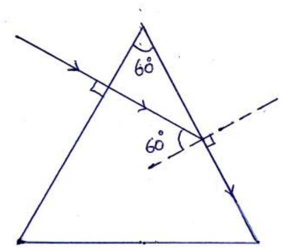
MARKING SCHEME : PHYSICS (042)

CODE : 55/4/3

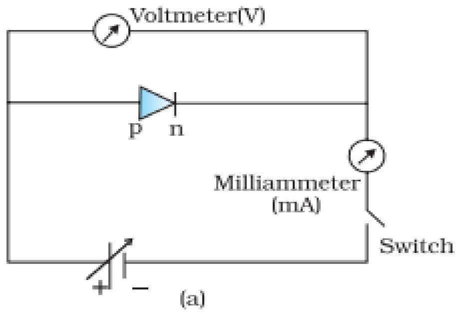
Q.NO	VALUE POINTS/EXPECTED ANSWERS	MARKS	TOTAL MARKS
	SECTION - A		
1	(A) 2 pE	1	1
2	(B) Repulsive and $\frac{q\lambda}{2\pi\varepsilon_0 x}$	1	1
3	(A) Zero.	1	1
4	(D) Closer together and weaker in intensity.	1	1
5	No option is correct, award 1 mark.	1	1
6	No option is correct, award 1 mark.	1	1
7	(A) R	1	1
8	(B) 1mA	1	1
9	(C) $\frac{1}{\sqrt{2}}\sqrt{\left(i_1^2+i_2^2\right)}$	1	1
10	(A) There is a minimum frequency of incident radiation below which no electrons are emitted.	1	1
11	(A) Small and negative.	1	1
12	(C) $r_n \, \alpha \, n^2$	1	1
13	(A) Both assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).	1	1
14	(C) Assertion (A) is true and Reason (R) is false.	1	1
15	(B) Both assertion (A) and Reason (R) are true and Reason (R)is not the correct explanation of Assertion(A).	1	1
16	(D) Both Assertion (A) and Reason (R) are false.	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 $\frac{n_1}{v}-\frac{n_2}{u}=\frac{n_1-n_2}{R}$ u = - 20 cm , R= - 40 cm , n_1 = 1 , n_2 = 1.5 $\frac{1}{v}-\frac{1.5}{(-20)}=\frac{1-1.5}{(-40)}$ v = -16 cm Nature of image is virtual. OR (b) Finding the focal lengths of the objective and eyepiece 2 Distance between objective and eyepiece fo + fe = 1.00 m = 100 cm Magnifying power $\lvert m\rvert=\frac{fo}{fe}=19$ On solving fo = 95 cm = 0.95 m fe = 5 cm = 0.05 m	½ ½ ½ ½ ½ ½ ½ ½	2

18	Finding $\frac{V_p}{V_d}$ 2 De Broglie wavelength of proton $\lambda_p = \frac{h}{\sqrt{2meV_p}}$ De Broglie wavelength of deutron $\lambda_d = \frac{h}{\sqrt{2(2m)eV_d}}$ $\frac{\lambda_p}{\lambda_d} = \frac{1}{2} = \frac{\sqrt{2(2m)eV_d}}{\sqrt{2meV_p}}$ On solving $\frac{V_p}{V_d} = 8$	½ ½ ½ ½	2
19	Finding refractive index of the medium 2  From snell's law, $\mu.\sin i = \mu_m.\sin r$ $\mu.\sin 60^0 = \mu_m.\sin 90^0$ $\mu_m = \mu.\frac{\sqrt{3}}{2}$ **<u>Alternatively</u>** $\mu_{ga} = \frac{1}{\sin C}$ $\frac{\mu}{\mu_m} = \frac{1}{\sin 60^0}$ $\mu_m = \frac{\sqrt{3}}{2}\mu$	½ ½ ½ ½ 1 ½ ½	2
20	Finding temperature of conductor 2 $R_2 = R_1 + 25\% \text{ of } R_1 = 1.25R_1$ Temperature coefficient of resistance $\alpha = \frac{R_2 - R_1}{R_1.\Delta T}$ $T_2 - 27 = \frac{1.25R_1 - R_1}{R_1 \times 2 \times 10^{-4}}$ $T_2 = 1277\ ^0C$	½ ½ ½ ½	2

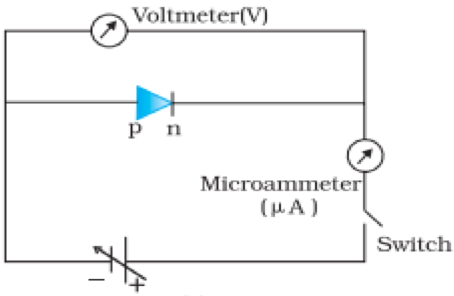
21

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)

