Rao IIT Academy
Symbol of Excellence and Perfection
JEE | MEDICAL-UG | BOARDS | KVPY | NTSE | OLYMPIADS

XII CBSE - BOARD - MARCH - 2016

CODE (55/1/S) SET -1

Date: 05.03.2016

PHYSICS - SOLUTIONS

SECTION - A

1. $R_{cu} = \rho_{cu}\dfrac{l_{cu}}{A_{cu}}$

$R_{mg} = \rho_{mg}\dfrac{l_{mg}}{A_{mg}}$

$\dfrac{\rho_{mg}}{\rho_{cu}} = \dfrac{A_{mg}}{A_{cu}}$

$\dfrac{\rho_{mg}}{\rho_{cu}} > 1$

$\dfrac{A_{mg}}{A_{cu}} > 1$

so magnin wire is thicker **[1 Mark]**

Topic:Current Electricity; Sub-Topic:Resistivity_ L-1 _Target-2016_ XII-CBSE Board Exam__Physics

2. $\cos\phi = 0.5$

$\cos\phi = \dfrac{1}{2}$

$\phi = 60$ **[1 Mark]**

Topic:Alternating current_; Sub-Topic:Power factor_L-_1 _Target-2016_ XII-CBSE Board Exam__Physics

3. If capacitor is getting charged, then during charging, there is no conduction current between two plates, but there is displacement. **[1 Mark]**

Topic: Electromagnetic waves_; Sub-Topic:Displacement current_ L-_2_Target-2016_ XII-CBSE Board Exam__Physics

4. P is NOT Gate

Q is OR Gate **[1 Mark]**

Topic:Semi conductor electronoics_; Sub-Topic:Logic gates_L-_1_Target-2016_ XII-CBSE Board Exam__Physics

5. **Relaxation time:** The average time that elapses between two successive collisons of an electron is called relaxation time. **[1 Mark]** .

Topic:Current electricity_; Sub-Topic:Relaxation time_ L-_1_Target-2016_ XII-CBSE Board Exam__Physics

SECTION - B

6. Any cavity in a conductor remains shielded from outside electric influence. The field inside the cavity is always zero. This is known as electrostatic shielding. **[1 Mark]**

This property can be used in actual practice in protectig sensitive instruments from outside electric influence by surrounding them with a closed conducting surface. Potential in the cavity of a charged conductor is same as the potential of the surface of conductor which will not be zero. **[1 Mark]**

Topic:Electric charges and fields_; Sub-Topic: Electrostatic shielding_ L-_2 _Target-2016_ XII-CBSE Board Exam__Physics

7. Two properties of electromagnetic waves:

(i) They can pass through vacuum.

(ii) They are transverse in nature. **[1 Mark]**

When an electromagnetic wave falls on a surface, it exert pressure on the surface which shows that they carry momentum. **[1 Mark]**

Topic:Electromagnetic waves_; Sub-Topic:Properties of EMW_ L-_1_Target-2016_ XII-CBSE Board Exam__Physics

8. Here electron are diffracted by nickle crystal and wave nature of electron is proved: **[1 Mark]**

$$P = \sqrt{2mE}$$

$$\frac{h}{\lambda} = \sqrt{2 \times 9.1 \times 10^{-31} \times 120 \times 1.6 \times 10^{-19}}$$

$$\frac{6.6 \times 10^{-34}}{\lambda} = \sqrt{2 \times 9.1 \times 120 \times 1.6 \times 10^{-50}}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{18.2 \times 120 \times 1.6 \times 10^{-50}}}$$

$$= \frac{6.6 \times 10^{-34}}{59.11 \times 10^{-25}}$$

$$= 0.11 \times 10^{-9}$$

$$\lambda = \boxed{0.011 \mathring{A}}$$ **[1 Mark]**

Topic:Atoms_; Sub-Topic:DeBroglie Wavelength_ L-_1_Target-2016_ XII-CBSE Board Exam__Physics

9. Transdncers : Convert one form of energy into another form of energy.

e.g. Loud speaker $\rightarrow$ Current into sound **[1 Mark]**

Repeater $\rightarrow$ Repeater is combination of tansmitter, an amplifier and receiver which picks up a signal from the transmitter, amplifies and re transmitts it to receiver. **[1 Mark]**

Topic:Communication system_; Sub-Topic:Introduction_ L-_1_Target-2016_ XII-CBSE Board Exam__Physics

10. $r \propto n^2$

$$\therefore n^2 = \frac{21.2 \times 10^{-11}}{5.3 \times 10^{-11}}$$

$\boxed{n = 2}$ **[1 Mark]**

$$E_2 = -\frac{13.6}{2^2}$$

$E_2 = \boxed{-3.4\ eV}$ **[1 Mark]**

Topic:Atoms_; Sub-Topic:Energy of atoms_ L-_2_Target-2016_ XII-CBSE Board Exam__Physics

OR

For (B)

$\because\ \Delta E = h\nu$ **[1 Mark]**

$$4.5 \times 1.6 \times 10^{-19} = \frac{6.6 \times 10^{-19} \times 3 \times 10^8}{\lambda}$$

$\therefore \boxed{\lambda = 275\ nm}$ **[1 Mark]**

Topic:Atoms_; Sub-Topic:Energy of Atoms_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

SECTION - C

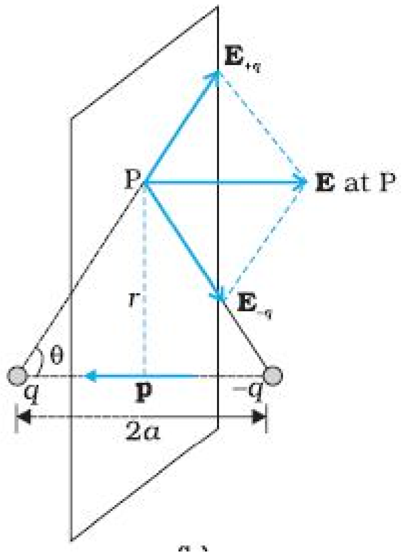
11. The magnitudes of the electric fields due to the two charges $+q$ and $-q$ are given by

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

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

and are equal. **[1 Mark]**

The directions of $\mathbf{E}_{+q}$ and $\mathbf{E}_{-q}$ are as shown in figure. Clearly, the components normal to the dipole axis cancel away. The components along the dipole axis add up. The total electric field is opposite to $\hat{p}$.



