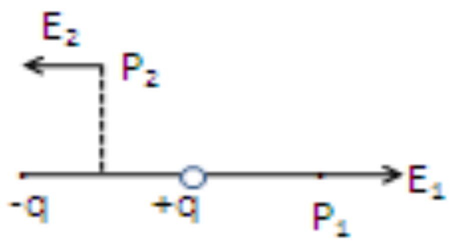
CBSE - STD XII

PHYSICS

1.What is the angle between the directions of electric field at any (i) axial point and (ii) equatorial point due to an electric dipole?



The direction of electric field E_1 at axial point P_1 and electric field E_2 at equatorial point P_2 are shown in fig. Obviously, angle between E_1 and E_2 is 180^0

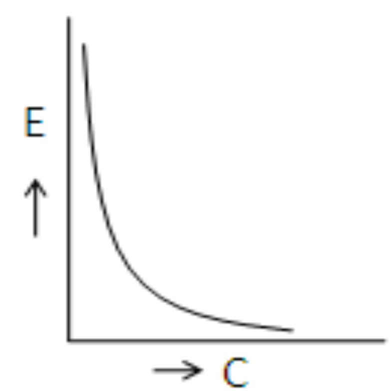
2. The graph shown here shows the variation of total energy (E) atored in a capacitor against the value of the capacitance (C) itself. Which of the two : the charge on capacitor or the potential used to charge it is kept constant for this graph ?

The given graph represents $E \alpha 1/C$

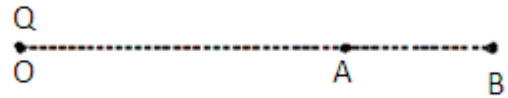
This is satisfied by the expression

$E = q^2 / 2C \alpha 1/c$ for constant q.

That is the charge (q) is kept constant



3. A point charge Q is placed at point O as shown in the figure. Is the potential difference $V_A - V_B$ positive, negative, or zero, if Q is (i) positive (ii) negative ?



The potential due to a point charge decreases with increase of distance, so in case (i) $V_A - V_B$ is positive. (ii) $V_A - V_B$ is negative

4.A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10V what is the potential at the centre of the sphere?

Potential at centre of sphere = 10V.

5. Consider two conducting spheres of radii R_1 and R_2 with $R_1 > R_2$. If the two are at the same potential, the larger sphere has more charge than the smaller sphere. State whether the charge density of the smaller sphere is more or less than that of the larger one.

Since two spheres are at the same potential, therefore

$$V_1 = V_2$$

$$\frac{Q_1}{4\pi\varepsilon_0 R_1} = \frac{Q_2}{4\pi\varepsilon_0 R_2}$$

$$\Rightarrow \frac{Q_1}{Q_2} = \frac{R_1}{R_2}$$

Given $R_1 > R_2$

$Q_1 > Q_2$

$\Rightarrow$ Larger sphere has more charge

Now, $\sigma_1 = \frac{Q_1}{4\pi R_1^2}$ and $\sigma_2 = \frac{Q_2}{4\pi R_2^2}$

.
$$\frac{\sigma_1}{\sigma_2} = \frac{Q_2}{Q_1} \frac{R_1^2}{R_2^2}$$

$$\Rightarrow \frac{\sigma_1}{\sigma_2} = \frac{R_1}{R_2} \frac{R_1^2}{R_2^2} = \frac{R_1}{R_2}$$ From equation

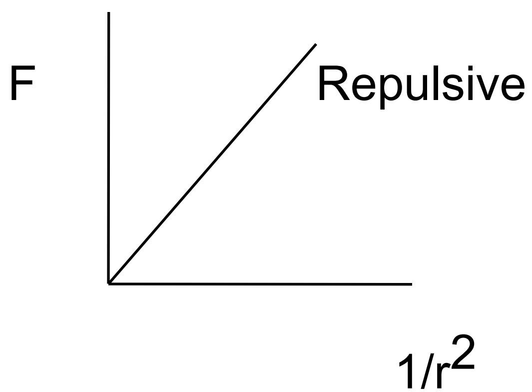
Since $R_1 > R_2$ therefore $\delta_2 > \delta_1$

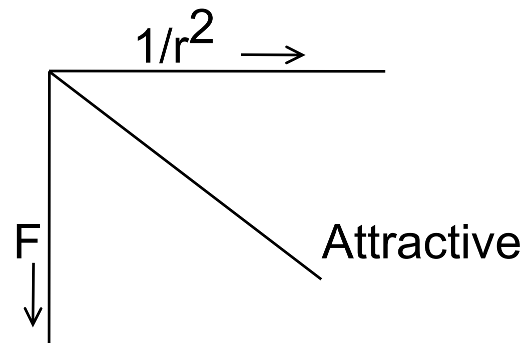
Charge density of smaller sphere is more than that of larger one.

6. Plot a graph showing the variation of coulomb force (F) versus $(1/2^2)$ where r is the distance between the two charges of each pair of charges: (1μC, 2μC) and (2μC, -3μC). Interpret the graph obtained

$F = 1/4 \Pi\varepsilon o \; q_1 q_2 / r^2$

The graph between F and $1/r^2$ is a straight line of slope $1/4 \Pi\varepsilon o \; q_1 q_2$ passing through origin.





since, magnitude of the slope is more for attraction, therefore, attractive force is greater than repulsive force.

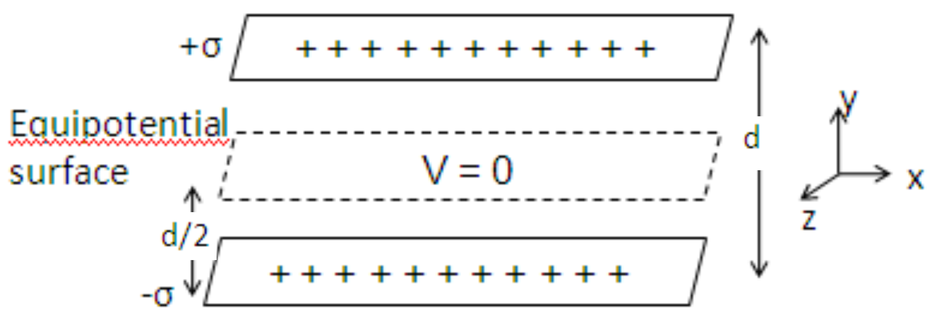
7. a) Define Electric flux. Write its SI Unit. b) A spherical rubber ballon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change/ Give reason.

a)The total number of electic field lines crossing diverging a surface normally is called electric flux. Electric flux through surface element ΔS is $\Delta\Phi = E. \Delta S$
$= E. \Delta S \cos \theta$ where E is electric field strength. Electric flux through entire closed surface is $\Phi = \int E.dS$. S.I. Unit of electric flux is volt meter. Total electric flux through the surface = q/ ε_o

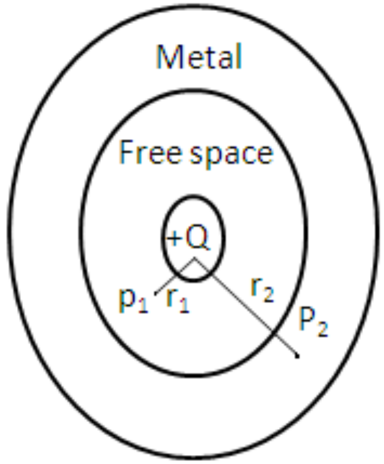
As charge remains unchanged when size of ballon increases, electric flux through the surface remains unchanged.

