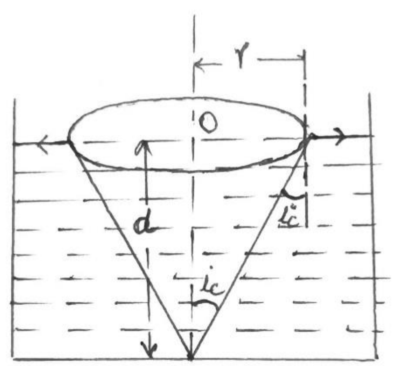
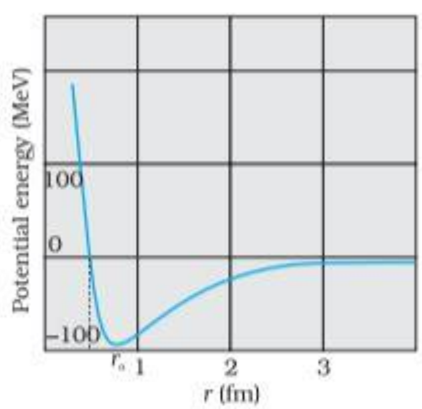
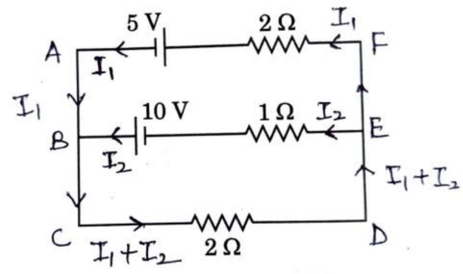
SOLUTIONS: PHYSICS(042)			
Code: 55/6/3			
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1.	(D) 2	1	1
2.	(C) $2I_0$	1	1
3.	(C) $\left[\frac{mv^2}{qE}\right]$ *in X − Y plane*	1	1
4.	(C) g	1	1
5.	(D) $F_{pp} = F_{pn} = F_{nn}$	1	1
6.	(A) 10 V	1	1
7.	(B) $\frac{1}{2}$	1	1
8.	(C) $\left[\frac{n^2-1}{n}\right]R$	1	1
9.	(D) does not move at all	1	1
10.	(D) linear momentum	1	1
11.	(C) small resistance in parallel	1	1
12.	(B) 1.326×10^{-27}	1	1
13.	(D) Both Assertion (A) and Reason (R) are false.	1	1
14.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
15.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1
16.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
	SECTION - B		
17.	Explanation for higher electron concentration in n-type semiconductor in comparison to hole concentration 2 In a doped semiconductor the total number of conduction electrons is due to the electrons contributed by donors and those generated intrinsically, while the total number of holes is only due to the holes from the intrinsic sources.	2	2

18.	(a) Difference between velocity and drift velocity of electrons in a conductor 1 (b) Find the cross-sectional area of the wire 1 (a) **Velocity** is the rate of change of displacement with time. **Drift velocity** is the average velocity of free electrons under the influence of external electric field. (b) $I = neAv_d$ $A = \frac{I}{nev_d}$ $A = \frac{3.4}{8.5\times10^{28}\times1.6\times10^{-19}\times0.2\times10^{-3}}$ $A = 1.25\times10^{-6}\ \text{m}^2$	½ ½ ½ ½	 2
19.	(a) Finding the intensity for path difference of (i) $\frac{\lambda}{3}$ 1 (ii) $\frac{\lambda}{2}$ 1 (i) $\Delta\phi = \frac{2\pi}{\lambda}.\Delta x$ $\Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{3} = \frac{2\pi}{3}$ $I = 4I_0\cos^2\frac{\phi}{2}$ $I = 4I_0\cos^2\frac{\pi}{3}$ $I = I_0$ (ii) $\Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{2} = \pi$ $I = 4I_0\cos^2\frac{\pi}{2}$ $I = 0$ OR	½ ½ ½ ½	 2