[1 Mark]

We have

$$\mathbf{E} = -(E_{+q} + E_{-q})\cos\theta\ \hat{\mathbf{p}}$$

$$= -\frac{2qa}{4\pi\varepsilon_o(r^2+a^2)^{3/2}}\hat{\mathbf{p}}$$

At large distances ($r >> a$), this reduces to

$$E = \frac{2qa}{4\pi\varepsilon_0 r^3}\hat{\mathbf{p}} \qquad (r >> a)$$

From Equations it is clear that the dipole field at large distances does not involve q and a separately; it depends on the product qa. This suggests the definition of dipole moment. The *dipole moment vector* **p** of an electric dipole is defined by

$$\mathbf{p} = q \times 2a\ \hat{\mathbf{p}}$$

that is, it is a vector whose magnitude is charge q times the separation $2a$ (between the pair of charges $q, -q$) and the direction is along the line from $-q$ to q. In terms of **p**, the electric field of a dipole at large distances takes simple forms:

At a point on the dipole axis

$$\mathbf{E} = -\frac{\mathbf{p}}{4\pi\varepsilon_0 r^3} \qquad (r >> a) \qquad (\text{Direction} + q \text{ to} - q)$$ **[1 Mark]**

Topic:Electric charges and field; Sub-Topic:Intensity due to dipole_ L-2 _Target-2016_ XII-CBSE Board Exam__Physics

12. (a) Since loop is not completed so charges will not flow from C_1 capacitor C_2 capcitor **[1 Mark]**

(b) For series $u_1 = \frac{1}{2}cv^2 \times 3$

$$= \frac{1}{2} \times 3\left(\frac{v}{3}\right)^2 \times 3$$

$$= \boxed{\frac{v^2}{2}}$$

for parellel **[1 Mark]**

$$u_2 = \frac{1}{2}\ 3 \times v^2 \times 3$$

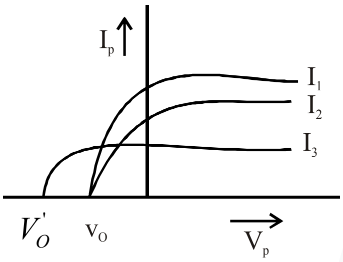
$$u_2 = \frac{9v^2}{2}$$

$$\therefore \frac{u_1}{u_2} = \boxed{\frac{1}{9}}$$ **[1 Mark]**

Topic:Electric potential and capacitance_; Sub-Topic:Capcitor_ L-2 _Target-2016_ XII-CBSE Board Exam__Physics

13 (a) It is defined as energy of photons crossing per unit area per unit time. **[1 Mark]**

(b)



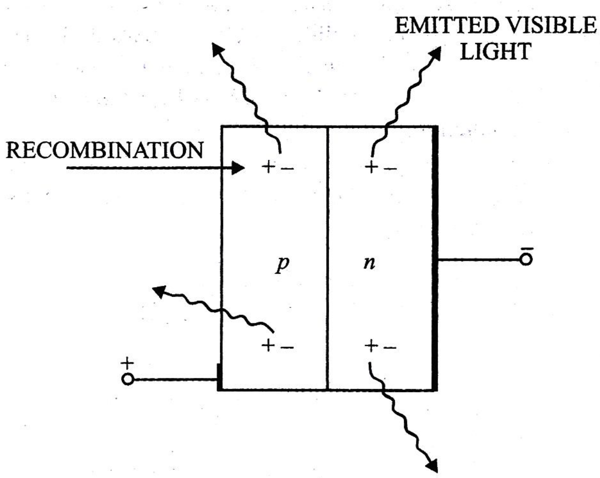
[1 Mark]

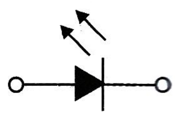
(c) $v_0 = \frac{h\upsilon}{e} - \frac{\phi_0}{e}$

For same frequency, stopping potentail is same and for different frequency it will different. **[1 Mark]**

Topic:Dual nature of matter amd radiation_; Sub-Topic:Particle nature of light_ L-1 _Target-2016_ XII-CBSE Board Exam__Physics

14. (a) When light emitting diode (LED) is forward biased as shown in figure, the electrons from the n–type material cross the pn junction and recombine with holes in the p – type material. Recall that these free electrons are in the conduction band and at a higher energy level than the holes in the valence band. When recombination takes place, the recombining electrons release energy in the form of heat and light.





[1 Mark]

(b) Gallium, Arsenide etc. are used upto to make LED, because entire energy gap is convert into light.

[1 Mark]

(c) Advantages of LEDs :

(i) Low voltage

(ii) Longer life (more than 20 years)

(iii) Fast on – off switching. **[1 Mark]**

Topic:Semi conductor electronics_; Sub-Topic:LED_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

15. Given, $R = 100\,\Omega, L = \frac{4}{\pi^2}\text{H},\ v_{rms} = 200\text{v},\ f = 50\text{Hz}$.

For the current to be in phase with the voltage, the net reactance must be zero, i.e. the circuit should be in resonance,

$$\therefore \quad f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$

$$\therefore \quad \frac{1}{LC} = 4\pi^2 f^2$$ **[1 Mark]**

$$\therefore \quad C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4\pi^2 \times 50^2 \times \frac{4}{\pi^2}}\text{F}$$

$$\therefore \quad C = \frac{1}{40000}\text{F} = 25\times10^{-6}\text{F}$$

or, $C = 25\,\mu\text{F}$ **[1 Mark]**

Impedence in this case is equal to resistance $100\,\Omega$.

