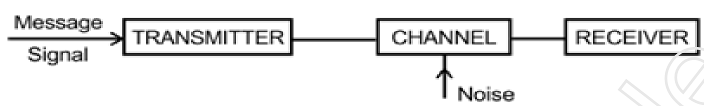
**SAMPLE PAPER-03**
**PHYSICS (Theory)**
**Class – XII**

Time allowed: 3 hours Maximum Marks: 70

**Solutions**

1. The conventional direction of electric current in a circuit tells the direction of flow of positive charge. The direction of flow of electrons gives the direction of electronic current, which is opposite to that of conventional current.
2. $B_H = \sqrt{3}\, B_V \rightarrow B\cos\theta = \sqrt{3}\, B \sin\theta$
   $\tan\theta = 1/\sqrt{3} \rightarrow \theta = 30^0$
3. Television signals are of high frequencies, they can be reflected to earth by ionosphere whereas sky waves are reflected from ionosphere.
4. 

5. $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}} \Rightarrow K_p < K_e$
6. This is due to the increase in intensity, no effect on K.E. of photo electrons as well as on potential difference. As due to increase in intensity there is only an increase in the number of photons per unit area and not the energy incident.
7. When a current is circular, it means the current is passing through a circular coil. The magnetic field produced due to the current through circular coil is in the form of straight and parallel magnetic lines of force at the centre of the circular coil, lying in a plane perpendicular to the plane of coil. It means the magnetic field is straight at the centre of the circular coil carrying current.

   **Or**

   Given B = $10^{-4}$ T then $v$ =?

   $m = 9 \times 10^{-31}$ kg

   $e = 1.6 \times 10^{-19}$ C

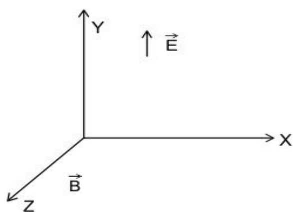
   $$Bev = \frac{mv^2}{r}$$

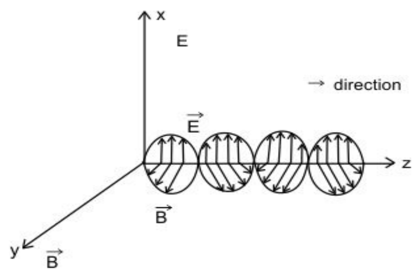
   $$v = \frac{Be}{2\pi m} = \frac{10^{-14} x 1.6 x 10^{-19}}{2x3.14x9x10^{-31}} = 2.83x10^6\, Hz$$
8. $E = n\frac{hc}{\lambda} = nh\upsilon$

10 x 1000 = n x 6.6 x $10^{-34}$ x 6 x $10^{5}$

$$n = \frac{10000}{6.6 \text{ x } 6 \text{ x } 10^{-29}} = 2.5 \text{ x } 10^{31} \text{ per second}$$

9.




10. $V_P = 200$ V $\eta = 80\%$

$V_S = 20$v

R =20Ω

$$\eta = \frac{V_p I_p}{V_s I_s} = \frac{V_p I_p}{V_s \frac{V_s}{R}} = \frac{V_p I_p R}{V_s^2}$$

$$I_p = \eta \frac{V_s^2}{V_p R} = \frac{80}{100} \text{ x } \frac{20 \text{ x } 20}{200 \text{ x } 20} = 0.08A$$

11.

$$r = \frac{mv}{qB} = \frac{p}{qB} = \frac{\sqrt{2mk}}{qB} = \frac{\sqrt{2mqv}}{qB}$$

$$\frac{r_p}{r_d} = \sqrt{\frac{m_p}{m_\alpha}\frac{q_\alpha}{q_p}} = \sqrt{\frac{m_p}{4m_p}\frac{2q_p}{q_p}}$$

$$\frac{r_p}{r_\alpha} = \frac{q}{\sqrt{2}}$$

12. $\mu_{ga} 1.5 R_1 = R_2 = 20cm$

$h_1$= 5 cm, u = - 10 cm

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{v} - \frac{1}{u}$$

$$\Rightarrow (1.5-1)\left(\frac{1}{20}-\frac{1}{-20}\right)=\frac{1}{v}-\frac{1}{-10}$$

$$\Rightarrow 0.5 \text{ x } \frac{2}{20}=\frac{1}{v}+\frac{1}{10}$$

$$\Rightarrow \frac{1}{v}=\frac{1}{10}-\frac{1}{20}=\frac{1}{20}$$

$$\Rightarrow v = 20cm$$

$$\therefore m=\frac{h_2}{h_1}=\frac{v}{u}$$

$$h_2=\frac{v}{u}h_1=\frac{20}{-10} \text{ x } 5$$

$$\text{h}_2=-10cm$$

13. Given L = 31.4 cm

*m* = 0.2 Am

*M* =?