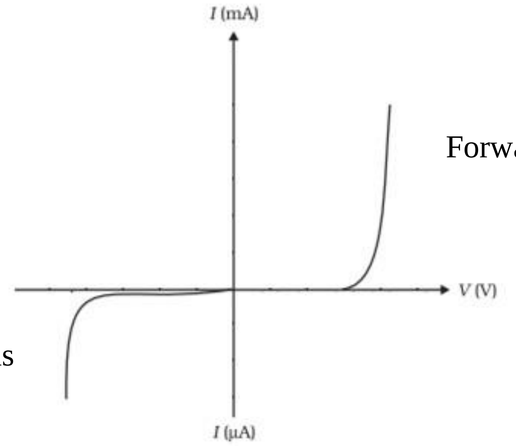


(a) ½



(b) ½

I-V characteristics in forward and reverse bias



Forward bias

Reverse bias

½ + ½

2

SECTION - C

22 (a)

(i) Defining mutual inductance	½
SI unit of mutual inductance	½
(ii) Deriving expression for mutual inductance	2

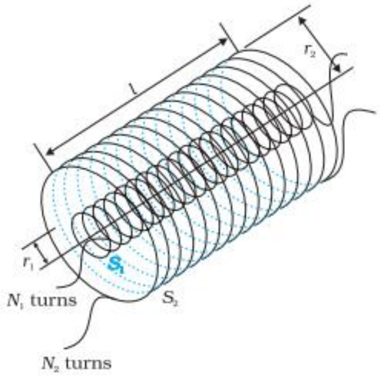
(i) Mutual inductance between two coils is defined as the magnetic flux associated with a coil when unit current flows through neighbouring coil. ½

Alternatively

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

$$N_1\phi_1 = N_1\left(\frac{\mu_0 N_2 I_2}{l}\right)\pi r_1^2$$

$$N_1\phi_1 = \frac{\mu_0 N_1 N_2 \pi r_1^2 I_2}{l} \quad \text{.............................(1)}$$ ½

$$N_1\phi_1 = M_{12} I_2 \quad \text{............................. (2)}$$ ½

From equations (1) and (2)

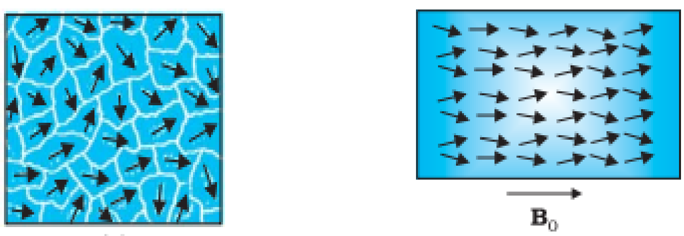
$$M_{12} = \frac{\mu_0 N_1 N_2 \pi r_1^2}{l}$$ ½ **3**

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. 1



(a) (b) ½ + ½

In absence of external magnetic field, domains are randomly oriented and it exhibits weak magnetisation. ½

In the presence of external magnetic field domains orient themselves in the direction of magnetic field and it exhibits strong magnetisation. ½

23

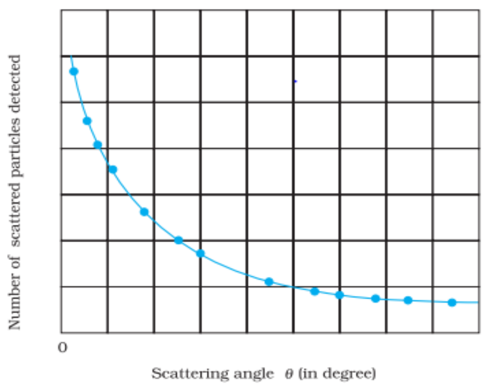
Finding expression for final potential of shell A	3

