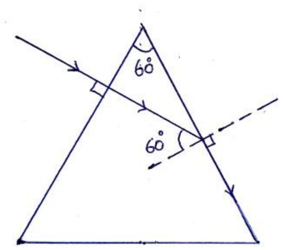
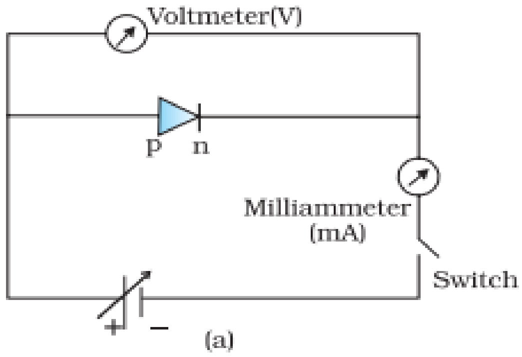
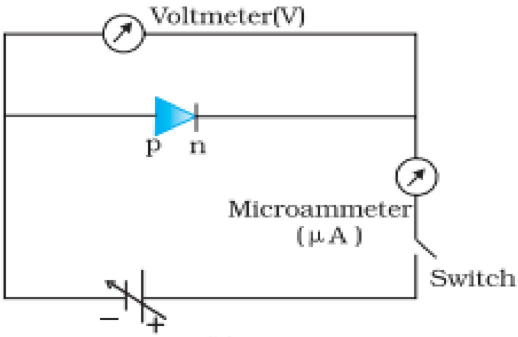
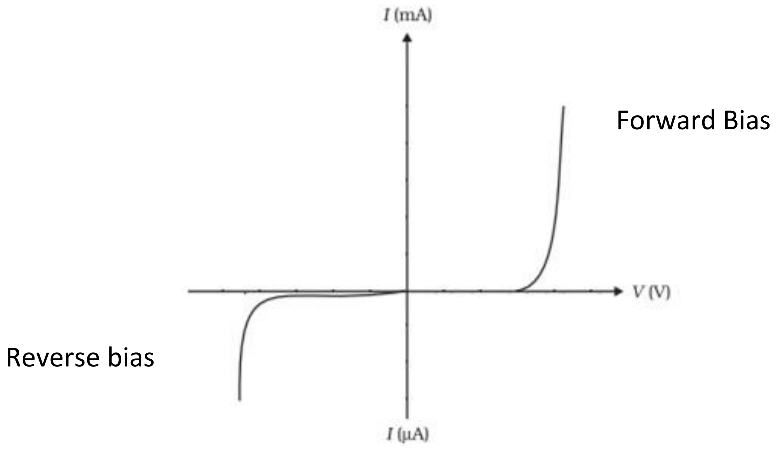
MARKING SCHEME : PHYSICS (042)			
CODE : 55/4/2			
Q.NO	VALUE POINTS/EXPECTED ANSWERS	MARKS	TOTAL MARKS
SECTION - A			
1	(A) $\frac{11}{48}\frac{q}{\pi\varepsilon_0 L}$	1	1
2	(D) $q_3>q_1>q_2$	1	1
3	(A) Small and negative .	1	1
4	(A) R	1	1
5	(C) Helical path.	1	1
6	(A) There is a minimum frequency of incident radiation below which no electrons are emitted.	1	1
7	(A) Zero	1	1
8	(C) $r_n \alpha n^2$	1	1
9	(B) 20 mA	1	1
10	(B) 1 mA	1	1
11	(D) Close together and weaker in intensity.	1	1
12	No option is correct, award 1 mark.	1	1
13	(C) Assertion (A) is true and Reason (R) is false.	1	1
14	(A) Both assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).	1	1
15	(D) Both Assertion (A) and Reason (R) are false.	1	1
16	(B) Both assertion (A) and Reason (R) are true and Reason (R)is not the correct explanation of Assertion(A).	1	1
SECTION – B			
17	(a) Finding nature and position of image 2		
	Using refraction formula at spherical surface from denser to rarer medium		
	n_1 = refractive index of rarer medium		
	n_2 = refractive index of denser medium		
	$\frac{n_1}{v}-\frac{n_2}{u}=\frac{n_1-n_2}{R}$	½	
	u = - 20 cm , R= - 40 cm , n_1 = 1 , n_2 = 1.5	½	
	$\frac{1}{v}-\frac{1.5}{(-20)}=\frac{1-1.5}{(-40)}$	½	
	v = -16 cm		
	Nature of image is virtual.	½	**2**
	OR		
	(b) Finding the focal lengths of the objective and eyepiece 2		
	Distance between objective and eyepiece fo + fe = 1.00 m = 100 cm	½	
	Magnifying power $\lvert m\rvert=\frac{fo}{fe}=19$	½	
	On solving fo = 95 cm = 0.95 m	½	
	fe = 5 cm = 0.05 m	½	

