HSE II **PHYSICS** SY-524

MARCH - 2024 Maximum : 60 Score

Time : 2 Hours
Cool-off time : 15 Minutes

1 to 7 — 5 x 1 = 5

1.The SI unit of electric flux

(a)NC^{-1} (b)NmC (c)Nm^2C^{-1} (d)Nm^2C

Ans : (c)Nm^2C^{-1}

2.The net electric field inside a conductor when placed in an external electric field is

(a)Zero (b)Half (c)Two times (d)Four times

Ans : (a)Zero

3.The SI unit of power of lens

(a)N (b)J (c)W (d)D

Ans : (d)D

4."The locus of points which have the same phase is called a wave front" the statement is True/False

Ans : True

5.The expression for de Broglie wavelength associated with a particle is -------------

Ans : $\frac{h}{mv} = \frac{h}{P}$

6.Which element in the periodic table shows maximum binding energy per nucleon ?

Ans : Fe^{56} or Iron

7.What is an intrinsic semiconductor :

Ans : Pure semiconductor

8 to 14 — 5 x 2 = 10

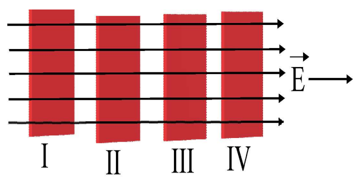
8.What is an equipotential surface ? Give an example.

Ans :

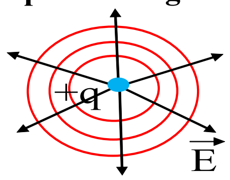
An equipotential surface is the locus of all those points at which the potential due to charge distribution is the same.

Example : The surface of a charged conductor.
Earth is an equipotential surface.

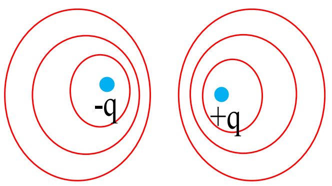
(i) For a uniform electric field



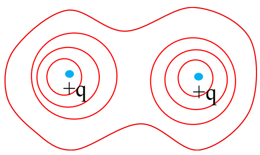
(ii) For an isolated point charge



(iii) For an electric dipole



(iv) Two identical positive charge



9.Define drift velocity, give its equation.

Ans :

Drift velocity is defined as the velocity with which the free electrons get drifted towards the positive terminal under the effect of the applied electric field.

$$\vec{V}_d = \frac{-e\vec{E}\tau}{m}$$

10.State Gauss's law in magentism

Ans :

The net magnetic flux through any closed surface is zero.

$$\phi_B = \sum_{all} B.\Delta S = 0$$

11.What is magnetic flux and how is it measured ?

Ans :

Magnetic flux is defined as the number of magnetic field lines passing through a given area.

Measure of the number of lines of magnetic field lines passing through the surface.

$$\phi = \sum_{all} B.\Delta S \quad \text{or} \quad d\phi = \vec{B}.\vec{ds} = Bds\cos\theta$$

12.The household line voltage of ac measured is 220V, calculate its peak voltage.

Ans :

$v_m = v_{rms} \times \sqrt{2}$
$= 1.414 \times 220$
$= 311V$

13.What is stopping potential ?

Ans :

Minimum negative potential given to collector plate for which the photo electric current becomes zero is called the stopping potential.

14.What is nuclear fission? Give one example.

Ans :

The splitting of a heavy nucleus into two lighter nuclei is called the nuclear fission.

(Slow neutron) (Uranium) (Compound Uranium) (Barium) (Krypton) (Neutrons) (Energy)

$${}_0n^1 + {}_{92}U^{235} \rightarrow {}_{92}U^{236} \rightarrow {}_{56}Ba^{144} + {}_{36}Kr^{89} + 3\,{}_0n^1 + Q$$

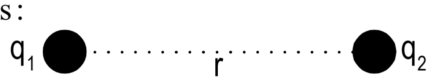
Splitting of the uranium-235 nucleus when it is bombarded with neutrons.

Splitting of the plutonium-239 nucleus.

15 to 21 — 6 x 3 = 18

15.State and explain the force between electric charges.