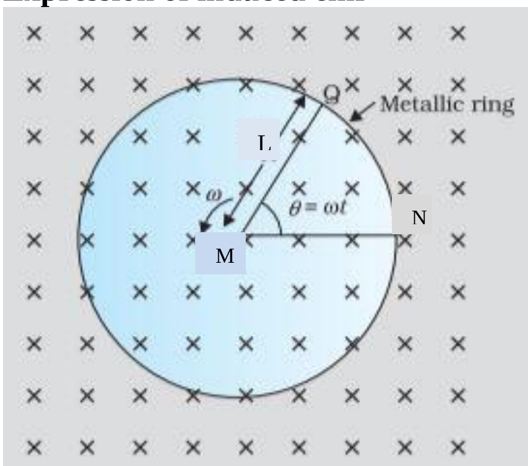
	(b) Finding- The position of the image 1½ The nature of the image ½ $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ $\frac{1.5}{v} - \frac{1}{(-12)} = \frac{1.5-1}{30}$ v = -22.5 cm Image is virtual and erect.	½ ½ ½ ½	
20.	Theoretical justification for same value of distance of closest approach 2 For a given nucleus, the distance of closest approach for a charged particle depends only on the accelerating potential difference. Since both α -particle and a deuterium ion are accelerated through same potential difference, therefore distance of closest approach will be same for both. **Note:** Award 1 mark if a student proves it mathematically.	2	2
21.	Calculating the diameter of opaque disc on the liquid surface 2 $\sin i_c = \frac{1}{\sqrt{2}}$ $i_c = 45^0$ $\tan i_c = \frac{r}{d}$ $r = d \tan 45^0$ $r = 30 \times 1$ cm $D = 2r = 60$ cm  **Alternatively:** $D = 2r = \frac{2d}{\sqrt{n^2 - 1}}$ $= \frac{2 \times 30}{\sqrt{(\sqrt{2})^2 - 1}}$ $D = 60 \text{cm}$	½ ½ 1 1 ½ ½	2

	SECTION - C		
22.	Naming the electromagnetic waves 1½ Writing wavelength range 1½ The electromagnetic waves used are (i) Microwaves (ii) Ultraviolet / Infrared (iii) X-rays Wavelength range of electromagnetic waves used (i) 0.1 m to 1 mm (ii) 400 nm to 1 nm / 1mm to 700 nm (iii) 1 nm to 10^{-3} nm	 ½ ½ ½ ½ ½ ½	3
23.	(a) Differentiating between 'Nuclear fission' and 'Nuclear fusion' with example 1 + 1 (b) Drawing the graph 1 (a) **Nuclear fission** is the process of splitting up of a heavy nucleus into lighter ones with a release of energy. $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{236}_{92}U \rightarrow ^{144}_{56}Ba + ^{89}_{36}Kr + 3^{1}_{0}n$ (or any other reaction) **Nuclear fusion** is the process of fusing of two lighter nuclei to form a heavier nucleus with the release of energy. $^{1}_{1}H + ^{1}_{1}H \rightarrow ^{2}_{1}H + e^{+} + \nu + 0.42\,\text{MeV}$ (or any other reaction) (b) 	½ ½ ½ ½ 1	3
24.	Finding- (i) The torque acting on the loop 1 (ii) The magnitude and direction of net force 2		

	(i) $\tau = mB\sin\theta$ As $\vec{m}$ and $\vec{B}$ are in same direction, $\theta = 0^0$ $\tau = 0$ (ii) $F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$ $F_{net} = \frac{\mu_0 I_1 I_2 l}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $= \frac{4\pi\times10^{-7}\times2\times1\times5\times10^{-2}}{2\pi\times10^{-2}}\left(1-\frac{1}{2}\right)$ $F_{net} = 1\times10^{-6}$ N Net force on the loop is towards the long straight wire.	½ ½ ½ ½ ½ ½	3
25.	(a) Calculating • Object distance 1 • Image distance 1 (b) Justification if the silver coating around the centre of a concave mirror is removed 1 (a) $m = -\frac{v}{u}$ $-2 = -\frac{v}{u}$ $v = 2u$ $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\frac{1}{-10} = \frac{1}{2u} + \frac{1}{u}$ $u = -15$ cm $v = -30$ cm (b) Yes, same image is formed with reduced intensity, because reflecting area get reduced and laws of reflection still hold good for remaining part of the mirror.	½ ½ ½ ½ 1	3
26.	Stating Kirchoff's laws ½ + ½ Finding the values of current in all the three branches 2 **Junction rule:** At any junction, the sum of the currents entering the junction is equal to the sum of the currents leaving the junction. **Loop rule:** the algebraic sum of changes in potential around any closed loop involving resistors and cells in the loop is zero.	½ ½	

