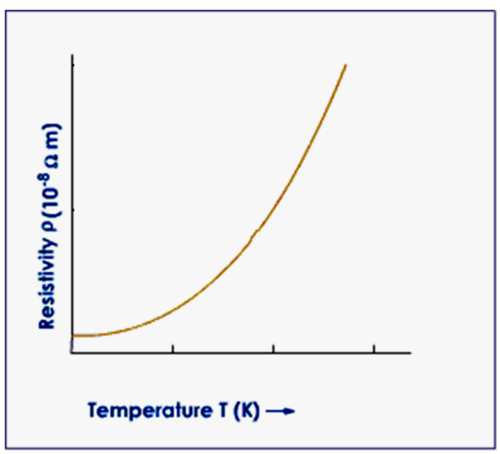
MARKING SCHEME
SET 55/1/1

Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	Magnitude of the drift velocity of charge carrier per unit Electric field is called mobility. Alternatively, $\mu = \frac{\lvert v_d \rvert}{E}$ or $\frac{e\tau}{m}$ SI unit = m^2 / (volt second) or $ms^{-1}N^{-1}C$	½ ½	1
2.	Modulation Index = $\frac{a_m}{a_c}$ = 1/2 = 0.5	½ ½	1
3.	If Electric field is not normal, it will have non-zero component along the surface. In that case, work would be done in moving a charge on an equipotential surface.	1	1
4.	Glass. In glass there is no effect of electromagnetic induction, due to presence of Earth's magnetic field, unlike in the case of metallic ball.	½ ½	1
5.		1	1
6.	20cm	1	1
7.	$$\vec{F} = q(\vec{v} \times \vec{B})$$ Perpendicular to the plane formed by $\vec{v}$ and $\vec{B}$ / $\vec{F} \perp \vec{v}$ and $\vec{F} \perp \vec{B}$ [**Note:** Give full credit for writing the expression.]	½ ½	1
8.	X: Channel It connects the Transmitter to the Receiver	½ ½	1

9.	**Identification of magnetic material** ½ + ½ **Susceptibility** ½ + ½ A: Paramagnetic B: Diamagnetic Susceptibility For A: positive For B: negative	 ½ ½ ½ ½	 2
10.	**Finding flux in two cases** 1+1 $\phi = EA \cos\theta$ $= 5 \times 10^3 \times 10^{-2} \cos 0^0 \; NC^{-1} m^2$ $= 50 \; NC^{-1} m^2$ $\phi = 5 \times 10^3 \times 10^{-2} \cos 60^0 \; NC^{-1} m^2$ $= 25 \; NC^{-1} m^2$	 ½ ½ ½ ½	 2
11.	**Explanation of the given statement** 1 + 1 In the first case, the overlapping of the contributions of the wavelets from two halves of a single slit produces a minimum because corresponding wavelets from two halves have a path difference of $\frac{\lambda}{2}$. In the second case, the overlapping of the wavefronts from the two slits produces first maximum because these wavefronts have the path difference of λ. (**Alternatively**, if a student writes the conditions given below, give full credit.) Condition for first minimum in single slit diffraction is , $\theta \approx \lambda / a$, Whereas in case of two narrow slits separated by distance a, first maximum occurs at angle $\theta \approx \lambda / a$ [**Note:** Award 1 mark even if the candidate attempts this question partly.]	 1 1	 2

12.

Truth Table	1
Names of gates used	½ + ½

Truth Table

Input		Output	
A	B	Y’	Y
0	0	0	0
0	1	1	0
1	0	1	1
1	1	1	1

1

Gate R: OR Gate ½
S: AND Gate ½ 2

OR

Identification	1
Truth Table	1

P: NAND Gate ½
Q: OR Gate ½

Truth Table

Input		Output
A	B	X
0	0	1
1	0	1
0	1	1
1	1	1

1

2

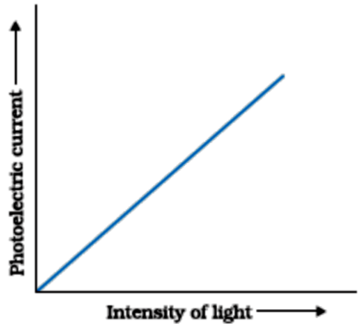
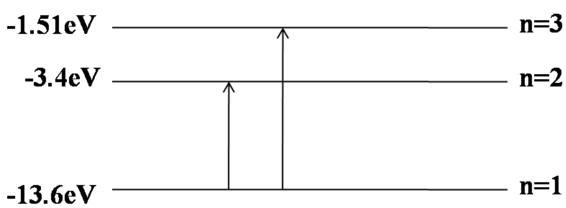
13.

