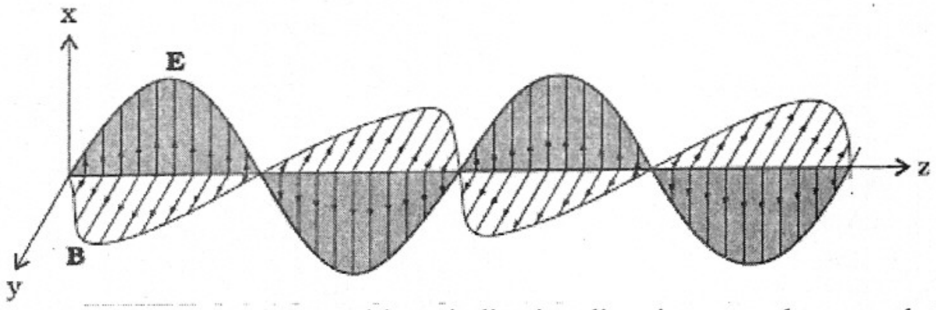
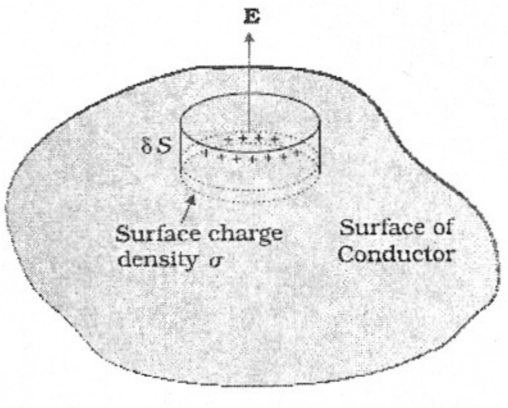
Senior School Certificate Examination
Marking Scheme- Physics (Code 55/1, 55/2, 55/3)

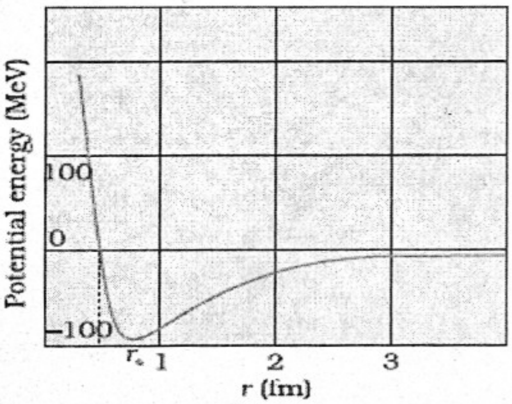
General Instructions

1. The Marking Scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicative. If a student has given any other answer, which is different from the one given in the Marking Scheme, but conveys the meaning correctly, such answers should be given full weightage.
2. Evaluation is to be done as per instructions provided in the marking scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed.
3. If a question has parts, please award marks in the right hand side for each part. Marks awarded for different part of the question should then be totalled up and written in the left hand margin and circled.
4. If a question does not have any parts, marks are be awarded in the left hand margin only.
5. If a candidate has attempted an extra question, marks obtained in the question attempted first should be retained and the other answer should be scored out.
6. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.
7. Deduct ½ mark for writing wrong units, or missing units, in the final answer to numerical problems.
8. Formula can be taken as implied from the calculations even if not explicitly written.
9. In short answer type questions, asking for two features/ characteristics/ properties, if a candidate writes three features/ characteristics/ properties or more, only the correct two should be evaluated.
10. Full marks should be awarded to a candidate if his/her answer in a numerical problem, is close to the value given in this scheme.

Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	Electric potential, scalar	½ + ½	1
2.	Negative Z direction ($-\hat{k}$)	1	1
3.	Magnetic flux linked through a coil when current flowing through is unity./ induced emf in a coil when current is changing at the unit rate. SI unit is henry.	½ + ½	1
4.	$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$ $as\ f_1=-f_2$ (award 1mark even if the student directly writes $f=\infty$) $\therefore f \Rightarrow \infty$	½ + ½	1
5.	Minimum energy required to free an electron from the ground state. Its value for hydrogen atom is 13.6eV.	½ + ½	1
6.	$I=n_X eAv_X=n_Y eAv_Y$ $\Rightarrow \frac{v_X}{v_Y}=\frac{n_Y}{n_X}=\frac{n_Y}{2n_Y}=\frac{1}{2}$	½ + ½	1
7.	X Rays. Any one application	½ + ½	1
8.	No, because energy depends on amplitude and frequency only./(or Energy does not depend on speed.)	½ + ½	1
9.	Derivation 2 $Current\ due\ to\ revolution\ of\ electron\ I=\frac{e}{T}$ & $T=\frac{2\pi r}{v}$ $\therefore\ I = ev/2\pi r.$ Magnetic moment $\mu_l = I\pi r^2 = evr/2.$	½ ½ 1	2
10.	(a) surface charge density on inner and outer surface ½ + ½ (b) expression for electric field 1 (a) (i) surface charge density on inner surface $\sigma=\frac{-q}{4\pi r_1^2}$ (ii) surface charge density on outer surface $\sigma=\frac{Q+q}{4\pi r_2^2}$	 ½ ½	

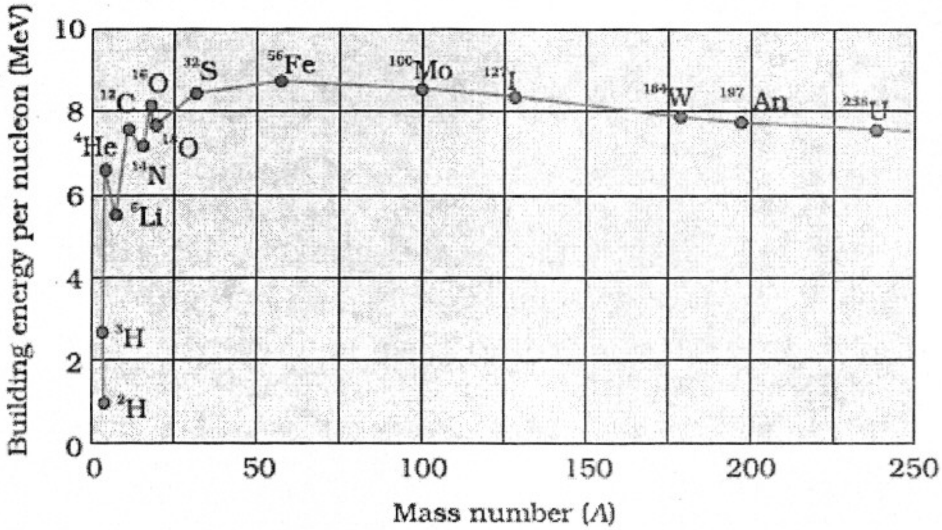
	.Electric field at(an outside) point distant x from centre of the shell $E = \dfrac{Q+q}{4\pi\varepsilon_0 x^2}$	1	2
11.	Sketch of plane em wave 1 Directions of electric and magnetic fields 1  (Note: If diagram is drawn without indicating direction, award one mark. If only directions are written without any diagram , award one mark)	1+1	2
12.	Derivation 2  $E\delta S = \dfrac{\sigma \delta S}{\varepsilon_0}$ $\Rightarrow E = \dfrac{\sigma}{\varepsilon_0}$ *In vector form* $\vec{E} = \dfrac{\sigma \hat{n}}{\varepsilon_0}$	½ ½ ½ ½	

	Alternatively: Also accept the derivation of electric field on the surface of spherical shell. $\oint_s \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0}$ $E \times 4\pi r^2 = \frac{q}{\varepsilon_0}$ $E = \frac{q}{4\pi r^2 \varepsilon_0}$ $\Rightarrow \vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$	½ ½ 1	2
13.	Comparision of induced emf 1 Comparision of currents 1 (i) Emf produced in two coils is same because it depends only on rate of change of magnetic flux which is same for both the loops. (ii) Current in copper loop is more because resistivity/resistance of copper is less. (I=V/R) .	1 1	2
14.	Formula ½ Substitution and calculation 1½ $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mqV}}$ $As \quad m_\alpha = 4m_p \quad and \quad q_\alpha = 2q_p$ $\frac{\lambda_\alpha}{\lambda_p} = \frac{\sqrt{2m_p q_p}}{\sqrt{2m_\alpha q_\alpha}} = \frac{\sqrt{m_p q_p}}{\sqrt{4m_p 2q_p}} = \frac{\sqrt{1}}{\sqrt{8}} = \frac{1}{2\sqrt{2}}$	½ ½ 1	2
15.	Two factors 1 Calculation of peak voltage of modulating signal 1 (i)Appropriate size of the antenna or aerial (ii)Effective power radiated by an antenna (iii) To avoid Mixing up of signals from different transmitters (Any Two)	½+½	

	Modulation Index $\mu = \dfrac{a_m}{a_c}$ $\therefore\ 0.75 = \dfrac{a_m}{12V}$ $\Rightarrow a_m = 9V$	½ ½	2
16.	Einstein's photoelectric equation: ½ Three salient features ½ each Einstein's photoelectric equation: $K_{max} = h\nu - \varphi_0 \quad = h(\nu - \nu_0)$ (i) K_{max} of electrons depends linearly on ν. (ii) K_{max} is independent of intensity of radiation. (iii) There exists a threshold frequency ν_0 (= φ_0/h) for the metal surface, below which no photoelectric emission is possible. (No matter how intense the incident radiation may be or how long it falls on the surface.) (iii) For $\nu > \nu_0$, photoelectric current is proportional to intensity of incident radiations. (Any three)	½ ½ ½ ½	2
17.	Plot of potential energy of pair of nucleon 1 Two important conclusions ½ +½  Two important conclusions: (i)The nuclear force between two nucleons falls rapidly to zero at distances more than a few femtometres. (ii) The nuclear force is attractive for $r>r_0$. (iii) The nuclear force is repulsive for $r<r_0$. (iv)The nuclear force is a strong force. (any two)	1 ½+½	2

OR

Plot of Binding Energy per nucleon	1
Explanation	1



1

(ii) The constancy of the binding energy in the range $30 < A < 170$ is a consequence of the fact that the nuclear force is short-ranged.
If a nucleon can have a maximum of p neighbours within the range of nuclear force, its binding energy would be proportional to p. If we increase A by adding nucleons they will not change the binding energy of a nucleon inside. Since most of the nucleons in a large nucleus reside inside it and not on the surface, the change in binding energy per nucleon would be small. Hence the binding energy per nucleon is a constant.[saturation property of nuclear force.] 1 2

18.

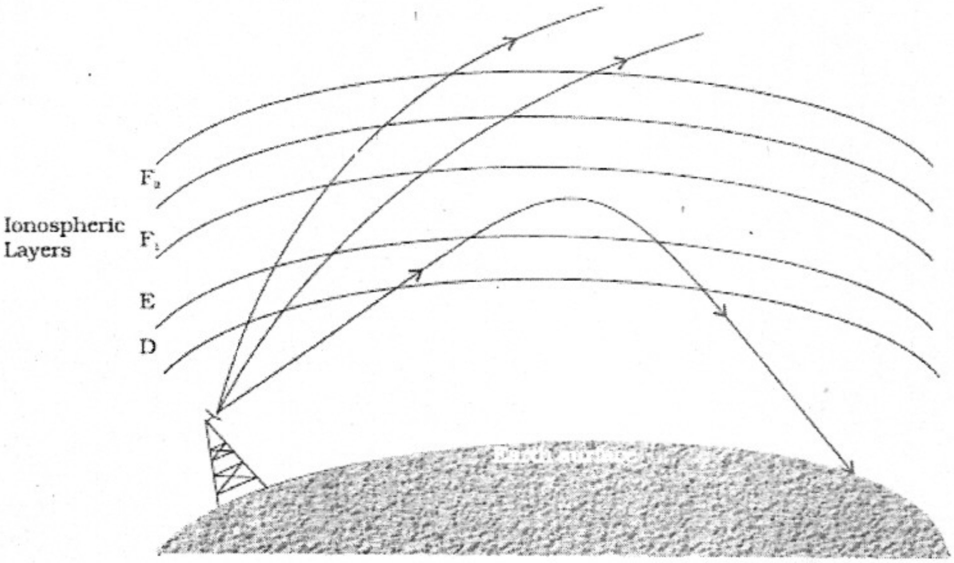
Identification of gates P and Q	½ +½
Output at X for the given inputs	½+ ½