When the wire is bent in the form of a semicircle of radius r

$$L=\pi r=3.14r$$

$$r=\frac{L}{3.14}=\frac{31.4}{3.14}=10cm$$

Distance between the two ends of wire

2*l* = 2r = 20 cm = 0.2 m

M = m x 2l = 0.2 x 0.2 = 0.04 Am$^2$

**Or**

Given $m_1$ = m, $m_2$ = 4 m

*r* = 10 cm = 0.1 m

F = 10gf = $10^{-2}$ x 9.8 N

$$F=\frac{\mu_0}{4\pi}\frac{m_1 m_2}{r^2}$$

$$9.8 \text{ x } 10^{-2}=10^{-7}\frac{m(4m)}{(0.1)^2}$$

4m$^2$ = 9800 m$^2$ = 2450

*m* = 49.5 Am

Strength of one pole = 49.5 Am

Strength of other pole = 4 x 49.5 = 198 Am

14.

Condition for resonance is $v = \dfrac{Be}{2\pi m}$

or $\quad B = \dfrac{2\pi mv}{e} = \dfrac{2\times3.14\times1.67\times10^{-27}\times10\times10^{6}}{1.6\times10^{-19}}$

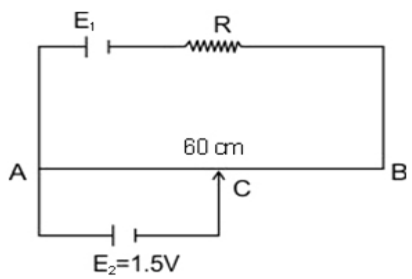
tesla $\quad$ =0.655 tesla

maximum kinetic energy $= \dfrac{B^2e^2r_m^{\ 2}}{2m}$

$= \dfrac{(0.655)^2\times(1.6\times10^{-19})^2(0.6)^2}{2\times1.67\times10^{-27}} J = 1.18\times10^{-12} J$

$= \dfrac{1.18\times10^{-12}}{1.6\times10^{-13}} Mev = 7.4 MeV$

15. Sensitivity – sensitivity of a potentiometer is related to potential gradient smaller the potential gradient, more sensitive be the potentiometer.



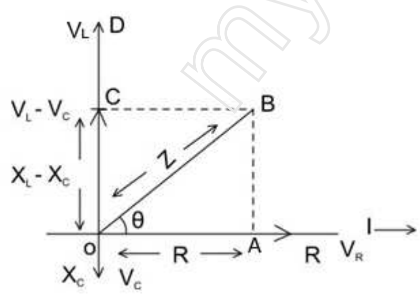

(i) $E_2 = KI_2$

$1.5 = K \times 60 \times 10^{-2}$

$K = \dfrac{1.5}{60 \times 10^{-2}} = \dfrac{150}{60} = 2.5$

(ii) No, as current is lowered as emf of driver cell is less than balancing cell.

16.




$OA = V_R$, $OD = V_L$, $OE = V_C$, $OC = V_L - V_C$

$V^2 = V_R^2 + (V_L - V_C)^2$

$= i^2[R^2 + (X_L - X_C)^2]$

$$V = i\sqrt{R^2 + (X_L - X_C)^2}$$
$$\Rightarrow \frac{V}{i} = \sqrt{R^2 + (X_L - X_C)^2}$$

= total resistance offered 'p' impedance

17. Mass of electron = 9 x $10^{-31}$ kg

De Broglie wavelength $\lambda_e = \frac{h}{mv}$

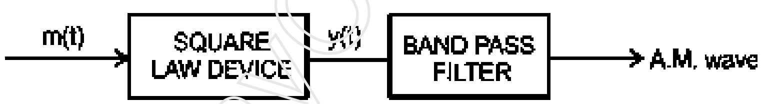
$$\lambda_e = \frac{6.63x10^{-34}}{9x10^{-31}x10^5}m = 7.4x10^{-9}m$$

Mass of proton = 1.67 x $10^{-27}$ kg

$$\lambda_p = \frac{h}{mv} = \frac{6.63x10^{-34}}{1.67x10^{-27}x10^5}m = 3.97x10^{-12}m$$

18. The neutrons produced by fission are fast, with kinetic energy of about 2 MeV. However, fission is induced most effectively by thermal neutrons. The fast neutrons can be slowed down by mixing the uranium fuel with a substance called moderator. It have two properties.
    a. It should be effective in slowing neutrons via elastic collisions. If a moving particle has a head on elastic collision with a stationary particle, the moving particle loses all its kinetic energy if the two particles have the same mass.
    b. The moderator should not absorb neutrons.