8) Two uniformly large parallel thin plates having charge densities +δ and –δ are kept in the X-Z plane at a distance 'd' apart. Sketch an equipotential surface due to electric field between the plates. If a particle of mass m and charge '-q' remains stationary between the plates, what is the magnitude and direction of this field?

The equipotential surface is at a distance d/2 from either plate in X-Z plane. For a particle of charge (-q) at rest between the plates, then (i) weight mg acts, vertically downward (ii) electric force qE acts vertically upward. So mg = qE = E=mg/q vertically downward, i.e. long (-) Y axis.



9) A small metal sphere carrying charge +Q is located at the centre of a spherical cavity in a large uncharged metal sphere as shown in fig. Use Gauss's theorem to find electric field at points P_1 and P_2.



Now consider a spherical surface of radius r_2 such that $QP_2 = r_2$ charge induced on inner surface of metallic sphere = - Q

Charge induced on outer surface of metallic sphere = +Q

Therefore Net charge enclosed by surface $S_2 = Q – Q = 0$

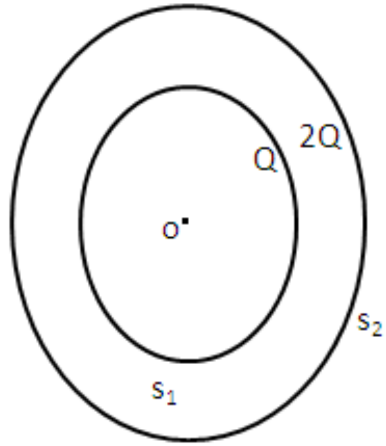
Therefore by Gauss Theorem total electric flux through surface $S_2 = 1/ \varepsilon_o$ x net charge enclosed.

$E_2 . 4\Pi r^2 = 1/ \varepsilon o \times 0$; Therefore $E_2 = 0$ i.e. electric field at P_2 is zero.

10) S_1 and S_2 are two hollow concentric spheres enclosing charges Q and 2Q respectively as shown in the fig.

a)What is the ration of electric flux through S_1 and S_2

b)How will the electric flux through the sphere S_1 change if a medium of dielectric constant 5 is introduced in the space inside S_1 in place of air.



i)Surface S_1 encloses charge Q only, therefore, electric flux through S_1 is $\Phi_1 = Q/\varepsilon o$

surface S_2 enclosed both charges Q and 2Q (i.e. total charge 3Q); therefore, electric flux through S_2 is $\Phi_2 = 3Q/\varepsilon o$

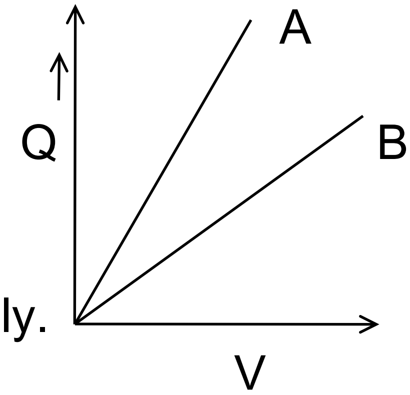
Ratio $\Phi_1 : \Phi_2 = Q/\varepsilon o : 3Q/\varepsilon o = \Phi_1 : \Phi_2 = 1:3$

ii)When a medium of dielectric constant K = 5 is introduced in the space inside S_1 the electric flux through S_1 will become $\Phi_1' = Q/K\varepsilon o = Q\,\varepsilon o/K = \Phi_1/5$

i.e. The electric flux through S_1 will become one fifth of that in air.

11) The given graph shows the variation of charge q versus potential difference V for capacitors C_1 and C_2. The two capacitors have the same plate separation, but the plate area of C_2 is doubled that of C_1 Which of the lines in the graph correspond to C_1 and C_2 and why?

Capacitance of parallel plate capacitor $C = \varepsilon_0 A / d \propto A$
As plate area of C_2 is doubled that of C_1 : $C_2 = 2C_1$
slope of q –V graph = q/v = C
As slope of A is greater than slope of B, A is corresponding to larger capacitance and B to smaller capacitance.
So lines corresponding to C_1 and C_2 are B and A respectively.



12) Two conducting wires X and Y of same diameter but different materials are joined in series across a battery. If the number density of electrons in X is twice that in Y, find the ratio of drift velocity of electron in the two wires.

In series current is same, So, $I_A = I_B = I = netAv_d$
For same diameter, cross – sectional area is same $A_A = A_B = A$
Therefore $I_A = I_B = n_x eAv_x = n_y eAv_y$.

Given $n_x = 2n_y$

$$\Rightarrow \frac{v_x}{v_y} = \frac{n_y}{n_x} = \frac{n_y}{2n_y} = \frac{1}{2}$$

13) Two heated wires of the same dimensions are first connected in series and then in parallel to a source of supply. What will be the ratio of heat produced in the two cases ?

For same voltage $Q = V^2 / R \; t \; \alpha \; 1/R$

$$Q = \frac{V^2}{R} t \propto \frac{1}{R}$$

$$\frac{Q_{series}}{Q_{parallel}} = \frac{Q_{series}}{Q_{parallel}} = \frac{(R.R)/(R+R)}{R+R} = \frac{R/2}{2R} = \frac{1}{4}$$

14) a (i) series (ii) parallel combination of two given resistors is connected, one by one,across a cell. In which case will the terminal potential difference, across the cell have a higher value?

Terminal potential difference across a cell $V = \varepsilon = Ir$

i)In series arrangement, current $I_s = \dfrac{E}{R_1 + R_2 + r}$

i)ii) In parallel arrangement, current, $I_P = \dfrac{E}{\dfrac{R_1 R_2}{R_1 + R_2} + r}$

Obviously $I_P > I_S$, so $V_P < V_S$

That is series arrangement will have higher terminal potential difference.

15) State the condition under which the terminal p.d. across a battery and its emf are equal.

The terminal p.d. across a battery is equal to its emf when battery is in open circuit, i.e. when no current is being drawn from the cell.

16) Using the mathematical expression for the conductivity of a material, explain how it varies with temperature for (i) semiconductor (ii) good conductors.

Conductivity of a material, $\sigma = ne^2t /m$

Where m = mass of charge carrier, e = charge on each carrier

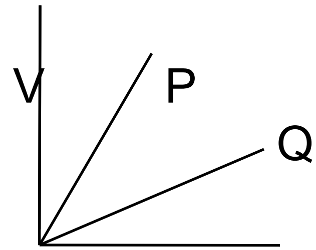
t = relaxation time , n = number density of charge carriers.

i) In the case of semi conductors; when temperature increases, covalent bonds break and charge carriers (electrons and holes) become free i.e. n increases, so conductivity increases with rise of temperature.

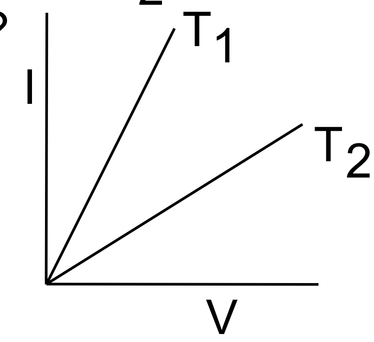
ii) In the case of good conductors ; when temperature increases, the number of collisions of electrons with ion-lattice increases, so relaxation time decreases, so conductivity of good conductor decreases with rise of temperature.

17) The variation of potential difference V with length l in the case of two potentiometer P and Q is as shown. Which of these two will you prefer for comparing the emfs of two primary cells?