Statements of two Laws	½ + ½
Justification	½ + ½

Junction rule: At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction. ½

	Alternatively, $\sum i = 0$ **Justification** : Conservation of charge **Loop rule**: The Algebraic sum of changes in the potential around any closed loop involving resistors and cells in the loop is zero. **Alternatively**, $\sum \Delta V = 0$, where ΔV is the changes in potential **Justification** : Conservation of energy	 ½ ½ ½	 2
14.	Effect on glow of bulb in — Part (i) 1; Part (ii) 1 (i) Reactance of the capacitor will decrease, resulting in increase of the current in the circuit. Therefore the bulb will glow brighter. (ii) Increased resistance will decrease the current in the circuit, which will decrease glow of the bulb. [**Note** : Do not deduct any mark for not giving the reasons.]	 1 1	 2
15.	Underlying principle 1 Brief working 1 It makes use of the principle that the energy of the charged particles / ions can be made to increase in presence of crossed Electric and magnetic fields. A normal Magnetic field acts on the charged particle and makes them move in a circular path .While moving from one dee to another; particle is acted upon by the alternating electric field, and is accelerated by this field, which increases the energy of the particle.	 1 1	 2
16.	Calculation of Potential energy of the dipole 2 $\tau = pE\sin\theta$ $4\sqrt{3} = pE\sin 60^0 = pE\frac{\sqrt{3}}{2}$ $\Longrightarrow pE = 8$ Potential energy	 ½ ½	

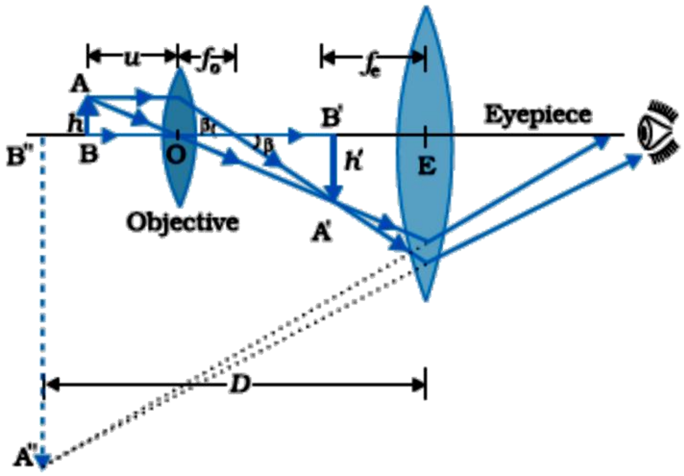
	$U = -pE\cos\theta$ $= -8 \times \cos 60^0 = -4J$ [Give full credit to alternative methods of finding Potential energy.]	½ ½	2
17.	Part (a) and reason ½ + ½ Part (b) and reason ½ + ½ (a) de Broglie wavelength is given by $\lambda = \frac{h}{\sqrt{2mqV}}$ As mass of proton < mass of deuteron and $q_p = q_d$ and v is same $\Rightarrow \lambda_p > \lambda_d$ for same accelerating potential. (b) Momentum = $\frac{h}{\lambda}$ $\because \lambda_p > \lambda_d$ $\therefore$ momentum of **proton** will be less , than that of deuteron	½ ½ ½ ½	2
18.	(a) Estimation of no. of photons per second 1 (b) Plot showing the variation 1 (a) Power = $nh\nu$, where n = no. of photons per second $2.0 \times 10^{-3} = n \times 6.6 \times 10^{-34} \times 6 \times 10^{14}$ $n = \frac{2.0 \times 10^{-3}}{6.6 \times 10^{-34} \times 6 \times 10^{14}}$ $= 0.050 \times 10^{17} = 5 \times 10^{15}$ photons / second [**Note**: Even if the student doesn't write the formula but calculates correctly, give full credit to this part]	½ ½	

	(b)  	1	2
19.	Finding maximum energy level of hydrogen atoms ½ Calculation of wavelengths 2 ½ $E_n = \frac{-13.6}{n^2}\ eV$ Energy required to excite hydrogen atoms from ground state to the second excited state $= E_{final} - E_{initial}$ $= -1.51 - (-13.6) = 12.09$ eV i.e. hydrogen atoms would be excited upto third energy level(i.e n=3) / second excited state.[**Note :** If the student just writes gaseous hydrogen is made up of the molecule or just writes the formula for E_n , award this ½ mark.] **Alternatively ,**  For Lyman $\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$ $\frac{1}{\lambda} = 1.097 \times 10^7\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$ $\lambda = 122\ nm$ For Balmer $\frac{1}{\lambda} = 1.097 \times 10^7\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$ $\lambda = 656.3\ nm$ [**Note :** Also accept the answers given in terms of R only]	½ ½ ½ ½ ½ ½	3

