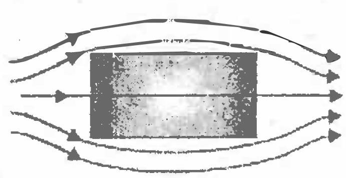
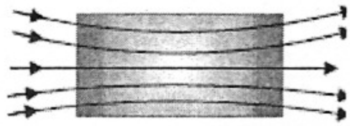
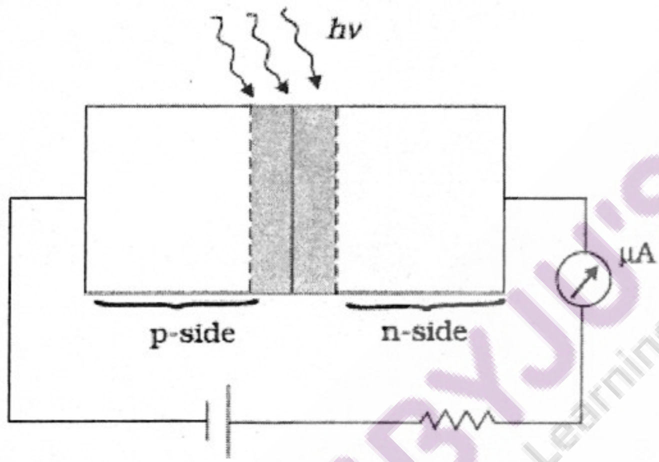
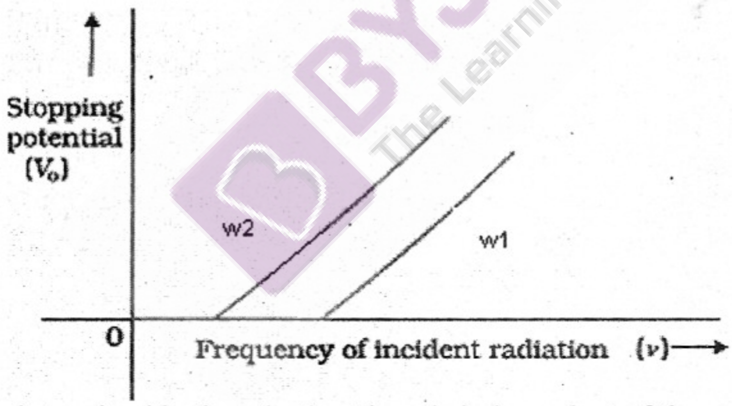
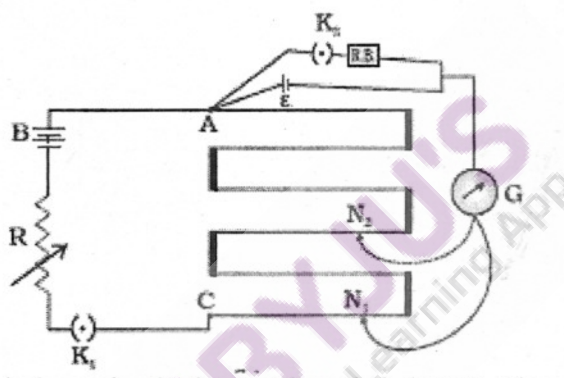
Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	When dipole is (i) parallel to field (ii) antiparallel to the field(or correct fig of two cases.)	½ +½	1
2.	γ -Rays.	1	1
3.	Line A.	1	1
4.	Electric flux $\phi = \frac{q}{\varepsilon_0}$	1	1
5.	1.45.	1	1
6.	$r \propto n^2 \therefore \frac{r_1}{r_2}$ = 4: 1(award ½ mark if student write only formula)	1	1
7.	$R_{effective} = 2R$.	1	1
8.	(i) refraction should take place from denser to rarer medium (ii) angle of incidence should be greater than the critical angle.	½ +½	1
9.	Function of repeater 2 A repeater, picks up the signal from the transmitter, amplifies and retransmits it to the receiver sometimes with a change in carrier frequency. Repeaters are used to extend the range of a communication system	2	2
10.	Two characteristics of material ½+½ Reason 1 (i) (a) High Coercivity (b) High Retentivity.(c) high permeability. (any two) (ii) Because of high permeability and low retentivity. **OR** Drawing of magnetic field lines ½+½ Property to distinguish the behaviour 1 (i) Diamagnetic material 	½+½ ½+½ ½	 2