For greater accuracy of potentiometer, the potential gradient (slope) V/I must be as small as possible. In the graph given the slope V/I is smaller for a potentiometer Q; hence we shall prefer potentiometer Q for comparing the emfs of two cells.

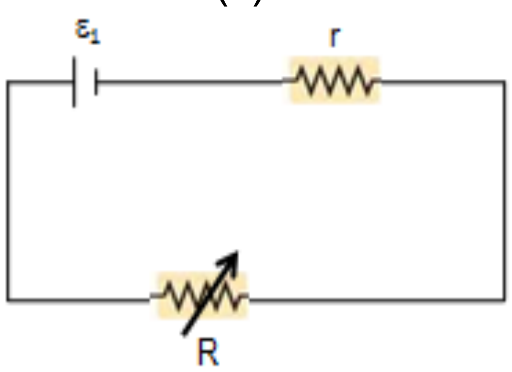


18) V-I graph for a metallic wire at two different temperatures T_1 and T_2 is shown in the figure. Which of these two temperatures is higher and why ?



The slope of V-I graph given, gives I/V = 1/R Smaller the slope, Larger the resistance. As resistance of a metal increases with The increase of temperature, resistance at temperature T_2 is Higher.

19) A cell of emf (ε) and internal resistance (R) is connected across a variable external resistance (R). Plot graphs to show variation of (i) E with R. (ii) Terminal p.d. of the cell (V) with R

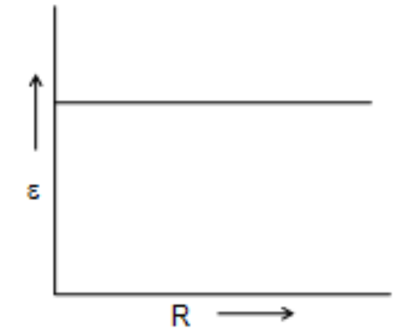


i) The emf of cell ε is independent of external resistance R, so graph is a straight line parallel to R-axis.

ii) Current in circuit $I = \varepsilon / R+r$

Terminal potential difference $V = IR = (\varepsilon / R+r)\ R$

$$= \frac{\varepsilon}{(R+r)iR} = \frac{\varepsilon}{1+\ r/R}$$



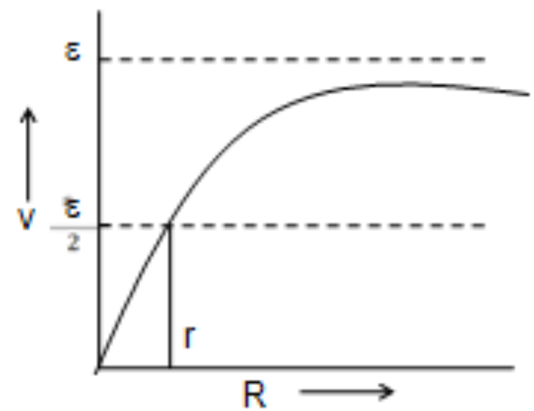
When R increases r/R decreases, so terminal potential difference increases with the increases of R.

When R = 0, V   0

When R = r, $V = \varepsilon/2$

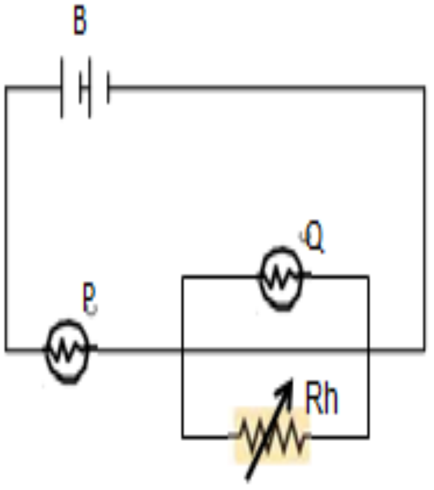
When R   (open circuit) $V = \varepsilon$

The graph of terminal potential difference V versus R is shown in figure



20)The circuit shown in the diagram contains a battery ‘B’ a rheostat ‘Rh’ and identical lamps P and Q. What will happen to the brightness of the lamps if the resistance through the rheostat is increases? Give reasons.

When resistance of rheostat is increased, the resistance of circuit increases, so current in main circuit decreases. As a result the potential difference across P decreases and that across Q increases ; so brightness of bulb P decreases and that of Q increases.



21) An electron is moving along positive X=axis in the presence of uniform magnetic field along positive Y axis. What is the direction of force acting on it ?

Magnetic force $\vec{F} = q\vec{v} \times \vec{B}$

Here $q = -e$, $\vec{v} = vi$

$\vec{B} = Bj$ Therefore $\vec{F} = -e(vi \times Bj) = evB(-k)$

Thus magnetic force acts along negative Z axis.

22) Which are of the following will describe the smallest circle when projected with the same velocity v perpendicular to the magnetic field B

(i) alpha particle (ii) Beta particle.

Radius of circular path in transverse magnetic field

$$r = \frac{mv}{qB} \propto \frac{m}{q}$$ for same v and B

For alpha particle $\left(\frac{m}{q}\right)_\alpha = \frac{4m_p}{2e} = \frac{2m_p}{e}$ where m_P is mass of proton.

For Beta particle $\left(\frac{m}{q}\right)_\beta = \frac{\frac{1}{1840}m_p}{e} = \frac{1}{1840}\left(\frac{m_p}{e}\right)$

Clearly Beta particles has smallest value of m/q ; so Beta particle will describe the smallest circle.

23)Why is the core of an electromagnet made of ferromagnetic materials?

Ferromagnetic material has a high retentivity. So on passing current through windings it gains sufficient magnetism immediately.

24) An ammeter and a milliameter are converted from the same galvanometer. Out of the two, which current measuring instrument has a higher resistance ?

Shunt resistant, S = G =

clearly, smaller the value of range, larger is the shunt resistance. Obviously, milliammeter will have a larger shunt resistance and hence it will have a higher resistance.

Higher the S, higher the R_A for given G

25) Two wires of equal length are bent in the form of two loops. One of the loops is square shaped whereas the other loop is circular. These are suspended in a

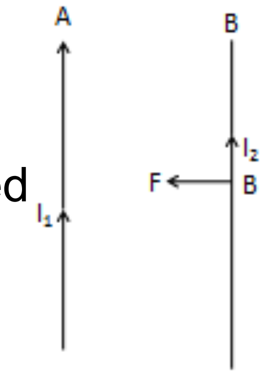
Uniform magnetic field and the same current is passed through them. Which loop will experience greater torque. Give reason.

Torque t = IAB sinɵ α A. For given perimeter the area of circular loop is maximum so a circular loop will experience greater torque.

26)Distinguish between diamagnetic and ferromagnetic materials in respect of their (i) intensity of magnetism (ii) behaviour in non-uniform magnetic field and (iii) susceptibility.

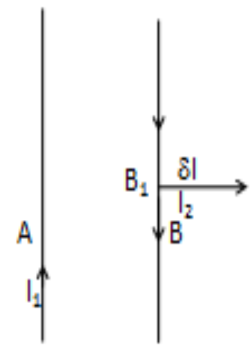
S.No.	**Property**	**Diamagnetic**	**Ferromagnetic**
1.	Intensity of magnetisation	Negative & very small	Positive & very large
2.	Behaviour in non uniform magnetic field.	Attracted towards a region of weaker magnetic field.	Attracted towards a region of stronger Magnetic field.
3.	Susceptibility	Negative & small $0 < x < ε$ ε small quantity.	Positive & large x of the order of hundreds & thousands

27) Explain why two straight parallel conductors carrying current in same direction attract each other.