Power dissipated in the circuit will be

$$P = v_{rms} \times i_{rms}$$

or, $P = v_{rms} \times \frac{v_{rms}}{R}$ $(\because \text{impedence } Z = R)$

$$\therefore \quad P = \frac{v_{rms}^2}{R} = \frac{(200\text{V})^2}{100\,\Omega} = 400\text{ W}$$ **[1 Mark]**

Topic:Alternating current; Sub-Topic:Resonance_ L-2 _Target-2016_ XII-CBSE Board Exam__Physics

16. (i) Given, $\mu = \sqrt{3}, \delta_{min} = A$

$\therefore$ using prism formula

$$\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\frac{A}{2}},$$ **[1 Mark]**

$$\therefore \qquad \mu = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin\frac{A}{2}} \qquad \{\because \delta_{min} = A\}$$

$$\Rightarrow \qquad \sin A = \mu \sin\frac{A}{2}$$

$$\Rightarrow \qquad 2\sin A\cos\frac{A}{2} = \mu\sin\frac{A}{2}$$

$$\Rightarrow \qquad 2\cos\frac{A}{2} = \mu \quad \text{or,} \quad \cos\frac{A}{2} = \frac{\mu}{2}$$

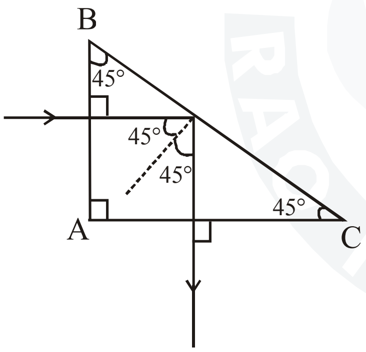
$$\text{or,} \qquad \cos\frac{A}{2} = \frac{\sqrt{3}}{2} = \cos 30°$$

$$\text{or,} \qquad \frac{A}{2} = 30° \quad \text{or,} \quad A = 60°$$

[1 Mark]

Topic:Ray optics_; Sub-Topic:Prism formula_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

(ii)

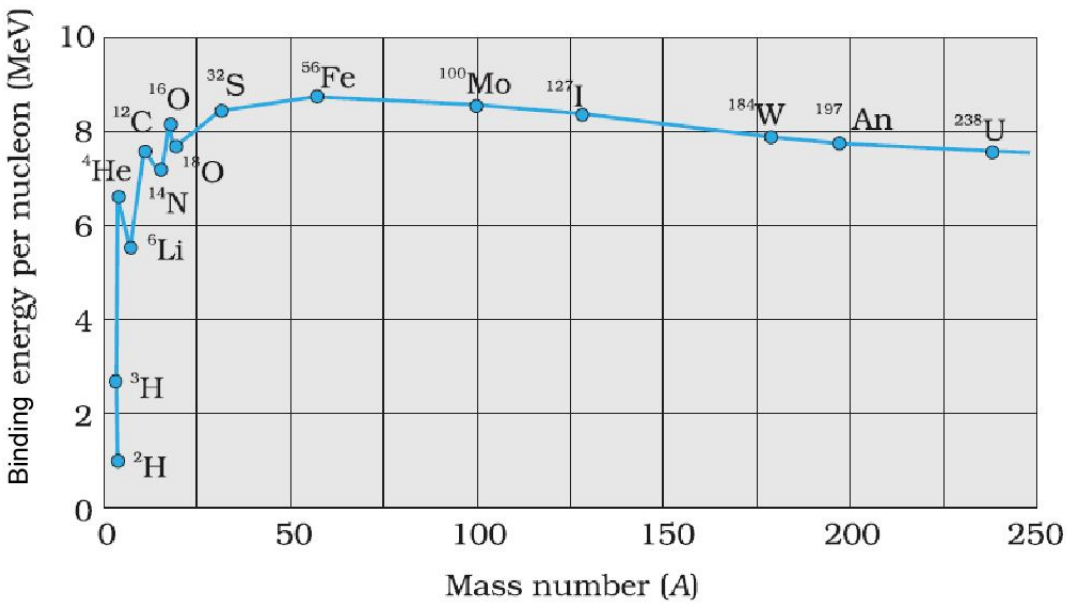


($\because$ critical angle $i_c = \tan^{-1}\left(\frac{1}{\mu}\right) = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right) = 30°$ Hence, there will be total internal reflection at the surface BC)

[1 Mark]

Topic:Ray optics_; Sub-Topic:Total internal reflection_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

17.



[1 Mark]

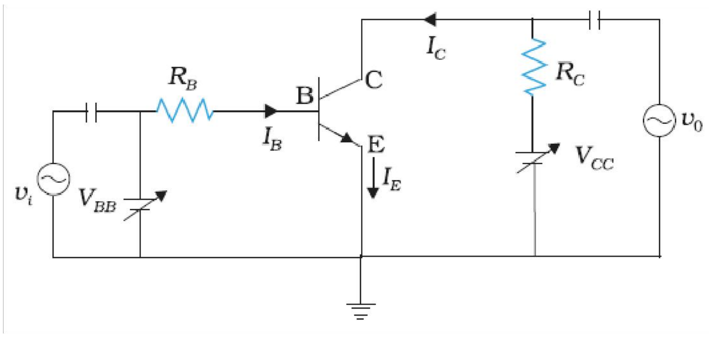
The constancy of the binding energy in the range 30 < A < 170 is a consequence of the fact that the nuclear force is short - ranged. **[1 Mark]**

A very heavy nucleus, (say A = 240) has lower binding energy per nucleon compared to that of a light nucleus (say with A = 120). Thus if a nucleus (A = 240) breaks into two light nuclei (with A = 120), nucleons get more tightly bound. This implies energy would be released in the process this explains release of energy in fission.

If we consider two very light nuclei $(A \le 10)$ joining to form heavier nucleus, the binding energy per nucleon of the fused heavier nucleus is more than the binding energy per nucleon of the ligher nuclei. This means that the final system is more tightly bound than the initial system. This implies energy will be released in the process. This explains release of energy in fusion. **[1 Mark]**

Topic:_Nuclei_; Sub-Topic:B.E.Curve_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

18.