20.	(i) Effect of em waves on health 1 (ii) Values displayed 1 (iii) Estimation of the range 1 (i) Electromagnetic radiations emitted by an antenna can cause (a) Cardiac problem (b) Cancer (c) Giddiness and headache **(any one of the above / or any other effect on health**) (ii) Scientific temperament, awareness (**any one / any other correct value**) (iii) Range = $\sqrt{2h_T R}$ $= \sqrt{2 \times 20 \times 6.4 \times 10^6}$ km $= \sqrt{4 \times 64 \times 10^6}$ = 16 km	 1 1 ½ ½	 3
21.	Calculation of potential gradient 2 Determination of emf of primary cell 1 Current flowing in Potentiometer wire, $I = \frac{V}{R + R'}$ $= \frac{6}{10 + 5}$ A = 0.4 A Potential drop across the potentiometer wire V = IR = 0.4 x 10 V = 4.0 V Potential Gradient k = V/ $\ell =$ 4.0 V/m ∴ unknown emf of the cell (E) = Kℓ' = 4.0 x 0.4 V = 1.6 V	 ½ ½ ½ ½ ½ ½	 3

22.

Ray diagram of compound microscope 1 ½
Calculation of focal length of objective and eyepiece 1 ½



1½

For eyepiece $m_e = \frac{v_e}{u_e}$

$$u_e = \frac{v_e}{m_e} = \frac{-20}{5}\,cm = -4\,cm$$ ½

Also, $\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e}$

$$\frac{1}{f_e} = \frac{-1}{20} + \frac{1}{4}$$

$$f_e = 5cm$$ ½

m = m_e x m_o

-20 = 5 x m_o => m_0 = -4

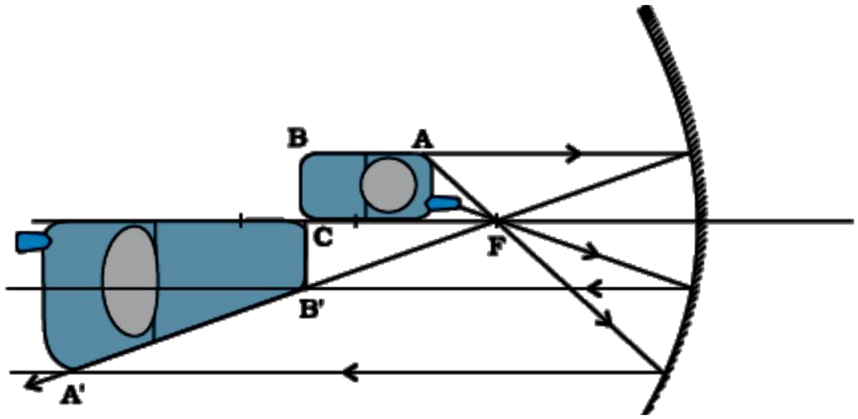
Also $|v_o| + |u_e| = 14$

=> v_o = (14 – 4) cm = 10cm

$m_0 = 1 - \frac{v_o}{f_0}$ => $-4 = 1 - \frac{10}{f_o}$

=> f_o = 2cm ½ 3

where subscripts e and o are used for eyepiece and objective respectively.

23.	(a) Explanation with the help of suitable diagram 2 (b) Effect of covering of lower half of the mirror 1 (a) 	1	
	Magnification is non-uniform because the position of the image of different parts of the phone, depends on their location with respect to the mirror. From the figure it can be observed that whereas BC = B'C , the images of the other parts of the phone ,are getting magnified in accordance with their 'object distance' from the mirror.	1	
	(b) By covering the mirror with an opaque material , the area of the reflecting surface has been reduced (i.e. halved). Therefore , the intensity of the image is reduced to half. (Award full marks even if student writes that there would be no effect on the size and / or position of the image.)	1	3
24.	(a) Derivation of the expression of energy stored per unit volume 2 (b) Calculation of work done 1 (a) Work done by the source of potential, in storing an additional charge (dq) , is dW = V.dq But V = q / C => $dW = \frac{q}{C}dq$ Total work done in storing the charge Q, $\int dW = \int_0^Q \frac{q}{C} dq$	½	

$$W = \frac{1}{C}\left(\frac{q^2}{2}\right)_0^Q = \frac{Q^2}{2C}$$ ½

This work is stored as electrostatic energy in the capacitor.