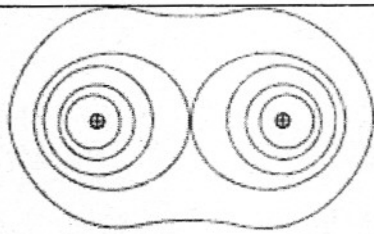
	(ii) Paramagnetic material 	½	
	Paramagnetic substance: permeability slightly greater than one/susceptibility small but positive. Diamagnetic substance: permeability very slightly less than one/susceptibility very small but negative.	½+½	2
11.	Circuit diagram 1 Explanation for measurement of light intensity 1		
	Circuit diagram of an illuminated photodiode: 	1	
	Explanation: The magnitude of the photocurrent depends on the intensity of incident light (photocurrent is proportional to incident light intensity). Thus photodiode can be used to measure light intensity.	1	2
12.	Effect of change in capacitance 1 Effect of change in frequency 1		
	(i) $X_c = \frac{1}{\omega C} = \frac{1}{2\pi\nu C}$	½	
	As C decreases, X_c will increase. Hence brightness will decrease.	½	
	(ii) $X_c = \frac{1}{\omega C} = \frac{1}{2\pi\nu C}$	½	
	As frequence (ν) decreases, X_c will increase. Hence brightness will decrease.	½	2
13.	Arrangement in ascending order of frequency 1 Two uses of any one ½+½		
	Radio waves<Microwaves< X-rays< Gamma rays	1	

	Two uses of any one of these.	½ +½	2
14.	Formula 1 Substitution and calculation 1 $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ $\frac{1}{12}=(\mu-1)\left(\frac{1}{10}-\frac{1}{-15}\right)\Rightarrow\mu=1.5$	1 ½ +½	2
15.	Formula 1 Calculation of wavelength ½ Name of the part of spectrum ½ $\lambda=\frac{h}{\sqrt{2meV}}$ $or\ \lambda=\frac{12.27}{\sqrt{V}}A^0$ $\lambda=\frac{12.27}{\sqrt{100}}A^0=1.227A^0$ This wavelength corresponds to the **X rays**.	1 ½ ½	2
16.	Reaction 1 Calculation of energy released 1 $X^{240}\rightarrow Y^{110}+Z^{130}+Q$ Energy released per nucleon = 8.5 MeV- 7.6MeV=0.9MeV Therefore energy released= 0.9 $\times$240=216MeV Alternatively: Energy released=[240 x 8.5 – 7.6 (110+130)] MeV= 216MeV	1 1	2

17.	Reason of predominance of bluish colour 1 Reason of violet colour 1 (a) As per Rayleigh's law (scattering α $1/\lambda^4$), lights of shorter wavelengths scattered more by the atmospheric particles. This results in a dominance of bluish colour in the scattered light. (b)In the visible spectrum, violet light having its shortest wavelength, has the highest refractive index. Hence it is deviated the most.	1 1	2
18.	Graph 1 Factors 1/2 +1/2  (i) slope is determined by h and e.(or slope is independent of the metal used) (ii) work function of the metal.	1 ½ ½	2
19.	Effect on (i) capacitance (ii) potential difference (iii) energy stored 1+1+1 (i) Capacitance $C=\frac{K\varepsilon_0 A}{d}$. Hence capacitance increases K times. (ii) Potential difference $V=\frac{V_0}{K}$, Hence potential difference decreases by a factor K.	½ +½ ½ +½	