19. As for transmission of signals size of antenna L = λ /4 = C / 4υ, which is too large and hence reduces the size of antenna. Frequency other characteristics such as amplitude phase, should be modified and the process is known as modulation.

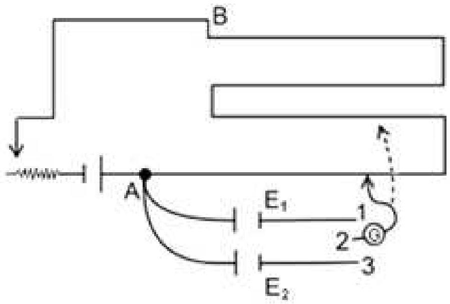



20. If potential difference is applied b/w the ends of a resistance wire of uniform cross section then potential drops along the two ends of wire is directly proportional length.

$V \alpha L$

$$\frac{V}{L} = \text{constant} = K$$

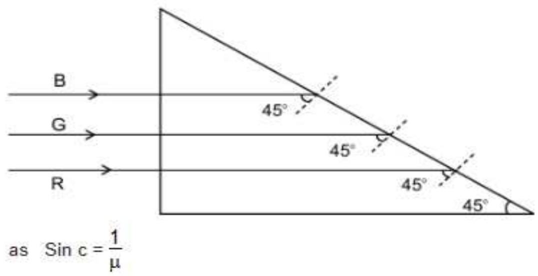
$$\frac{E_1}{E_2} = \frac{I_1}{I_2}$$



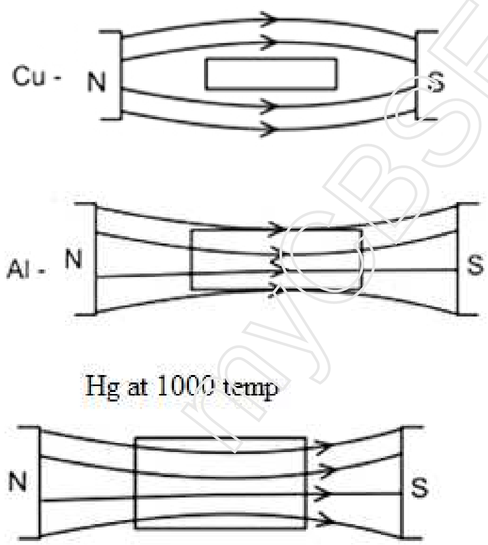

21. $\mu_R = 1.39$, $\mu_B = 1.47$, $\mu_G = 1.44$

$C_R = 44^0$, $C_B = 46.3^0$, $C_G = 48.8^0$

Therefore, $\angle i > \angle c$ for red colour, it will reflect.




22.




23.

a. The value of diagonals of the square = $\sqrt{2}$m

From the centre to the all the corners = $\frac{1}{\sqrt{2}}$ m

Now using the formula, $V = \frac{\Sigma q}{4\pi\varepsilon_0 r}$

Substituting the values, we get V = 5.09 x $10^2$ V

b. Using the formula, $\frac{q_1 q_2}{4\pi\varepsilon_0 r}$

Substituting the values, we get Potential energy = - 6.4 x $10^{-7}$J

24.

i) a) The electric force between an electron and a proton at a distance r apart is

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

Where the negative sign indicates that the force is attractive and the corresponding gravitational force is

$$F_G = -G\frac{m_p m_e}{r^2}$$

Where $m_p$ and $m_e$ are the masses of a proton and an electron respectively

$$\left|\frac{F_e}{F_G}\right| = \frac{e^2}{4\pi\varepsilon_0 G m_p m_e} = 2.4 \text{ x} 10^{39}$$

b) On similar lines, the ratio of the magnitudes of electric force to the gravitational force between two protons at a distance r apart is

$$\left|\frac{F_e}{F_G}\right| = \frac{e^2}{4\pi\varepsilon_0 G m_p m_e} = 1.3 \text{ x} 10^{36}$$