	In closed loop $BCDEB$ $2I_1+3I_2=10$ ------(1) In closed loop $ABCDEFA$ $4I_1+2I_2=-5$ ------(2) On solving eq. (1) and (2) $I_1=-\frac{35}{8}\text{A}$ *in arm AF* $I_2=\frac{25}{4}\text{A}$ *in arm BE* $I_1+I_2=-\frac{15}{8}\text{A}$ *in arm CD*  	½ ½ ½ ½	3
27.	Finding the value of- (i) Angular momentum of electron 1 (ii) Radius of the orbit 1 (iii) Kinetic energy of electron 1 (i) $L=\frac{nh}{2\pi}$ *for* $n=2$ $L=\frac{2\times6.63\times10^{-34}}{2\times3.14}$ $=2.11\times10^{-34}\ kg\,m^2\,s^{-1}$ (ii) $r_n=n^2r_0$ $r_2=4(0.5\overset{0}{\text{A}})$ $r_2=2\overset{0}{\text{A}}$ (iii) Total energy of electron $=-\frac{13.6}{n^2}$ eV $E=-3.4\text{eV}$ $(n=2)$ $K=-E$ $K=3.4\text{eV}$	½ ½ ½ ½ ½ ½	3
28.	(a) Stating Lenz's law 1 Obtaining expression for induced emf 2 **Lenz's law** The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.	1	

Expression of induced emf



The magnitude of the emf generated across the length dr of the rod as it moves at right angles to the magnetic field is given by

$d\varepsilon = B\text{v}\, dr$ ½

$\varepsilon = \int d\varepsilon$

$= \int_0^L B\text{v}\, dr$ ½

$\varepsilon = \int_0^L B\omega r\, dr$ ½

$\varepsilon = \frac{1}{2} BL^2\omega$ ½

Alternatively:

Area of the sector (QMN) = $\frac{1}{2}L^2\theta$ ½

Induced emf is $\varepsilon = B \times \frac{d}{dt}\left(\frac{1}{2}L^2\theta\right)$ ½

$\varepsilon = \frac{1}{2} BL^2 \frac{d\theta}{dt}$ ½

$\varepsilon = \frac{1}{2} BL^2\omega$ ½

OR

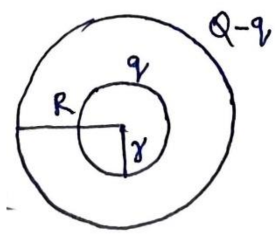
(b)

Definition of self inductance	1
Deriving expression for self inductance for a long solenoid	2

Self inductance of a coil is the ratio of the flux linkage to the current flowing in the coil. 1

Alternatively:

	Self inductance of a coil is defined as the flux linked with the coil when unit current flows through it. **Alternatively**: Self inductance of a coil may be defined as the magnitude of emf induced in the coil when current changes at the rate of 1 A/s in the coil. **Expression for self inductance of a long solenoid:** The magnetic field due to current flowing in the solenoid, B = $\mu_0 nI$ Total flux linked with the given solenoid $N\phi_B = (nl)(\mu_0 nI)\,A$ $N\phi_B = \mu_0 n^2\,A\,lI$ Self inductance $L = \frac{N\phi_B}{I}$ $L = \mu_0 n^2\,A\,l$	½ ½ ½ ½	3
	SECTION – D		
29.	(i) (a) (D) 6 OR (b) (B) $\frac{2K}{K+1}$ (ii) (C) $\frac{1}{2}\varepsilon_0 E^2 V$ (iii) (B) $\frac{\sigma}{\sigma - \sigma_p}$ (iv) (A) $\left(\frac{C}{4}\right)$	1 1 1 1	4
30.	(i) (a) (B) The applied voltage mostly drops across the depletion region OR (b) (C) 100 Hz (ii) (B) A layer of positive charge on n side and a layer of negative charge on p side appear (iii) (C) 0.05 eV (iv) (B) Antimony	1 1 1 1	4