β_{ac}, known as small signal current gain, is defined as ratio of change in collector current to change in base current. **[1 Mark]**

Change in base current.

$$\therefore \qquad \beta_{ac} = \frac{\Delta I_C}{\Delta I_B}$$

Where, ΔI_C = Change in collector current

$\Delta I_B =$ Change in base current **[1 Mark]**

As transistor is operated in active region in case of being used as an amplifier, I_C will increase almost linearly with I_B. So, $\frac{\Delta I_C}{\Delta I_B} \approx \frac{I_C}{I_B} = \beta_{dc}$

$\therefore\ \beta_{ac} \approx \beta_{dc}$ in case of transistor amplifier. **[1 Mark]**

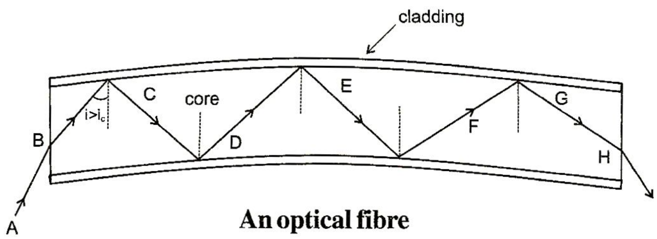
Topic:Semiconductor electronics; Sub-Topic:Transistors_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

19. (i) Total internal reflection **[1 Mark]**

(ii) The necessary conditions are

(a) The light ray must be moving from a denser to a rarer medium.

(b) The angle of incidence must be greater than the critical angle. **[1 Mark]**

(iii) 

An optical fibre **[1 Mark]**

Topic:Ray optics_; Sub-Topic:Total internal reflection_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

20. Application of the internet:

(a) Email : Electronic mail

(b) File transfer:

(c) WWW : World Wide Web

(d) E-commerce

(e) Chat **[1 Mark]**

[2 Marks for Any one application of explanation]

(a) **Email : Electronic mail:** It is a message sent and received through a computer network. Emailing allows exchange of text/graphic material using email software. One can write a letter and send it to the recipient through ISP's (Internet Service Providers) who work like the dispatching and receiving post offices.

Some advantages of E-mail are as follows :

i. Fast delivery ii. Low cost

iii. Easy record maintenance iv. Reduction of the wastage of paper stationery.

(b) **File transfer:** An FTP (File Transfer Protocol, the rules which take care of file's transfer) permits the transfer of files/software from one computer to another connected to the internet.

(c) **WWW : World Wide Web:** It is a set of protocols that allows us to access any document on the internet. WWW is based upon clients and servers. A web browser is a WWW client that navigates through the worldwide web and displays web pages. A web server is a WWW server that responds to the requests made by web browsers. A location on net server is called website. Each website has a unique address called URL (Uniform Resource Locator). The Internet structure of WWW is built on a set of rules called Hyper Text Transfer Protocol (HTTP) and a page description language called HyperText Markup Language (HTML). HTTP uses Internet addresses in a special format called a Uniform Resource Locator or URL.

(d) **E-commerce:** E-commerce is the collection of tools and practices involving internet technologies that allow a company to create, maintain and optimise business relations with consumers and other businesses. It helps on-line banking activities. Moreover, customers can view images and receive all the information about various products or services of companies through their websites. So they can do on-line shoping.

(e) **Chat:** It is the real time conversation among people with common interests through the typed messages on the net. Each person of the chat group gets the message instantaneously and can respond rapidly.

Topic:Communication system; Sub-Topic:Internet_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

21. $y_1 = a\cos\omega t$

$y_2 = a\cos(\omega t + \phi)$

$y = y_1 + y_2$

$= a\cos\omega t + a\cos(\omega t + \phi)$

$= a\cos\omega t + a[\cos\omega t\cdot\cos\phi - \sin\omega t\cdot\sin\phi]$

$= a\cos\omega t + a\cos\omega t\cdot\cos\phi - a\sin\omega t\cdot\sin\phi$

$= (1+\cos\phi)\,a\cos\omega t - a\sin\omega t\cdot\sin\phi$

$= (a + a\cos\phi)\cos\omega t - a\sin\omega t\cdot\sin\phi$

Put,

$a + a\cos\phi = A\cos\theta$

$a\sin\phi = A\sin\theta$

$= A\cos\theta\cdot\cos\omega t - A\sin\omega t\cdot\sin\theta$

$y = A\cos(\omega t - \theta)$ **[1 Mark]**

If, I_1 and I_2 are the intensities of two interfering waves then

$I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

If, $I_1 = I_2 = I$

$I_R = I + I + 2\sqrt{I^2}\cos\phi$

$= 2I + 2I\cos\phi$

$= 2I\ (1 + \cos\phi)$

$I_R = 4I\cos^2\frac{\phi}{2}$

if $\phi = 0$

$\cos\phi = \cos 0 = 1$

$I_R = 4I$ **[1 Mark]**

condition for constructive interference and destructive interference in terms of phase angle ϕ

For bright point phase difference $= 2n\frac{\lambda}{2}\times\frac{2\pi}{\lambda}$

$\therefore$ Phase difference $= 2\pi n$

For dark point, phase difference $= (2n-1)\frac{\lambda}{2}\times\frac{2\pi}{\lambda}$

$= (2n-1)\ \pi\ ,\ n \in I$ **[1 Mark]**

Topic:Wave optics_; Sub-Topic:Interference_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

22. (i) (a) High saturation magnetization.

(b) Low retentivity and coercivity **[1 Mark]**

(ii) **Gauss's law in magnetism:**

$$\oint_S \vec{B}\cdot\overrightarrow{dS} = 0$$

This is Gauss's law in magnetism which states that the surface integral of a magnetic field over a closed surface is always zero. But the surface integral of a magnetic field over a surface gives magnetic flux through that surface. So Gauss's law in magnetism can also be stated as follows:

The net magnetic flux, through a closed surface is zero.