Ans :



The force of attraction or repulsion between two point charges is directly proportional to the product of the charge and inversely proportional to the square of the distance between them.The force between the charges is given by,

$$F \propto q_1q_2$$

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

$$F \propto \frac{q_1q_2}{r^2}$$

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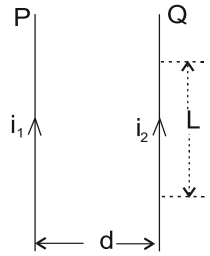
$$F = K\frac{q_1q_2}{r^2}$$

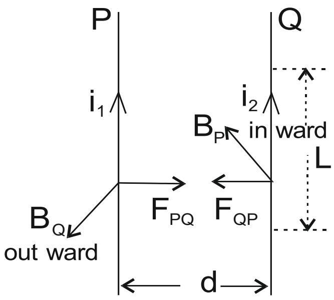
When the medium between the charges is air or vacuum.

$$F_{vacuum} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$$

16.Figure shows the two current carrying conductors. Derive the expression for force between the conductors.



Ans :



The magnitude of the magnetic induction B_P at the right side conductor Q is,

$$B_P = \frac{\mu_0 i_1}{2\pi d}$$

The force on a length L of the 'Q' conductor is

$$F_{QP} = B_P\, i_2\, L$$

$$= \frac{\mu_0 i_1}{2\pi d} i_2 L$$

$$= \frac{\mu_0 i_1 i_2}{2\pi d} L \qquad |F_{QP}| = |F_{PQ}|$$

17.Compare dia, para and ferromagnetic substance with suitable examples.

Ans :

(Any one difference and one example for each)

Diamagnetic substance

1.These substances when placed in a magnetic field, acquire feeble magnetism opposite to the direction of the magnetic field.

2.These substance are feebly repelled by a magnet.

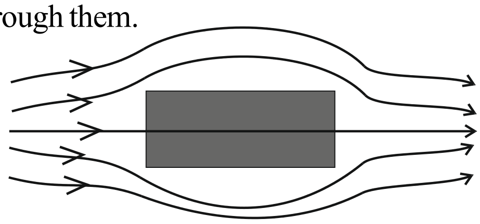
3.Diamagnetic rod is suspended freely between two magnetic poles, its axis becomes perpendicular to the magnetic field.

4.In non-uniform magnetic field, they move from stronger to weaker magnetic field.

5.The relative permeability of these substances are slightly less than 1.

6.The susceptibility of these substance is small and negative.

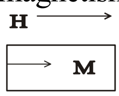
7.When they are placed in a magnetic field, the magnetic lines of force do not prefer to pass through them.



Examples : Copper, Silver, Bismuth, Zinc,Diamond, Salt, Water,Mercury, Nitrogen, Hydrogen, Magnetism, Gold

Paramagnetic substance

1.These substances when placed in a magnetic field, acquire feeble magnetism in the direction of the magnetic field.



2.These substance are feebly attracted by a magnet.

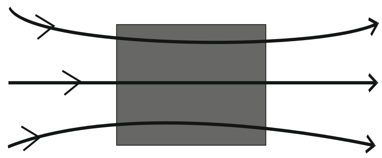
3.Paramagnetic rod becomes parallel to the magnetic field.

4.In non-uniform magnetic field they move from weaker to stronger magnetic field slowly.

5.The relative permeability of these substances are slightly greater than 1.

6.The susceptibility of these substance is small and positive.

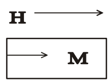
7.When they are placed in a magnetic field, the magnetic lines of force prefer to pass through them.



Examples : Aluminium, Sodium, Potassium, Platinum, Manganese, Copper sulphate, Oxygen

Ferromagnetic substance

1.These substances when placed in a magnetic field are strongly magnetised in the direction of the magnetic field.



2.These are strongly attracted by a magnet.

3.Ferromagnetic rod also becomes parallel to the magnetic field.

4.In non-uniform magnetic field they move from weaker to stronger magnetic field rapidly.

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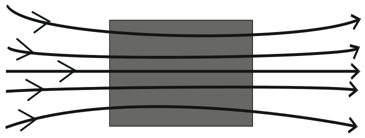
5.The relative permeability of these substances is very high.
6.The susceptibility of these substance is large and positive.
7.When they are placed in a magnetic field, most of the magnetic lines of force prefer to pass through them.