$\because$ Q= CV , $\therefore U = \frac{1}{2}CV^2$

Energy stored per unit volume = $\dfrac{\frac{1}{2}CV^2}{Ad} = \dfrac{\frac{1}{2}\left(\frac{\varepsilon_o A}{d}\right)(Ed)^2}{Ad}$ ½

$= \frac{1}{2}\varepsilon_o E^2$ ½

(b) Work done in moving the charge q from a to b , and from c to d is zero because Electric field is perpendicular to the displacement. ½

Work done from b to c = - Workdone from d to a ½

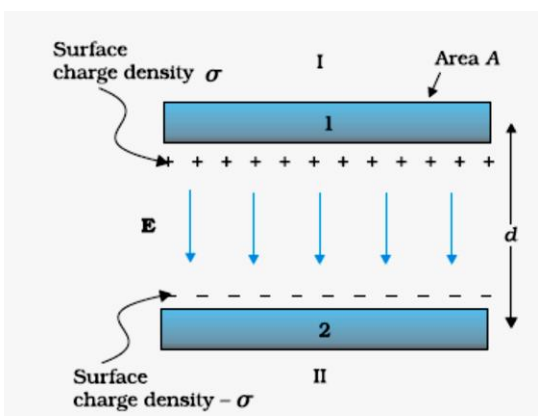
$\therefore$ Total work done in moving a charge q over a closed loop = 0

(Award this one mark if a student writes correct answer directly) 3

OR

(a) Derivation of capacitance of parallel plate capacitor	2
(b) Finding the Ratio of surface charge densities	1

(a)



Electric field between the plates of capacitor E= $\frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0}$ ½

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∴ potential difference

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

Capacitance

$$C = \frac{Q}{V} = \frac{\varepsilon_0 A}{d}$$

(b) When the two charged spherical conductors are connected by a conducting wire , they acquire the same potential

i.e $\frac{Kq_1}{R_1} = \frac{Kq_2}{R_2} \Longrightarrow \frac{q_1}{q_2} = \frac{R_1}{R_2}$

Hence , ratio of surface charge densities

$$\frac{\sigma_1}{\sigma_2} = \frac{q_1/4\pi {R_1}^2}{q_2/4\pi {R_2}^2}$$

$$= \frac{q_1 {R_2}^2}{q_2 {R_1}^2}$$

$$= \frac{R_1}{R_2} \times \frac{{R_2}^2}{{R_1}^2} = \frac{R_2}{R_1}$$

</td><td>½

1

½

½</td><td>3</td></tr>
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(a) Statement of Ampere's circuital Law 1 ½
(b) Calculation of net magnetic field
(i) inside and (ii) outside 1 ½

(a) Statement of law
Expression of the law in integral form:
$\oint \vec{B} . \vec{dl} = \mu_0 i$

(Award 1 mark if the student just writes the integral form of Ampere's circuital law)

(b) $B = \mu_o n I$

Magnitude of net magnetic field inside the combined system on the axis ,
$B = B_1 - B_2$
$\Longrightarrow B = \mu_o(n_1 - n_2) I$

Also accept if the student writes $B = \mu_o(n_2 - n_1) I$

(iii)Outside the combined system, the net magnetic field is zero.

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½

½

½</td><td>3</td></tr>
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26.	Part (a) 1 Part (b) 1 Part (c) 1 (a) Microwaves Frequency range: 10^{10} to 10^{12} Hz [**Note :** If the student correctly identifies the name of the em wave award full marks.] (b) Average surface temperature will be lower , Because there will be no green house effect in absence of atmosphere. (c) Since electromagnetic waves carry both energy and momentum, therefore, they exert pressure on the surface on which they are incident. (Award one mark for any other correct answer)	½ ½ ½ ½ 1	3
27.	(a) Derivation of the law of Radioactive decay 1 ½ (b) (i) Processes expressing β^+ decay ½ + ½ (ii) Identification as isotope / isobar ½ (a) $\frac{dN}{dt} = -\lambda N$ $\int_{N_0}^{N} \frac{dN}{N} = \int_0^t -\lambda dt$ $[\log_e N]_{N_0}^{N} = -\lambda[t]_0^t$ $\log_e \frac{N}{N_0} = -\lambda t$ $N = N_0\, e^{-\lambda t}$ (b) (i) ${}^{22}_{11}Na \rightarrow {}^{22}_{10}Ne + e^+ + v$ Also accept , if a student does not identify the product nucleus and writes as ${}^{22}_{11}Na \rightarrow {}^{22}_{10}X + e^+ + v$ Basic process p$\rightarrow n + e^+ + v$ (ii) Isobar	½ ½ ½ ½ ½ ½	3

28.

(a) (i) Reason	1
(ii) Obtaining expression for the resulant intensity	2
(b) Finding the intensity of light at a required point	2

(a) Light waves, originating from two independent monochromatic sources, will not have a constant phase difference. Therefore, these sources will not be coherent and, therefore , would not produce a sustained interference pattern. 1

(b) (i) y = $y_1 + y_2$ ½

$= a\cos\omega t + a\cos(\omega t + \emptyset)$

$= 2a\cos\frac{\emptyset}{2}.\cos(\omega t + \frac{\emptyset}{2})$ ½

Amplitude of resultant displacement is $2a\cos\frac{\emptyset}{2}$ ½

∴ Intensity ,

$I = 4\,a^2\cos^2\frac{\emptyset}{2}$ ½

$\boldsymbol{Note}: \ Accept\,, if\ a\ student\ derives\ the\ expression$

$I = C\,[{a_1}^2 + {a_2}^2 + 2a_1a_2\cos\emptyset]$ where 'a' is the amplitude of the monochromatic light.