The magnetic field produced by wire A at the vicinity of wire B will be Vertically downward. By Fleming left hand rule, the force experienced by wire B will be towards wire A. Thus two parallel wires carrying current in the same direction attract each other.

28) Explain why two long parallel straight conductors carrying current in opposite direction in air repel.



The magnetic field produced by current carrying conductor A in the vicinity of conductor B is vertically downward. By Fleming left hand rule, the force experienced by any element of conductors B will be away from A. Thus two parallel straight Conductors carrying opposite currents repel each other.

29)Explain why steel is preferred for making permanent magnets while soft iron is preferred for making electromagnets.

Steel has high retentivity and high coercivity. A permanent magnet must have these characteristics. So steel is preferred for making permanent magnet.

Soft iron has high retentivity and low coercivity. Electromagnet must have these characteristics, so soft iron is preferred for making electromagnets.

30) State two reasons why a galvanometer cannot be used as such to measure current in a given circuit..

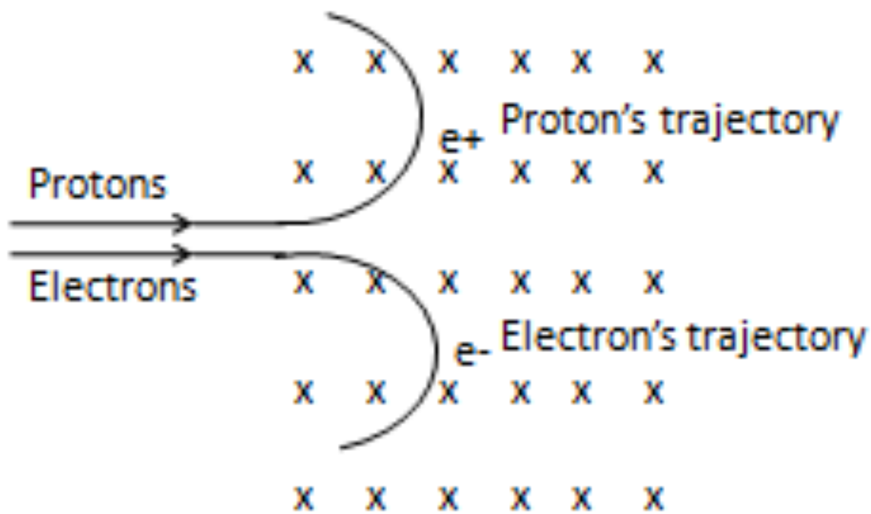
A galvanometer can be used as such to measure current due to following two reasons.

(i) A galvanometer has a finite large resistance and is connected in series in the circuit, so it will increase the resistance of circuit and hence change the value of current in the circuit.

(ii) A galvanometer is a very sensitivity device, it gives a full scale deflection for the current of the order of microampere, hence if connected as such it will not measure current of the order of ampere.

31) An electron and a proton, moving parallel to each other in the same direction with equal momenta, enter into a uniform magnetic field which is at right angles to their velocities. Trace their trajectories in the magnetic field.

Both electron and proton transverse circular paths of same radius but in opposite sense (fig.) $\left[r\left(=\frac{mv}{qB}\right)=\frac{p}{eB}\right]$



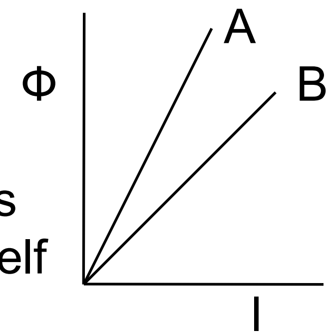
33)A bar magnet falls from a height 'h' through a metal ring. Will its acceleration be equal to g? Give reason for your answer.

when magnet falls, the magnetic flux linked through the metal ring changes, current is induced in the ring which (according to Lenz's law) opposes the approach of magnet, so its acceleration will be less than g.

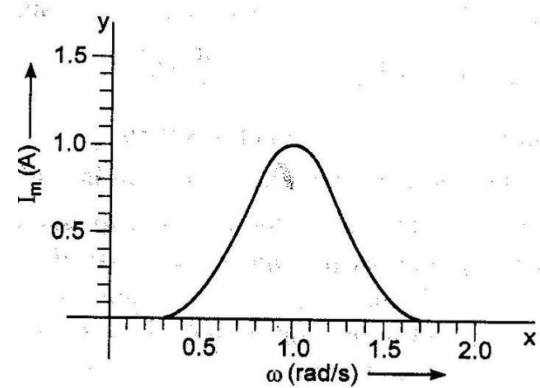
34) A plot of magnetic flux (Φ) versus current, (I) is shown in the figure for two inductors A and B. Which of the two has large value of self inductance ?

$\Phi = LI$ $\dfrac{\Phi}{I} = L$

The slope of of straight line is equal to self inductance L. It is larger for inductor A ; therefore inductor A has larger value of self inductance 'L'



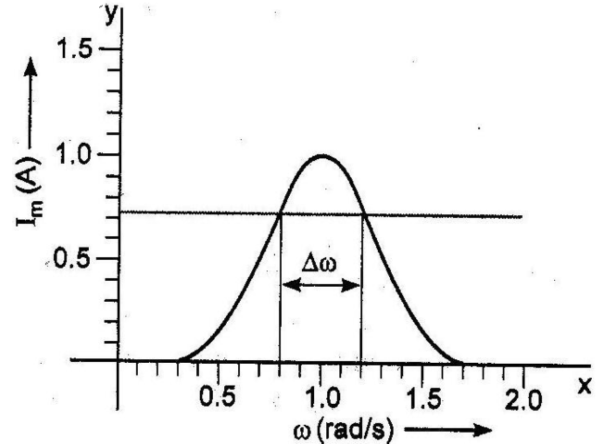
35)In series LCR circuit, the plot of I_{MAX} VS (i) is shown in the figure. Find the bandwidth and mark in the figure.



Band width corresponds to frequencies at which

$I_m = 1/\sqrt{2}\ I\ max\ = 0.7I\ max.$

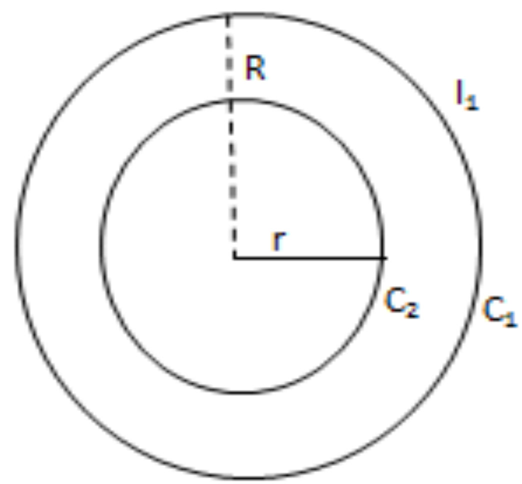
it is shown in the figure $\Delta\omega = 1.2 - 0.8 = 0.4$ rad/s



36) Two circular coils, one of radius r and the other of radius R are placed co – axially with their centres coinciding. For R >>r, obtain an expression for the mutual inductance of the arrangement.