(i) P : NAND GATE ½

Q: OR GATE ½

(ii) Inputs A=0 & B=0 then output X=1 ½

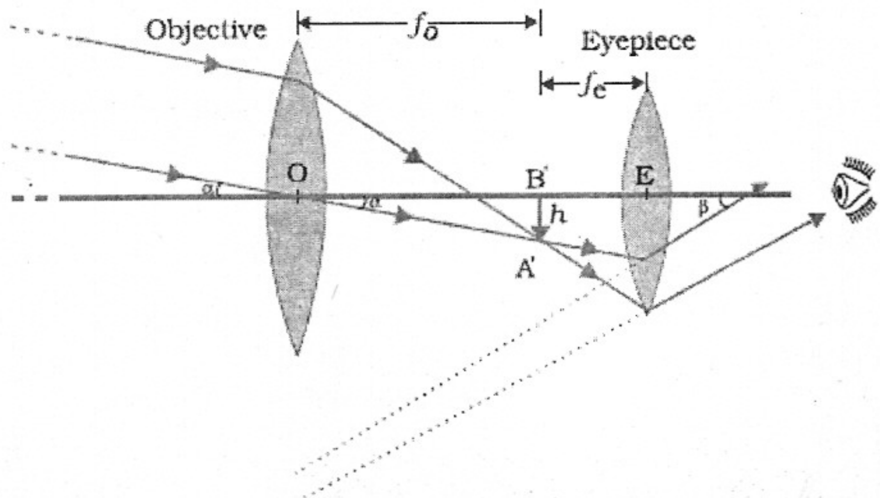
Inputs A=1 & B=1 then output X=1 ½ 2

19.	Name of Mode of Propagation ½ Diagram+ explanation ½+1 Reason for upper limit 1		
	Sky wave propagation/ Ionospheric reflection	½	
		½	
	E M waves of these frequencies are reflected, by the ionosphere towards the earth.	1	
	Electromagnetic waves of frequencies higher than 30 MHz penetrate the ionosphere and escape.	1	3
20.	Two factors : ½ +½ Calculation of internal resistance: 2		
	(i) Nature of electrolyte. (ii) Temperature of electrolyte. (iii) Area of electrode (iv) Concentration of electrolyte. (v) Distance of separation between the electrodes (any Two)	½ ½	

	Calculation of internal resistance:		
	Given		
	$E = 2.2V; R = 5\Omega \, and \, V = 1.8V$	½	
	$\therefore I = \frac{V}{R} = \frac{1.8}{5} = 0.36A$	½	
	$Now \quad V = E - Ir$	½+½	
	$\Rightarrow r = \frac{E-V}{I} = \frac{2.2-1.8}{0.36} = \frac{10}{9} \simeq 1.1\Omega$		
	Alternatively:	1	
	$r = \left(\frac{E-V}{V}\right) \times R$	½	
	$= \left(\frac{2.2-1.8}{1.8}\right) \times 5$	½	3
	$\simeq 1.1\Omega$		
21.	Calculation of (a) Equivalent capacitance 1½ (b) Charge on each capacitor 1½		
	(a)		
	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$	½	
	$\frac{1}{C} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} = \frac{1}{4}$		
	$\Rightarrow C = 4\mu F \; or \; simply \, C_s = \frac{C}{3} = \frac{12}{3}\mu F = 4\mu F$	½	
	$Equivalent \, Capaci\tan ce$		
	$C_{eq} = C + C_4 = 12 + 4 = 16\mu F$	½	
	(b) Calculation of charge on each capacitor:		
	Charge on capacitor C_4		
	$Q_4 = C_4V = 12 \times 500\mu C = 6000\mu C = 6 \times 10^{-3}C$	½	
	Charge on capacitors C_1, C_2 & C_3		
	$Q_{123} = 4\mu F \times 500V = 2 \times 10^{-3}C$	½+½	3

22.

Labelled ray diagram in normal adjustment	½+1
Brief working	½
Calculation of Magnifying power	1



1½

(Deduct ½ mark if labeling is not done or arrows are not shown)

Light from a distant object enters the objective and a real image is formed in the tube at its second focal point. The eyepiece magnifies this image producing a final inverted image at infinity. ½

Calculation of Magnifying power:

$Given: power\ of\ eyepiece = 10\,D$

$power\ of\ objective\, 1\,D$

$Magnifying\ power\ in\, normal\ adjustment: m = \frac{f_0}{f_e} = \frac{p_e}{p_0} = \frac{10}{1} = 10$ ½ +½

OR

Labelled ray diagram of compound microscope	½+1
Working in brief	½
Reason	1

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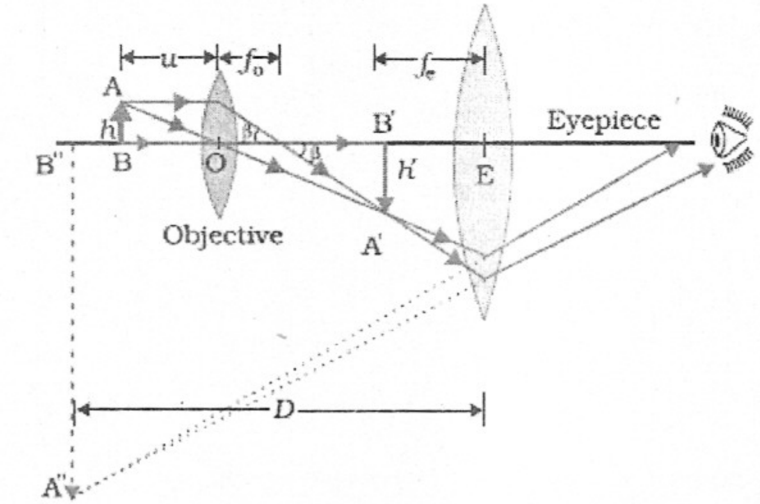

(Deduct ½ mark if labeling is not done or arrows are not shown)

The *objective* forms a real, inverted, magnified image of the object. This serves as the object for the second lens, the *eyepiece*, which functions essentially like a simple microscope or magnifier, produces the final image, which is enlarged and virtual.

To achieve a large magnification of a *small* object; both the objective and eyepiece should have small focal lengths.
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½

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Calculation of distance of second bright and dark fringe	2
Effect on fringe pattern	1

Distance of nth maxima from central maxima

$$x_n = \frac{n\lambda D}{d}$$

Given : n=2 ,d=0.15 mm ,λ =450 nm and D=1.0 m

$$x_2 = \frac{2\times 450\times 10^{-9}\times 1.0}{0.15\times 10^{-3}} = 6\times 10^{-3}\,m = 6\,mm$$

Distance of nth minima from central maxima

$$y_2 = \frac{(2n-1)\lambda D}{2d} = \frac{(2\times 2-1)450\times 10^{-9}\times 1}{2\times 0.15\times 10^{-3}} = 4.5\times 10^{-3}\,m = 4.5\,mm$$

When the screen is moved away from the slits fringes become farther apart. (fringe width α distance of screen.)
</td>
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½

½+½

1</td>
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Statement of Kirchoff's rules	½+1
Equations for currents	½+½+½

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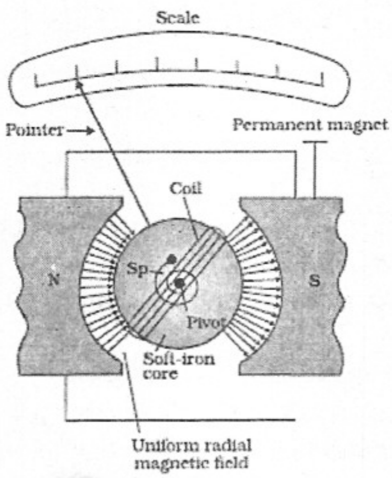
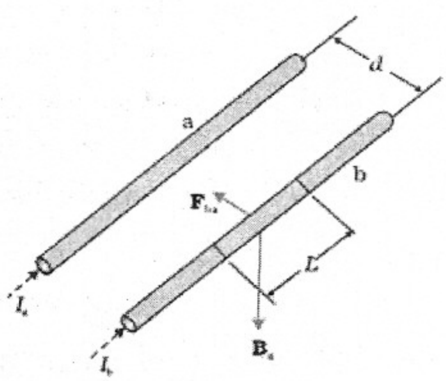
	(a) Junction rule: At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction . (b) Loop rule: The algebraic sum of changes in potential, around any closed loop, involving resistors and cells in the loop, is zero Expressions for the currents I_1,I_2 and I_3 using given loop. (i) $I_3 = I_2 + I_1$ (ii) $4I_1 - 3I_2 + 1 = 0$ (iii) $3I_2 + 2I_3 - 3 = 0$ (Accept the equations if all the sign of the terms are taken in opposite order.)	½ 1 ½ ½ ½	3
25.	Decay process 1 Derivation of average life 1 Relationship with half life 1 β^- decay process $^{32}_{15}P \rightarrow {}^{32}_{16}S + e^- + \bar{\nu}$ or $^{32}_{15}P \rightarrow {}^{32}_{16}X + {}_{-1}e^0 + \bar{\nu}$ Derivation of average life: $\tau = \frac{\lambda N_0 \int_0^\infty t e^{-\lambda t} dt}{N_0} = \lambda \int_0^\infty t e^{-\lambda t} dt$ $\Rightarrow \quad \tau = 1/\lambda$ Relation of average life with half life: $T_{1/2} = \frac{\ln 2}{\lambda} = \tau \ln 2$	1 ½ ½ 1	3
26.	Explanation of polarization of unpolarised light 1 Expression for the intensity 1 Orientation corresponding to minimum and maximum intensity 1 A polaroid consists of long chain molecules aligned in a particular direction. The electric vectors (associated with the propagating light wave) along the direction of the aligned molecules get absorbed. Thus, if an unpolarised light wave is incident on such a polaroid then the light wave will get linearly polarised with the electric vector oscillating along a direction perpendicular to the aligned molecules. (Give full credit if student explains it through a diagram) **Expression for the intensity transmitted through second Polaroid.** $I = (I_0 \cos^2\theta)\cos^2(90^0 - \theta) = I_0(\cos\theta \sin\theta)^2 = I_0 \sin^2 2\theta / 4$ where I_0 is the intensity of the polarized light after passing through the first	1 1	

	polaroid.		
	Intensity will be maximum when $\theta = 45^0$ and minimum when $\theta = 0^0$	½+½	3
27.	Calculation of focal length 2½ Nature of lens ½		
	$for\ real\ image\ m = -2 = \frac{v}{u} \Rightarrow v = -2u$	½	
	$given \lvert u \rvert + \lvert v \rvert = 90\,cm$		
	$\Rightarrow 3\lvert u \rvert = 90cm$	½	
	$\Rightarrow \lvert u \rvert = 30\,cm$		
	We have for a lens	½	
	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$	½	
	$\therefore \frac{1}{f} = \frac{1}{60} - \frac{1}{-30}$		
	$\frac{1}{f} = \frac{1}{20}$		
	$\Rightarrow f = 20\,cm$	½	
	Nature of lens : Convex / Converging	½	3
28.	(a) Diagram ,principle and working 1+1+1 (b) Importance and production of radial magnetic field ½+½ (c) Reason ½+½		
		1	



	Principle: Torque acts on the current carrying loop when placed in magnetic field. ($\tau = NI\,AB \sin\theta$.)	1	
	Working: The magnetic torque tends to rotate the coil. A spring provides a counter torque that balances the magnetic torque; resulting in a steady angular deflection. The deflection is indicated on the scale by a pointer attached to the spring.	1	
	Importance and production of radial magnetic field: In a radial magnetic field magnetic torque remains maximum for all positions of the coils. It is produced due to cylindrical pole pieces and soft iron core.	½+½	
	Reason: Voltmeter: this ensures that a very low current passes through the voltmeter and hence does not change (much) the original potential difference to be measured.	½	
	Ammeter: this ensures that the total resistance of the circuit does not change much and the current flowing remains (almost) at its original value.	½	5
	OR		
	(a) Derivation of expression of force — 2½ (b) Definition of SI unit of current — 1 (c) Calculation of force (magnitude and direction) — 1+½		
	(a)  	½	
	Two long parallel conductors 'a' and 'b' are separated by a distance d and carry (parallel) currents I_a and I_b, respectively. The conductor 'a' produces, the same magnetic field $\mathbf{B}_a$ at all points along the conductor 'b'. $B_a = \frac{\mu_0 I_a}{2\pi d}$	1	
	$\mathbf{F}_{ba}$, is the force on a segment L of 'b' due to 'a'. The magnitude of this force is given by	½	
	$F_{ba} = I_b L B_a$ $= \frac{\mu_0 I_a I_b}{2\pi d} L$	½	
	(b) The *ampere* is the value of that steady current which, when maintained		

in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newtons per metre of length. 1

(c) Magnetic field due to the straight wire AB at a perpendicular distance d from it. ½

$$B = \frac{\mu_0 I}{2\pi d}$$

Therefore force on proton moving with velocity 'v' perpendicular to B, is 1

$$f = qvB = \frac{\mu_0 I q v}{2\pi d}$$ ½

Direction: towards right 5

29.