(ii) A path difference of λ , corresponds to a phase difference of 2π ½

∴ The intensity, $K = 4a^2 \quad => \ a^2 = \frac{K}{4}$ ½

A path difference of $\frac{\lambda}{3}$, corresponds to a phase difference of $\frac{2\pi}{3}$ ½

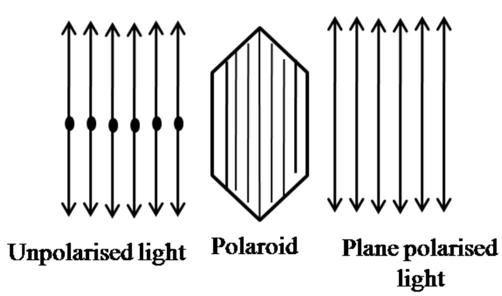
∴ Intensity = $4 \times \frac{K}{4}.\cos^2\frac{2\pi}{3} = \frac{K}{4}$ ½

5

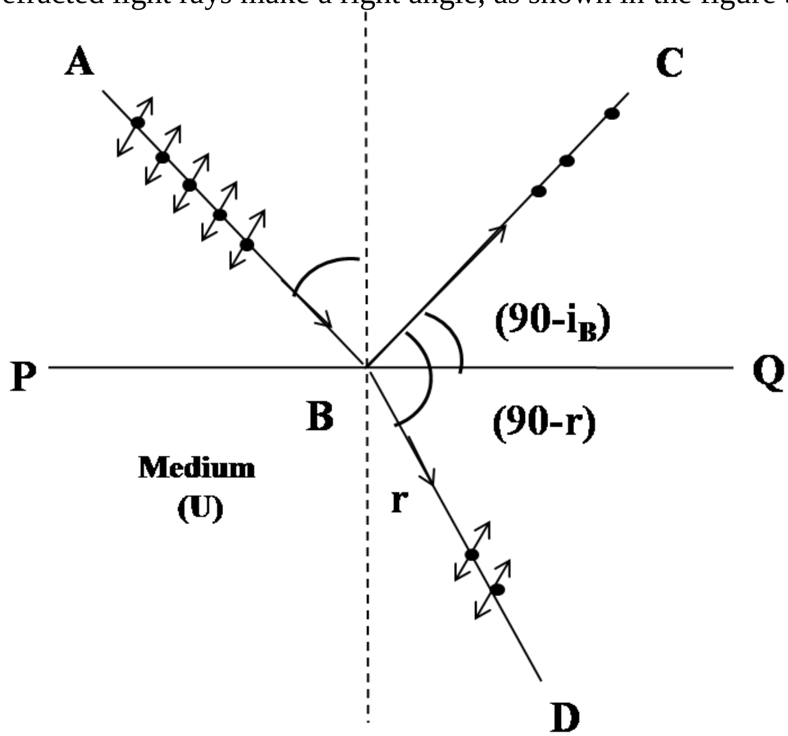
OR

(a) Demonstration of polarisation by a polaroid	2
(b) Showing polarisation by reflection at $\mu = tani_B$	3

(a)



1

	The components of electric vector associated with light wave, along the direction of aligned molecules of a polaroid, get absorbed. As a result after passing through it, the components perpendicular to the direction of aligned molecules will be obtained in the form of plane polarised light.	1	
	(b) When unpolarised light is incident on the boundary between two transparent media, the reflected light is polarised, with electric vector perpendicular to the plane of incidence when the reflected and refracted light rays make a right angle, as shown in the figure below.	½	
		1	
	Since , $\angle CBQ + \angle QBD = 90^0$ $(90 - \iota_B) + (90 - r) = 90^0$ $\iota_B + r = 90^0$ $r = 90 - \iota_B$ Using Snell's law,		
	$\mu = \frac{\sin \iota_B}{\sin r}$	½	
	$= \frac{\sin \iota_B}{\sin(90 - \iota_B)}$	½	
	$= \frac{\sin \iota_B}{\cos \iota_B}$		
	\ $\mu = tan\ \iota_B$	½	5

29.