Examples : Iron, Nickel, Cobalt, Magnetite or natural magnet

18.What is self-induction and define the expression for self-inductance of a solenoid.
(derive the expression in malayam version)
Ans :
Self induction is the property of the circuit by virtue of which it opposes the growth or decay of current in it.(When current in a coil changes the magnetic flux linked with the coil also changes and hence emf is induced in the coil.This phenomenon is known as self induction).
The magnetic flux through one turn of the solenoid is given by, $\phi = BA = (\mu_0 nI)A$
The magnetic flux linkage in the solenoid with a total number of nl turns is given by,

$\phi = \mu_0 n^2 AlI$

But $\phi = LI$

$\therefore LI = \mu_0 n^2 AlI$

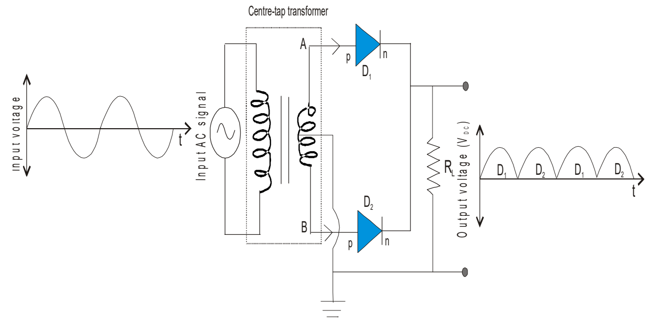
$L = \mu_0 n^2 Al$ or $L = \dfrac{\mu_0 N^2 A}{l}$

19.Briefly explain the electromagnetic spectrum.
Ans :
Electromagnetic spectrum is the arrangement of electro magnetic waves in the ascending order of wavelength.
The e.m waves have been arranged in terms of increasing wavelength :-
γ -ray, X - ray, Ultraviolet rays,Visible light, Infrared rays, Microwaves, Radio waves.
Explain with use or wavelength or frequency or scientist who discovered or generation of waves.

20.Write the postulates of Bohr's atom model.
Ans : (Deleted topic)
1.An atom has a small positively charged core where whole of the mass of an atom is supposed to be concentrated.This core is called nucleus of the atom.
2.The electrons revolve round the nucleus in fixed orbits of definite radii.As long as the electron is in certain orbit, it does not radiate any energy.
3.The electrons can revolve only in those orbits, in which its angular momentum is an integral multiple of $h/2\pi$. $L = mvr = \dfrac{nh}{2\pi}$
where n is known as quantum number of the orbit and h is Planck's constant.
4. Electron jumps from higher energy orbit to lower energy orbit, they emit the energy equivalent to the energy gap, in the form of radiations.

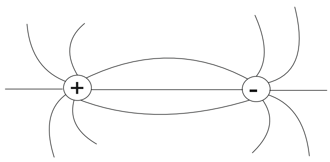
$h\upsilon = E_2 - E_1$

21.What is a rectifier? Draw the circuit diagram and input, output wave forms of a full wave rectifier.
Ans :
Rectifier is a device which converts AC to DC



22 to 25	3 x 4 = 12

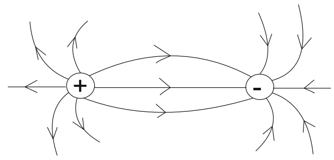
22.(a)Complete the diagram with proper making of direction.



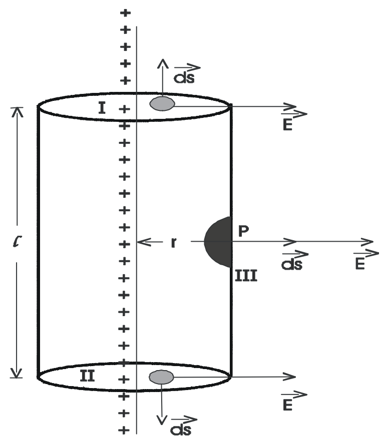
(b)Derive the expression for electric field intensity at a point from an infinitely long straight conductor carrying charge.