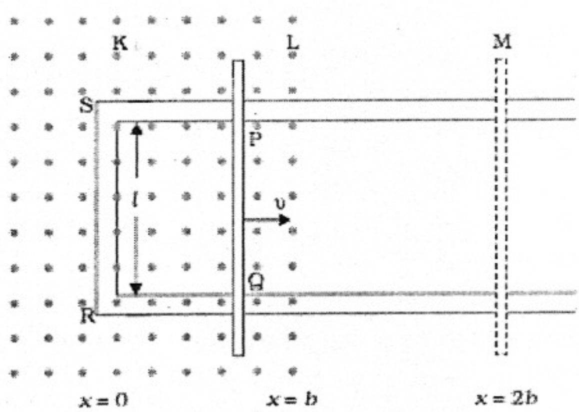
Faraday's Law of electromagnetic induction	1
Expression for flux and induced emf	1+1
Sketch of the variation of these quantities with distance	1+1

The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit. 1

Alternatively

Mathematically, the induced emf is given by

$$e = \frac{-d\phi}{dt}$$



First consider the forward motion from $x = 0$ to $x = 2b$

The flux Φ_B linked with the circuit SPQR is

$\Phi_B = Blx \qquad 0 \le x < b$ ½

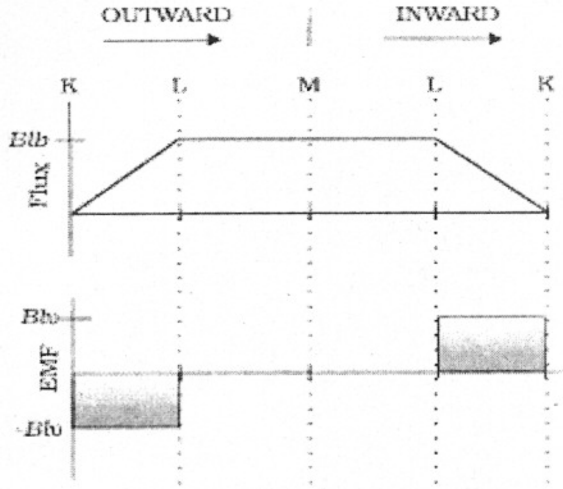
$\quad = Blb \qquad b \le x < 2b$ ½

The induced emf is,

$$\varepsilon = -\frac{d\Phi_B}{dt}$$ ½

$\quad = -Blv \qquad 0 \le x < b$ ½

$\quad = 0 \qquad b \le x < 2b$



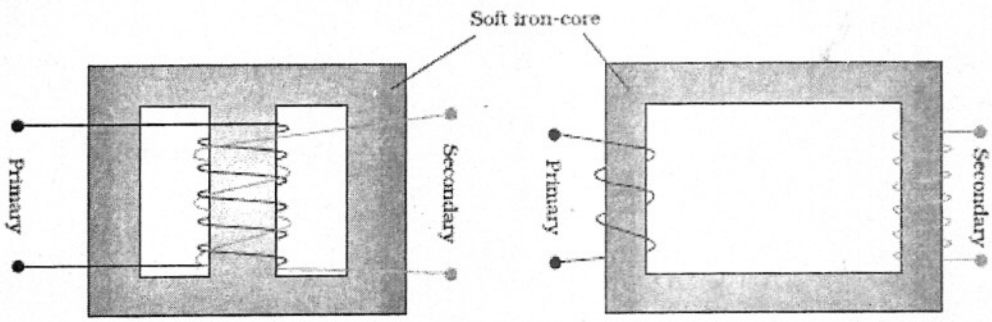
1

1

5

OR

Schematic diagram	1
Working principle	1
Derivation	1½
Ratio of currents	½
Distribution of energy over long distance	1



(a) (b)

1

(Any one of the above diagrams)

Principle: 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.(mutual induction .) 1

Derivation:

The induced emf or voltage e_s, in the secondary ,with *Ns* turns, is ½

$$e_s = \frac{-N_s d\phi}{dt}$$

The alternating flux φ also induces an emf, called back emf, in the primary. This is

$$e_p = \frac{-N_p d\phi}{dt}$$

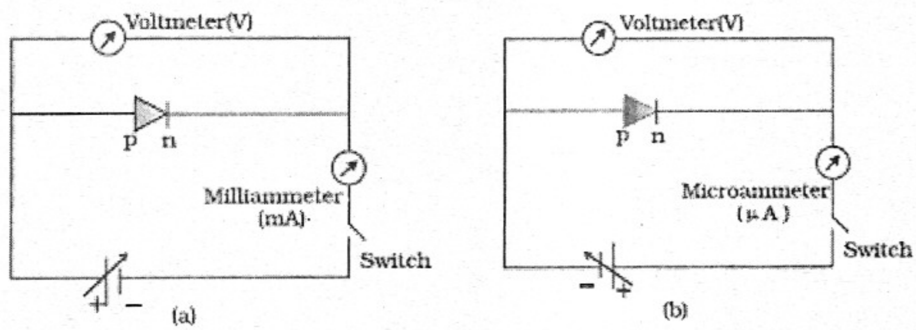
But $e_s = v_s$ and $e_p = v_p$

therefore

	$v_s = \frac{-N_s d\phi}{dt}$ and $v_p = \frac{-N_p d\phi}{dt}$	½	
	Hence $\frac{v_s}{v_p} = \frac{N_s}{N_p}$	½	
	If the transformer is assumed to be 100% efficient (no energy losses), the power input is equal to the power output, and since $p = i\,v$, $i_p v_p = i_s v_s$. then $\frac{v_s}{v_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s}$	½	
	The large scale transmission and distribution of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up (so that current is reduced and consequently, the I^2R loss is cut down). It is then transmitted over long distances to an area sub-station near the consumers. There the voltage is stepped down. It is further stepped down at distributing sub-stations and utility poles before a power supply of 240 V reaches our homes.	1	5

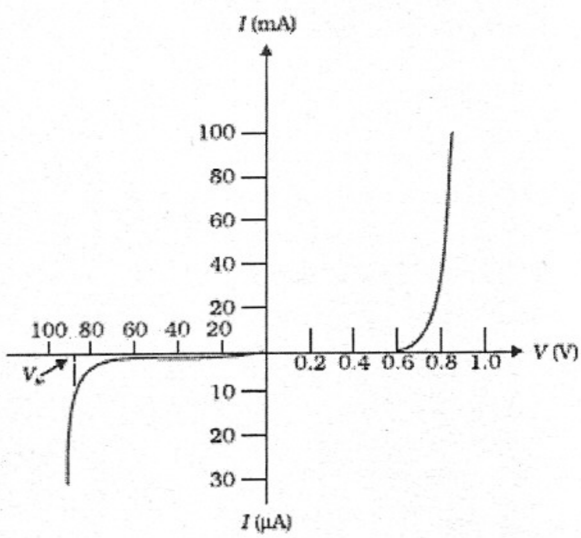
30.

(a)Circuit diagram	1+1
Typical V-I characteristics	½+½
(b) LED ; two important advantages	1+½+½



1+1

The battery is connected to the diode through a potentiometer (or rheostat) so that the applied voltage to the diode can be changed. For different values of voltages, the value of the current is noted. A graph between V and I is obtained. Note that in forward bias measurement, we use a milliammeter (since the expected current is large) while a microammeter is used in reverse bias.



½+½

Typical V-I characteristics of a silicon diode.

Light emitting diode

It is a heavily doped p-n junction which under forward bias emits spontaneous radiation./ p-n junction diode which emits light when forward) 1

Advantages:

(i) Low operational voltage and less power.

(ii) Fast action and no warm-up time required.

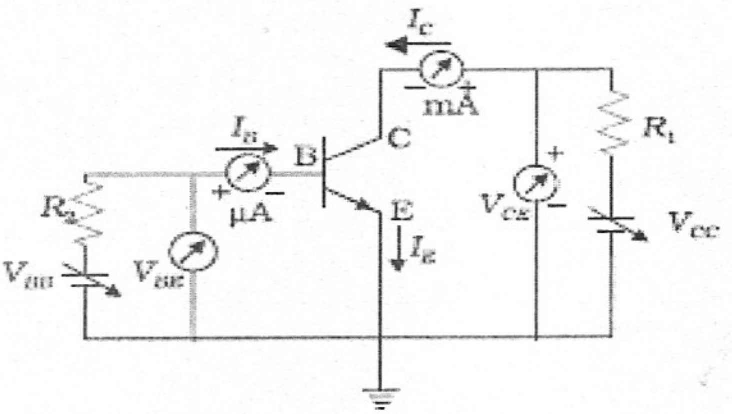
(iii) The bandwidth of emitted light is 100 Å to 500 Å or in other words it is nearly (but not exactly) monochromatic.

(iv) Long life and ruggedness. ½+½
(v) Fast on-off switching capability
(Any two) 5

OR

(a)Circuit diagram for transistor characteristics	2
Definitions	½+½
(b)Circuit diagram	1
Explanation of self sustained oscillations	1

(a)



2

(i) **Input resistance**: This is defined as the ratio of change in base emitter voltage (ΔV_{BE}) to the resulting change in base current (ΔI_B) at constant collector-emitter voltage (V_{CE}).

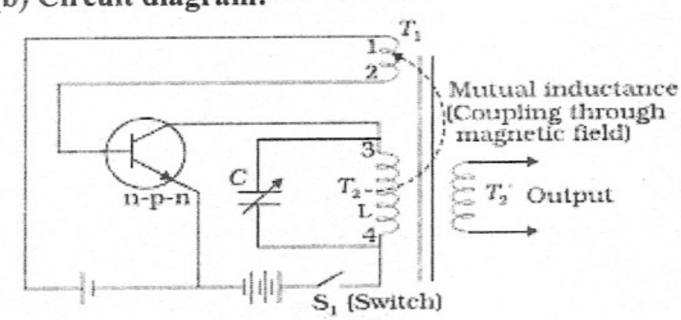
$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$ ½

(ii) ***Current amplification factor*** **(β):** This is defined as the ratio of the change in collector current to the change in base current at a constant collector-emitter voltage (V_{CE}) when the transistor is in active state.

$$\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$ ½

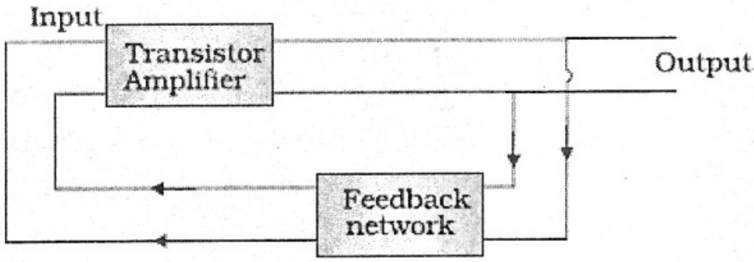
(give each of these marks if student writes the only the correct expressions)

(b) Circuit diagram:



1

Working: In an oscillator, we get an ac output without any external input signal. Hence, the output in an oscillator is *self-sustained*. To attain this, an amplifier is taken. A portion of the output power is returned back (fedback) to 1

	the input *in phase* with the starting power (this process is termed *positive fedback)*. [give ½ mark if student just draws the block diagram:] 		5

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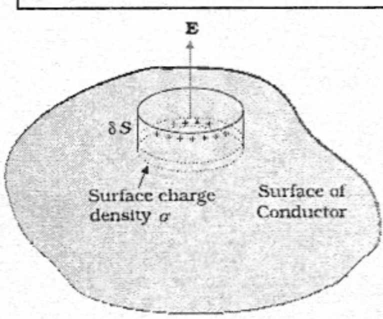
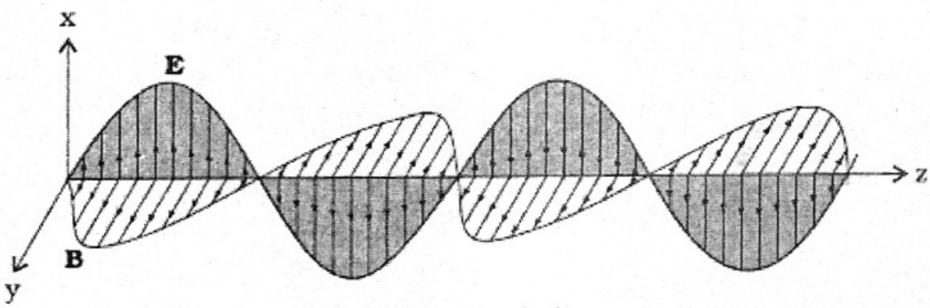
7. Deduct ½ mark for writing wrong units, or missing units, in the final answer to numerical problems.
8. Formula can be taken as implied from the calculations even if not explicitly written.
9. In short answer type questions, asking for two features/ characteristics/ properties, if a candidate writes three features/ characteristics/ properties or more, only the correct two should be evaluated.
10. Full marks should be awarded to a candidate if his/her answer in a numerical problem, is close to the value given in this scheme.