(a) Description of an experiment/activity showing the polarity of emf induced — 2

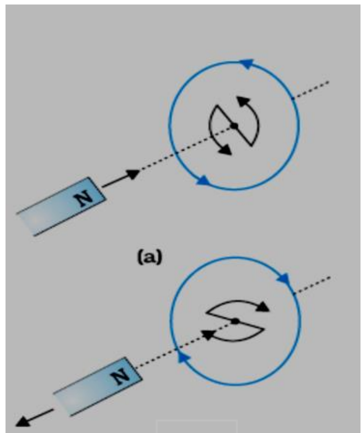
(b) Plots showing variation of

(i) Magnetic flux vs current — 1

(ii) Induced emf vs dI/dt — 1

(iii) Magnetic Potential energy vs current — 1

(a)



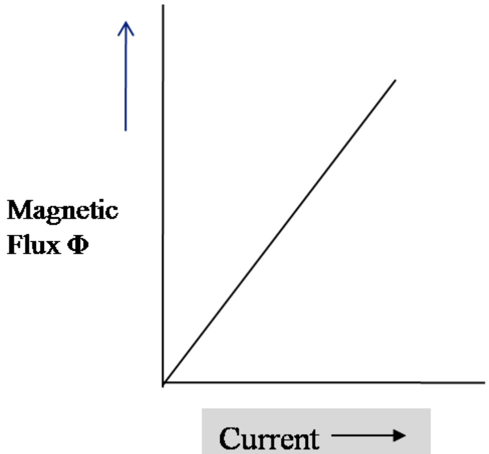
(b)

1

When a bar magnet is brought close to the coil (fig a), the approaching North Pole of the bar magnet increases the magnetic flux linked to it. This produces an induced emf which produces (or tends to produce, if the coil is open) an induced current in the anti-clockwise sense. The face of the coil, facing the approaching magnet, then has the same polarity as that of the approaching pole of the magnet. The induced current, therefore, is seen to oppose the change of magnetic flux that produces it. 1

[**Note:** Give full credit to the candidate who explains this activity by considering the motion of the magnet away from the coil(Fig b) and says that the induced current is in clockwise sense.]

(b) (i) Magnetic flux versus current



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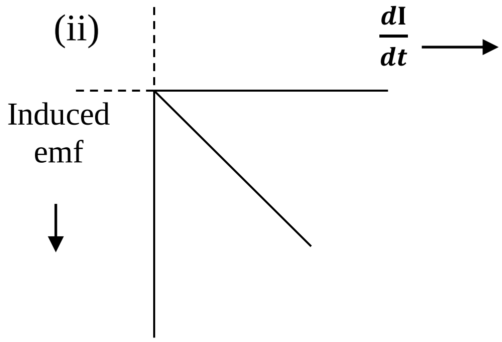
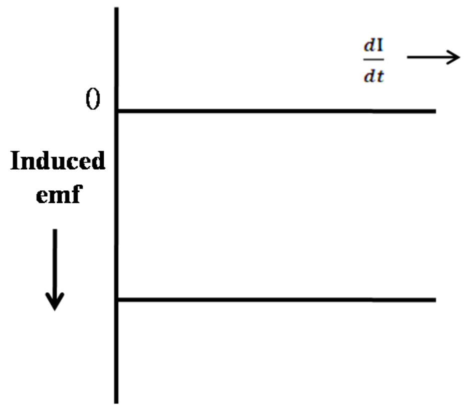
(ii)



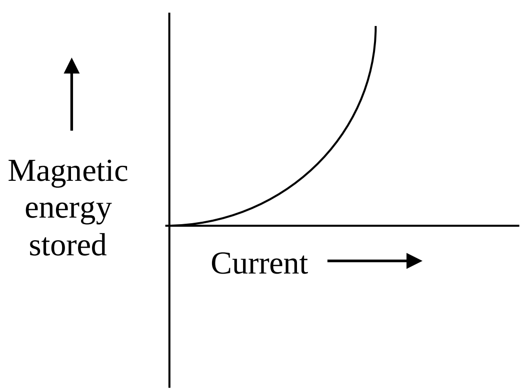
Alternatively ,



when I is increasing at constant value.

[**Note :** If the student draws induced emf vs $\frac{dI}{dt}$ graph of any shape, while keeping induced emf -ve , award this 1 mark.] 1

(iii) Magnetic energy stored

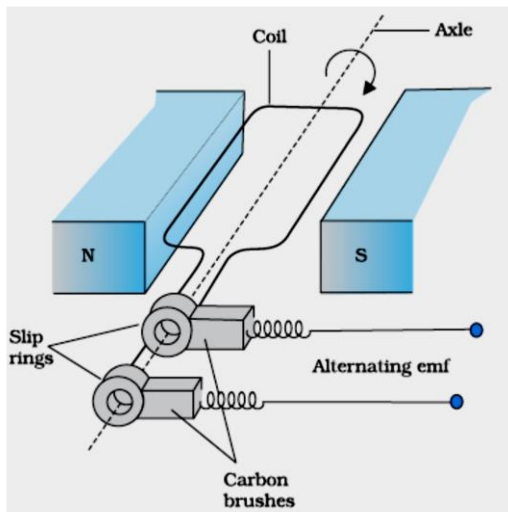


1

[Note: If a student writes only the mathematical formulae for these cases, award ½ mark for each case] 5