	SECTION – E		
31.	(i) Finding the amount of work done — 2 (ii) Finding (I) The electric field at their common centre — 1 (II) The potential at their common centre — 2		
	(a)		
	(i) $V = -\int \vec{E} \cdot \vec{dr}$		
	$= -\int 40\, x\, dx$		
	$= -20\, x^2$	½	
	Potential at A (0, 3m), $V_A = 0$		
	Potential at B (5m, 0), V_B = -500 V	½	
	Work done in taking a unit positive charge from a point (0, 3m) to the point (5m, 0)		
	$W = q(V_B - V_A)$	½	
	$= 1(-500 - 0)$		
	$W = -500\,J$	½	
	(ii) (I) Electric field at the common centre will be zero as the charge enclosed by the inner sphere is zero.	1	
			
	Alternatively: $q_{en} = 0$	½	
	$\phi_E = 0$		
	$\oint \vec{E}.\vec{ds} = 0$		
	$E = 0$	½	
	(II) ∵ Surface charge densities are equal		
	$\frac{q}{4\pi r^2} = \frac{Q-q}{4\pi R^2}$	½	
	$q = \frac{Qr^2}{R^2 + r^2}$	½	
	Potential at common centre		
	$V = \frac{kq}{r} + \frac{k(Q-q)}{R}$	½	

$$V=\frac{k}{r}\frac{Qr^2}{(R^2+r^2)}+\frac{k}{R}\left[Q-\frac{Qr^2}{(R^2+r^2)}\right]$$

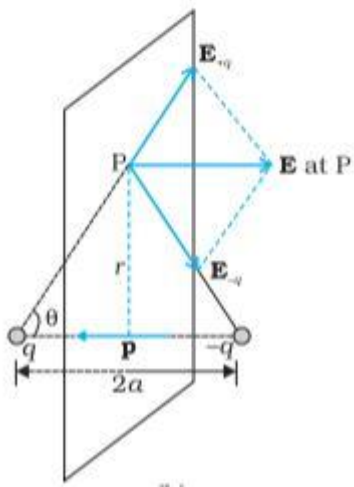
$$V=\frac{kQ(R+r)}{R^2+r^2}$$ ½

OR

(b)

(i)	Obtaining expression for electric field due to a dipole on its equatorial plane	2
	Finding electric field:	
	(I) At centre of the dipole	½
	(II) At a point r >> a	½
(ii)	Calculating net electric flux through cube	2

(i)



½

The magnitudes of the electric field due to two charges +q and -q are

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

$$E_{-q}=\frac{q}{4\pi\varepsilon_0}\frac{1}{(r^2+a^2)}$$ ½

The total electric field

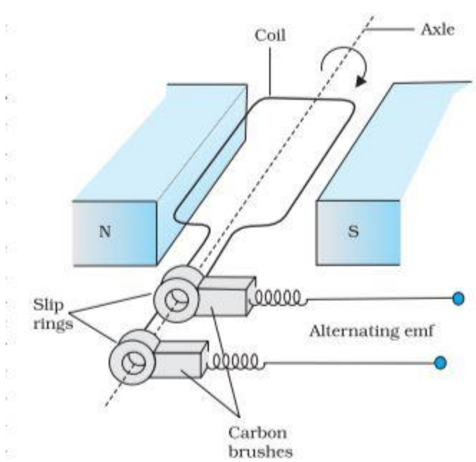
$$\vec{E}=-(E_{+q}+E_{-q})\cos\theta\,\hat{p}$$