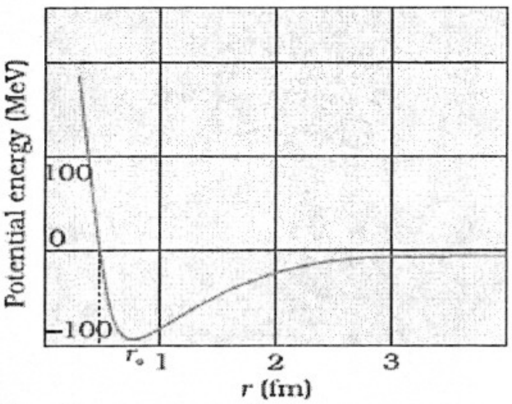
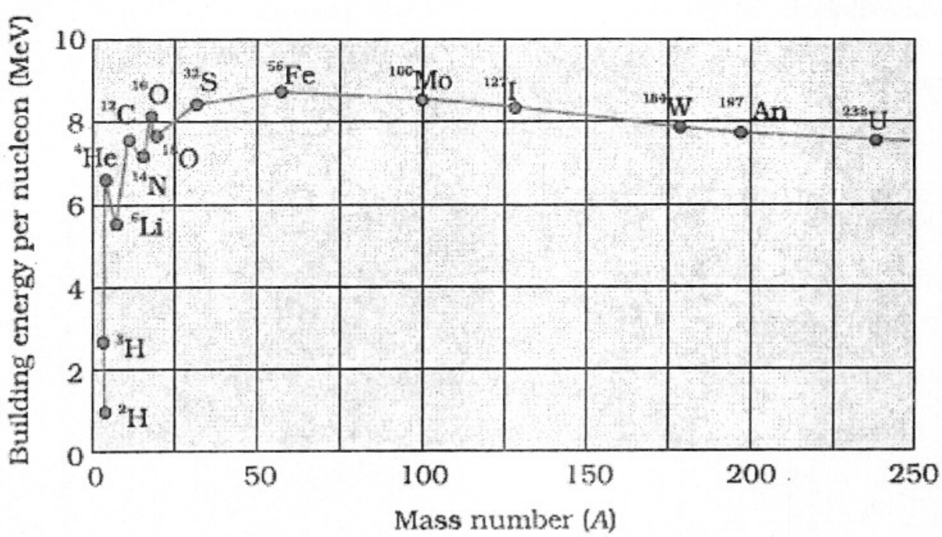
MARKING SCHEME
SET 55/2

Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	$E_n = \frac{-13.6}{n^2} eV$ $\Rightarrow \frac{E_{21}}{E_{\infty 1}} = \frac{10.2}{13.6}$ [Give ½ mark if student writes , Ratio= $\frac{(E_2 - E_1)}{\lvert E_1 \rvert}$]	½ ½	1
2.	$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ $as\ f_1 = -f_2$ (award 1mark even if the student directly writes $f = \infty$) $\therefore f = \infty$	½ + ½	1
3.	Electric potential, scalar	½ + ½	1
4.	Positive Z direction ($+\hat{k}$)	1	1
5.	X-rays	1	1
6.	Magnetic flux linked through a coil when current flowing through is unity./ induced emf in a coil when current is changing at the unit rate. SI unit is henry.	½ + ½	1
7.	$I = n_X eAv_X = n_Y eAv_Y$ $\Rightarrow \frac{v_X}{v_Y} = \frac{n_Y}{n_X} = \frac{n_Y}{2n_Y} = \frac{1}{2}$	½ + ½	1
8.	No, because energy depends on amplitude and frequency only./ energy does not depend on speed.	½ + ½	1
9.	Derivation 2  $E\delta S = \frac{\sigma \delta S}{\varepsilon_0}$ $\Rightarrow E = \frac{\sigma}{\varepsilon_0}$ *In vector form* $\vec{E} = \frac{\sigma \hat{n}}{\varepsilon_0}$	½ ½ ½ ½	2

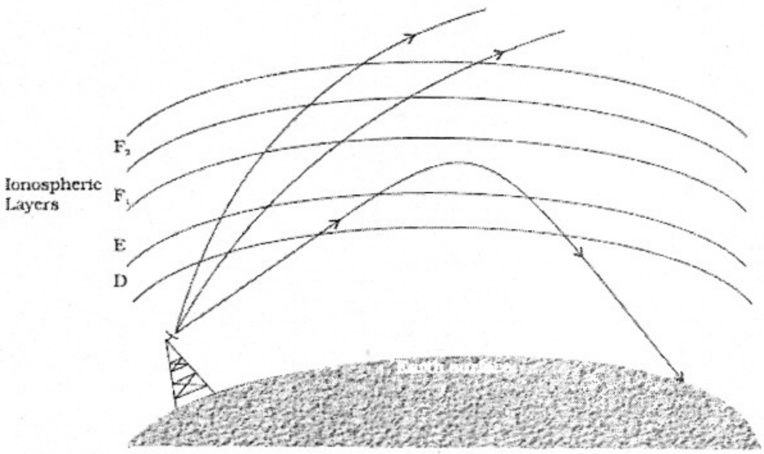
	Alternatively: also accept the derivation of electric field on the surface of spherical shell. $\oint_s \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0}$ $E \times 4\pi r^2 = \frac{q}{\varepsilon_0}$ $E = \frac{q}{4\pi r^2 \varepsilon_0}$ $\Rightarrow \vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$	½ ½ 1	 2
10.	Sketch of plane em wave 1 Directions of electric and magnetic fields 1  (Note: If diagram is drawn without indicating direction, award one mark. If only directions are written without any diagram , award one mark)	1+1	2
11.	(a) surface charge density on inner and outer surface ½ + ½ (b) expression for electric field 1 (a) (i) surface charge density on inner surface $\sigma = \frac{-q}{4\pi r_1^2}$ (ii) surface charge density on inner surface $\sigma = \frac{Q+q}{4\pi r_2^2}$ Electric field at point distant x from centre of the shell $E = \frac{Q+q}{4\pi \varepsilon_0 x^2}$	½ ½ 1	 2

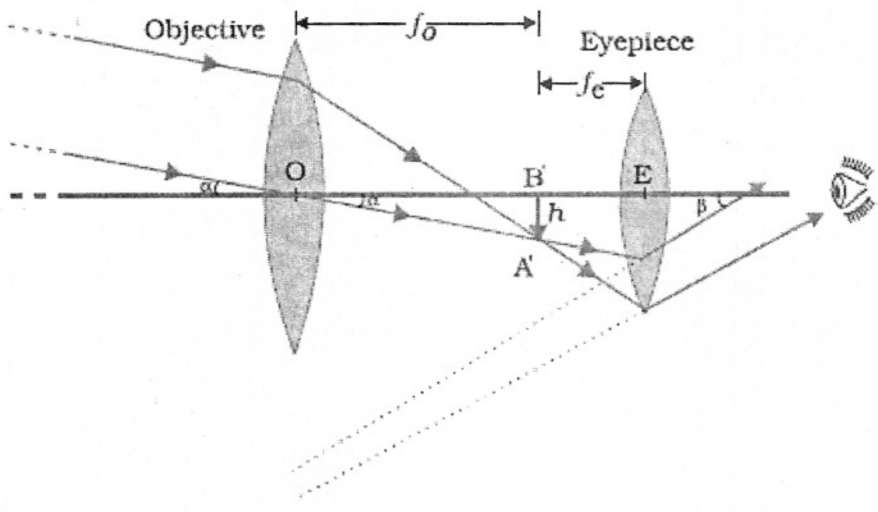
12.	Name of loop 1 Explanation 1 Rectangular loop The rate of change of area is constant for the rectangular loop but not for the circular loop.	1 1	 2
13.	Formula ½ Substitution and calculation 1½ $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mqV}}$ $As \quad m_\alpha = 4m_p \quad and \quad q_\alpha = 2q_p$ $\frac{\lambda_\alpha}{\lambda_p} = \frac{\sqrt{2m_p q_p}}{\sqrt{2m_\alpha q_\alpha}} = \frac{\sqrt{m_p q_p}}{\sqrt{4m_p 2q_p}} = \frac{\sqrt{1}}{\sqrt{8}} = \frac{1}{2\sqrt{2}}$	½ ½ 1	 2
14.	Einstein's photoelectric equation: ½ Three salient features ½ each Einstein's photoelectric equation: $K_{max} = h\nu - \varphi_0 \quad = h(\nu - \nu_0)$ (i) K_{max} of electrons depends linearly on ν. (ii) K_{max} is independent of intensity of radiation. (iii) There exists a threshold frequency ν_0 (= φ_0/h) for the metal surface, below which no photoelectric emission is possible. (No matter how intense the incident radiation may be or how long it falls on the surface.) (iv) For $\nu > \nu_0$, photoelectric current is proportional to intensity of incident radiations. (Any three)	½ ½ ½ ½	 2
15.	Derivation 2		

	(ii) The constancy of the binding energy in the range 30 < A < 170 is a consequence of the fact that the nuclear force is short-ranged. If a nucleon can have a maximum of p neighbours within the range of nuclear force, its binding energy would be proportional to p. If we increase A by adding nucleons they will not change the binding energy of a nucleon inside. Since most of the nucleons in a large nucleus reside inside it and not on the surface, the change in binding energy per nucleon would be small. Hence the binding energy per nucleon is a constant.[saturation property of nuclear force.]	1	2
17.	Two factors 1 Calculation of peak voltage of modulating signal 1 (i)Appropriate size of the antenna or aerial (ii)Effective power radiated by an antenna (iii) To avoid Mixing up of signals from different transmitters (Any Two) *Modulation Index* $\mu = \frac{a_m}{a_c}$ $\therefore\ 0.75 = \frac{a_m}{12V}$ $\Rightarrow a_m = 9V$	½+½ ½ ½	2
18.	Identification of gates P and Q ½ each Output at X for the given inputs ½ each (i) P : NAND GATE Q: OR GATE (ii) Inputs A=0 & B=0 then output X=1 Inputs A=1 & B=1 then output X=1	½ ½ ½ ½	2

	Current due to revolution of electron $I = \dfrac{e}{T}$ & $T = \dfrac{2\pi r}{v}$ *Therefore* $I = ev/2\pi r$. Magnetic moment $\mu_l = I\pi r^2 = evr/2$.	½ ½ 1	2
16.	Plot of potential energy of pair of nucleon 1 Two important conclusions ½ +½  Two important conclusions: (i)The nuclear force between two nucleons falls rapidly to zero at distances more than a few femtometres. (ii) The nuclear force is attractive for $r>r_0$. (iii) The nuclear force is repulsive for $r<r_0$. (iv)The nuclear force is a strong force. (any two) **OR** Plot of Binding Energy per nucleon 1 Explanation 1  	1 ½ +½ 1	

19.	Calculation of (a) Equivalent capacitance 1½ (b) Charge on each capacitor 1½ (a) $\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$ $\frac{1}{C}=\frac{1}{15}+\frac{1}{15}+\frac{1}{15}=\frac{1}{5}$ $\Rightarrow C=5\mu F\ \ or\ simply\ C_s=\frac{C}{3}=5\mu F$ *Equivalent Capacitance* $C_{eq}=C+C_4=15+5=20\mu F$ (b) Calculation of charge on each capacitor: Charge on capacitor C_4 $Q_4=C_4V=15\times 500\mu C=7.5mC=7.5\times 10^{-3}C$ Charge on capacitor C_1 ,C_2 & C_3 $Q_{123}=5\mu F\times 500V=2.5mC=2.5\times 10^{-3}C$	½ ½ ½ ½ ½+½	3
20.	Two factors : ½ +½ Calculation of internal resistance: 2 (i) Nature of electrolyte. (ii) Temperature of electrolyte. (iii) Area of electrode (iv) Concentration of electrolyte. (v) Separation between the electrodes. (any Two) Calculation of internal resistance: *Given* $E=2.0V; R=3\Omega\ and\ V=1.5V$ $as\ I=\frac{V}{R}=\frac{1.5}{3}=0.50A$ *we have* $V=E-Ir$ $\Rightarrow r=\frac{E-V}{I}=\frac{2.0-1.5}{0.50}=\frac{0.5}{0.5}=1.0\Omega$	½ ½ ½ ½ ½+½	

	Alternatively: $r = \left(\frac{E-V}{V}\right) \times R$ $= \left(\frac{2.0-1.5}{1.5}\right) \times 3$ $= 1.0\Omega$	1 ½ ½	3
21.	Name of Mode of Propagation ½ Diagram+ explanation ½+1 Reason for upper limit 1 Sky wave propagation/ Ionospheric reflection  E M waves of these frequencies are reflected, by the ionosphere towards the earth. Electromagnetic waves of frequencies higher than 30 MHz penetrate the ionosphere and escape.	½ ½ 1 1	3
22.	Calculation of distance of second bright and dark fringe 2 Effect on fringe pattern 1 Distance of n^{th} maxima from central maxima $x_n = \frac{n\lambda D}{d}$ given : n=2 ,d=0.12 mm ,λ =420 nm and D=1.0 m. $x_2 = \frac{2 \times 420 \times 10^{-9} \times 1.0}{0.12 \times 10^{-3}} = 7 \times 10^{-3} m = 7\,mm$ Distance of n^{th} minima from central maxima	 ½ ½	

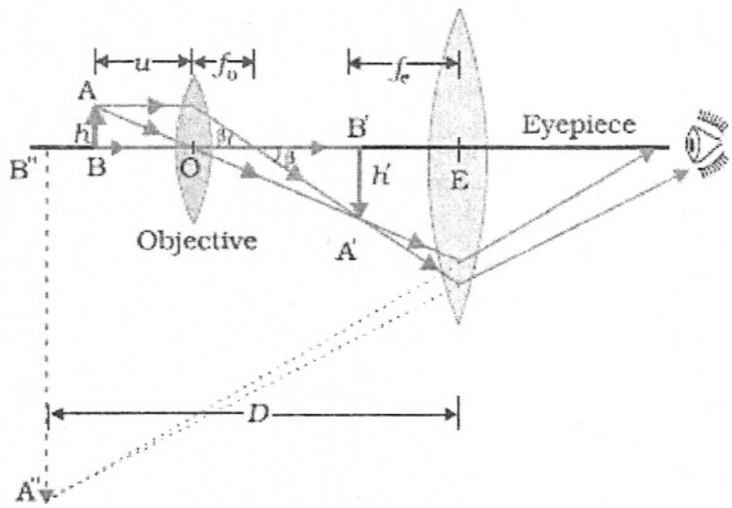
	$y_2 = \frac{(2n-1)\lambda D}{2d} = \frac{(2\times 2-1)420\times 10^{-9}\times 1}{2\times 0.12\times 10^{-3}} = 5.25\times 10^{-3}m = 5.25\,mm$ When the screen is moved away from the slits fringes becomes farther apart. (fringe width α distance of screen.)	½+½ 1	3
23.	Statement of Kirchoff's rules ½+1 Expression for currents 1½ (a) Junction rule: At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction . (b) Loop rule: The algebraic sum of changes in potential around any closed loop involving resistors and cells in the loop is zero Expressions for the currents I_1,I_2 and I_3 using given loop. $(i)\ \ I_3 = I_2 + I_1$ $(ii)\ \ 0.5I_1 + 12I_3 - 6 = 0$ $(iii)\ \ I_2 + 12I_3 - 10 = 0$ (Accept the equations if all the terms are written with opposite sign.)	½ 1 ½ ½ ½	3
24.	Labeled ray diagram in normal adjustment ½+1 Brief working ½ Calculation of Magnifying power 1  (Deduct ½ mark if labeling is not done or arrows are not shown) Light from a distant object enters the objective and a real image is formed in the tube at its second focal point. The eyepiece magnifies this image producing a final inverted image at infinity.	1½ ½	