18	Defining matter waves 1 Arranging de Broglie wavelength in increasing order 1		
	The waves associated with every moving particle are called matter waves.	1	
	$\lambda = \dfrac{h}{\sqrt{2mK}}$		
	For same kinetic energy , $\lambda \;\alpha\; \dfrac{1}{\sqrt{m}}$	½	
	$m_\alpha > m_p > m_e$		
	$\therefore \;\; \lambda_\alpha < \lambda_p < \lambda_e$	½	**2**
19	Finding refractive index of the medium 2		
		½	
		½	
	From snell's law, $\mu.\sin i = \mu_m.\sin r$		
	$\mu.\sin 60^0 = \mu_m.\sin 90^0$	½	
	$\mu_m = \mu.\dfrac{\sqrt{3}}{2}$	½	**2**
	<u>Alternatively</u>		
	$\mu = \dfrac{1}{\sin C}$	1	
	$\dfrac{\mu}{\mu_m} = \dfrac{1}{\sin 60^0}$	½	
	$\mu_m = \dfrac{\sqrt{3}}{2}\mu$	½	
20	(i) Finding resistance $\left(\dfrac{R_A}{R_B}\right)$ 1 (ii) Finding resistivity $\left(\dfrac{\sigma_A}{\sigma_B}\right)$ 1		
	(i) Slope of *I*-*V* graph = $\left(\dfrac{\Delta I}{\Delta V}\right) = \dfrac{I}{R}$	½	

	$$\frac{R_A}{R_B} = \frac{\text{Slope of B}}{\text{Slope of A}}$$ $$= \frac{\tan 45^0}{\tan 30^0}$$ $$\frac{R_A}{R_B} = \sqrt{3}$$	½	
	(ii) $$\frac{\sigma_A}{\sigma_B} = \frac{R_A \frac{A_A}{l_A}}{R_B \frac{A_B}{l_B}}$$	½	
	$$= \frac{R_A}{R_B} \cdot \frac{A_A}{A_B} \cdot \frac{l_B}{l_A}$$ $$= \sqrt{3} \times \frac{4}{1} \times \frac{2}{1}$$ $$= 8\sqrt{3}$$	½	**2**
21	Drawing of circuit diagram of p-n junction diode (i) Forward bias ½ (ii) Reverse bias ½ I-V charcteristics in forward and reverse bias ½ + ½		
	(i)  (a)	½	
	 (b)	½	