However, it may be mentioned here that the signs of the two forces are different. For two protons, the gravitational force is attractive in nature and the Coulomb force is repulsive. The actual values of these forces between two protons inside a nucleus (distance between two protons is ~ $10^{-15}$ m inside a nucleus) are $Fe$ ~ 230 N whereas $FG$ ~ 1.9 × $10^{-34}$ N. The (dimensionless) ratio of the two forces shows that electrical forces are enormously stronger than the gravitational forces.

ii) The electric force F exerted by a proton on an electron is same in magnitude to the force exerted by an electron on a proton; however the masses of an electron and a proton are different. Thus, the magnitude of force is

$$|F| = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} = \frac{8.987 \text{ x } 10^9}{\frac{1.6 \text{ x } 10^{-19}}{10^{-10}}} = 2.3 \text{ x } 10^{-8} \text{ N.}$$

Using Newton's second law of motion, $F = ma$, the acceleration that an electron will undergo is

$$a = \frac{2.3 \times 10^{-8}}{9.11 \times 10^{-31}} = 2.5 \times 10^{22} m/s^2$$

Comparing this with the value of acceleration due to gravity, we can conclude that the effect of gravitational field is negligible on the motion of electron and it undergoes very large accelerations under the action of Coulomb force due to a proton. The value for acceleration of the proton is

$$a = \frac{2.3 \times 10^{-8}}{1.67 \times 10^{-27}} = 1.4 \times 10^{19} m/s^2$$

**Or**

Consider a closed path of radius r inside the cross section of the wire. The current enclosed by this path is

$$I' = \left(\frac{I}{\pi a^2}\right)\pi r^2 = I\frac{r^2}{a^2}$$

Therefore, by Ampere's circuital law,

$$\phi \overrightarrow{B_r}, dl = \mu_0 I'$$

$$B_r 2\pi r = \mu_0 I \frac{r^2}{a^2}$$

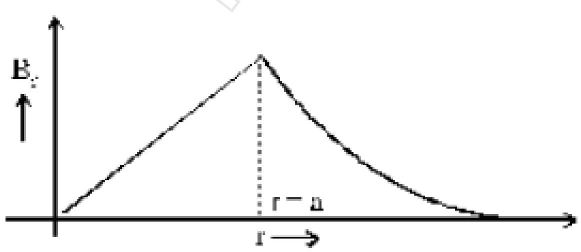
$$\therefore B_r = \frac{\mu_0 I}{2\pi a^2} r \quad [\because B \alpha r, \text{ for } r < a]$$

Outside the wire, the field of the wire is given by,

$$B.2\pi r = \mu_0 I$$

$$\therefore B = \frac{\mu_0 I}{2\pi r} \quad [\text{for } r > a]$$

The graph is shown as follows:




Therefore, $B_1$ and $B_2$ denote respectively, the values of the magnetic field points a/2 above and a/2 below the surface of the wire,

$$B_1 = \frac{\mu_0 I}{2\pi\left(3\frac{a}{2}\right)} = \frac{\mu_0 I}{3\pi a}$$

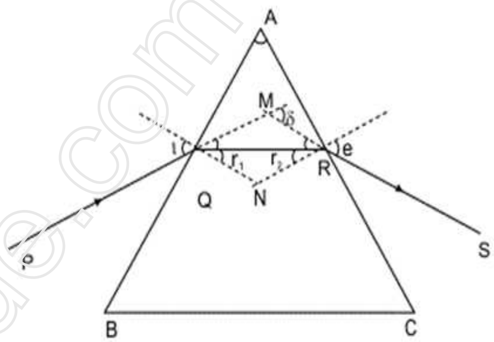
$$B_2 = \frac{\mu_0 I}{2\pi a^2} = \frac{a}{2} = \frac{\mu_0 I}{4\pi a}$$

$$\therefore \frac{B_1}{B_2} = \frac{4}{3}$$

The maximum value of the field is at r = a, we have

$$B_{\max} = \frac{\mu_0 I}{2\pi a}$$

25.