<table>
<tr><td></td><td>Calculation of Magnifying power:

$Given: power\ of\ eyepiece = 10\,D$
$power\ of\ objective\ 1\,D$

$Magnifying\ power\ in\ normal\ adjustment: m = \frac{f_0}{f_e} = \frac{p_e}{p_0} = \frac{10}{1} = 10$</td><td>½ +½</td><td>3</td></tr>
<tr><td></td><td>OR

Labeled ray diagram of compound microscope	½+1
Working in brief	½
Reason	1



(Deduct ½ mark if labeling is not done or arrows are not shown)</td><td>1½</td><td></td></tr>
<tr><td></td><td>The objective forms a real, inverted, magnified image of the object. This serves as the object for the second lens, the eyepiece, which functions essentially like a simple microscope or magnifier, produces the final image, which is enlarged and virtual.</td><td>½</td><td></td></tr>
<tr><td></td><td>To achieve a large magnification of a small object; both the objective and eyepiece should have small focal lengths.</td><td>1</td><td>3</td></tr>
</table>

25.	Explanation of polarization of unpolarised light 1 Expression for the intensity 1 Orientation corresponding to minimum and maximum intensity 1 A polaroid consists of long chain molecules aligned in a particular direction. The electric vectors (associated with the propagating light wave) along the direction of the aligned molecules get absorbed. Thus, if an unpolarised light wave is incident on such a polaroid then the light wave will get linearly polarised with the electric vector oscillating along a direction perpendicular to the aligned molecules. (Give full credit if student explains it through a diagram) **Expression for the intensity transmitted through second Polaroid.** $I = (I_0 \cos^2\theta)\cos^2(90^0 - \theta) = I_0(\cos\theta \sin\theta)^2 = I_0 \sin^2 2\theta / 4$ where I_0 is the intensity of the polarized light after passing through the first polaroid. Intensity will be maximum when $\theta = 45^0$ and minimum when $\theta = 0^0$	1 1 ½+½	3
26.	Decay process 1 Derivation of average life 1 Relationship with half life 1 β^- decay process $${}^{32}_{15}P \rightarrow {}^{32}_{16}S + e^- + \bar{\nu} \;\; or \;\; {}^{32}_{15}P \rightarrow {}^{32}_{16}X + {}_{-1}e^0 + \bar{\nu}$$ Derivation of average life: $$\tau = \frac{\lambda N_0 \int_0^\infty t e^{-\lambda t} dt}{N_0} = \lambda \int_0^\infty t e^{-\lambda t} dt$$ $\Rightarrow \quad \tau = 1/\lambda$ Relation of average life with half life: $T_{1/2} = \frac{\ln 2}{\lambda} = \tau \ln 2$	1 ½ ½ 1	3
27.	Calculation of object distance 1½ Calculation of image distance 1½ *For virtual image* $m = +4$ $\therefore \frac{v}{u} \Rightarrow v = 4u$ We have for a lens	½ ½	

	$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$	½	
	$\frac{1}{20}=\frac{1}{4u}-\frac{1}{u}=\frac{-3}{4u}$	½	
	$\Rightarrow u=-15\,cm$	½	
	$v=-60\,cm$	½	3

28.

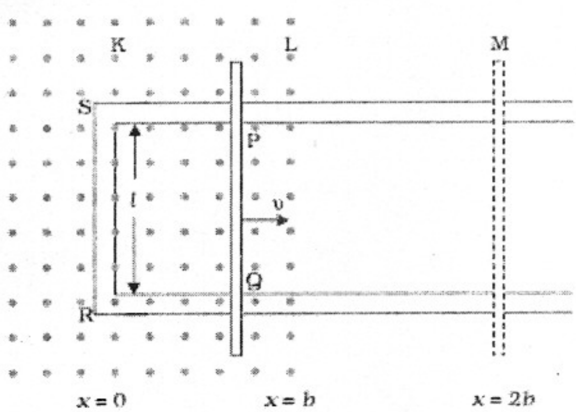
Faraday's Law of electromagnetic induction	1
Expression for flux and induced emf	1+1
Sketch of the variation of these quantities with distance	1+1

The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit.

Alternatively

Mathematically, the induced emf is given by — 1

$$e=\frac{-d\phi}{dt}$$



First consider the forward motion from $x = 0$ to $x = 2b$

The flux Φ_B linked with the circuit SPQR is

$\Phi_B = Blx \qquad 0 \le x < b$ — ½

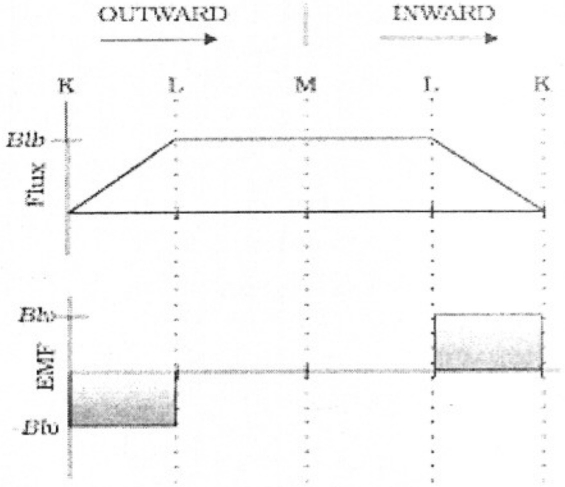
$\quad = Blb \qquad b \le x < 2b$ — ½

The induced emf is,

$$\varepsilon = -\frac{d\Phi_B}{dt}$$

$= -Blv \qquad 0 \le x < b$ — ½

$= 0 \qquad b \le x < 2b$ — ½



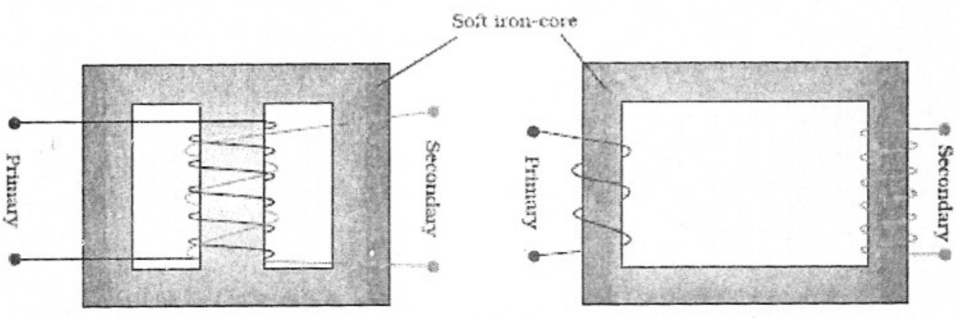
1

1

5

OR

Schematic diagram	1
Working principle	1
Derivation	1½
Ratio of currents	½
Distribution of energy over long distance	1



(a) (b)

1

(Any one of the above diagrams)

Principle: 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.(mutual induction .) 1

Derivation:

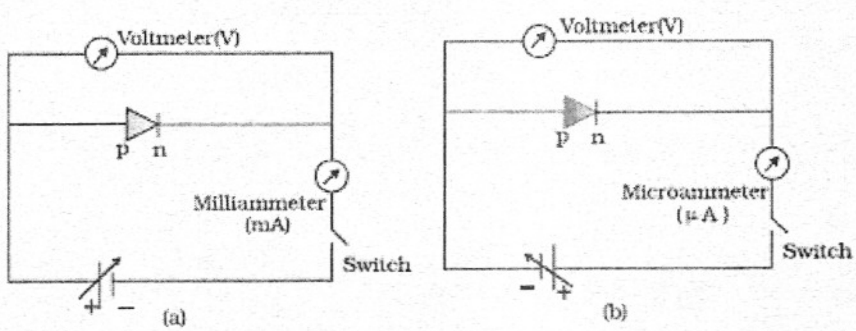
The induced emf or voltage e_s, in the secondary ,with *Ns* turns, is ½

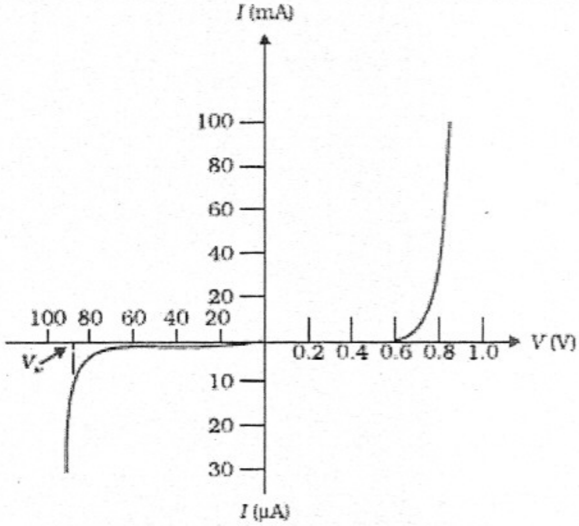
$$e_s = \frac{-N_s d\phi}{dt}$$

The alternating flux φ also induces an emf, called back emf, in the primary. This is

$$e_p = \frac{-N_p d\phi}{dt}$$

But $e_s = v_s$ and $e_p = v_p$

	therefore $v_s = \frac{-N_s d\phi}{dt}$ and $v_p = \frac{-N_p d\phi}{dt}$	½	
	Hence $\frac{v_s}{v_p} = \frac{N_s}{N_p}$	½	
	If the transformer is assumed to be 100% efficient (no energy losses), the power input is equal to the power output, and since $p = i\,v$, $i_p v_p = i_s v_s$. then $\frac{v_s}{v_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s}$	½	
	The large scale transmission and distribution of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up (so that current is reduced and consequently, the I^2R loss is cut down). It is then transmitted over long distances to an area sub-station near the consumers. There the voltage is stepped down. It is further stepped down at distributing sub-stations and utility poles before a power supply of 240 V reaches our homes.	1	5
29.	(a)Circuit diagram — 1+1 Typical V-I characteristics — ½+½ (b) LED ; two important advantages — 1+½+½		
		1+1	
	The battery is connected to the diode through a potentiometer (or rheostat) so that the applied voltage to the diode can be changed. For different values of voltages, the value of the current is noted. A graph between V and I is obtained. Note that in forward bias measurement, we use a milliammeter (since the expected current is large) while a microammeter is used in reverse bias.		



Typical *V-I* characteristics of a silicon diode. ½+½

Light emitting diode

It is a heavily doped p-n junction which under forward bias emits spontaneous radiation./ p-n junction diode which emits light when forward) 1

Advantages:

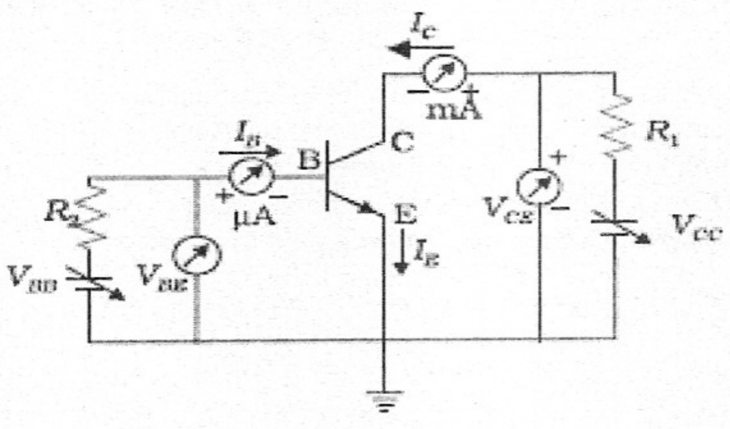
(i) Low operational voltage and less power.
(ii) Fast action and no warm-up time required.
(iii) The bandwidth of emitted light is 100 Å to 500 Å or in other words it is nearly (but not exactly) monochromatic.
(iv) Long life and ruggedness. ½+½
(v) Fast on-off switching capability
(Any two)

5

OR

(a)Circuit diagram for transistor characteristics	2
Definitions	½+½
(b)Circuit diagram	1
Explanation of self sustained oscillations	1

(a)



2

(i) **Input resistance**: This is defined as the ratio of change in base emitter voltage (ΔV_{BE}) to the resulting change in base current (ΔI_B) at constant collector-emitter voltage (V_{CE}).