I-V characteristics in forward and reverse bias

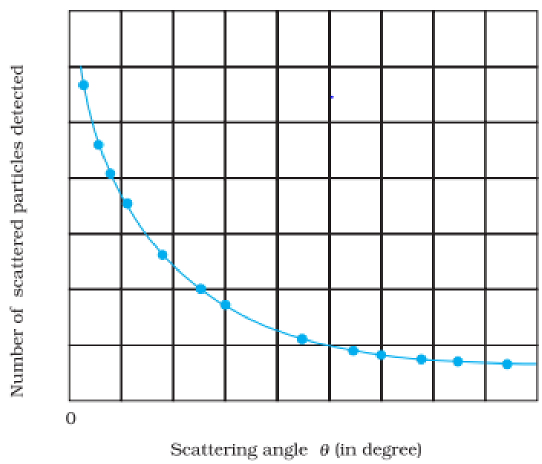


½ + ½ — **2**

SECTION – C

22

Drawing graph showing variation of scattered particles detected(N) with scattering angle(θ)	1
Two conclusions	1
Obtaining expression for the distance of closest approach	1



1

Two conclusions

(i) Most of an atom is empty space. ½

(ii) Almost entire mass and entire positive charge is concentrated in a very small region called nucleus. ½

At distance of closest approach

$E_k = E_P$ ½

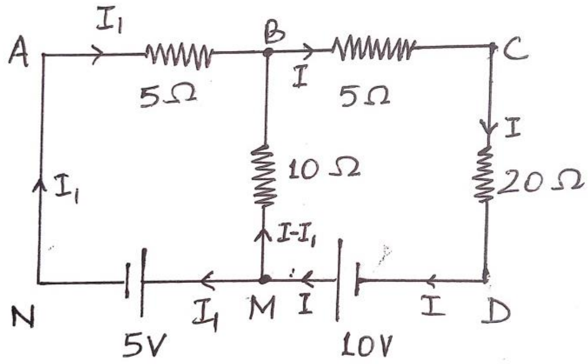
$$K = \frac{1}{4\pi\varepsilon_0}\frac{(Ze).(2e)}{d}$$

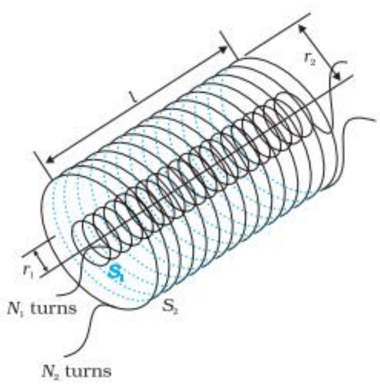
$$d = \frac{1}{4\pi\varepsilon_0}\frac{(2Ze^2)}{K}$$ ½ — **3**

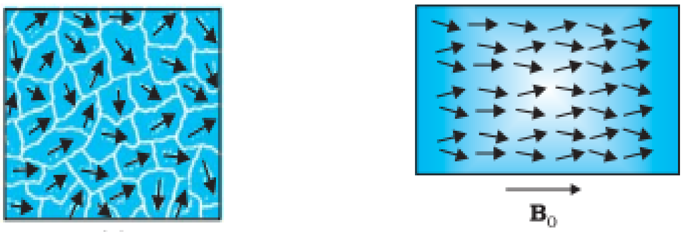
23

(i) Finding charge density on outer surface of shell	1 ½
(ii) Finding the potential at a distance of (R/2) from the centre of the shell	1 ½