Charge on spherical Shell A

$$q_A = 4\pi R^2\sigma$$ ½

Charge on speherical shell B

$$q_B = 4\pi(2R)^2\sigma = 16\pi R^2\sigma$$ ½

	After connecting by a wire , their potentials will become equal after sharing of charge. $\frac{1}{4\pi\varepsilon_0}\frac{q'_A}{R} = \frac{1}{4\pi\varepsilon_0}\frac{q'_B}{2R}$	½	
	$q'_B = 2q'_A$ From conservation of charge $q_A + q_B = q'_A + q'_B$	½	
	$4\pi R^2\sigma + 16\pi R^2\sigma = 3q'_A$ $q'_A = \frac{20\pi R^2\sigma}{3}$	½	
	Final potential of Shell A $V_A = \frac{1}{4\pi\varepsilon_0}\frac{q'_A}{R}$ $V_A = \frac{1}{4\pi\varepsilon_0}\frac{20\pi R^2\sigma}{3R}$ $V_A = \frac{5\sigma R}{3\varepsilon_0}$	½	3
	Alternatively Charge on spherical shell A $q_A = 4\pi R^2\sigma$	½	
	Charge on spherical shell B $q_B = 4\pi(2R)^2\sigma = 16\pi R^2\sigma$	½	
	After connecting by a wire , their potential will become equal after sharing of charges	½	
	Therefore the potential of shell A $V_A = V_{common} = \frac{q_A + q_B}{C_A + C_B}$	½	
	$= \frac{4\pi R^2\sigma + 16\pi R^2\sigma}{4\pi\varepsilon_0 R + 4\pi\varepsilon_0(2R)}$	½	
	$= \frac{5\sigma R}{3\varepsilon_0}$	½	
24	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. (ii) Almost entire mass and entire positive charge is concentrated in a very small region called nucleus. At distance of closest approach $E_k = E_P$ $K = \frac{1}{4\pi\varepsilon_0}\frac{(Ze).(2e)}{d}$ $d = \frac{1}{4\pi\varepsilon_0}\frac{(2Ze^2)}{K}$	½ ½ ½ ½	**3**
25	(i) Calculating effective resistance 2 (ii) Calculating power supplied by battery 1 i) $R_{ABC} = 10+10 = 20\Omega$ Equivalent resistance across AC $R_{AC} = \frac{20\times20}{20+20} = 10\Omega$ Equivalent resistance across AD $R_{AD} = \frac{20\times20}{20+20} = 10\ \Omega$ Equivalent resistance across AM $R_{AM} = \frac{20\times30}{20+30} = 12\Omega$ ii) Net resistance of circuit $R_{net} = 12+10+8 = 30\ \Omega$ Power supplied $P = \frac{V^2}{R_{net}}$ $= \frac{(6)^2}{30}$ $= 1.2\ W$ **<u>Alternatively</u>** Net resistance of circuit $R_{net} = 12+10+8 = 30\ \Omega$ $I = \frac{\varepsilon}{R_{net}}$ $= \frac{6}{30}$ $= 0.2\ A$	½ ½ ½ ½ ½ ½ ½	**3**

	Power supplied $P = VI$ $= 6\times 0.2$ $= 1.2\,W$	½	
26	Finding magnitude of force 2 ½ Finding direction of force ½ Magnetic field at P due to infinite straight conductor carrying current $\vec{B} = \frac{\mu_0 I}{2\pi r}\hat{k}$ Force on charge q in this magnetic field $\vec{F} = q(\vec{v}\times\vec{B})$ $\vec{F} = q\left[(v_0\,\hat{j})\times\left(\frac{\mu_0 I}{2\pi r}\right)\hat{k}\right]$ $\vec{F} = \frac{\mu_0 q v_0 I}{2\pi r}\hat{i}$ The magnitude of force $F = \frac{\mu_0 q v_0 I}{2\pi r}$ The direction of force on charge is along +ve X-axis.	 ½ ½ ½ ½ ½ ½	**3**
27	Reasons for i) Difference in mode of interaction of electromagnetic wave with matter 1 ii) Containing water in food items to be heated in microwave 1 iii) Wearing facemask with glasses by welders during welding 1 (i) Since they have different wavelenghts and frequencies, they differ considerably in their mode of interaction with matter. (ii) Frequency of microwave matches with the resonant frequency of water molecules so that energy from wave is transferred to water molecules. (iii) To protect their eyes from large amount of ultraviolet rays produced by welding arcs.	 1 1 1	**3**
28	(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 ${}_{94}Pu^{239}$ $= \frac{6.023\times 10^{23}}{239}$ $= 2.5\times 10^{21}$	 ½ ½ 1	

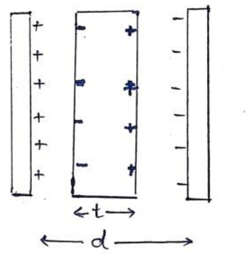
	Energy released in fission of 1 g of ${}_{94}Pu^{239}$, $E = 180\,\text{MeV} \times 2.5 \times 10^{21}$ $E = 4.5 \times 10^{23}$ MeV	1	**3**
	SECTION - D		
29	(i) (B) 0.01 eV (ii) (D) 5×10^{22} m^{-3} (iii) (a) (C) Electrons diffuse from n-region into p-region and holes diffuse from p-region to n-region. OR (b) (A) Diffusion current is large and drift current is small. (iv) (D) 50 Hz , 100 Hz.	1 1 1 1	**4**
30	(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**
	SECTION - E		
31	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