$$\vec{E}=-\frac{\vec{p}}{4\pi\varepsilon_0(r^2+a^2)^{3/2}}$$ ½

Direction of electric field is opposite to dipole moment ($\vec{p}$) ½

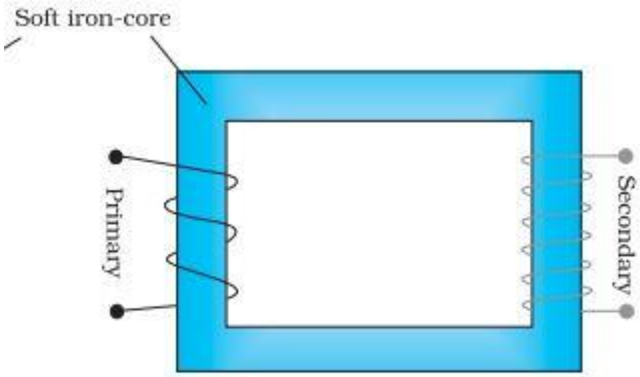
(I) At centre of dipole, r = 0

$$\vec{E}=-\frac{-\vec{p}}{4\pi\varepsilon_0 a^3}$$ ½

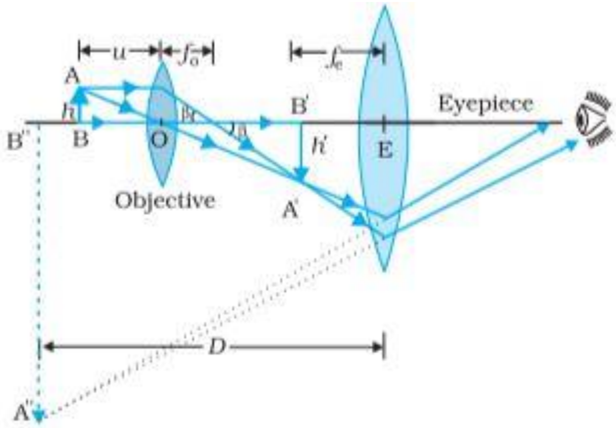
	(II) At a point r>>a $\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 r^3}$ (ii) $\vec{E} = (10x+5)\hat{i}$ N/C $\phi_L = \int \vec{E}.\vec{ds}$ $= -E_L(L^2)$ $= -5L^2$ $\phi_R = E_R(L^2)$ $= (10L+5)L^2$ $\phi_{net} = \phi_L + \phi_R$ $= -5L^2 + (10L+5)L^2$ $= 10L^3$ Nm^2/C	½ ½ ½ ½ ½	5
32.	**(a)** (i) Writing principle of ac generator 1 Labelled diagram of ac generator 1 Working of ac generator 1 (ii) Finding rms voltages across three circuit elements 1½ Explanation of the algebraic sum of rms voltages across three circuit elements is more than the rms voltage source ½ **(i) Principle:** It works on the principle of electromagnetic induction.  **Working:** The coil is mechanically rotated in the uniform magnetic field. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. (i) $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$	1 1 1	

	$= \sqrt{(400)^2 + \left(100\pi \times \frac{5}{\pi} - \frac{1}{100\,\pi \times \frac{50}{\pi} \times 10^{-6}}\right)^2}$ $= 500\,\Omega$ $I_{rms} = \frac{V_{rms}}{Z}$ $I_{rms} = \frac{140}{\sqrt{2} \times 500} = \frac{0.28}{\sqrt{2}}$ A $(V_{rms})_R = I_{rms}\ R$ $= \frac{0.28}{\sqrt{2}} \times 400$ $= \frac{112}{\sqrt{2}} = 56\sqrt{2}$ V	½	
	$(V_{rms})_L = I_{rms}\ \omega$L $= \frac{0.28}{\sqrt{2}} \times 500$ $= \frac{140}{\sqrt{2}} = 70\sqrt{2}$ V	½	
	$(V_{rms})_C = I_{rms}\ \frac{1}{\omega C}$ $= \frac{0.28}{\sqrt{2}} \times 200$ $= \frac{56}{\sqrt{2}} = 28\sqrt{2}$ V	½	
	The algebraic sum of voltages is more than the rms voltage of source because voltages across R, L and C are not in phase.	½	
	OR **(b)**		