	(i) When a point charge Q is placed at the centre of the shell, a charge (–Q) is induced at its inner surface, consequently a net charge on outer surface of the shell = q + Q Charge density on outer surface of the shell $\sigma = \frac{charge}{Area}$ $= \frac{q+Q}{4\pi R^2}$ (ii) Potential due to shell at a distance of (R/2) from the centre of the shell $V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$ Potential due to charge Q at a distance of (R/2) from the centre of the shell $V_2 = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R/2}$ Net potential at a distance of (R/2) from the centre of the shell $V = V_2 + V_2$ $V = \frac{1}{4\pi\varepsilon_0 R}(q+2Q)$	1 ½ ½ ½ ½	3
24	(a) Difference between nuclear fission and fusion (1) (b) Calculating energy released in fission (2) (a) In nuclear fission , a heavy nucleus splits into two or more lighter nuclei and energy is released. In nuclear fusion, lighter nuclei combine together a form a heavy nucleus and larger amount of energy is released. (b) Number of atoms in 1 g of $_{94}Pu^{239}$ $= \frac{6.023\times10^{23}}{239}$ $= 2.5\times10^{21}$ Energy released in fission of 1 g of $_{94}Pu^{239}$, $E = 180 MeV\times2.5\times10^{21}$ $E = 4.5\times10^{23}$ MeV	 ½ ½ 1 1	3
25	Finding magnitude and direction of the net magnetic field at point P_1 1 ½ Finding magnitude and direction of the net magnetic field at point P_2 1 ½ Net magnetic field at point P_1 $B = B_{y(wire)} - B_{x(wire)}$ $= \frac{\mu_0 I_1}{2\pi r} - \frac{\mu_0 I_2}{2\pi r}$ $= \frac{\mu_0}{2\pi\times2}(5-3)$ $B = 2\times10^{-7}$ T	 ½ ½	

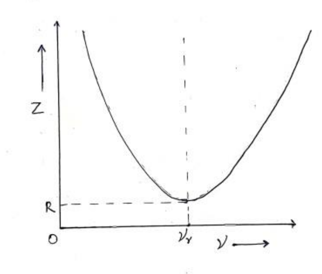
	The direction of net magnetic field is along –ve z-axis. Net magnetic field at point P_2 $B = B_{y(wire)} + B_{x(wire)}$ $= \frac{\mu_0 I_1}{2\pi r} + \frac{\mu_0 I_2}{2\pi r}$ $= \frac{4\mu_0}{2\pi \times 1}(5+3)$ $= \frac{4\mu_0}{\pi}$ $= 16\times 10^{-7}$ T The direction of net magnetic field is along +ve z-axis.	½ ½ ½ ½	3
26	Defining displacement current 1 Difference between Displacement current and conduction current 1 Justification of the continuity of current in the circuit 1 Displacemnt current is the current which arises due to rate of change of electric field. Displacement current is due to varying electric field. Conduction current is due to motion of electrons in the presence of electric field . When the capacitor is being charged by a source of emf , the electric field between the plates of capacitor changes with time. It produces a displacement current i_d whose magnitude is equal to conduction current i_c. Therefore the current is continious in the circuit.	1 ½ ½ 1	3
27	Finding current in the arm AB 1 ½ Finding current in the arm BC 1 ½ Circuit diagram with distribution of current  Using Kirchhoff's voltage rule In closed loop ABMNA, $-5I_1 + 10(I - I_1) - 5 = 0$ ……………………… (1) In closed loop ACDNA $-5I - 20I + 10 - 5 - 5I_1 = 0$ ……………………….. (2)	1 ½ ½	

	Solving eq (1) and (2)		
	$I_1 = -\frac{3}{17}$ A and $I = \frac{4}{17}$		
	Magnitude of current in arm AB = $\frac{3}{17}$ A	½	
	Magnitude of current in arm BC = $\frac{4}{17}$ A	½	**3**
28	(a) (i) Defining mutual inductance ½ SI unit of mutual inductance ½ (ii) Deriving expression for mutual inductance 2		
	(i) Mutual inductance between two coils is defined as the magnetic flux associated with a coil when unit current flows through neighbouring coil.	½	
	<u>Alternatively</u> Mutual inductance between two coils is defined as the magnitude of induced emf in a coil when the rate of change of current in neighbouring coil is unity.		
	SI unit of mutual inductance is henry(H).	½	
	(ii) 		
	When current I_2 flows in outer solenoid, the resulting flux linkage with inner solenoid.		
	$N_1\phi_1 = N_1 B_2 A_1$	½	
	$N_1\phi_1 = N_1\left(\frac{\mu_0 N_2 I_2}{l}\right)\pi r_1^2$		
	$N_1\phi_1 = \frac{\mu_0 N_1 N_2 \pi r_1^2 I_2}{l}$ ………………………(1)	½	
	$N_1\phi_1 = M_{12} I_2$ ………………………(2)	½	
	From equations (1) and (2)		
	$M_{12} = \frac{\mu_0 N_1 N_2 \pi r_1^2}{l}$	½	**3**
	OR		
	(b) Defining ferromagnetic materials 1 Explanation of ferromagnetism with diagram 2		