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

Energy stored in parallel combination

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

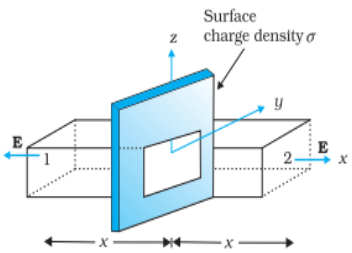
$$C_2=1\times10^{-5}\ \text{F or } 10\,\mu\text{F}$$ ½ **5**

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)

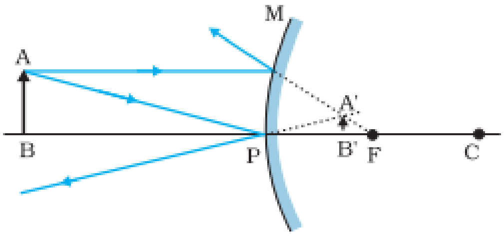
$$\phi = \frac{q_{en}}{\varepsilon_0}$$ ½

$$q_{en} = \phi.\varepsilon_0$$
$$= 5\times10^{-4}\times8.85\times10^{-12}$$
$$= 4.43\times10^{-15}\,\mathrm{C}$$ ½

32

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

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

Therefore , $\frac{B'A'}{BA} = \frac{B'P}{BP}$ ----------------------------------- (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

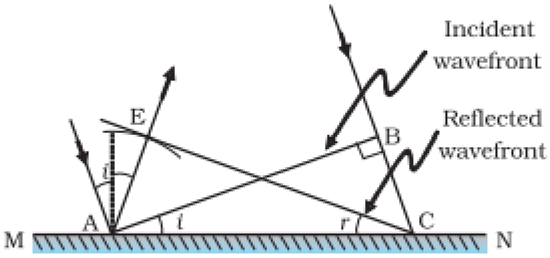
i) Wavefront is a surface of constant phase. ½

<u>Alternatively</u> Locus of points, which oscillate in phase

<u>Ray -</u> The straight line path along which light travels (or energy propagates). ½

<u>Alternatively –</u> Ray is normal to wave front.

ii) **<u>Huygens' Principle</u>** 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

$$x_{4(bright)} = 4\frac{D\lambda}{d}$$ ½

Position of 2nd dark fringe

$$x_{2(dark)} = \frac{3}{2}\frac{D\lambda}{d}$$ ½

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

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

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

33 (a)

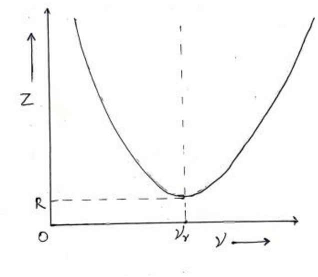
(i) Factors on which the resonant frequency of a series LCR circuit depends	1
Plotting of graph	1
(ii) Diagram of a transformer	1
Working of a step-up transformer	1
(iii) Two causes of energy loss in a real transformer	1

(i) Inductance ½

Capacitance ½

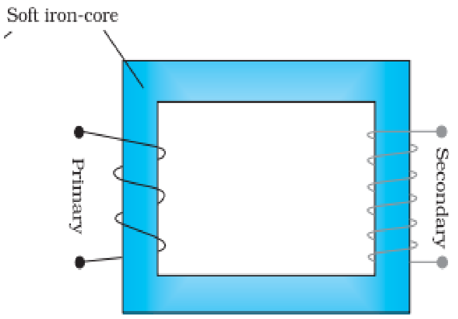
<u>Alternatively</u>

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



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

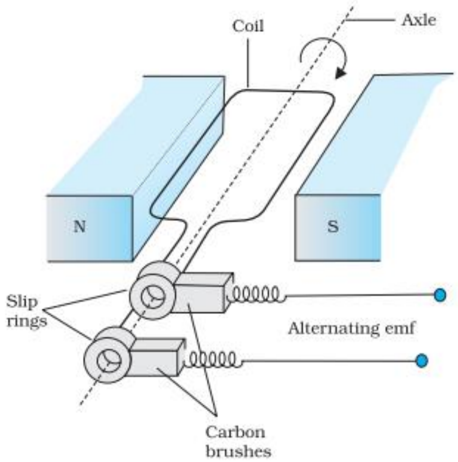
½ + ½ | 5

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

<u>Construction</u> – 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

<u>Alternatively</u>

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. **Alternatively** If a student derives $e = e_0 \sin \omega t$ give one mark for working. (ii) The equivalent current $I = \frac{q}{t} = \frac{e}{\frac{2\pi r}{v}} = \frac{ev}{2\pi r}$ Mangetic moment of revolving electron $m = IA$ $= \frac{ev}{2\pi r} \times \pi r^2$ $= \frac{1}{2} evr$	1 ½ ½ ½ ½	