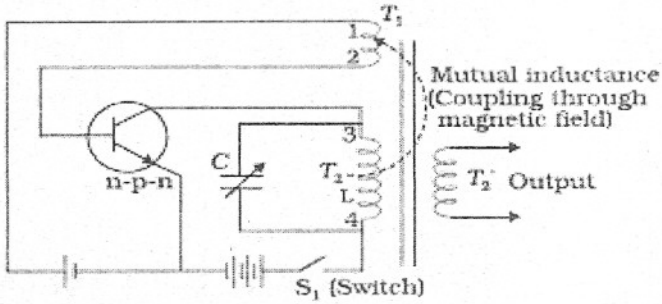
$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$ ½

(ii) ***Current amplification factor*** **(β):** This is defined as the ratio of the change in collector current to the change in base current at a constant collector-emitter voltage (V_{CE}) when the transistor is in active state.

$$\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$ ½

(give each of these marks if student writes the only the correct expressions)

(b) Circuit diagram:

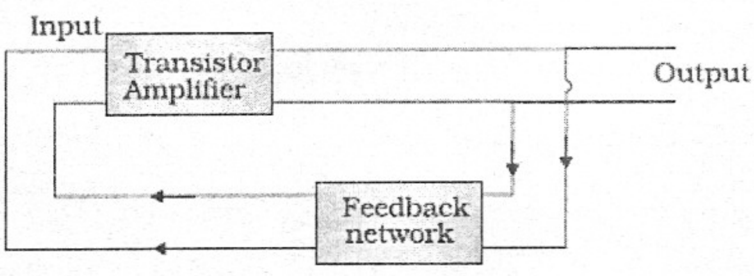


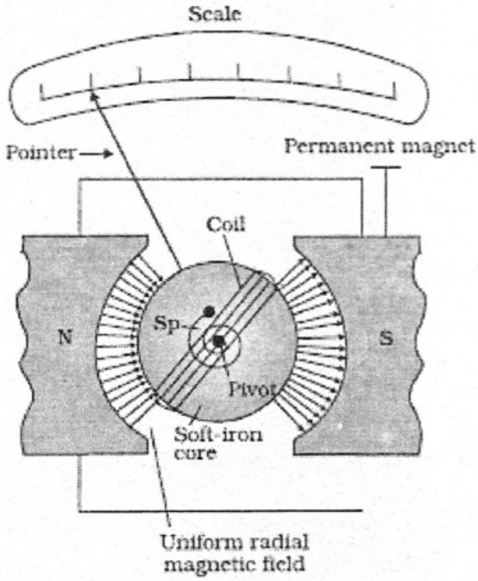
1

Working: In an oscillator, we get an ac output without any external input signal. Hence, the output in an oscillator is *self-sustained*. To attain this, an amplifier is taken. A portion of the output power is returned back (fedback) to the input *in phase* with the starting power (this process is termed *positive* 1

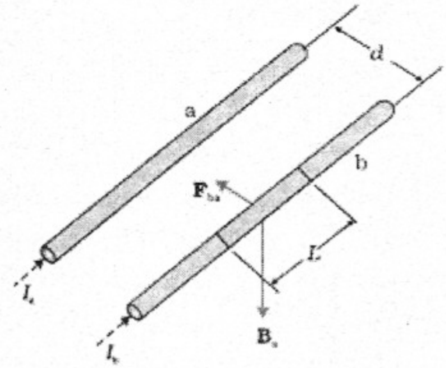
fedback).

[give ½ mark if student just draws the block diagram:] 5



30	(a) Diagram ,principle and working 1+1+1 (b) Importance and production of radial magnetic field ½+½ (c) Reason ½+½		
		1	
	Principle: Torque acts on the current carrying loop when placed in magnetic field. ($\tau = NI\,AB\sin\theta$.)	1	
	Working: The magnetic torque tends to rotate the coil. A spring provides a counter torque that balances the magnetic torque; resulting in a steady angular deflection. The deflection is indicated on the scale by a pointer attached to the spring.	1	
	Importance and production of radial magnetic field: In a radial magnetic field magnetic torque remains maximum for all positions of the coils. It is produced due to cylindrical pole pieces and soft iron core.	½+½	
	Reason: Voltmeter: this ensures that a very low current passes through the voltmeter and hence does not (much) the original potential difference to be measured.	½	
	Ammeter: this ensures that the total resistance of the circuit does not change much and the current flowing remains (almost) at its original value.	½	5
	OR		
	(a) Derivation of expression of force 2½ (b) Definition of SI unit of current 1 (c) Calculation of force (magnitude and direction) 1+½		

(a)



½

Two long parallel conductors ‘a’ and ‘b’ are separated by a distance d and carry (parallel) currents I_a and I_b, respectively. The conductor ‘a’ produces, the same magnetic field $\mathbf{B}_a$ at all points along the conductor ‘b’.

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$ 1

$\mathbf{F}_{ba}$, is the force on a segment L of ‘b’ due to ‘a’. The magnitude of this force is given by

$$F_{ba} = I_b L B_a$$ ½

$$= \frac{\mu_0 I_a I_b}{2\pi d} L$$ ½

(b) The *ampere* is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newtons per metre of length. 1

(c) Magnetic field due to the straight wire AB at a perpendicular distance d from it.

$$B = \frac{\mu_0 I}{2\pi d}$$ ½

Therefore force on proton moving with velocity 'v' perpendicular to B, is

$$f = qvB = \frac{\mu_0 Iqv}{2\pi d}$$ 1

Direction: *towards right* ½ 5

Senior School Certificate Examination
Marking Scheme- Physics (Code 55/1, 55/2, 55/3)

General Instructions

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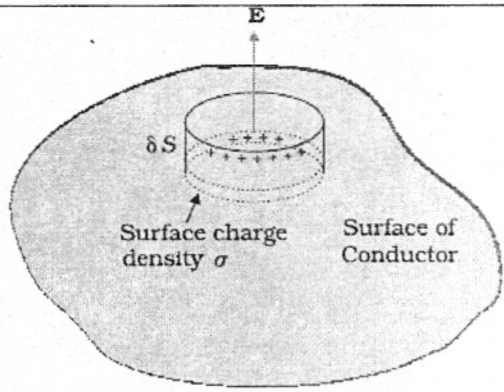
MARKING SCHEME
SET 55/3

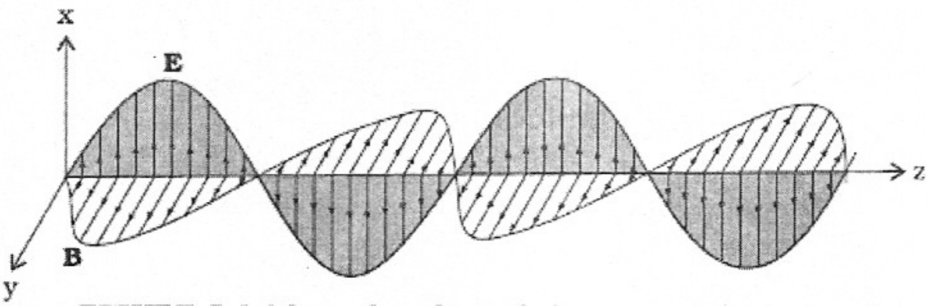
Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	Positive Z direction ($+\hat{k}$)	1	1
2.	No, because energy depends on amplitude and frequency only.(energy does not depend on speed.)	½ + ½	1
3.	Magnetic flux linked through a coil when current flowing through is unity./ induced emf in a coil when current is changing at the unit rate. SI unit is henry.	½ + ½	1
4.	$I = n_X eAv_X = n_Y eAv_Y$ $\Rightarrow \frac{v_X}{v_Y} = \frac{n_Y}{n_X} = \frac{n_Y}{2n_Y} = \frac{1}{2}$	½ + ½	1
5.	Radio waves, Infrared, blue light, X rays	1	1
6.	Electric potential, scalar	½ + ½	1
7.	$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ $as\ f_1 = -f_2$ (award 1mark even if the student directly writes $f = \infty$) $\therefore f = \infty$	½ + ½	1
8.	K.E= +13.6eV & P.E =-27.2eV	½ + ½	1
9.	Two factors 1 Calculation of peak voltage of modulating signal 1 (i)Appropriate size of the antenna or aerial (ii)Effective power radiated by an antenna (iii) To avoid Mixing up of signals from different transmitters (Any Two) *Modulation Index* $\mu = \frac{a_m}{a_c}$ $\therefore\ 0.75 = \frac{a_m}{12V}$ $\Rightarrow a_m = 9V$	½+½ ½ ½	 2
10.	Derivation 2		

		½	
	$E\delta S = \frac{\sigma \delta S}{\varepsilon_0}$	½	
	$\Rightarrow E = \frac{\sigma}{\varepsilon_0}$	½	
	In vector form		
	$\vec{E} = \frac{\sigma \hat{n}}{\varepsilon_0}$	½	
	Alternatively: also accept the derivation of electric field on the surface of spherical shell.		
	$\oint_s \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0}$	½	
	$E \times 4\pi r^2 = \frac{q}{\varepsilon_0}$	½	
	$E = \frac{q}{4\pi r^2 \varepsilon_0}$		
	$\Rightarrow \vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$	1	2
11.	Identification of gates P and Q — ½ each Output at X for the given inputs — ½ each		
	(i) P : NOT GATE	½	
	Q: OR GATE	½	
	(ii) Inputs A=0 & B=0 then output X=1	½	
	Inputs A=1 & B=1 then output X=1	½	2

12.	Formula ½ Substitution and calculation 1½ $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mqV}}$ $As \quad m_\alpha = 4m_p \quad and \quad q_\alpha = 2q_p$ $\frac{\lambda_\alpha}{\lambda_p} = \frac{\sqrt{2m_p q_p}}{\sqrt{2m_\alpha q_\alpha}} = \frac{\sqrt{m_p q_p}}{\sqrt{4m_p 2q_p}} = \frac{\sqrt{1}}{\sqrt{8}} = \frac{1}{2\sqrt{2}}$	½ ½ 1	2
13.	(a) surface charge density on inner and outer surface ½ + ½ (b) expression for electric field 1 (a) (i) surface charge density on inner surface $\sigma = \frac{-q}{4\pi r_1^2}$ (ii) surface charge density on inner surface $\sigma = \frac{Q+q}{4\pi r_2^2}$ .Electric field at point distant x from centre of the shell $E = \frac{Q+q}{4\pi\varepsilon_0 x^2}$	½ ½ 1	2
14.	Derivation 2 $Current\ due\ to\ revolution\ of\ electron\ I = \frac{e}{T} \quad \& \quad T = \frac{2\pi r}{v}$ *Therefore* $I = ev/2\pi r$. Magnetic moment $\mu_l = I\pi r^2 = evr/2$.	½ ½ 1	2

15.

Sketch of plane em wave	1
Directions of electric and magnetic fields	1



1+1

2

(Note: If diagram is drawn without indicating direction, award one mark. If only directions are written without any diagram , award one mark)

16.

Comparision of induced emf	1
Comparision of currents	1

(i) Emf produced in two coils is same because it depends only on rate of change of magnetic flux which is same for both the loops. 1

(ii) Current in copper loop is more because resistivity/resistance of copper is less. (I=V/R) . 1 2

17.

Einstein's photoelectric equation:	½
Three salient features	½ each

Einstein's photoelectric equation:

$$K_{\max} = h\nu - \varphi_0 \quad = h(\nu\text{-}\nu_0)$$ ½

(i) K_{max} of electrons depends linearly on ν.

(ii) K_{max} is independent of intensity of radiation.

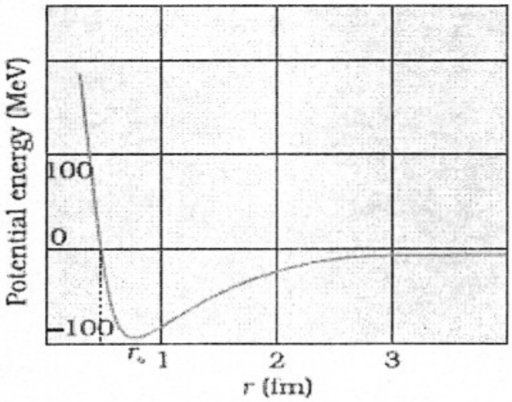
(iii) There exists a threshold frequency ν_0 (= φ_0/h) for the metal surface, below which no photoelectric emission is possible. (No matter how intense the incident radiation may be or how long it falls on the surface.) ½ ½

(iv) For $\nu > \nu_0$, photoelectric current is proportional to intensity of incident radiations. ½ 2

(Any three)

18.

Plot of potential energy of pair of nucleon	1
Two important conclusions	½ +½



1

Two important conclusions:

(i)The nuclear force between two nucleons falls rapidly to zero at distances more than a few femtometres. ½

(ii) The nuclear force is attractive for $r>r_0$.