	Ferromagnetic substances are those which get strongly magnetised when placed in an external magnetic field.  (a) (b) In absence of external magnetic field, domains are randomly oriented and it exhibits weak magnetisation. In the presence of external magnetic field domains orient themselves in the direction of magnetic field and it exhibits strong magnetisation.	1 ½ + ½ ½ ½	
SECTION - D			
29	(i) (B) $\frac{-5}{3}D$ (ii) (C) $\frac{3}{2}$ (iii) (A) increases when a lens is dipped in water. (iv) (a) (B) 10 cm , right from lens. OR (b) (A) real , 24 cm	1 1 1 1	**4**
30	(i) (B) 0.01 eV (ii) (D) 5×10^{22} m^{-3} (iii) (a) (C) Electrons diffuse from n-region into p-region and holes diffuse from p-region to n-region. OR (b) (A) Diffusion current is large and drift current is small. (iv) (D) 50 Hz , 100 Hz.	1 1 1 1	**4**
SECTION - E			
31	(a) (i) Factors on which the resonant frequency of a series LCR circuit depends 1 Plotting of graph 1 (ii) Diagram of a transformer 1 Working of a step-up transformer 1 (iii) Two causes of energy loss in a real transformer 1 (i) Inductance Capacitance	½ ½	

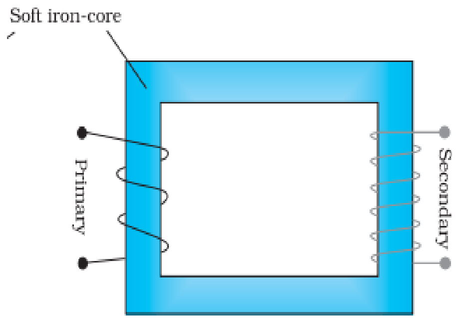
Alternatively

$$\nu_0 = \frac{1}{2\pi\sqrt{LC}}$$



1

(ii)



1

Working - when an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. 1

(iii) Causes of energy loss (any two)

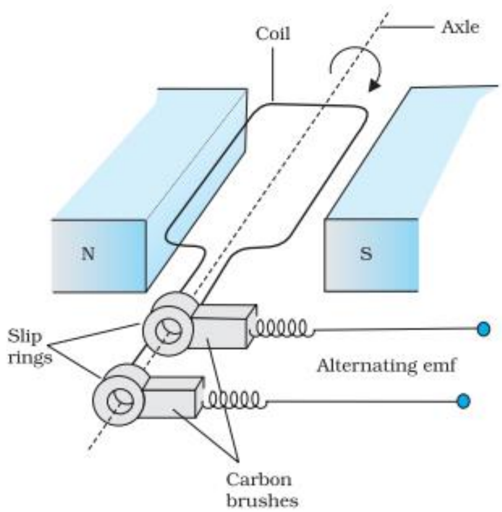
(1) Flux leakage
(2) Resistance of the windings
(3) Hysteresis
(4) Eddy currents ½ + ½ 5

OR

(b)

(i)	Diagram of ac generator	1
	Brief explanation of construction and working of ac generator	2
(ii)	Obtaining expression of magnetic moment associated with revolving electron	2

(i)



1

Construction – It consists of a coil placed in a magnetic field. The coil is mounted on a rotor shaft. The ends of the coil are connected to an external circuit by means of slip rings and brushes. — 1

Alternatively

If a student draws only a labeled diagram of ac generator give 2 marks for construction and diagram.