	(iii) Energy stored $E=\frac{1}{2}CV^2$, As capacitance becomes K times & potential difference becomes 1/K times therefore energy stored becomes 1/K times. Alternatively: Energy stored = $Q^2/2C$. As capacitance increases by a factor K, the energy stored will decrease by the same factor.	½ +½	3
20.	Working principle ½ Circuit diagram 1 Determination of internal resistance 1½		
	Working principle: When constant current flows through a wire of uniform cross section then potential difference across the wire is directly proportional to the length. $V \propto l$	½	
		1	
	With key K_2 open, balance is obtained at length l_1 (AN_1). Then, $\varepsilon = \varphi\, l_1$ (φ= potential gradient) When key K_2 is closed, the cell sends a current (I) through the resistance box (R). If V is the terminal potential difference of the cell and balance is obtained at length l_2 (AN_2), $V = \varphi\, l_2$ $\varepsilon/V = l_1/l_2$	½	
	$But\ \frac{\varepsilon}{V}=\frac{I(R+r)}{IR}=\left(1+\frac{r}{R}\right)$ $\therefore \left(1+\frac{r}{R}\right)=\frac{l_1}{l_2}$	½	
	$\Rightarrow r=\frac{(l_1-l_2)}{l_2}R$	½	3
21.	Expression for magnetic moment 1 Reason 1 Expression 1		

	$\vec{m} = I\vec{A}$ $\quad (\vec{A} = area\, vector)$	1	
	(for students using the corrected current direction) Torque: The magnetic field due to the long current carrying wire is perpendicular to the plane of paper. Hence the force acting on each of the four sides is in the plane of the paper and the net torque is zero. Alternatively $\vec{m}$ is perpendicular to the plane of paper and $\vec{B}$ is perpendicular to the plane of paper. Hence $\vec{\tau} = \vec{m} \times \vec{B} = 0$	1	
	Force: Force on upper horizontal side= $\frac{Il\mu_0 I_1}{2\pi l} = \frac{I\mu_0 I_1}{2\pi} (attractive)$	½	
	Force on lower horizontal side= $\frac{Il\mu_0 I_1}{2\pi(2l)} = \frac{I\mu_0 I_1}{4\pi} (repulsive)$ The direction of these forces being opposite to each other therefore net force= $\frac{\mu_0 I_1 I}{4\pi} (attractive)$ (the net force on the two vertical sides is zero)	½	3
	(for students using the given current direction) Torque: The magnetic field due to the long current carrying wire is perpendicular to the plane of paper. Hence the force acting on each of the four sides is in the plane of the paper and the net torque is zero. Alternatively $\vec{m}$ is perpendicular to the plane of paper and $\vec{B}$ is perpendicular to the plane of paper. Hence $\vec{\tau} = \vec{m} \times \vec{B} = 0$ Force: Award this mark irrespective of result obtained or calculation done by the students.		
22.	Drawing of equipotential surface 1 Expression of potential energy 2 (a) Equipotential surfaces for a system of two identical positive charges:		



1

(b) Expression for the potential energy of a system of two point charges in external field:

Work done in bringing the charge q_1 from infinity to $\mathbf{r}_1$. ½

Work done = $q_1 V(\mathbf{r}_1)$

Work done in bringing the charge q_2 from infinity to $\mathbf{r}_2$.

work done against the external electric field= $= q_2 V(r_2)$ ½

Work done = work done against the external electric field + Work done on q_2 against the field due to q_1 ½

$$= q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$$

3

Potential energy of the system

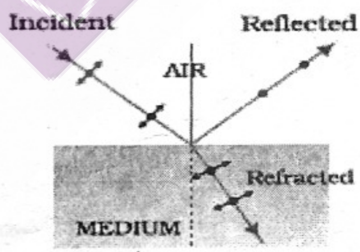
= the total work done in assembling the configuration

$$= q_1 V(r_1) + q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$$ ½

23.