OR

(a) Schematic sketch of ac generator	1½
Working principle	1
Plot of variation of (i) Magnetic flux and (ii) alternating emf vs time	1+1
(b) Need of choke coil	½

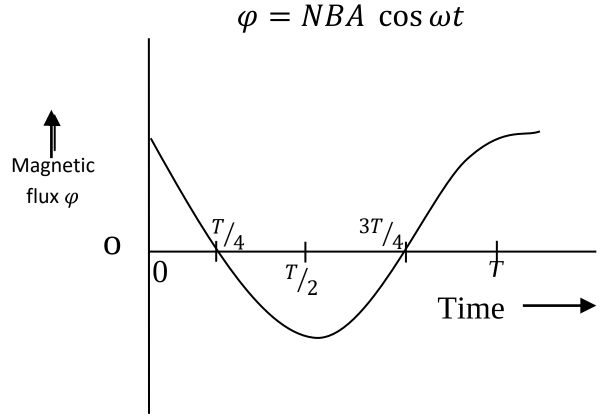


1½

It works on the process of electromagnetic induction, i.e. when a coil rotates continuously in a magnetic field, the effective area of the coil, linked (normally) with the magnetic field lines, changes continuously with time. This variation of magnetic flux with time results in the production of an (alternating) emf in the coil. 1

(1) Magnetic flux versus time

$$\varphi = NBA\ \cos \omega t$$



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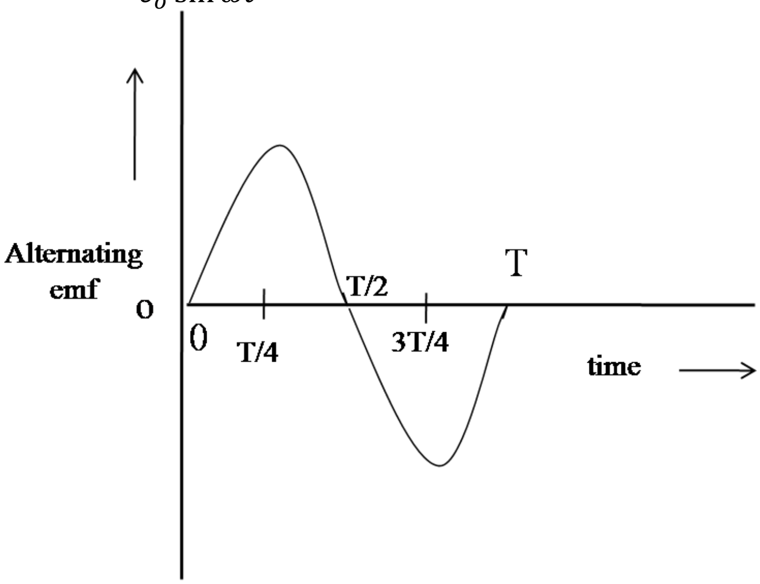
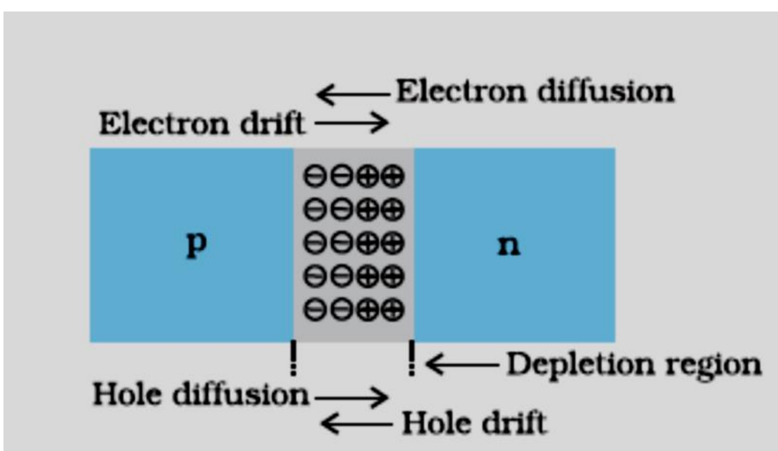
(2) Alternating emf versus time

e=NABω sin ωt

	$=e_o \sin \omega t$  [Note : Give credit of ½ mark for each case for writing the mathematical expressions without plotting the graphs.] (b)A choke coil reduces the volatge across the fluorescent tube without wastage of power. [**Note :** Award these ½ marks if the student gives any other significant reason.]	1 ½	5
30	(a) Processes involved in the formation of depletion region 2 (b) Circuit diagrams ½ + ½ V-I characteristics in forward biasing and reverse biasing ½ + ½ Use of the characteristics in rectification 1  Two processes involved during the formation of p-n junction are diffusion and drift . Due to the concentration gradient, across p and n sides of the junction , holes diffuse from p → n , and electrons from n→ p . This movement of charge carriers leaves behind ionised acceptors on the p-side and donors on the n- side of the junction . This space charge region on either	1 1	