Working – The coil is rotated in the uniform magnetic field by some external means. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. — 1

Alternatively

If a student derives $e = e_0 \sin \omega t$ give one mark for working.

(ii) The equivalent current

$$I = \frac{q}{t} = \frac{e}{\frac{2\pi r}{v}} = \frac{ev}{2\pi r}$$ — ½

Mangetic moment of revolving electron — ½

$$m = IA$$

$$= \frac{ev}{2\pi r} \times \pi r^2$$ — ½

$$= \frac{1}{2} evr$$ — ½

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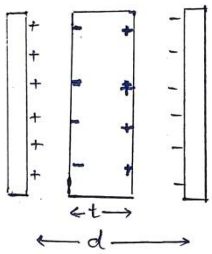
32 a)

(i) Obtaining expression for capacitance	3
(ii) Finding capacitance of capacitors	2

a) (i)



Electric field in air between plates

$$E_0 = \frac{\sigma}{\varepsilon_0}$$ — ½

Electric field inside the dielectric

$$E = \frac{\sigma}{\varepsilon_0 K}$$ — ½

Potential difference between the plates

$$V = E_0(d-t) + Et$$ — ½

$$V = \frac{\sigma}{\varepsilon_0}\left[d - t + \frac{t}{K}\right]$$

$$V = \frac{q}{A\varepsilon_0}\left[d - t + \frac{t}{K}\right]$$ — ½

Capacitance

$$C = \frac{q}{V}$$ — ½

$$C = \frac{A\varepsilon_0}{d - t + \frac{t}{K}}$$

$$C = \frac{A\varepsilon_0}{d - t\left(1 - \frac{1}{K}\right)}$$ — ½

ii) Total energy stored in series combination

$$\frac{1}{2}\left(\frac{C_1C_2}{C_1+C_2}\right)V^2 = 40\times10^{-3}\text{ J}\ldots\ldots\ldots\ldots(1)$$ ½

Energy stored in parallel combination

$$\frac{1}{2}(C_1+C_2)V^2 = 250\times10^{-3}\text{ J}\ldots\ldots\ldots\ldots(2)$$ ½

Substituting value of V=100 V in eq (1) and (2) , on solving

$$C_1 = 4\times10^{-5}\text{ F or } 40\,\mu\text{F}$$ ½

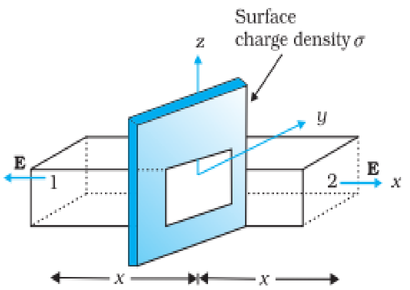
$$C_2 = 1\times10^{-5}\text{ F or } 10\,\mu\text{F}$$ ½ **5**

OR

b)

i) Showing electric field at a point due to a uniformly charged infinite plane sheet		3
ii) Calculating	(1) electric flux through the cube	1
	(2) charge enclosed by cube	1

(i)



1

$$\oint \vec{E}.d\vec{s} = \int_1 \vec{E}.d\vec{s} + \int_2 \vec{E}.d\vec{s}$$ ½

$$= 2EA$$

From Gauss's law

$$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$$ ½

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$ ½

Vectorially $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ ½

Electric field is normally outward of the sheet.