The magnetic field produced by current carrying larger coil C in the vicinity of small coil C_1 is $B_1 = \frac{\mu_o I_1}{2R}$

The magnetic flux linked with shorter coil C_2 is



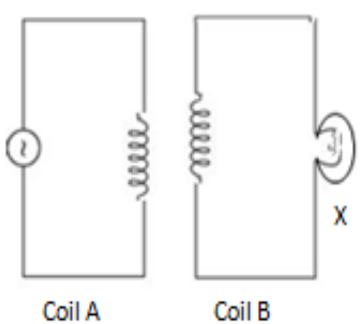
Mutual inductance M =

37) Two identical loops, one of copper and the other of aluminium, are rotated with the same angular speed in the same magnetic field. Compare (i) the induced emf and (ii) the current produced in the two coils. Justify your answer.

i) Induced emf, $\varepsilon = d\Phi / dt = d/dt\ (BA \cos \omega t) = BA\ \omega \sin \omega t$
As B, A, ω are same for both loops, so induced emf is same in both loops.

ii) Current induced $I = \varepsilon/R = \varepsilon / PlIA = \varepsilon A / pl$
As area A, length l and emf ε are same for both loops but resistivity p is less for copper, therefore current I induced is larger in copper loop.

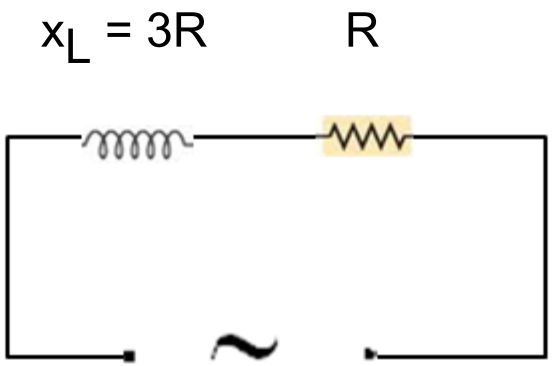
38)Fig shows an arrangement by which current flows through the bulb (X) connected with coil B. When ac is passed through coil A.
i) Name the phenomenon involved.
ii) If a copper sheet is inserted in the gap between the coils, explain how the brightness of the bulb would change ?

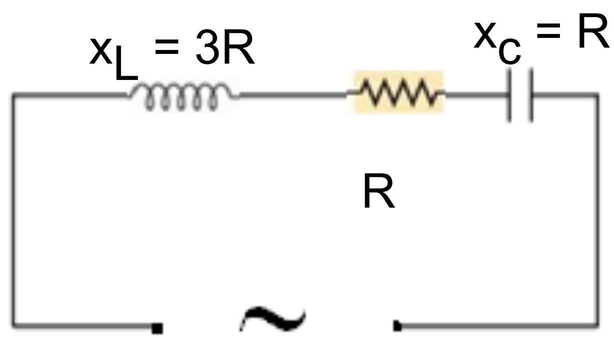


i) The phenomenon involved in mutual induction.
ii) when a copper sheet is inserted in the gap between the coils, the addy currents are induced in the coil, due to which the current in coil B is reduced, so brightness of bulb decreases.

39) Given below are two electrical circuits A and B, calculate the ratio of power factor of circuit B to the power factor of circuit A.

Power factor, $\cos \Phi = R/z$





Independence of circuit B, $Z_B = \sqrt{R^2 + (X_L - X_C)^2}$

Ratio of power factor of circuit B to that of A is

$$\frac{(\cos \phi)_B}{(\cos \phi)_A} = \frac{R/z_B}{R/z_A} = \frac{z_A}{z_B} = \frac{\sqrt{R^2 + X_L^2}}{\sqrt{R^2 + (X_L - X_C)^2}}$$

$$= \frac{\sqrt{R^2 + (3R)^2}}{\sqrt{[R^2 + \sqrt{(3R) - (R)^2}]}} = \frac{\sqrt{10}}{\sqrt{5}} = \sqrt{2}$$

40) What is the ratio of speed of infrared rays and ultraviolet rays in vacuum.

All electromagnetic waves travel in vacuum with the same speed.

$$\text{Ratio} = C_{infrared} / C_{ultraviolet} = 1$$

41) The following table gives the wavelength range of some constituents of the electromagnetic spectrum.

S.No.	Wavelength Range
1	1 mm to 700 nm
2	400 nm to 1 nm
3	1 nm to 10^{-3} nm
4	< 10^{-3}nm

42) Special devices, like the klystron value or the magnetron value, are used for production of electromagnetic waves. Name the waves and also write one of their applications.

Name: Microwaves. Uses: for cooking in microwaves ovens.

43) The frequency of oscillation of the electric field vector of a certain electromagnetic wave is 5×10^{14} Hz. What is the frequency of oscillation of the corresponding magnetic field vector and to which part of the electromagnetic spectrum does it belong ?

Frequency of oscillation of magnetic field vector is same as that of electric field vector i.e. $V = 5 \times 10^{14}$HZ It lies in visible region.

44) Name the charact3eristics of electromagnetic waves that (i) increases (ii) remains constant in the electromagnetic spectrum as one moves from radio wave region towards ultraviolet region.

(i)Frequency increases (ii) speed in vacuum remains constant.

45) Why does microwave oven heats up a food item containing water molecules most efficiently ?

This is due to the frequency of the microwave matches the resonant frequency of water molecular.

46) You are given a 2μ F parallel plate capacitor. How would you establish an instantaneous displacement current of 1mA in the space between its plates?

Given

$$I_D = 1\,mA = 1\times10^{-3}A;$$

$$C = 2\mu F = 2 \times 10^{-6}F$$

$$I_D = C\frac{dV}{dt}$$

$$1\times10^{-3} = 2 \times 10^{-6}\frac{dV}{dt}$$

$$\frac{dV}{dt} = \frac{1}{2}\times10^{3} = 5 \times10^{2}\ V/s$$

Hence applying a varying potential difference of 5×10^2 V/s would produce a displacement current of desired value.

47) Show that the radiation pressure exerted by an EM wave of intensity I on a surface kept in vacuum is I/c

Pressure

P = Force / Area = F/A = 1/A = $\Delta p / \Delta t$ (F = $\Delta p / \Delta t$ = rate of change of momentum)

= 1/A . U/ Δtc ($\Delta pc = \Delta U$ = energy imparted by wave in time Δt)

= I/c (Intensity I = U/ A Δt)

48) An object is placed at the principal focus of a concave lens of focal length f. Where will its image be formed?

1/f = 1/v-1/u = 1/v = 1/f+ 1/u

Here u = -f and for a concave lens f = -f

Therefore 1/v = -1/f -1/f = v = - f/2 that is image will be formed between optical centre and focus of lens; towards the side of the object.

49) How does the power of convex lens vary, if the incident red light is replaced by violet light?

Power of a lens increases if red light is replaced by violet light because
$P = 1/f = ({}_an_g\ -1)\ (1/R_1 - 1/R_2)$ and refractive index is maximum for violet light in visible region of spectrum.

50) A converging lens of refractive index 1.5 is kept in a liquid medium having same refractive index. What is the focal length of the lens in this medium.