Definition	1
Method of polarization	1
Expression of Brewster angle	1

In an unpolarised light the vibrations of electric field vector are in every plane perpendicular to the direction of propagation of light. 1



When unpolarised light is incident on the boundary between two transparent media, the reflected light is polarised with its electric vector perpendicular to the plane of incidence when the refracted and reflected rays make a right angle with each other. 1

Brewster angle: $\mu = \tan i_p$ 1

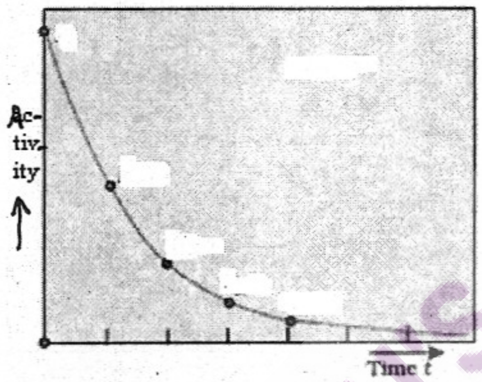
3

i) Definition	½
SI unit	½
ii) Graph	1
iii) Values for D	½+½

(i) The total decay rate (of a sample)at the given instant i.e. the number of radionuclides disintegrating per unit time is called the *activity* of that sample. ½

The SI unit for activity is becquerel (Bq). ½

(ii)Graph:

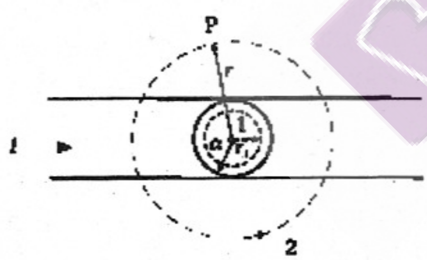


1

(iii) 72and 180 ½+½ 3

25.

Diagram	½
Calculation of magnetic field (i) inside (ii) outside	1½+1



½

(a) Consider the case $r < a$. The Amperian loop is a circle labelled 1.
For this loop, taking the radius of the circle to be r, $L = 2\pi r$

Now the current enclosed $I_e = I\left(\frac{\pi r^2}{\pi a^2}\right) = \frac{Ir^2}{a^2}$ ½

Using Ampere's law,

$$B(2\pi r) = \frac{\mu_0 I r^2}{a^2} \Rightarrow B = \frac{\mu_0 I r}{2\pi a^2}$$ 1

(b) Consider the case $r > a$. The Amperian loop, labelled 2, is a circle concentric with the cross-section. For this loop, $L = 2\pi r$

Ie = Current enclosed by the loop = I ½

$B(2\pi r) = \mu_0 I$

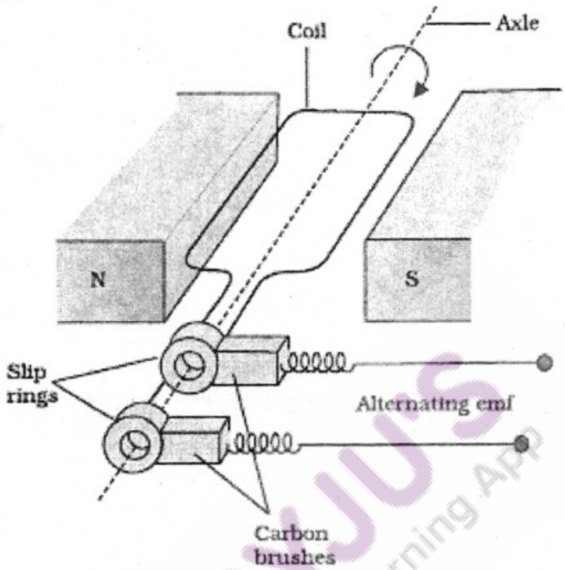
	$\Rightarrow B=\dfrac{\mu_0 I}{2\pi r}$	½	3
	OR		
	Principle 1 Two reasons ½+½ Two factors ½+½		
	Principle: Torque acts on a current carrying coil suspended in magnetic field. ($\tau = NIAB\sin\theta$)	1	
	Two reasons: (i) Galvanometer is a very sensitive device, it gives a full-scale deflection for a current of the order of a few μA. (ii) For measuring currents, the galvanometer has to be connected in series, and as it has a finite resistance, this will change the value of the current in the circuit.	½+½	
	Two factors: The current sensitivity of a moving coil galvanometer can be increased by (i) increasing the number of turns (ii) increasing area of the loop (iii) increasing magnetic field (iv) decreasing the torsional constant of the suspension wire. (Any two)	½+½	3
26.	Space wave propagation 1 Two examples ½+½ Calculation of maximum distance 1		
	When waves travel in space in a straight line from the transmitting antenna to the receiving antenna, this mode of propagation is called the space wave propagation.	1	
	Examples: Television broadcast, microwave links , satellite communication (any two)	½+½	
	$d=\sqrt{2hR}=\sqrt{2\times 80\times 6.4\times 10^6}$ = 32 km	½+½	3
27.	Determination of values of R and S 1½+1½		
	$\dfrac{R}{S}=\dfrac{40}{60}=\dfrac{2}{3}$	½	
	$\dfrac{R(12+S)}{12S}=\dfrac{50}{50}=1$	1½	