$$\delta = (i - r_1) + (e - r_2)$$

$$\delta = (i + e) - (r_1 + r_2) - - - - - - (1)$$

In $\Delta$ QNR,

$$r_1 + r_2 + \angle N + = 180 = \angle A + \angle N$$

$$\angle N + = 180 = \angle A + \angle N$$

$$\Rightarrow r_1 + r_2 = \angle A - - - - - - - (2)$$

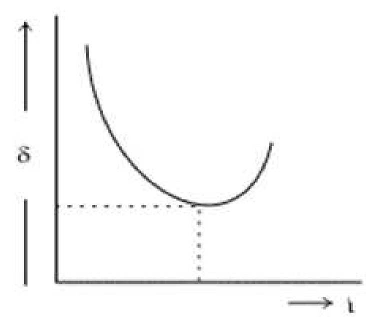
$$\delta = i + e - A$$

For minimum angle of deviation,

$$\angle i = \angle e \quad \& \quad r_1 = r_2$$

$$\Rightarrow \delta_m = 2i - A$$

$$\Rightarrow i = \frac{\delta_m + A}{2} \,\&\, r = \frac{A}{2}$$

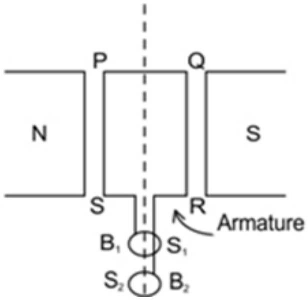


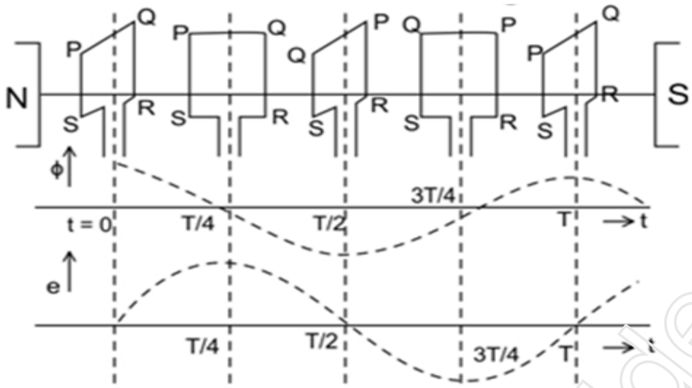

$$\therefore \text{Refractive index } \mu = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A + \mu_m}{2}\right)}{\sin \frac{A}{2}}$$

**Or**

Principle

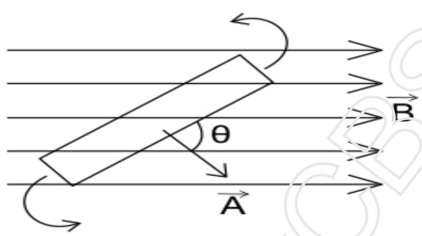
When a coil is rotated in a uniform magnetic field with a uniform angular velocity w flux linked with coil changes and emf is induced.




Induced emf e = $e_0$sinwf

= NBA w sinwf




Let θ be angle between $\vec{B}$ and $\vec{A}$ at anytime t = wf, θ = wt

As $\frac{d\theta}{dt}$ = w,

Let N be the number of turns in the coil, θ = $\vec{B}.\vec{A}$

= $N\left(\vec{B}.\vec{A}\right)$ = NAB cos θ

Induced emf e = $-\frac{d\phi}{dt} = -\frac{d}{dt}(NAB\cos\theta)$ = NAB (sin wt) w

E = NAwB sin wt

= $e_o$ sin wt

26.

| S. No | Ammeter | Voltmeter |
|---|---|---|
| 1. | It is a low resistance instrument. | It is a high resistance instrument. |
| 2. | It is always connected in series. | It is always connected in parallel. |
| 3. | The resistance of an ideal ammeter is zero. | The resistance of an ideal voltmeter is infinity. |
| 4. | It is not possible to decrease the range of a given ammeter. | It is possible to decrease the range of a given voltmeter. |
| 5. | Since ammeter is a parallel combination of galvanometer and shunt resistance therefore, the resistance of the ammeter is less than that of the galvanometer. | Since voltmeter is a series combination of galvanometer and resistance therefore the resistance of the voltmeter is greater than that of the galvanometer. |

**Or**

a) Yes, it does change with time. Time scale for appreciable change is roughly a few hundred years. But even on a much smaller scale of a few years, its variations are not completely negligible.

b) Magnetisation of a ferromagnet is not a single valued function of the magnetising field. Its value for a particular field depends both on the field and also on the history of the magnetisation.

c) The atoms of a paramagnetic substance possess small magnetic dipole moments. But these atomic dipoles are oriented in a random manner. In the presence of the external magnetic field, these dipoles tend to align in the direction of the field. But the tendency for alignment is hindered by thermal agitation. So, the magnetisation of paramagnetic salt decreases with increase in temperature.

d) Hysteresis loop gives useful information about the different properties, of materials such as coercivity, retentivity, energy loss. This information helps us in the suitable selection of materials for different purposes.