Gauss's law in electrostatics states that the surface integral of the electrostatic field $\vec{E}$ over a closed surface S is equal to $\frac{1}{\varepsilon_0}$ times the total charge q enclosed by the surface S, i.e.,

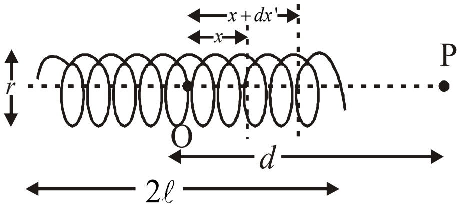
$$\oint_S \vec{E}\cdot\overrightarrow{dS} = \frac{q}{\varepsilon_0}$$

Gauss's law in magnetism is different because of the fact that magnetic charges do not exist in isolation. They are always in pairs of equal and opposite magnetic charges so that net magnetic charge inside a closed surface is always zero. **[1 Mark]**

Topic:Moving charges and magnetism_; Sub-Topic:Gauss Law__ L-1 _Target-2016_ XII-CBSE Board Exam__Physics

OR

We consider a solenoid of length '2ℓ', radius 'r' and number of turns per unit length 'n' carrying current I. Let P be a point on the axis of the solenoid at a distance 'd' from the centre.



The magentic field at an axial point at a distance d from one complete turn of the soleniod, is

$$B = \frac{\mu_0 I r^2}{2\left(r^2 + d^2\right)^{3/2}}$$ (along the axis) **[1 Mark]**

We consider a part of the solenoid at a distance x from centre having length dx. The magnetic field at P due to this element is

$$dB = \frac{\mu_0 I r^2}{2\left\{r^2 + (d-x)^2\right\}^{3/2}} \cdot (ndx)$$

$$\therefore \; dB = \frac{\mu_0 n I r^2}{2} \cdot \frac{dx}{\left\{r^2 + (d-x)^2\right\}^{3/2}}$$ **[1 Mark]**

$\therefore$ Magnetic field due to entire solenoid is

$$B = \frac{\mu_0 n I r^2}{2} \int_{-\ell}^{\ell} \frac{dx}{\left\{r^2 + (d-x)^2\right\}^{3/2}}$$

$$\therefore \; B = \frac{\mu_0 n I r^2}{2} \left[\frac{-1}{r^2} \left(\frac{d-x}{\sqrt{(d-x)^2 + r^2}} \right) \right]_{-\ell}^{\ell}$$

$$\text{or, } B = \frac{\mu_0 n I}{2} \left\{ \frac{d+\ell}{\sqrt{(d+\ell)^2 + r^2}} - \frac{d-\ell}{\sqrt{(d-\ell)^2 + r^2}} \right\}$$

This field becomes equivalent to that produced by a bar magnet if the distance 'd' of the axial point P is large enough i.e., $d >> \ell, r$ **[1 Mark]**

Topic:Moving charges and magnetism; Sub-Topic:Field at an axial point of solenoid_ L-4_Target-2016_ XII-CBSE Board Exam__Physics

SECTION - D

23. (a) Two values of Hari.

(1) Hari is good human being.

(2) He has helping nature. **[1 Mark]**

(b) Because when bird sit on line wire that time circuit is not completed but when boys touched the wire that time circuit is completed due to ground. **[2 Mark]**

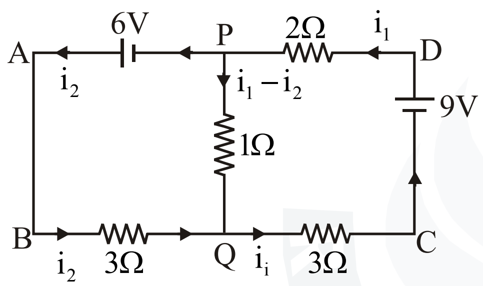
(c) To reduce the power loss during transmission. **[1 Mark]**

Topic:Current electricity_; Sub-Topic:Electric power_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

SECTION - E

24.

(i)



Applying Kirchhoff's loop rule in the loop ABQPA

$$-3i_2 + (i_1 - i_2) + 6 = 0$$

$$\Rightarrow i_1 - 4i_2 + 6 = 0$$

$$\Rightarrow 4i_2 - i_1 = 6 \quad \text{......(i)}$$ **[1 Mark]**

Applying Kirchhoff's loop rule in the loop DPQCD,

$$-2i_1 - (i_1 - i_2) - 3i_1 + 9 = 0$$

$$-6i_1 + i_2 + 9 = 0$$

or, $-i_2 + 6i_1 = 9$ ....(ii) **[1 Mark]**

Solving equation (i) and (ii), $i_1 = \frac{42}{23} A$ and $i_2 = \frac{45}{23} A$

$\therefore$ Current in 1 Ω resistance is $i_1 - i_2 = \frac{-3}{23} A$ **[1 Mark]**

The negative sign indicates that current will be from Q to P having magnitude $\frac{3}{23} A$

Topic:Current electricity; Sub-Topic:Kirchhoff's Law_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

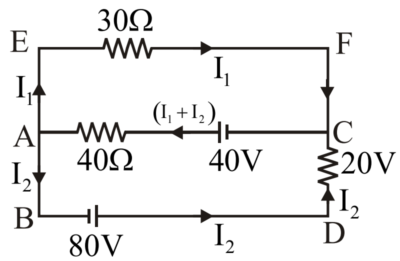
(ii) (a) As value of resistance R is increased, the potential drop across wire AB descreases. This will shift the position of null point towards B. **[1 Mark]**

(b) If S is decreased, the current through S will increase, which will decrease the termind potential difference of the cell $\left(V = \varepsilon - ir\right)$ if the cell is having some internal resistance.

This will make the null point ot shift towards A. **[1 Mark]**

Topic:Current electricity_; Sub-Topic:Potentiometer_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

OR



(a) Using Kirchhoff's junction rule at A, the current in the arm AC is $\left(I_1 + I_2\right)$ $\{from\ C\ to\ A\}$.