$\Rightarrow R = 4\Omega \;\; \& \;\; S = 6\Omega$ ½+ ½ 3

28.

Description of basic elements with Labelled diagram	2
Underlying principle	1
Production of emf in loop	1½
Expression	½

Labelled diagram:

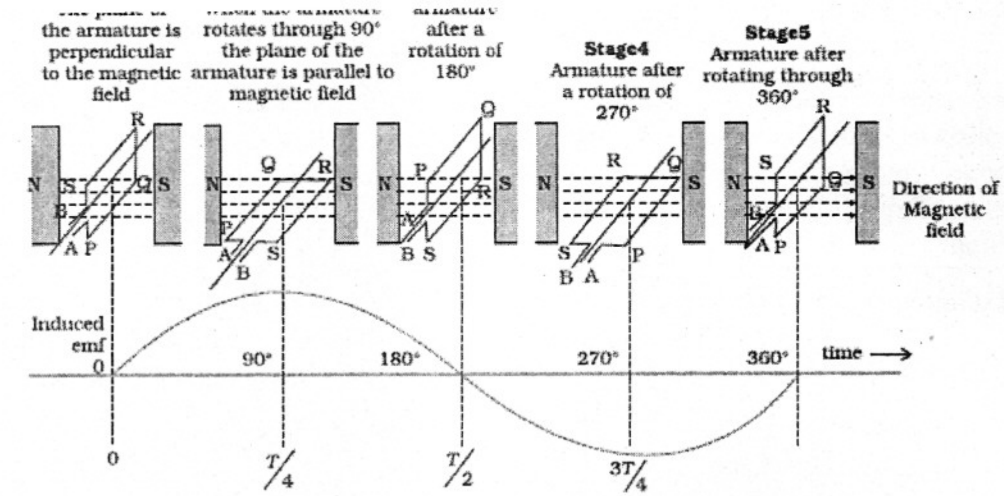


1

It consists of a coil mounted on a rotor shaft. The axis of rotation of the coil is perpendicular to the direction of the magnetic field. The coil (called armature) is mechanically rotated in the uniform magnetic field by some external means. The ends of the coil are connected to an external circuit by means of slip rings and brushes. 1

Underlying principle : As the coil rotates in a magnetic field **B**, the effective area of the loop (the face perpendicular to the field) which is A cos θ, where θ is the angle between area **(A)** and magnetic field **(B)** changes continuously. Hence magnetic flux linked with the coil keeps on changing with time and an induced emf is produced. 1

Production of emf in loop:



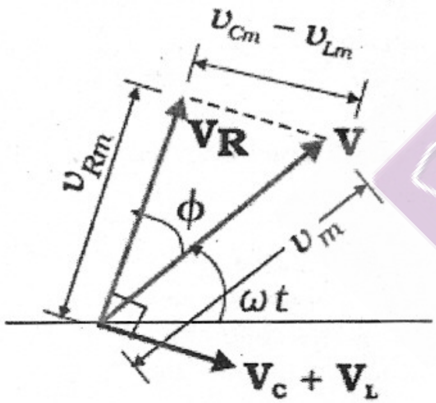
1

½

The instantaneous value of the emf is $\varepsilon = NBA\omega \sin\omega t$ ½ 5

OR

Derivation of Expression for instantaneous current	3
Obtaining condition of resonance	½
Definition of power factor	½
Condition of maximum and minimum	½+ ½