(ii)

(1) Electric flux through the cube

$$\phi = \phi_L + \phi_R$$ (½)

$$\phi = \int \vec{E}_L . d\vec{s} + \int \vec{E}_R . d\vec{s}$$

$$= -2\times100\times10^{-4} + [5\times(10\times10^{-2})^2 + 2]\times100\times10^{-4}$$

$$\phi = 5\times10^{-4}\ \text{Nm}^2\text{C}^{-1}$$ (½)

(2)

$$\phi = \frac{q_{en}}{\varepsilon_0}$$ (½)

$$q_{en} = \phi.\varepsilon_0$$

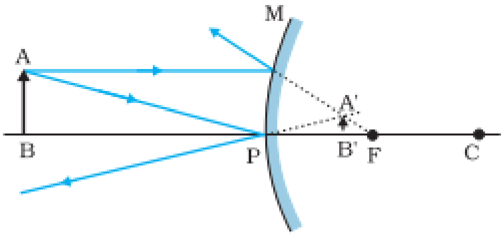
$$= 5\times10^{-4}\times8.85\times10^{-12}$$

$$= 4.43\times10^{-15}\,\text{C}$$ (½)

33

a) i) Drawing of ray diagram	1
Obtaining mirror equation	2
ii) Reason for using multi-component lenses	1
iii) Finding magnification produced by the objective	1

i)



(1)

For paraxial rays MP can be considered to be a straight line perpendicular to CP, Therefore right angled triangles $A'B'F$ and MPF are similar

$$\frac{B'A'}{PM} = \frac{B'F}{FP}$$

Or $$\frac{B'A'}{BA} = \frac{B'F}{FP} \quad (\because PM = AB) \quad \text{----------------(1)}$$ (½)

Since $\angle$ APB = $\angle$ $A'PB'$, the right angled triangles $A'PB'$ and ABP are also similar

Therefore , $$\frac{B'A'}{BA} = \frac{B'P}{BP} \quad \text{------------------------------------ (2)}$$ (½)

Comparing eq (1) and (2), we get

$$\frac{B'F}{FP} = \frac{B'P}{BP}$$

$$\frac{PF - PB'}{FP} = \frac{B'P}{BP}$$

Using sign convention

PF = f, PB' = +v , PB = -u (½)

on solving $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ ½

ii) To improve image quality by minimizing various optical aberrations in lenses. 1

iii) Magnification produced by compound microscope

$$m = m_o \times m_e$$ ½

$$m_o = \frac{m}{m_e} = \frac{m}{\left|\frac{D}{fe}\right|}$$

$$m_o = \frac{200}{\frac{25}{2}} = 16$$ ½ **5**

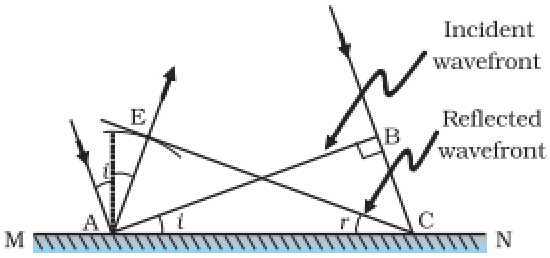
OR

(b)

i) Difference between a wavefront and a ray	1
ii) Statement of Huygens' principle	1
Verification of the law of reflection	1 ½
iii) Finding wavelength of light	1 ½

i) Wavefront is a surface of constant phase. ½
Alternatively Locus of points, which oscillate in phase
Ray - The straight line path along which light travels (or energy propagates). ½
Alternatively – Ray is normal to wave front.

ii) **Huygens' Principle** Each point of the wave front is the source of secondary disturbance and the wavelets emanating from the points spread out in all directions with speed of wave. The wavelets emanating from wave front are usually referred to as secondary wavelets. A common tangent to all these spheres gives the new position of the wave front at a later time. 1



1

Triangles EAC and BAC are congruent therefore $\angle i = \angle r$ ½

iii) Position of 4th bright fringe ½

$$x_{4(bright)} = 4\frac{D\lambda}{d}$$

Position of 2nd dark fringe ½

$$x_{2(dark)} = \frac{3}{2}\frac{D\lambda}{d}$$

$$x_{4(bright)} - x_{2(dark)} = 5mm$$

$$4\frac{D\lambda}{d} - \frac{3}{2}\frac{D\lambda}{d} = 5\times10^{-3}$$

$$\lambda = 6\times10^{-6} \text{ m}$$ ½