Using Kirchhoff's loop rule, the loop ABDCA

$$80 - 20\,I_2 + 40\left(I_1 + I_2\right) = 0$$

or $4 - I_2 + 2 - 2\left(I_1 + I_2\right) = 0$

or $6 - 2I_1 - 3I_2 = 0$

or $2I_1 + 3I_2 = 6$ ....(i) **[1 Mark]**

Using Kirchhoff's loop rule, in the loop AEFCA,

$$-30\,I_1 + 40 - 40\left(I_1 + I_2\right) = 0$$

or, $-3I_1 + 4 - 4\left(I_1 + I_2\right) = 0$

or, $-7\,I_1 - 4I_2 + 4 = 0$

or, $7I_1 + 4I_2 = 4$ ....(ii) **[1 Mark]**

Solving equation (i) and (ii)

$$I_1 = \frac{-12}{13}\,A,\ I_2 = \frac{34}{13}\,A$$

$\therefore$ Current in the arm AC is $\left(I_1 + I_2\right) = \frac{22}{13}\,A$ from C to A. **[1 Mark]**

Topic:_Current electricity_; Sub-Topic:Kirchhoff's Law__ L-1_Target-2016_ XII-CBSE Board Exam__Physics

(b) Metre bridge works on the principle of Wheatstone bridge. Metal strips are used to form gaps across which unknown resistance and variable resistance are connected. These metal strips are thick so that their resistance can be neglected. **[2 Marks]**

Topic:Current electricity; Sub-Topic:Metre bridge_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

25. (i) According to Biot-Savart law, the mgnitude of the field $\overrightarrow{dB}$ is

(a) directly proportional to the current I through the conductor, $dB \propto I$

(b) directly proportional to the length dl of the current element, $dB \propto dl$

(c) directly proportional to $\sin\theta$, $dB \propto \sin\theta$

(d) inversely proportional to the square of the distance r of the point P from the current element,

$$dB \propto \frac{1}{r^2}$$

Combining all these four factors, we get

$$dB \propto \frac{I\ dl\ \sin\ \theta}{r^2}$$

or $$dB = K \cdot \frac{I\ dl\ \sin\theta}{r^2}$$ **[1 Mark]**

The proportionality constant K depends on the medium between the observation point P and the current element and the system of units chosen. For free space and in SI units,

$$K = \frac{\mu_0}{4\pi} = 10^{-7}\ T\ mA^{-1}\ (\text{or}\ Wbm^{-1}A^{-1})$$

Here μ_0 is a constant called permeability of free space. So the Biot-Savart law in SI units may be expressed as

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I\,dl\sin\theta}{r^2}$$

We can write the above equation as

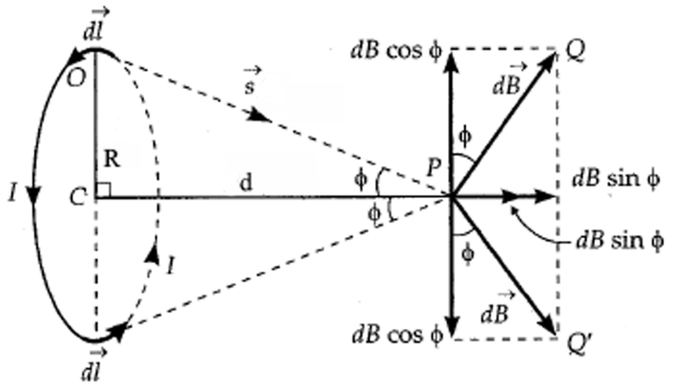
$$dB = \frac{\mu_0 I}{4\pi}\frac{dl\,r\ \sin\theta}{r^3}$$

As the direction of $\overrightarrow{dB}$ is perpendicular to the plane of $\vec{dl}$ and $\vec{r}$, so from the above equation, we get the vector form of the Biot-Savart law as

$$\overrightarrow{dB} = \frac{\mu_0 I}{4\pi}\frac{\vec{dl} \times \vec{r}}{r^3}$$ **[1 Mark]**

Topic:Moving charges and magnetism_; Sub-Topic:Biot-sabort's Law_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

(ii) **Magnetic field along the axis of a circular current loop**: Consider a circular loop of wire of radius R_1 and carrying current I, as shown in Figure. Let the plane of the loop be perpendicular to the plane of paper. We wish to find field $\vec{B}$ at an axial point P at a distance *d* from the centre C.



Consider a current element $\vec{dl}$ at the top of the loop. It has an outward coming current.

If $\vec{s}$ be the position vector of point P relative to the element $\vec{dl}$, then from Biot-Savart law, the field at point P due to the current element is

$$dB = \frac{\mu_0}{4\pi}.\frac{I\,dl\sin\theta}{s^2}$$

Since $\vec{dl} \perp \vec{s}$, i.e., $\theta = 90°$, therefore

$$dB = \frac{\mu_0}{4\pi}\cdot\frac{I\,dl}{s^2}$$

The field $d\vec{B}$ lies in the plane of paper and is perpendicular to $\vec{s}$, as shown by $\overrightarrow{PQ}$. Let ϕ be the angle between OP and CP. Then dB can be resolved into two rectangular components.

$dB \sin\phi$ along the axis,

$dB \cos\phi$ perpendicular to the axis.

For any two diametrically opposite elements of the loop, the components perpendicular to the axis of the loop will be equal and opposite and will cancel out. Their axial components will be in the same direction, i.e., along CP and get added up.

$\therefore$ Total magnetic field at the point P in the direction CP is

$$B = \int dB \sin\phi$$

But $\sin\phi = \frac{R}{s}$ and $dB = \frac{\mu_0}{4\pi}\cdot\frac{I\,dl}{s^2}$

$\therefore$ $$B = \int \frac{\mu_0}{4\pi}.\frac{I\,dl}{s^2}.\frac{R}{s}$$ **[1 Mark]**

Since μ_0 and I are constant, and s and R are same for all points on the circular loop, we have

$$B = \frac{\mu_0 IR}{4\pi s^3}\int dl = \frac{\mu_0 IR}{4\pi s^3}.2\pi R = \frac{\mu_0 IR^2}{2s^3}$$

$$[\because \int dl = \text{circumference} = 2\pi R]$$

or $$B = \frac{\mu_0 IR^2}{2(d^2+R^2)^{3/2}} \qquad [\because s = (d^2+R^2)^{1/2}]$$

As the direction of the field is along + ve X-direction, so we can write

$$\vec{B} = \frac{\mu_0 IR^2}{2(d^2+R^2)^{3/2}}\hat{i}$$

If the coil consists of N turns, then

$$B = \frac{\mu_0 N IR^2}{2(d^2+R^2)^{3/2}}$$ **[1 Mark]**

Topic:Moving charges of magnetism_; Sub-Topic:Magnetic field on axis of circular current loop_ L-2_ _Target-2016_ XII-CBSE Board Exam__Physics