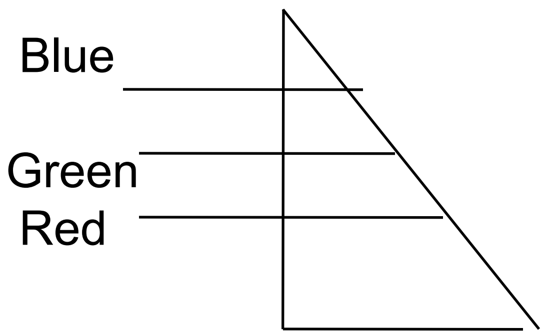
$1/fl = ({}_ln_g\ -1)\ (1/R_1 - 1/R_2) = (n_g / n_l\ -1)\ (1/R_1 - 1/R_2)$ Given $n_l = n_g = 15$
therefore $1/f_l = 0$ or $f_l = \infty$

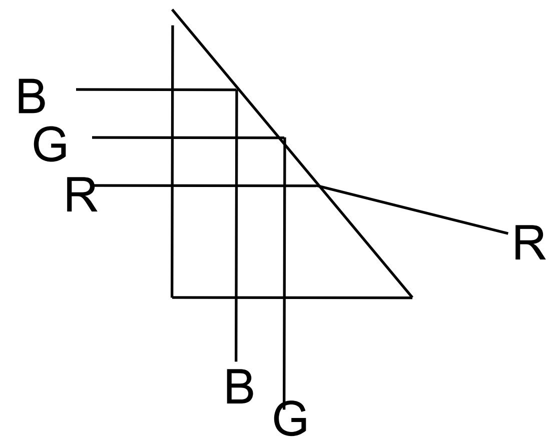
51) A diverging lens of focal length 'F' is cut into indentical parts, each forming a plano concave lens. What is the focal length of each part.

For a complete diverging lens.
$1/F = (n_g\ -1)\ (-\ 1/R - 1/R)\ = \quad F = -\ R / \ 2\ (n_g\ -1)$
for each planoconcave lens
$1/F' = (n_g\ -1)\ (-\ 1/R - 1/)\ \infty\ = \quad F = -\ R / \ (n_g\ -1) = 2F$
Therefore focal length of each half part will be twice the focal length of initial diverging lens.

52) In the fig. given below three light rays red (R) green (G) and blue (B) are incident on an isosceles right-angled prism abc at face ab. Explain with reason, which ray of light will be transmitted through the face ac. The refractive index of the prism for red, green, blue light are 1.39, 1.44, 1.47 respectively. Trace the path of rays after passing through face ab.

Angle of incidence at face ac for all three colours, $i = 45^0$
Refractive index corresponding to critical angle 45^0 is $\mu = 1/\sin 45^0 = \sqrt{2} = 1.414$





The rays will be transmitted through face ‘ac’ if $i < i_c$. This condition is satisfied for red colour (μ = 1.39) So only red ray will be transmitted, Blue and green rays will be totally reflected.

53) If s is the size of the source giving light of wavelength λ, separation between the slits, D its distance from the plane of slits, what should be the criterion for the interference fringes to be seen.

The size of source should be small. The condition is s/D < ג /d

54) How does the intensity of the central maximum change if the width of the slit is halved in a single slit diffraction experiment ?

If a is slit width, intensity of central maximum $I \propto a^2$. So if width is halved, the intensity becomes ¼ times.

55) Give reason for the following:

Astronomers prefer to use telescope with large objective diameters to observe astronomical objects.

The telescope of large objective diameters have high light gathering capacity and high resolving power.

56) The refractive index of a material is √3. What is the angle of refraction if the unpolarised light is incident on it at the polarising angle of the medium ?

From Brewster's law Polarising angle $i_p = \tan^{-1}(n) = \tan^{-1}\sqrt{3} = 60^0$.
Also $i_p + r = 90^0$. Therefore Angle of refraction $= 90^0 - i_p = 90^0 - 60^0 = 30^0$.

57) Tha radii of curvature of both the surfaces of a lens are equal. If one of the surfaces is made plane by grounding, then will the focal length of lens change? Will the power change ?

Focal length of lens $1/f = (n-1)(1/R + 1/R)$

$f = R / 2(n-1)$

When one surface is made plane, $1/f = (n-1)(1/R + 1/\infty)$

Therefore $f' = R / (n-1) = 2f$. That is, the focal length will be doubled.

As $P = 1/f$, so power will be halved.

58) For which colour the magnifying power of a simple microscope is highest ? For which colour it is lowerst?

It is highest for violet and lowest for red colour since $M = 1 + D/f$ and $f_V < f_R$.

59) Use the mirror equation to show that

a)an object placed between f and 2f of a concave mirror produces a real image beyond 2f.

b)a convex mirror always produces a virtual image independent of the location of the object.

c)an object placed between the pole and focus of a concave mirror produces a virtual and enlarged image.

a) Mirror equation is $1/f = 1/v+1/u$ or $1/v=1/f-1/u$

for a concave mirror, f is negative, i.e. $f < 0$

For a real object (on the left of mirror).

For u between f and 2f implies 1/u lies between 1/f and 1/2f i.e. $1/2f > 1/u>1/f$ (as u, f are negative)

or $- 1/2f < - 1/u < - 1/f$

or $1/f – 1/2f < 1/f - 1/u <0$

or $1/2f < 1/v < 0$ i.e. 1/v is negative.

This implies that v is negative and greater than 2f. This means that the image lies beyound 2f and it is real.

b) For a convex mirror, f is positive i.e. $f > 0$.

For a real object on the left u is negative.

$1/f = 1/v + 1/u$ implies $1/v = 1/f – 1/u$

As u is negative and f is positive; 1/v must be positive, so v must be positive i.e. image lies behind the mirror. Hence, image is virtual whatever the value of u may be.

c) For a mirror

$1/v = 1/f - 1/u$ for a concave mirror, f is negative $f<0$

As u is also negative, so $f < u < 0$ this implies, $1/f - 1/u > 0$

Then from (1) $1/v > 0$ or v is positive.

i.e. image is on the right and hence virtual

Magnification, $m = -v/u = -f / u-f$

As u is negative and f is positive, magnification $m = |f| / |f| - |u| > 1$

i.e image is enlarged.

60) i) show that a convex lens produces N - times magnified image when the object distances, from the lens, have magnitides (f+f/N), where f is the magnitude of the focal length of the lens.

ii) Hence find the two values of object distance, for which a convex lens of power 2.5 D, will produce an image that is four-times as large as the object?

(i)Magnification produced by a len M (=v/u) = f / f+u

Therefore $\pm N = f/ f+u$ or $f+u = \pm f/N$

Magnitude of object distances are $u_1 = f + f/N$ and $u_2 = f - f/N$

(ii) Given $P = 1/f = +2.5$ D $f = 1/2.5$ m = 0.4 m = 40 cm $N = 4$

$u_1 = 40 + 40 / 4 = 50$ cm, $u_2 = 40 - 40/4 = 30$ cm=

61) How does the resolving power of a compound microscope get affected on (i) decreasing the diameter of its objective ? (ii) increasing the focal length of its objective ?

Resolving limit of micrscope = 2 /גn sin θ

Resolving power ∞ 1/ Resolving limit

Resolving power ∞ n sin θ / ג

i)When diameter of objective lens decreases, θ and hence sin θ decreases; so resolving limit increases and hence resolving power decreases.

ii)The focal length of objective lens has no effect on resolving power of microscope.

62) How will the angular separation and visibility of fringes in Young’s double slit experiment change when (i) screen is moved away from the plane of the slits. (ii) width of source slit is increased.

i) Angular separation β_θ = β /D = ג /d

it is independent of D; therefore, angular separation remains unchanged if screen is moved away from the slits. But the actual separation between fringes

β = ג D/d increases, so visibility of fringes increases.

ii) When width of source slit is increased, then the angular fringe width remains unchanged but fringes becomes less and less sharp; so visibility of fringes decreases. If the condition $s/S < \lambda/d$ is not satisfied, the interference pattern disappears.

63) How can you distinguish between an unpolarised light and a linearly polarised light beam using a polaroid?