½

From the phasor diagram, we have

$$v_m^2 = v_{Rm}^2 + \left(v_{Cm} - v_{Lm}\right)^2$$ ½

$$= i_m^2\left[R^2 + (X_C - X_L)^2\right]$$

$$i_m = \frac{v_m}{\sqrt{R^2 + (X_C - X_L)^2}}$$ ½

The current is seen to lead the voltage by an angle Φ ,where

$$\tan\phi = \frac{X_C - X_L}{R},$$ ½

hence $i = i_m \sin\left(\omega t + \phi\right)$ ½

(Accept the analytical approach also)

Where

$$i_m = \frac{v_m}{\sqrt{R^2 + (X_C - X_L)^2}} \quad \text{and} \quad \phi = \tan^{-1}\left[\frac{\left(\omega L \sim \frac{1}{\omega C}\right)}{R}\right]$$ ½

Condition of resonance: $\omega L \sim \frac{1}{\omega C} = 0 \;\; or \;\; \omega L = \frac{1}{\omega C} \;\; or \;\; \omega = \frac{1}{\sqrt{LC}}$ ½

Power factor equals the cosine of the phase angle i.e power factor ½

$\cos\phi = \frac{R}{Z}$

Power factor is maximum when $\cos\phi = 1$ i.e when R=Z or $X_L = X_C$. ½

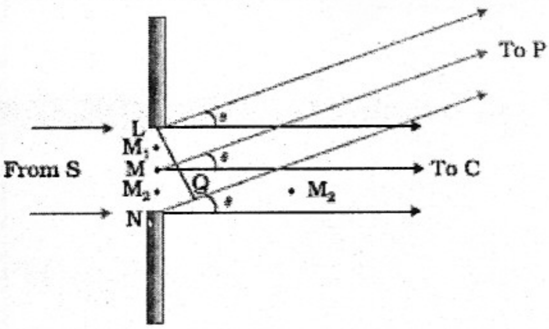
Power factor is minimum when $\cos\phi = 0$ i.e when R=0 . ½ 5

29.

Statement of Huygen's principle	1
Application to diffraction pattern	2
Plot	1
Explanation	1

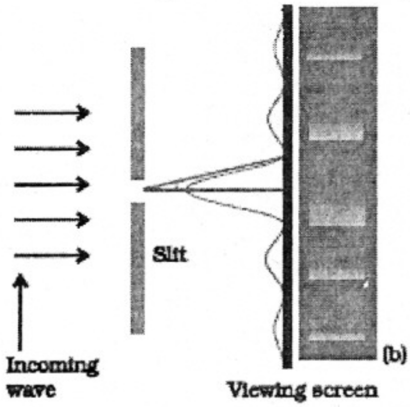
Huygens principle: Each point of wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. The common tangent/ forward envelope, to all these secondary wavelets gives the new wavefront at later time. 1

Application to diffraction pattern: All the points of incoming wavefront (parallel to the plane of slit)are in phase with plane of slit. However the contribution of the secondary wavelets from different points, at any point, on the observation screen have phase differences dependent on the corresponding path differences. Total contribution, at any point, may add up to give a maxima or minima dependent on the phase differences. 1



1

Plot of intensity distribution and explanation:



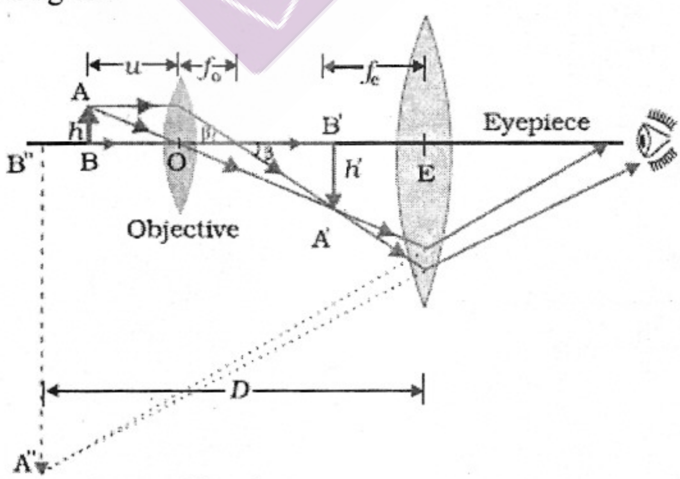
1

The central point is a maxima as the contribution of all secondary wavelet pairs are in phase here. Consider next a point on the screen where an angle $\theta = 3\lambda/2a$. Divide the slit into three equal parts. Here the first two-thirds of the slit can be divided into two halves which have a $\lambda/2$ path difference. The contributions of these two halves cancel. Only the remaining one-third of the slit contributes to the intensity at a point between the two minima. Hence, this will be much weaker than the central maximum (where the entire slit contributes in phase). We can similarly show that there are maxima at $\theta = (n + 1/2)\lambda/a$ with $n = 2, 3$, etc. These become weaker with increasing n, since only one-fifth, one-seventh, etc., of the slit contributes in these cases. 1

OR

Labelled Ray diagram	1
Derivation	2
Estmation of magnifying power	2

Labeled Ray diagram:



1

Expression for total magnification:

Magnification due to the **objective**,

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

Magnification m_e, due to eyepiece, (when the final image is formed at the near point)

$m_e = \left(1 + \frac{D}{f_e}\right)$	½
Total magnification, $m = m_0 m_e \simeq \frac{L}{f_0}\left(1 + \frac{D}{f_e}\right)$	1
Estimation of magnifying power: $Given: u_0 = -1.5cm; f_0 = 1.25cm;$ $we\ have$ $\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$	½
$\frac{1}{1.25} = \frac{1}{v_0} - \frac{1}{-1.5} \quad \Rightarrow v_0 = 7.5cm$	½
$m \simeq \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$	½
$= \frac{7.5}{-1.5}\left(1 + \frac{25}{5}\right) \Rightarrow m = -30$	½

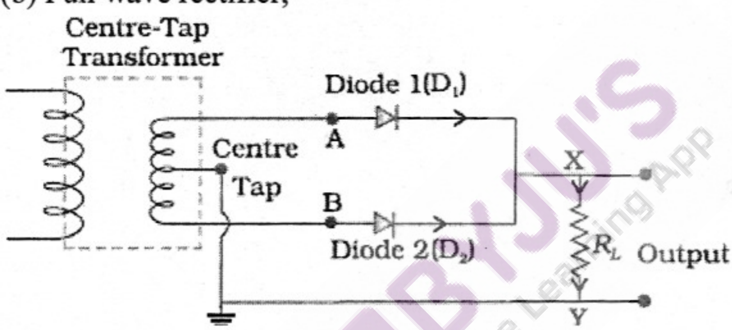
30.

Explanation of depletion layer and potential barrier	1+1
Name of device and circuit diagram	½+1
Identification of logic gate and truth table	½+1

(a) ***depletion region:*** Due to the concentration gradient across p-, and n-sides, holes diffuse from p-side to n-side (p → n) and electrons diffuse from n-side to p-side (n → p). As the electrons diffuse from n → p, a layer of positive charge (or positive space-charge region) is developed on n-side of the junction. Similarly as the holes diffuse, a layer of negative charge (or negative space-charge region) is developed on the p-side of the junction. This space-charge region on either side of the junction together is known as *depletion region.* 1

Barrier potential:
The loss of electrons from the n-region and the gain of electron by the p-region causes a difference of potential across the junction of the two regions. The polarity of this potential is such as to oppose further flow of carriers. 1