(i)	Writing principle of transformer	1
	Labelled diagram of step-up transformer	1
	Working of step-up transformer	1
(ii)	Finding-	
	• rms value of input current	1
	• expression for instantaneous output voltage	½
	• expression for instantaneous output current	½

	(i) **Principle**: It works on the principle of mutual induction.  **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. Since the no. of turns are more in secondary windings an emf induced is proportional to the no. of turns. Therefore more emf is developed across the secondary windings. (ii) $P_i = V_p I_p$ $200 = \frac{20}{\sqrt{2}} I_p$ $I_p = 10\sqrt{2}\text{A}$ $\frac{V_o}{V_i} = \frac{250}{50}$ $5 = \frac{V_o}{V_i}$ $V_o = 100\sin(100\pi)\,t\ \text{V}$ $P_o = (V_o)_{rms}(I_o)_{rms}$ $200 = \frac{100}{\sqrt{2}}(I_o)_{rms}$ $(I_o)_{rms} = 2\sqrt{2}\text{A}$ $\therefore I_o = (2\sqrt{2})\sqrt{2}\sin(100\pi)\,t$ $I_o = 4\sin(100\pi)\,t\ \text{A}$	1 1 1 ½ ½ ½ ½	5
33.	(a) (i) Drawing ray diagram of compound microscope — 1½ Obtaining an expression for total magnification — 1½ (ii) Calculating distance between the objective and the eye-piece — 2		

(i)



1½

Note: Deduct ½ mark for not showing arrows with the rays.

Magnification produced by objective

$m_0 = \frac{h'}{h} = \frac{L}{f_o}$ ½

Magnification produced by eye-piece

$m_e = 1 + \frac{D}{f_e}$

If the final image is formed at infinity

$m_e = \frac{D}{f_e}$ ½

Total magnification

$m = m_0 \times m_e$

$= \left(\frac{L}{f_o}\right)\left(\frac{D}{f_e}\right)$ ½

(i) $\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_0}$ ½

$\frac{1}{v_o} - \frac{1}{(-1.5)} = \frac{1}{1.25}$

$v_o = 7.5\text{cm}$ ½

$L = |v_o| + |f_e|$ as final image is formed at infinity ($v_e = \infty, u_e = f_e$) ½

L = 7.5 + 5

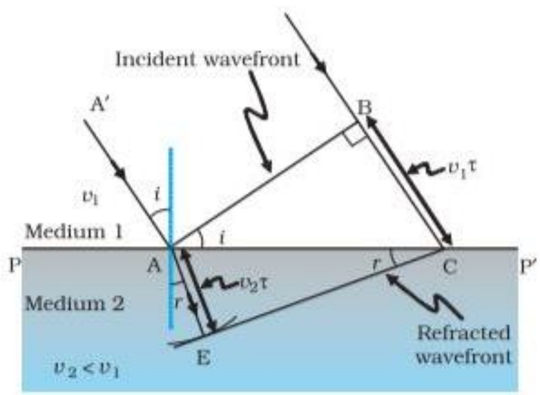
L= 12.5 cm ½

OR

(ii)

(i) Explaining the refraction of a plane wavefront	1
Verification of Snell's law	2
(ii) Deducing that a convex mirror always produces a virtual image of an object	2

(i)



1

$$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$$ ½

$$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$$ ½

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

$$\frac{\sin i}{\sin r} = \frac{c/n_1}{c/n_2}$$ ½

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} \text{ or } n_1 \sin i = n_2 \sin r$$ ½

(ii) $$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$ ½

$$u < 0 \ , \quad f > 0$$

$$\frac{1}{v} + \frac{1}{(-u)} = \frac{1}{f}$$ ½

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

$\frac{1}{v}$ is positive

∴ v is positive ⇒ virtual image ½

5