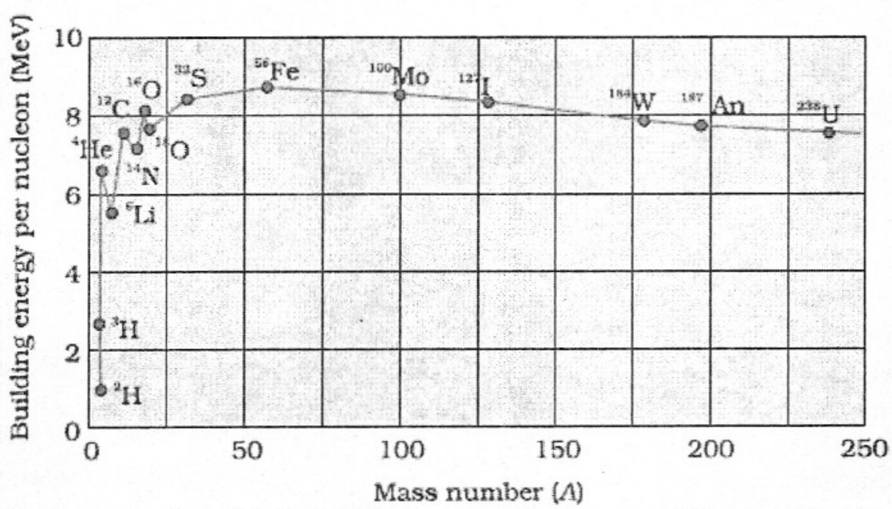
(iii) The nuclear force is repulsive for $r<r_0$. ½

(iv)The nuclear force is a strong force. 2

(any two)

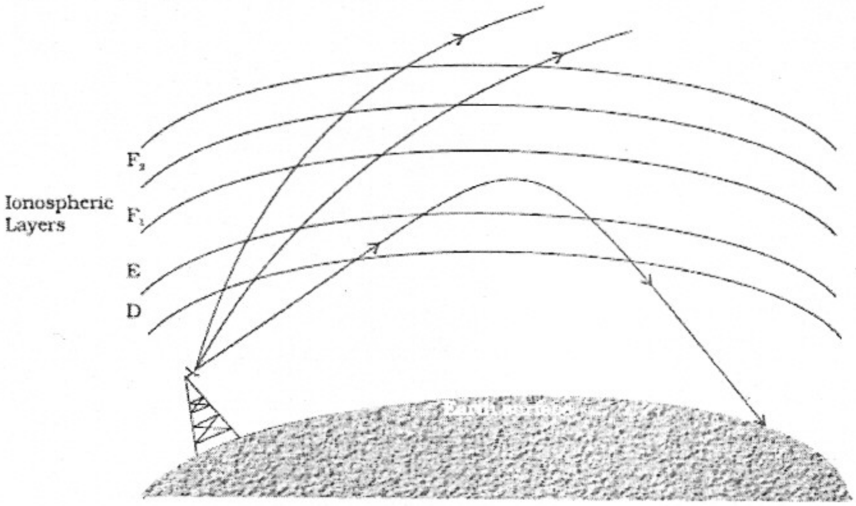
OR

Plot of Binding Energy per nucleon	1
Explanation	1



1

(ii) The constancy of the binding energy in the range 30 < A < 170 is a consequence of the fact that the nuclear force is short-ranged.
If a nucleon can have a maximum of *p* neighbours within the range of nuclear force, its binding energy would be proportional to *p*. If we increase *A* by adding nucleons they will not change the binding energy of a nucleon inside. Since most of the nucleons in a large nucleus reside inside it and not on the surface, the change in binding energy per nucleon would be small. Hence the binding energy per nucleon is a constant.[saturation property of nuclear force.] 1 2

19.	Name of Mode of Propagation ½ Diagram+ explanation ½+1 Reason for upper limit 1		
	Sky wave propagation/ Ionospheric reflection	½	
		½	
	E M waves of these frequencies are reflected, by the ionosphere towards the earth.	1	
	Electromagnetic waves of frequencies higher than 30 MHz penetrate the ionosphere and escape.	1	3
20.	Explanation of polarization of unpolarised light 1 Expression for the intensity 1 Orientation corresponding to minimum and maximum intensity 1		
	A polaroid consists of long chain molecules aligned in a particular direction. The electric vectors (associated with the propagating light wave) along the direction of the aligned molecules get absorbed. Thus, if an unpolarised light wave is incident on such a polaroid then the light wave will get linearly polarised with the electric vector oscillating along a direction perpendicular to the aligned molecules. (Give full credit if student explains it through a diagram)	1	
	Expression for the intensity transmitted through second Polaroid. $I = (I_0 \cos^2\theta)\cos^2(90^0 - \theta) = I_0(\cos\theta \sin\theta)^2 = I_0 \sin^2 2\theta / 4$ where I_0 is the intensity of the polarized light after passing through the first polaroid.	1	
	Intensity will be maximum when $\theta = 45^0$ and minimum when $\theta = 0^0$	½+½	3

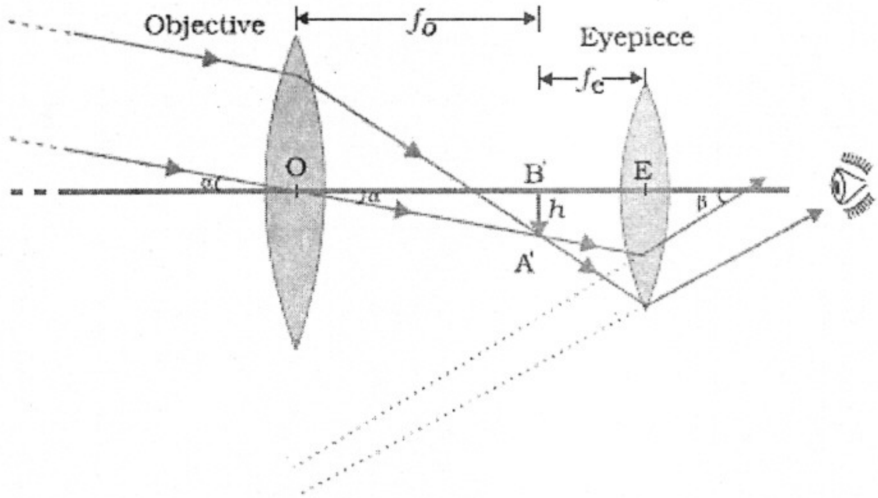
21.	Calculation of focal length 3 $For\ real\ image\ m=-19$ $=\frac{v}{u}=-19 \Rightarrow v=-19u$ We have for a lens $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ $\frac{1}{f}=\frac{1}{10}+\frac{19}{10}$ $\frac{1}{f}=\frac{20}{10}$ $\Rightarrow f=0.5\,m$	½ ½ ½ 1 ½	 3
22.	Calculation of (a) Equivalent capacitance 1½ (b) Charge on each capacitor 1½ (a) $\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$ $\frac{1}{C}=\frac{1}{15}+\frac{1}{15}+\frac{1}{15}=\frac{1}{5}$ $\Rightarrow C=5\mu F\ \ or\ simply\ C_s=\frac{C}{3}=5\mu F$ $Equivalent\ Capaci\ \mathrm{tan}\ ce$ $C_{eq}=C+C_4=15+5=20\mu F$ (b) Calculation of charge on each capacitor: Charge on capacitor C_4 $Q_4=C_4V=15\times 500\mu C=7.5mC=7.5\times 10^{-3}C$ Charge on capacitor C_1 ,C_2 & C_3 $Q_{123}=5\mu F\times 500V=2.5mC=2.5\times 10^{-3}C$	 ½ ½ ½ ½ ½+½	 3

23.	Decay process 1 Derivation of average life 2 β^- decay process $${}^{32}_{15}P \rightarrow {}^{32}_{16}S + e^- + \bar{\nu} \;\; or \; {}^{32}_{15}P \rightarrow {}^{32}_{16}X + {}_{-1}e^0 + \bar{\nu}$$ Derivation of average life: $$\tau = \frac{\lambda N_0 \int_0^\infty t e^{-\lambda t} dt}{N_0} = \lambda \int_0^\infty t e^{-\lambda t} dt$$ $\Rightarrow \quad \tau = 1/\lambda$ Relation of average life with half life: $T_{1/2} = \frac{\ln 2}{\lambda} = \tau \ln 2$	1 ½ ½ 1	3
24.	Two factors : ½ +½ Calculation of internal resistance: 2 (i) Nature of electrolyte. (ii) Temperature of electrolyte. (iii) Area of electrode (iv) concentration of electrolyte. (v) separation between two electrodes. (Any two) Calculation of internal resistance: *Given* $E = 2.5V; R = 5\Omega \; and \; V = 2.0V$ $as \; I = \frac{V}{R} = \frac{2.0}{5} = 0.40A$ *we have* $V = E - Ir$ $\Rightarrow r = \frac{E-V}{I} = \frac{2.5-2.0}{0.40} = \frac{0.5}{0.40} = 1.25\Omega$	½ ½ ½ ½ ½+½	

	Alternatively: $r=\left(\frac{E-V}{V}\right)\times R$ $=\left(\frac{2.5-2.0}{2.0}\right)\times 5$ $=1.25\Omega$	1 ½ ½	3
25.	Calculation of distance of second bright and dark fringe — 2 Effect on fringe pattern — 1 Distance of n^{th} maxima from central maxima $x_n=\frac{n\lambda D}{d}$ given : n=2 ,d=0.20 mm ,λ =600 nm and D=1.0 m. $x_2=\frac{2\times 600\times 10^{-9}\times 1.0}{0.2\times 10^{-3}}=6\times 10^{-3}m=6\,mm$ Distance of n^{th} minima from central maxima $y_2=\frac{(2n-1)\lambda D}{2d}=\frac{(2\times 2-1)600\times 10^{-9}\times 1}{2\times 0.20\times 10^{-3}}=4.5\times 10^{-3}m=4.5\,mm$ When the screen is moved away from the slits fringes becomes farther apart. (fringe width α distance of screen.)	½ ½ ½+½ 1	3
26.	Statement of Kirchoff's rules — ½+1 Expression for currents — 1½ (a) Junction rule: At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction . (b) Loop rule: The algebraic sum of changes in potential around any closed loop involving resistors and cells in the loop is zero Expressions for the currents I_1,I_2 and I_3 using given loop. (i) $I_3=I_2+I_1$ (ii) $200I_2+20I_3-5=0$ (iii) $60I_1+20I_3-4=0$ (Accept the equations if all the terms are written with opposite sign.)	½ 1 ½ ½ ½	3

27.

Labeled ray diagram in normal adjustment	½+1
Brief working	½
Calculation of Magnifying power	1



1½

(Deduct ½ mark if labeling is not done or arrows are not shown)

Light from a distant object enters the objective and a real image is formed in the tube at its second focal point. The eyepiece magnifies this image producing a final inverted image at infinity. ½

Calculation of Magnifying power:

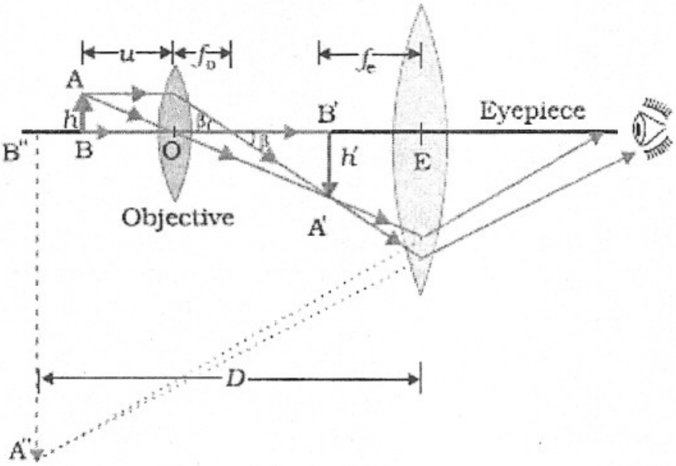
$Given: power\ of\ eyepiece = 10\,D$

$power\ of\ objective\ 1\,D$

$Magnifying\ power\ in\ normal\ adjustment: m = \frac{f_0}{f_e} = \frac{p_e}{p_0} = \frac{10}{1} = 10$ ½ +½ 3

OR

Labeled ray diagram of compound microscope	½+1
Working in brief	½
Reason	1



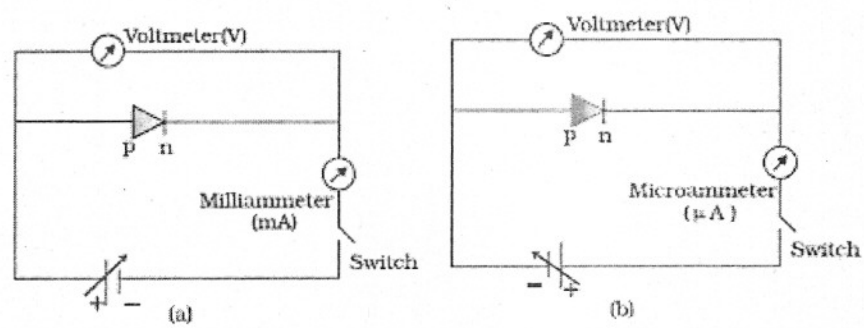
(Deduct ½ mark if labeling is not done or arrows are not shown) — 1½

The *objective* forms a real, inverted, magnified image of the object. This serves as the object for the second lens, the *eyepiece*, which functions essentially like a simple microscope or magnifier, produces the final image, which is enlarged and virtual. — ½

To achieve a large magnification of a *small* object; both the objective and eyepiece should have small focal lengths. — 1 — 3

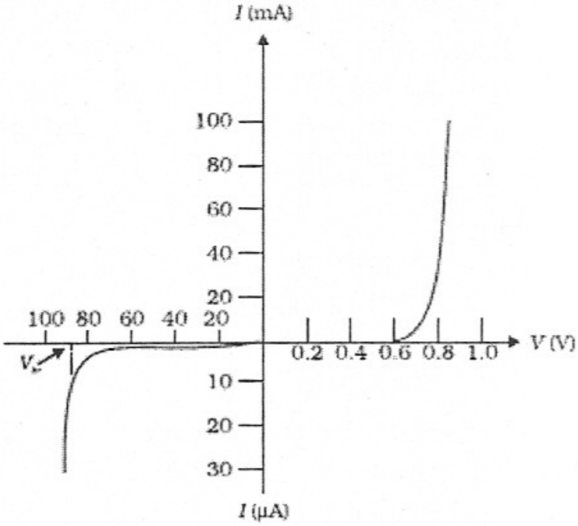
28.

