dfrac{1}{R} = n_1\dfrac{(1)}{(-u)} + n_2\dfrac{1}{v}$

$$\therefore \quad \frac{n_2 - n_1}{R} = \frac{n_2}{v} - \frac{n_1}{u}$$

*Out of Syllabus

OR

(b) (i) Graph of intensity of diffracted light versus diffraction angle in the Fraunhofer diffraction experiment for a single slit diffraction:



22. (a) (i) In a semiconductor diode, what is meant by potential barrier? **5**

***(ii) Draw a labelled circuit diagram of a Zener diode as a voltage regulator.**

***(iii) With the help of a diagram, how will you obtain an AND gate using only NAND gates. (Truth table is not required.)**

OR

(b) *(i) Draw a labelled circuit diagram of a transistor acting as a common emitter amplifier. What is meant by phase reversal?

***(ii) Draw the symbol of a NAND gate and write its truth table.**

Useful constant and relation:

1 u	=	931 MeV

Ans. (a) (i) Potential Barrier : The potential difference created across the depletion region of a P-N junction due to the diffusion of electron and holes is called potential barrier. The potential barrier in the P-N junction is the barrier which does not allow charge to flow across the junction normally. So charge requires additional energy to cross the barrier.

■■

***Out of Syllabus**