Ans : (1+3)

(a)



(b)



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According to Gauss theorem,

$$\oint_S \vec{E}.\vec{ds} = \frac{1}{\varepsilon_0}(q) = \frac{\lambda l}{\varepsilon_0}$$

$$\oint \vec{E}.\vec{ds} = \int_I \vec{E}.\vec{ds} + \int_{II} \vec{E}.\vec{ds} + \int_{III} \vec{E}.\vec{ds} = \frac{\lambda l}{\varepsilon_0}$$

For surface I and II angle between E and ds is 90^0

So $\vec{E}.\vec{ds}$ = Eds cosθ = Eds cos 90^0 = 0

$$\oint \vec{E}.\vec{ds} = \int_{III} \vec{E}.\vec{ds} = \frac{\lambda l}{\varepsilon_0}$$

$$\int_{III} Eds\ Cos0^0 = \frac{\lambda l}{\varepsilon_0}$$

$$E \int_{III} ds = \frac{\lambda l}{\varepsilon_0}$$

$$E\ 2\pi r l = \frac{\lambda l}{\varepsilon_0}$$

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

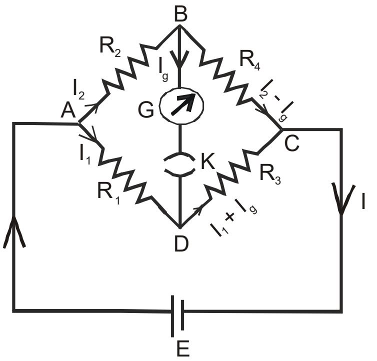
23.(a)State Ohm's law

(b)Derive Wheatstone's network principle.

Ans : (1+3)

(a)At constant temperature the current flowing through a conductor is directly proportional to the potential difference between its ends. V ∝ I

(b)



Applying Kirchhoff's loop law to the closed loop ADBA,

$$I_1R_1 - I_gG - I_2R_2 = 0 \text{ ....(1)}$$

Applying Kirchhoff's loop law to the closed loop BDCB,

$$I_gG + (I_1 + I_g)R_3 - (I_2 - I_g)R_4 = 0 \text{.............(2)}$$

In the case of balanced Wheatstone bridge, no current flows through the galvanometer $I_g = 0$

Hence eqn (1) becomes $I_1R_1 - I_2R_2 = 0$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1} \text{ ....(3)}$$

Similarly eqn (2) becomes, $I_1R_3 - I_2R_4 = 0$

$$\frac{I_1}{I_2} = \frac{R_4}{R_3} \text{ ....(4)}$$

From eqn (3) and (4) $\frac{R_2}{R_1} = \frac{R_4}{R_3}$

24.(a)State Snell's law of refraction.

(b)Explain critical angle and total internal reflection.

Ans : (1+1.5+1.5)

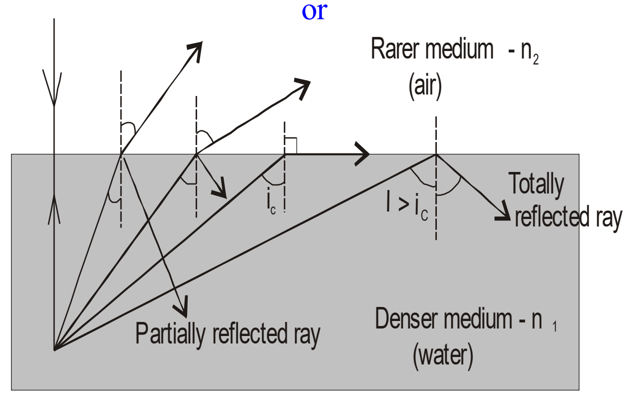
(a)The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

$$\frac{\sin i}{\sin r} = n_{21}$$

where n_{21} is a constant, called the refractive index of medium 2 with respect to medium 1.

(b)The angle of incidence for which angle of refraction becomes 90^0 is called critical angle. When the angle of incidence becomes greater than critical angle, there is no refracted light and all the light is reflected in the denser medium. This phenomenon is known as total internal reflection.

or



25.(a)What are coherent sources ?

(b)In Young's double slit experiment, interference pattern is observed at 5cm from the slits with a fringe width of 1mm. Calculate the seperation between the slits. (λ=5000A⁰) (Deleted topic)

Ans : (1+3)

(a)Two sources of light which emit light waves of same frequency, same wavelength and in same phase or having constant phase difference between them are called coherent sources.