(a)Circuit diagram	1+1
Typical V-I characteristics	½+½
(b) LED ; two important advantages	1+½+½



1+1

The battery is connected to the diode through a potentiometer (or rheostat) so that the applied voltage to the diode can be changed. For different values of voltages, the value of the current is noted. A graph between V and I is obtained. Note that in forward bias measurement, we use a milliammeter (since the expected current is large) while a microammeter is used in reverse bias.



½+½

Typical *V-I* characteristics of a silicon diode.

Light emitting diode

It is a heavily doped p-n junction which under forward bias emits spontaneous radiation./ p-n junction diode which emits light when forward) — 1

Advantages:

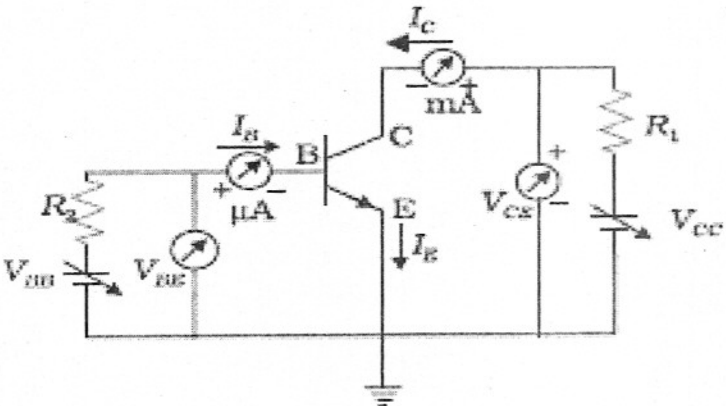
(i) Low operational voltage and less power.
(ii) Fast action and no warm-up time required.
(iii) The bandwidth of emitted light is 100 Å to 500 Å or in other words it is nearly (but not exactly) monochromatic.
(iv) Long life and ruggedness.
(v) Fast on-off switching capability
(Any two) — ½+½

5

OR

(a)Circuit diagram for transistor characteristics		2
Definitions	½+½	
(b)Circuit diagram		1
Explanation of self sustained oscillations		1

(a)



2

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(i) **Input resistance**: This is defined as the ratio of change in base emitter voltage (ΔV_{BE}) to the resulting change in base current (ΔI_B) at constant collector-emitter voltage (V_{CE}).

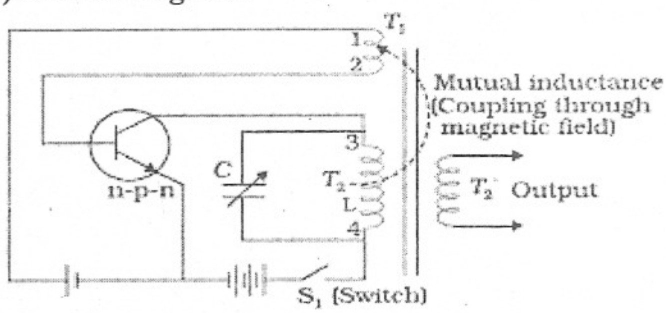
$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$

(ii) ***Current amplification factor*** **(β):** This is defined as the ratio of the change in collector current to the change in base current at a constant collector-emitter voltage (V_{CE}) when the transistor is in active state.

$$\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$

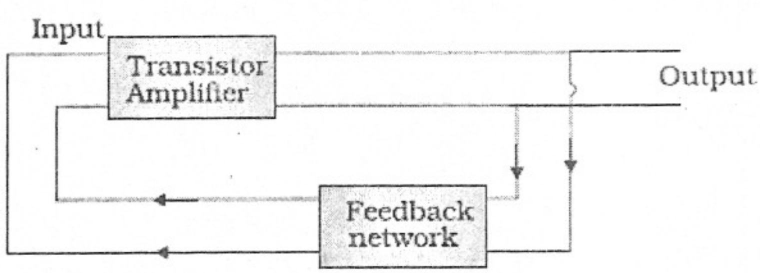
(give each of these marks if student writes the only the correct expressions)

(b) Circuit diagram:



Working: In an oscillator, we get an ac output without any external input signal. Hence, the output in an oscillator is *self-sustained*. To attain this, an amplifier is taken. A portion of the output power is returned back (fedback) to the input *in phase* with the starting power (this process is termed *positive fedback).*

[give ½ mark if student just draws the block diagram:]



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½

1

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(a) Diagram ,principle and working	1+1+1
(b) Importance and production of radial magnetic field	1
(c) Reason	1

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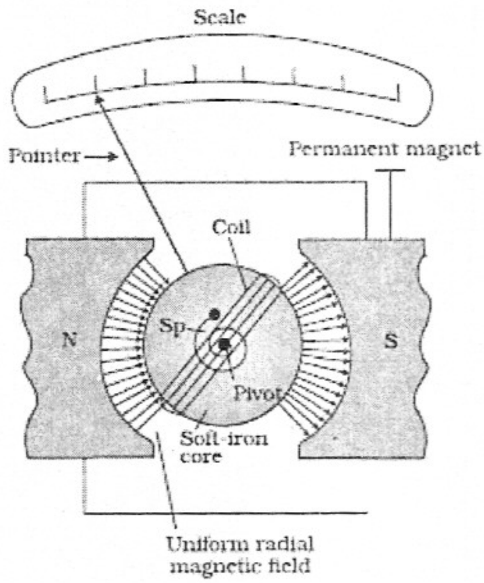
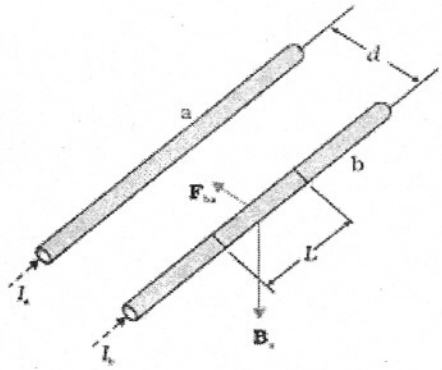
		1	
	Principle: Torque acts on the current carrying loop when placed in magnetic field. ($\tau = NI\,AB\,\sin\theta$.)	1	
	Working: The magnetic torque tends to rotate the coil. A spring provides a counter torque that balances the magnetic torque; resulting in a steady angular deflection. The deflection is indicated on the scale by a pointer attached to the spring.	1	
	Importance and production of radial magnetic field: In a radial magnetic field magnetic torque remains maximum for all positions of the coils. It is produced due to cylindrical pole pieces and soft iron core.	½+½	
	Reason: Voltmeter: this ensures that a very low current passes through the voltmeter and hence does not (much) the original potential difference to be measured.	½	
	Ammeter: this ensures that the total resistance of the circuit does not change much and the current flowing remains (almost) at its original value.	½	5

OR

(a) Derivation of expression of force	2½
(b) Definition of SI unit of current	1
(c) Calculation of force (magnitude and direction)	1+½

(a)



½

Two long parallel conductors ‘a’ and ‘b’ are separated by a distance *d* and carry (parallel) currents I_a and I_b, respectively. The conductor ‘a’ produces, the same magnetic field $\mathbf{B}_a$ at all points along the conductor ‘b’.

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$ 1

$\mathbf{F}_{ba}$, is the force on a segment *L* of ‘b’ due to ‘a’. The magnitude of this force is given by ½

$$F_{ba} = I_b L B_a$$ ½

$$= \frac{\mu_0 I_a I_b}{2\pi d} L$$

(b) The *ampere* is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newtons per metre of length. 1

(c) Magnetic field due to the straight wire AB at a perpendicular distance d from it.

5

$$B = \frac{\mu_0 I}{2\pi d}$$ ½

Therefore force on proton moving with velocity 'v' perpendicular to B, is

$$f = qvB = \frac{\mu_0 I q v}{2\pi d}$$ 1

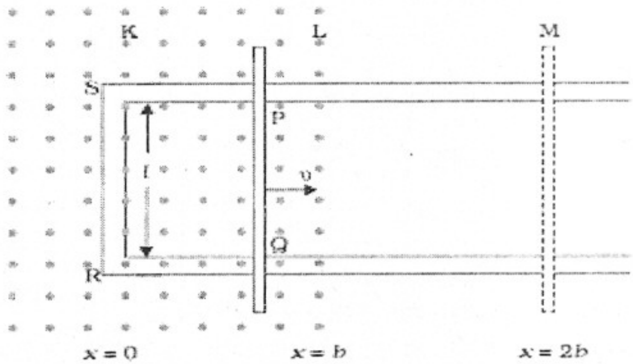
Direction: towards right ½

30.

Faraday's Law of electromagnetic induction	1
Expression for flux and induced emf	1+1
Sketch of the variation of these quantities with distance	1+1

The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit.
Alternatively
Mathematically, the induced emf is given by 1

$$e = \frac{-d\phi}{dt}$$



First consider the forward motion from $x = 0$ to $x = 2b$
The flux Φ_B linked with the circuit SPQR is

$\Phi_B = Blx \qquad 0 \le x < b$ ½

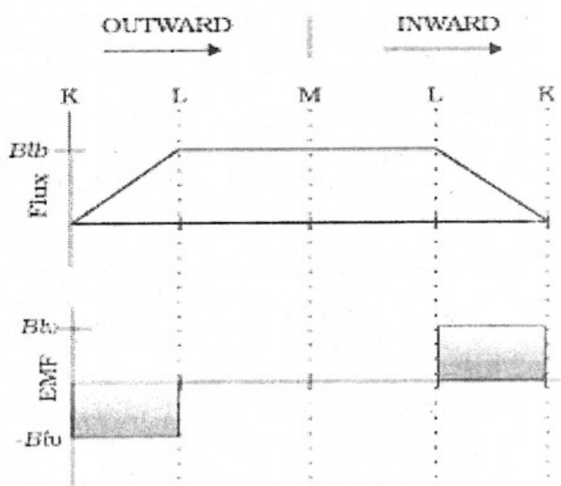
$\quad = Blb \qquad b \le x < 2b$ ½

The induced emf is,

$$\varepsilon = -\frac{d\Phi_B}{dt}$$

$= -Blv \qquad 0 \le x < b$ ½

$= 0 \qquad b \le x < 2b$ ½

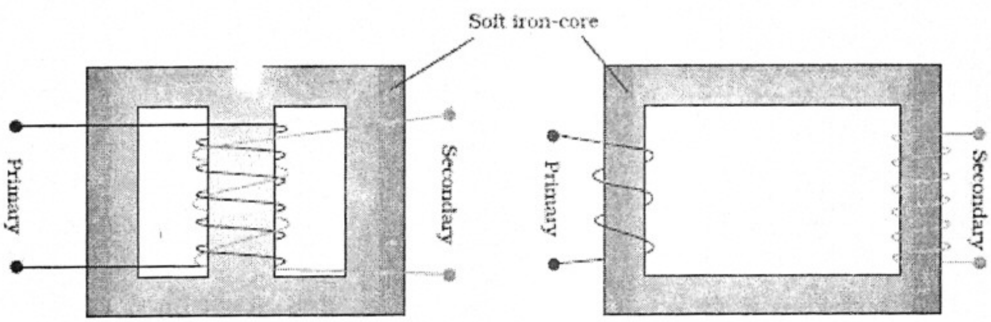


1

1 5

OR

Schematic diagram	1
Working principle	1
Derivation	1½
Ratio of currents	½
Distribution of energy over long distance	1



(a) (b)

1

(Any one of the above diagrams)

Principle: 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.(mutual induction .) 1

Derivation:

The induced emf or voltage e_s, in the secondary ,with *Ns* turns, is

$$e_s = \frac{-N_s d\phi}{dt}$$ ½

The alternating flux φ also induces an emf, called back emf, in the primary. This is

$$e_p = \frac{-N_p d\phi}{dt}$$

But $e_s = v_s$ and $e_p = v_p$

therefore

$$v_s = \frac{-N_s d\phi}{dt} \quad \text{and} \quad v_p = \frac{-N_p d\phi}{dt}$$ ½

Hence $\frac{v_s}{v_p} = \frac{N_s}{N_p}$ ½

If the transformer is assumed to be 100% efficient (no energy losses), the power input is equal to the power output, and since $p = i\,v$,

$i_p v_p = i_s v_s$. then

$$\frac{v_s}{v_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s}$$ ½

	The large scale transmission and distribution of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up (so that current is reduced and consequently, the I^2R loss is cut down). It is then transmitted over long distances to an area sub-station near the consumers. There the voltage is stepped down. It is further stepped down at distributing sub-stations and utility poles before a power supply of 240 V reaches our homes.	1	5