(iii) The magnitude of the magnetic field of this coil at the center

$$B_c = \frac{\mu_0 NIR^2}{2R^3} = \frac{\mu_0 NI}{2R}$$

The magnitude of the magnetic field of coil at an axial point.

$$B_a = \frac{\mu_0 NIR^2}{2(d^2+R^2)^{3/2}}$$

$$= \frac{\mu_0 NIR^2}{2(3R^2+R^2)^{3/2}}$$

$$= \frac{\mu_0 NIR^2}{2\times 8R^3}$$

$$B = \frac{\mu_0 NI}{16R}$$

$$\frac{B_c}{B_a} = \frac{\mu_0 NI}{2R}\times\frac{16R}{\mu_0 NI}$$

$$\frac{B_c}{B_a} = 8$$

$$B_c = 8\,B_a$$ **[1 Mark]**

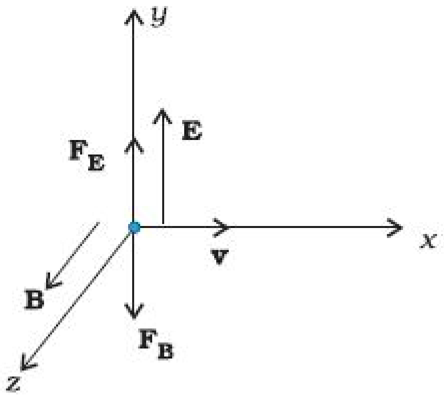
Topic:Moving charges and magnetism; Sub-Topic:Magnetic filed on axis of circular current loop_ L-1_ _Target-2016_ XII-CBSE Board Exam__Physics

OR

(a) A charge q moving with velocity v in presence of both electric and magnetic fields experiences a force given by

$F = q\ (E + v \times B) = F_E + F_B$

We shall consider the simple case in which electric and magnetic fields are perpendicular to each other and also perpendicular to the velocity of the particle, as shown in Figure. We have,



$\vec{E} = E\hat{j}, \vec{B} = B\hat{k},\ \vec{v} = v\hat{i}$

$\vec{F}_E = q\vec{E} = qE\ \hat{j},\ \vec{F}_B = q\vec{v} \times \vec{B} = q(v\hat{i} \times B\hat{k}) = -qvB\,\hat{j}$

Therefore, $F = q(E - vB)\hat{j}$ **[1 Mark]**

Thus, electric and magnetic forces are in opposite directions as shown in the figure. Suppose, we adjust the values of E and B such that magnitude of the two forces are equal. Then, total force on the charge is zero and the charge will move in the fields undeflected.

This happens when,

$qE = qvB \quad \text{or} \quad v = \frac{E}{B}$ **[1 Mark]**

This condition can be used to select charged particles of a particular velocity out of a beam containing charges moving with different speeds (irrespective of their charge and mass). The crossed E and B fields, therefore, serve as a velocity selector. Only particles with speed E/B pass undeflected through the region of crossed fields. This method was employed by J. J. Thomson in 1897 to measure the charge to mass ratio (e/m) of an electron. The principle is also employed in Mass Spectrometer – a device that separates charged particles, usually ions, according to their charge to mass ratio.

[1 Mark]

Topic:Moving charges and magnetism_; Sub-Topic:Velocity selector_ L-1_Target-2016_ XII-CBSE Board Exam__Physics

(b) **Cyclotron :**

It is used to accelerate + ve charge, Electric field applied across Dees to generate charges from source i.e.(Hydrogen or He gas) and to increase speed of charge particle.

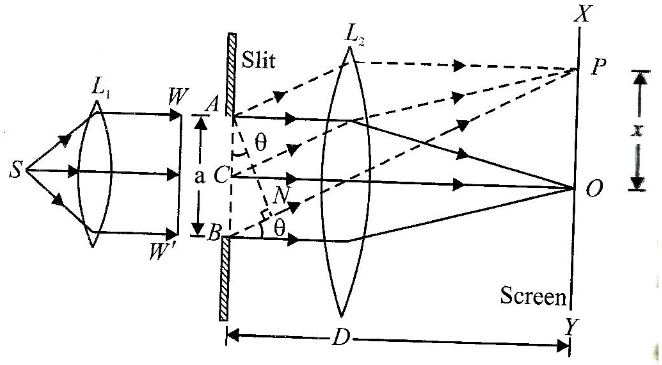
Magnetic field is used to change direction i.e. to give circular path to + ve charge particles.

Electric field lies in between dees (Gap), magnetic field lies in entire region even inside dees.

[2 Marks]

Topic:Moving charges and magnetism_; Sub-Topic:Cyclotron_ L-2_Target-2016_ XII-CBSE Board Exam__Physics

26.



[1 Mark]

If this path difference BN is λ (wavelength of light used) then point P will have minimum intensity i.e. P is a point of first secondary minima. This can be easily proved. The slit can be considered to be divided into two equal halves AC and CB. If the path difference between the secondary wavelets from A and B is λ, then path difference between secondary wavelets from A and C reaching P is $\lambda/2$ (i.e. a phase difference of 180^0) Similarly, the path difference between the wavelets from C and B reaching P is also $\lambda/2$. This is also true for any point in the upper half AC and the corresponding point in the lower half BC. Therefore, secondary waves from the upper half of the slit interfere destructively with secondary waves from the lower half of the slit. Hence P is a point of first secondary minimum.