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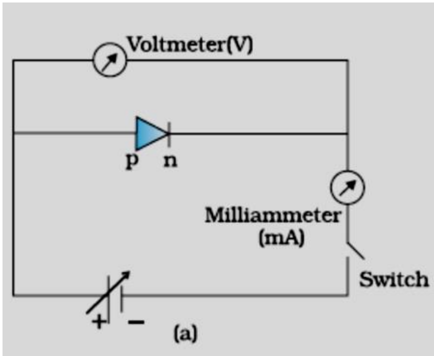
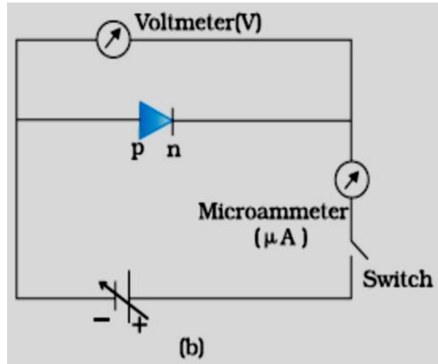
side of the junction , together , is known as depletion region.

(b)





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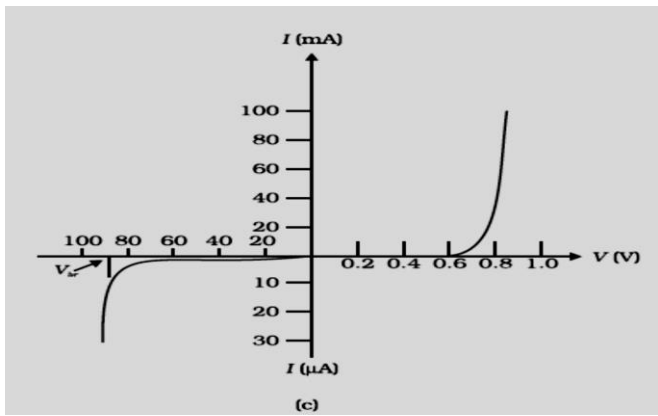
Using the circuit arrangements shown in fig (a) and fig (b) , we study the variation of current with applied voltage to obtain the V-I characteristics shown below.



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<td>From the V-I characteristics of a junction diode . it is clear that it allows the current to pass only when it is forward biased. So when an alternatively voltage is applied across the diode , current flows only during that part of the cycle when it is forward biased.</td>
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<td>5</td>
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OR

(a) Differences between three segments of a transistor ½ +½ + ½
(b) Transistor biasing in active state ½
(c) Circuit diagram of npn transistor in CE configuration for an amplifier and its brief description 1½ +1
Expression for the ac current gain ½
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<td>
(a) Emitter : It is of moderate size and heavily doped
Base : It is very thin and lightly doped
Collector : It is moderately doped and larger in size
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½
½</td>
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(b) Transistor is said to be in active state when its emitter-base junction is (suitably) forward biased and base-collector junction is (suitably) reverse biased.
[**Note** : In the active region, the emitter-base voltage lies between
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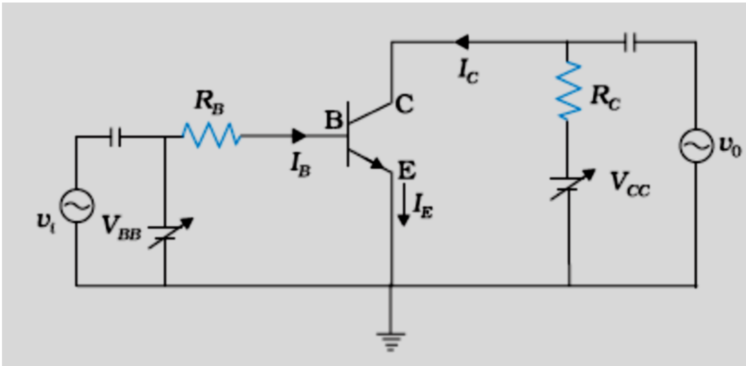
</tr>
</table>

Delhi	nearly 0.6 volt and 1.0 volt.] (c)  When a small sinusoidal voltage is superposed on the dc base bias , the base current will have sinusoidal variation superimposed on the value of I_B As a consequence , the collector current also will have sinusoidal variations , superimposed on the value of I_C , producing corresponding (amplified) changes in the value of V_0. ac current gain $\beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right)_{V_{CE}}$	1½ 1 ½	5