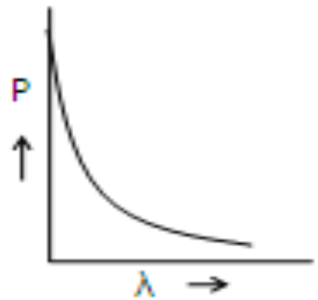
Distinction of unpolarised and polarised light: The given beam of light is made incident on a polaroid and the polaroid is rotated slowly and the intensity of transmitted beam is observed. If there is no variation in intensity, the given beam is unpolarised, but if the intensity varies with minimum intensity zero twice in a rotation, the given beam is linearly polarised.

64) In what ration will the intensity of image increase if the diameter of the objective lens of an astronomical telescope is doubled? What will be the effect on the limit of resolution ?

Intensity will become 4 times because intensity ∞ aperture are (πr^2) and limit of resolution will be halved because limit of resolution ∞ 1/d

65) Draw a plot showing the variation of power of a lens with the lens with the wavelength of the incident light.

Refraction index $n = A + B / \lambda^2$, where λ is the wavelength. Power of a lens $P = 1/f = (n_g - 1)(1/R_1 - 1/R_2)$ Clearly, power of a lens $\propto (n_g - 1)$. This implies that the power of a lens decreases with increase of wavelength ($P \propto 1/\lambda^2$ nearly). The plot is shown in fig.



66) How is the resolving power of a microscope affected when, (i) the wavelength of illuminating radiations is decreased ? (ii) the diameter of the objective lens is decreased ? Justify your answer.

Resolving limit of microscope $= 2 / \lambda n \sin \theta$

Where λ is the wavelength, n is the refractive index and θ is the semiangle of cone of rays entering the microscope. Resolving power $\propto$ 1/ Resolving limit

i)When wavelength of illuminating radiations decreases, the resolving limit decreases, so resolving power increases.

ii)When diameter of objective lens decreases θ and hence sin θ decreases; so resolving limit increases and hence resolving power decreases.

67) How does the stopping potential applied to a photocell change, if the distance between the light source and the cathode of the cell is doubled ?

Stopping potential remains unchanged.

Reason : On doubling the distance between the light source and the cathode of the cell the intensity of light incident on the photocell becomes one-fourth. As stopping potential does not depend on intensity, the stopping potential remains unchanged.

68) How does the maximum kinetic energy of electrons emitted vary with the work function of the metal ?

Maximum kinetic energy $E_k = hv – W$
Clearly smaller the work function W, greater is the E_k .This means that when work function of a metal increases, maximum kinetic energy of photoelectrons decreases.

69) The frequency v of incident radiation is greater than threshold frequency (v_0) in a photocell. How will the stopping potential vary if frequency (v) is increased, keeping other factors constant ?

From Einstein's photoelectric equation, stopping potential V_0 is

$eV_0 = hv – hv_0$ $V_0 = h/c\ (v-v_0)$

Give v>v so with increase of frequency v, stopping potential increases.

70) Ultra violet light is incident on two photosensitive materials having work function W_1 and W_2 ($W_1 > W_2$) in which case will the kinetic energy of the emitted electrons be greater ? Why ?

From the Einstein's photoelectric equation $hv = W + E_K$

$E_K = hv - W$; Clearly, smaller the work function, greater the K.E. as $W_1 > W_2$ K.E. for metal of work function W_2 will be greater.

71) a. An electron and a proton have the same kinetic energy. Which one of the two has the larger wavelength and why ?

An electron has the larger wavelength. Reason : de-Broglie wavelength in terms of kinetic energy is $\lambda = h/\sqrt{2mE_K}$ ά $1/\sqrt{m}$ for the same kinetic energy. As an electron has a smaller mass than a proton, an electron has larger de Broglie wavelength than a proton for the same kinetic energy.

b. An electron and a proton have the same de Broglie wavelength associated with them. How are their kinetic energies related to each other ?

de Broglie wavelength $\lambda = h/\sqrt{2mE_K}$ Given $\lambda_e = \lambda_p$; $h/\sqrt{2m_eE_e} = h/\sqrt{2m_pE_p}$

$E_e / E_p = m_p / m_e = 1840$

Kinetic energy of electron = 1840 x K.E. of proton.

72) There are two sources of light, each emitting with a power 100w. One emits X-rays of wavelength 1nm and the other visible light at 500 nm. Find the ratio of number of photons of X-rays the photons of visible light of the given wavelength.

Total E is constant. Let n_1 and n_2 be the number of photons of x-rays and visible region

$n_1 E_1 = n_2 E_2$; n_1 hc / $_1$ג = n hc / $_2$ג ; n / n = $_2$ג /$_1$ג ; n / n = 1 / 500

73)In a photoelectric effect, the yellow light is just able to emit electrons, will green light emit photoelectrons ? What about red light ?

Energy of photon = hc /ג /1 ∞ ג As ג green < ג yellow so green light photon has more energy than yellow light photon, so green light will eject electron.

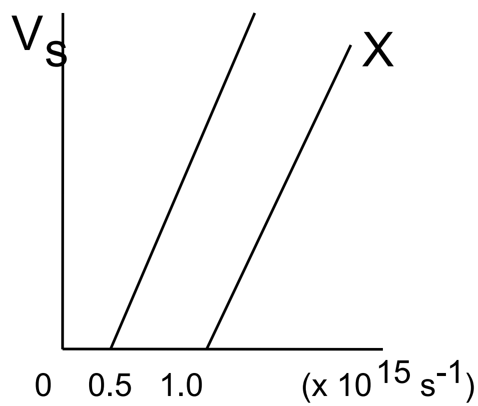
As ג red < ג yellow so red light photon has lesser energy than yellow light photon, so red light will not be able to eject electron.

74) Two metals X and Y when illuminated with appropriate radiations emit photoelectrons. The work function of X is higher than that of Y. Which metal has higher value of threshold frequency and why ?

Work function $W = hv_0 \propto v_0$ Given $W_X > W_Y$ so threshold frequency of X is higher than that of Y.

75) The following graph shows the variation of stopping potential V_S with the frequency (v) of the incident radiation for two photosensitive metals X and Y.
(i) which of the metals has larger threshold wavelength ? Give reason.
(ii) Explain giving reason which metal gives out electrons having larger kinetic energy, for the same wavelength of the incident radiation.

iii) If the distance between the light source and metal X is halved, what will be the kinetic energy of electrons emitted due to this change? Give reason.



i) Threshold frequency of X is 0.5×10^{15} s^{-1}
Threshold frequency of Y is 1.0×10^{15} s^{-1}
As threshold frequency wavelegnth is inversely proportional to threshold frequency, so metal X has larger threshold wavelength.

ii) Kinetic energy $E_K = hc/\lambda - hv_0$
As threshold frequency v_0 is smaller for X, so for same wavelength of incident radiation kinetic energy is larger for metal X.

iii. If the distance between light source and metal X is halved, the intensity of incident radiation become one fourth ($I \propto 1/r^2$), but kinetic energy of photoelectrons is independent of intensity; so kinetic energy of photoelectrons remains unchanged.

76) Assuming the nuclei to be spherical in shape, how does the surface area of a nucleus of mass number A_1 compare with that of a nucleus of mass number A_2 ?

Radius of nucleus of mass number A is $R = R_0 A^{1/3}$; where $R_0 = 1.2 \times 10^{-15}$ m constant.

Surface area of nucleus, $S = 4\pi R^2 \propto R^2$ $S_1 / S_2 = R_1 / R_2 = A_1 / A_2)^{2/3}$

77) What is the difference between an electron and a β particle ?
β particle are simply very fast moving electrons. The specific charge of electron is higher than that of β particle.