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

$$d = \frac{\lambda D}{\beta}$$

$$= \frac{5000 \times 10^{-10} \times 5 \times 10^{-2}}{1 \times 10^{-3}}$$

$$= 2.5 \times 10^{-5} \text{ m}$$

26 to 29 — 3 x 5 = 15

26.(a)What is the principle of a capacitor ?(Deleted topic)

(b)Derive the expression for capacitance of a parallel plate capacitor.

(c)A 12 pF capacitor is connected to 50V battery. How much electrostatic energy is stored in the capacitor ?

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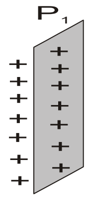
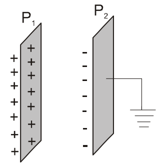
Ans : (1+2+2)

(a)



$C = \frac{Q}{V}$

Another earthed conductor P_2 is kept very close to P_1. By induction P_2 is charged negatively. As a result of this the potential of the plate P_1 falls to V'. Hence the capacitance is given by,

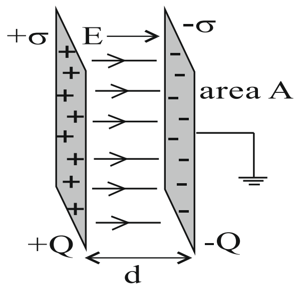


$C' = \frac{Q}{V'}$

Since V ' < V

$\therefore$ C' > C

(b)



Electric field between the plate is given by,

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$$

Potential difference b/w the two plates is,

$$V = Ed = \frac{Qd}{\varepsilon_0 A}$$

Capacitance of capacitor, $C = \frac{Q}{V}$

$$= \frac{Q}{\frac{Qd}{\varepsilon_0 A}}$$

$$= \frac{\varepsilon_0 A}{d}$$

(c) $U = \frac{1}{2} CV^2$

$$= \frac{1}{2} \times 12 \times 10^{-12} \times 50^2$$

$$= 1.5 \times 10^{-8}\ J$$

27.(a)The direction of magnetic field around a current carrying conductor is given by -------------

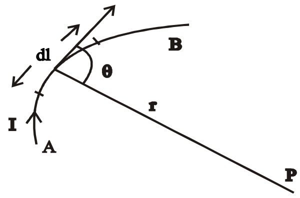
(b)State Biot-Savart law.

(c)Derive the expression for magnetic field on the axis of a circular coil carrying current.

Ans : (1+1+3)

(a)Right hand thumb rule or right hand grip rule or Maxwell's Cork screw rule

(b)



The strength of the magnetic field dB is

(i) directly proportional to the current I, $dB \propto I$

(ii) directly proportional to the length dl, $dB \propto dl$

(iii) directly proportional to the sinθ, $dB \propto \sin\theta$

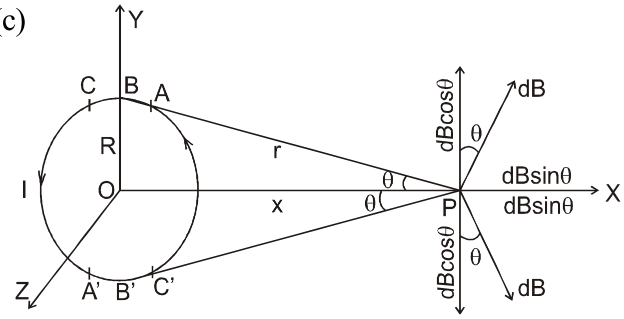
(iv) inversely proportional to the square of the distance between the element and the point,

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

Combining these

$$dB \propto \frac{Idl \sin\theta}{r^2} = \frac{\mu_0}{4\pi} \frac{Idl \sin\theta}{r^2}$$

(c)



Magnetic field at P due to the element ABC, (ABC=dl)

$$dB = \frac{\mu_0}{4\pi} \frac{Idl \sin\theta}{r^2} \qquad \theta = 90^0$$

$$= \frac{\mu_0}{4\pi} \frac{Idl}{r^2}$$

The magnetic fields at P due to different elements will be in different directions. All the components parallel to OP get added up while those perpendicular to OP cancel out.