Similarly if the path difference BN= 2λ, the point P will be the position of second secondary minimum. Hence the various secondary minima are formed at positions given by :

$$a\sin\theta_n = \pm n\lambda$$

here n = 1,2,3.......... an integer but not n = 0 where there is central maximum. The $\pm$ sign means that the secondary minima are formed on both sides of the central maximum. **[1 Mark]**

Positions of secondary maxima : If the path difference BN = $3\lambda/2$, then point P_1 (say) will have maximum intensity i.e. P_1 is a point of first secondary maxima.

$$\therefore BN = a\sin\theta' = \frac{3\lambda}{2} \text{.... first secondary maxima.}$$

The reason is simple. We can divide the slit into three equal parts. The path difference between the corresponding points of the first two parts will be $\lambda/2$ (i.e. a phase difference of 180^0) therefore, they will give rise to destructive interence. However, the wavelets from the third unused part will reinforce to produce weak first secondary maxima.

similary, the second maxima is located on the screen when the path difference is $5\lambda/2$

In general, the positions of the various secondary maxima are given by :

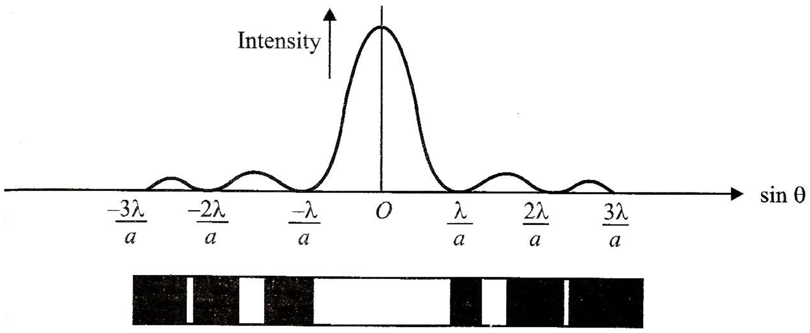
$$a\sin\theta_n' = \pm(2n+1)\frac{\lambda}{2} \text{..... where n=1,2,3........an integer}$$ **[1 Mark]**

The $\pm$ sign means that the secondary maxima are formed on both sides of the central maximum.

Intensity distribution curve : figure shows the intensity of diffraction pattern of a single slit as a function of $\sin\theta$.

positions of secondary minima : $\sin\theta_n = \pm\frac{n\lambda}{a}$ where $n = 1, 2, 3...$

positions of secondary maxima : $\sin\theta_n' = \pm(2n+1)\frac{\lambda}{2a}$ where $n = 1, 2, 3...$



[1 Mark]

The following points may be noted :

(a) The angular positions of the various secondary minima are $\sin\theta_n = \pm\frac{\lambda}{a}, \pm\frac{2\lambda}{a}, \pm\frac{3\lambda}{a}.....$

The angular positions of the various secondary maxima are $\sin\theta_n' = \pm\frac{3\lambda}{a}, \pm\frac{5\lambda}{a}....$

(b) The secondary maxima lie mid-way between the secondary minima.

(c) The intensity of secondary maxima decreases with distance from the centre O.

(d) The angular width of the central maxima is twice that of each secondary maximum,

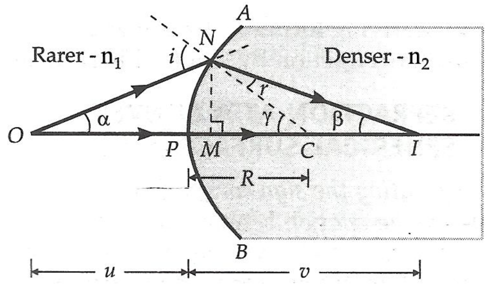
(e) Calculations show that intensity at the first secondary maximum is less than 5% of the intensity at O, the middle of the central maximum. Thus, most of the light incident on the slit is diffracted into the central maximum.

With increasing n , the contribution for intensity will be from lesser part of the slit (for first maxima it will be from 1/3rd of the slit, for second maxima it will be from 1/5th of the slit and so on) hence secondary maxima get weaker in intensity with increasing *n*. **[1 Mark]**

Topic:Wave optics_; Sub-Topic:Diffraction_ L-2 _Target-2016_ XII-CBSE Board Exam__Physics

OR

(i) The object lies in rarer medium and the image formed is real. In figure, APB is a convex refracting surface which separates a rarer medium of refractive index n_1 from a denser medium of refractive index n_2. Let P be the pole, C be the centre of curvature and R = PC be the radius of curvature of this surface. Suppose a point object O is placed on the principal axis in the rarer medium. Starting from the point object O, a ray ON is incident at an angle *i*. After refraction, it bends towards the normal CN at an angle of refraction *r*. Another ray OP is incident normally on the convex surface and passes undeviated. The two refracted rays meet at point I So I is the real image of point object O.



Draw NM perpendicular to the principal axis. Let α, β and γ be the angles, as shown in figure.

In ΔNOC, i is an exterior angle, therefore,

$$i = \alpha + \gamma$$

Similarly, from ΔNIC, we have

$$\gamma = r + \beta$$

$$r = \gamma - \beta$$ **[1 Mark]**

or

Suppose all the rays are paraxial. Then the angles i, r, α, β and γ will be small.

$$\therefore \; \alpha \simeq \tan\alpha = \frac{NM}{OM} = \frac{NM}{OP} \qquad [\because P \text{ is close to } M]$$

$$\beta \simeq \tan\beta = \frac{NM}{MI} \simeq \frac{NM}{PI}$$

and $\gamma \simeq \tan\gamma = \dfrac{NM}{MC} \simeq \dfrac{NM}{PC}$

From Snell's law of refraction

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

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

or $n_1 i = n_2 r$ **[1 Mark]**

or $n_1[\alpha + \gamma] = n_2[\gamma - \beta]$

or $n_1\left[\dfrac{NM}{OP} + \dfrac{NM}{PC}\right] = n_2\left[\dfrac{NM}{PC} - \dfrac{NM}{PI}\right]$

or $n_1\left[\dfrac{1}{OP} + \dfrac{1}{PC}\right] = n_2\left[\dfrac{1}{PC} - \dfrac{1}{PI}\right]$

or $\dfrac{n_1}{OP} + \dfrac{n_2}{PI} = \dfrac{n_2 - n_1}{PC}$

Using new Cartesian sign convention, we find

Object distance, $OP = -u$

Image distance, $PI = +v$

Radius of curvature $PC = +R$

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

or $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ **[1 Mark]**

(ii) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ **[1 Mark]**

As λ increases, n decreases and f increases.

(iii) When convex lens is immersed in water n decreases and focal length increases. **[1 Mark]**

Topic:Ray optics_; Sub-Topic:Refraction from convex surface / convex lens_ L-3 _Target-2016_ XII-CBSE Board Exam__Physics