78) Why do αparticles have high ionising power ?
αparticles are heavier, they move slowly; so posses large momentum. Due to this property they come in contact with large number of particles; so they posses high ionising power.

79) What happens to the width of depletion layer of a p-n junction when it is(i) forward biased, (ii) reverse biased ?
i)When forward biased, the width of depletion layer decreases.
ii)When reverse biased, the width of depletion layer increases.

80) How does the energy gap in a semiconductor vary, when doped with a pentavalent impurity ?

The energy gap decreases by mixing pentavalent impurity.

81) Zener diodes have higher dopant densities as compared to ordinary p-n junction diodes. How does it affect the (i) width of the depletion layer ? (ii) Junction field?

i)The widthof the depletion layer decreases.
ii)The junction field increases.

82) State with reason why a photodiode is usually operated at a reverse bias.

The fractional change due to incident light on minority charge carriers in reverse bias is much more than that over the majority charge carriers in forward bias. So photodiodes are used to measure the intensity in reverse bias condition.

83) State the reason why GaAs is most commonly used in making a solar cell.

For solar cell incident photon energy must be greater than band gap energy i.e. ($h\nu > E_g$) For GaAs, $E_g = 1.43$ eV and high optical absorption$\approx 10^4$ cm $^{-1}$, which are main criteria for fabrication of solar cells.

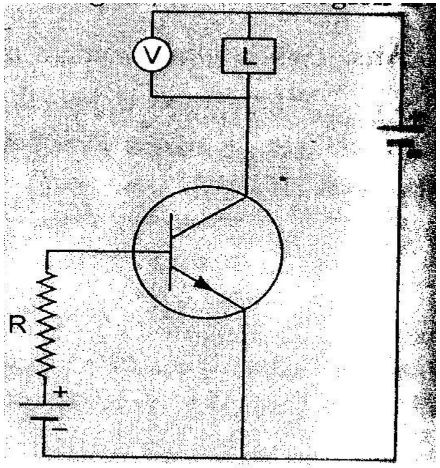
84) In a transistor, doping level in base is increased slightly. How will it affect (i) collector current and (ii) base current ?

When doping level in base is increased slightly, (i) collector current decreases slightly and (ii) base current increases slightly.

85) Can we measure the potential difference across an unbiased pn junction by connecting a sensitive voltmeter across it ?

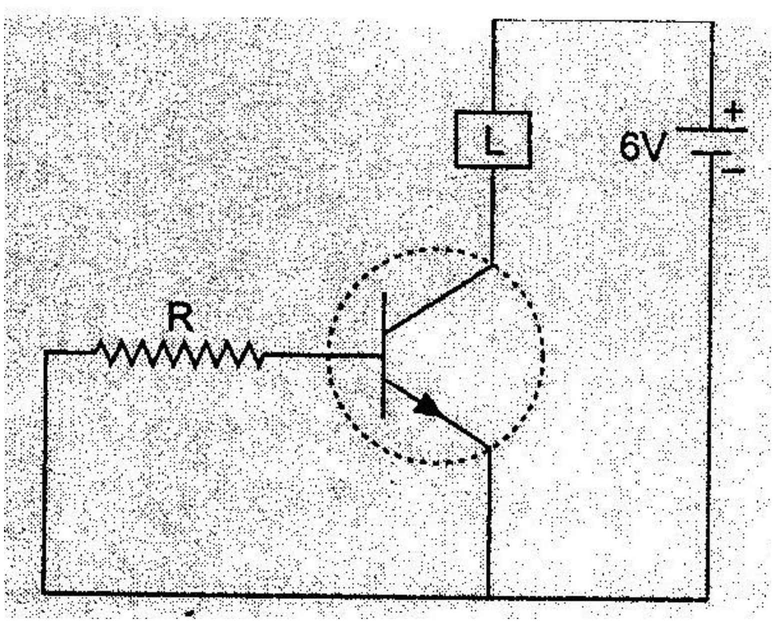
No the reason is there are no free charge carriers in the depletion region. Hence, in the absence of any external battery, there is no current flowing through the junction.

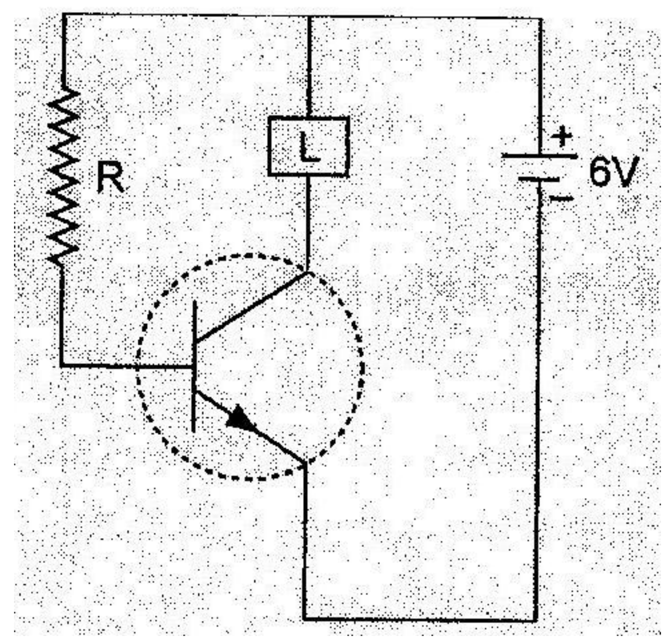
86)In the given circuit a voltmeter V is connected across the lamp L. What changes would occur at lamp L and the voltmeter V if the resistance R is reduced in value? Give reason for your answer.



The given circuit contains n-p-n transistor. When resistance R is reduced in value, the forward voltage across emitter – base junction increases, so collector current increases, so the voltmeter reading increases and the bulb glows, brighter.

87) In only one of the circuits given below the lamp L lights. Which circuits is it? Give reason for your answer.





In (i) circuit, the emitter base junction is not biased, so no current flows across L; hene lamp L does not light. In (ii) circuit, the emitter base junction is forward biased, so emitter and hence collector current flows and lamp L lights up.

88)Identify the parts X and Y in the following block diagram of a generalised communication system ?

X ------- Transmitter -------- Y --------- Receiver

Part X is message signal or information source.

Part Y is a transmission channel.

89) Give two examples of communication system which use space wave mode.

i)Line of sight (LOS) Communication (ii) Satellite Communication.

90) By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%

Transmission range of TV tower $d = \sqrt{2hR}$.

If height is increased by 21% , new height

$$h = h + \frac{\quad}{100} h = 1\cdot 21\, h$$

If d' is the new average range, then $\frac{d'}{d} = \sqrt{\frac{h'}{h}} = 1\cdot 1$

% increase in range $\frac{\Delta d}{d} \times 100\% = \left(\frac{d' - d}{d}\right) \times 100\% = \left(\frac{d'}{d} - 1\right) \times 100\%$

$$= (1\cdot 1 - 1) \times 100\%$$

$$= 10\ \%$$

91) Why is shortwave band used for long distance radio broadcast ?

Shortwaves are not absorbed by earth's atmosphere, hence used for long distance radio broadcast.

92)Name the type of radiowave propagation involved when TV signals, broadcast by a tall antenna, are intercepted directly by the receiver antenna.

Space wave propagation.

93) Why do we need carrier waves of very high frequency in the modulation of signals ?

High frequency waves require antenna of reasonable length can travel long distances without any appreciable power loss; so we need high frequency carrier waves.