Magnetic field at P due to the Whole loop,

$$B = \oint dB \sin\theta \qquad \sin\theta = \frac{R}{r}$$

$$= \oint \frac{\mu_0}{4\pi} \frac{Idl}{r^2} \sin\theta$$

$$= \frac{\mu_0}{4\pi} \frac{I}{r^2} \frac{R}{r} \oint dl$$

$$= \frac{\mu_0}{4\pi} \frac{I}{r^2} \frac{R}{r} 2\pi R$$

$$= \frac{\mu_0}{4\pi} \frac{2\pi R^2 I}{r^3}$$

$$= \frac{\mu_0}{4\pi} \frac{2\pi R^2 I}{(R^2+x^2)^{3/2}}$$

If there are n turns of the coil,

$$B = \frac{\mu_0}{4\pi} \frac{2\pi R^2 n I}{(R^2+x^2)^{3/2}}$$

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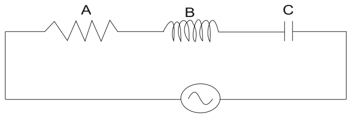
28.(a)Write the expression for instantaneous emf of a.c.
(b)Identify A, B and C in figure.



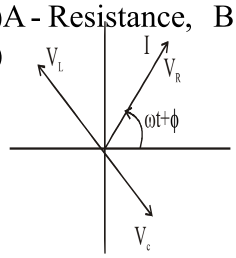
(c)Draw the phaser diagram of the above circuit and write the expression for impedance in the circuit, then mention the terms.

Ans : (1+1+3)

(a) $V = V_m \sin\omega t$ or $E = E_0 \sin\omega t$

(b) A - Resistance, B - Inductor, C - Capacitor

(c)



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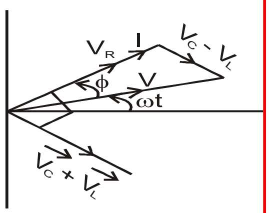


Impedance of the circuit Z is given by,

$$Z = \sqrt{R^2 + (X_c - X_L)^2}$$

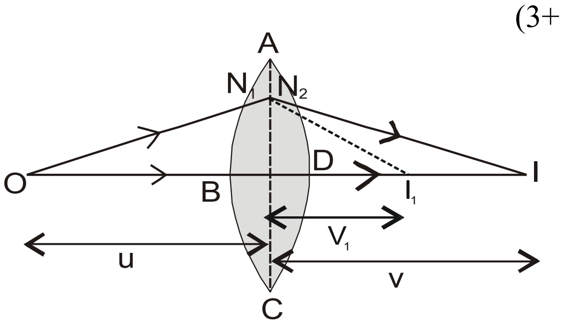
R :- Resistance, $X_L = L\omega$:– inductive reactance,

$X_C = \dfrac{1}{C\omega}$:- Capacitive reactance

29.(a)Derive lens maker's formula.
(b)Draw the image formation in a simple microscope.
(c)Write the value of least distance of distinct vision.

Ans : (3+1+1)

(a)



O is a point object placed at a distance u from B. After refraction at the face ABC, an image I_1 would be formed at distant V_1 from B such that,

$$\frac{n_1}{-u} + \frac{n_2}{V_1} = \frac{n_2 - n_1}{R_1} \quad ....(1)$$

Image I_1 act as a virtual object for refraction at the face ADC and the final image is formed at a distance V from D such that,

$$\frac{n_1}{V} + \frac{n_2}{-V_1} = \frac{n_2 - n_1}{-R_2} \quad ....(2)$$

Adding eqn (1) and (2)

$$\frac{n_1}{V} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) ....(3)$$

Dividing throughout by n_1

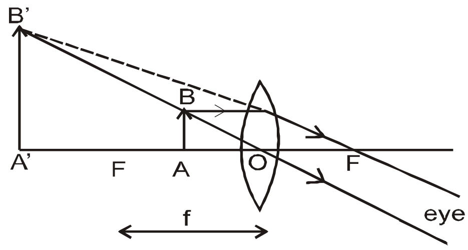
$$\frac{1}{V} - \frac{1}{u} = \left(\frac{n_2 - n_1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

When $u = \infty$, $V = f$

$$\frac{1}{f} = \frac{(n_2 - n_1)}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$= (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

(b)



(c) 25 cm

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