(b) Full wave rectifier, ½



1

½

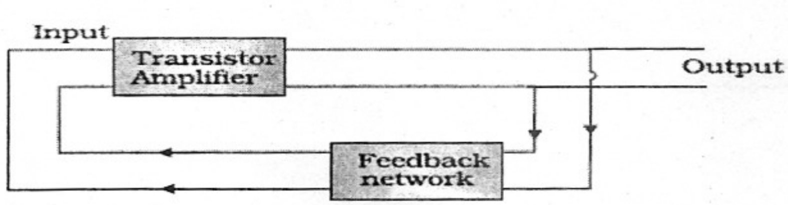
(c) AND Gate,

1

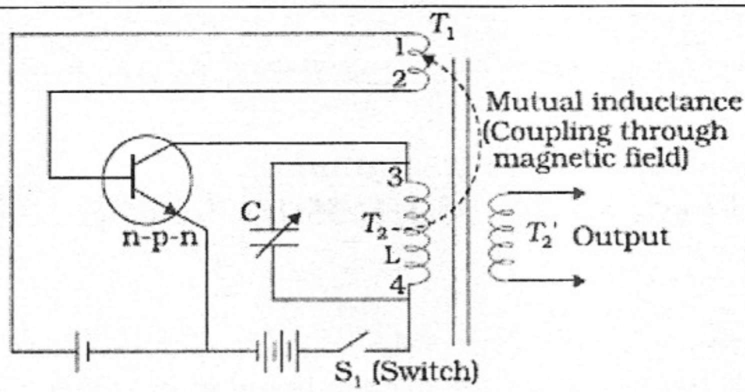
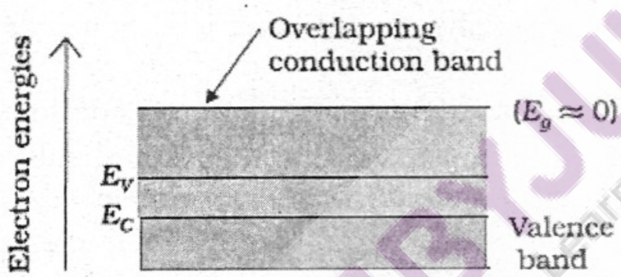
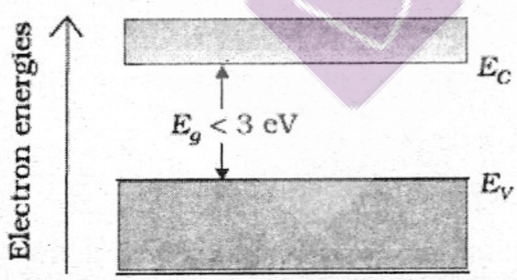
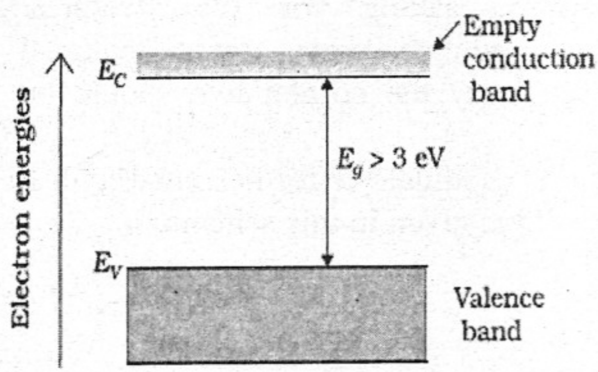
Input		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

OR

Circuit diagram	1
Working principle	2½
Distinction	1½



1

		1	
	Working principle: In an oscillator, we get ac output without any external input signal. i.e. the output in an oscillator is *self-sustained*. To attain this, a portion of the output powerof an amplifier, is returned back (fedback) to the input *in phase* with the starting power.	1½	
	The energy band diagrams, showing the distinction between a conductor, a semiconductor and an insulator are shown below:		
		½	
		½	
		½	5