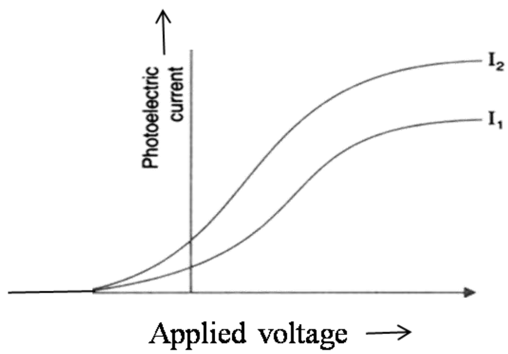
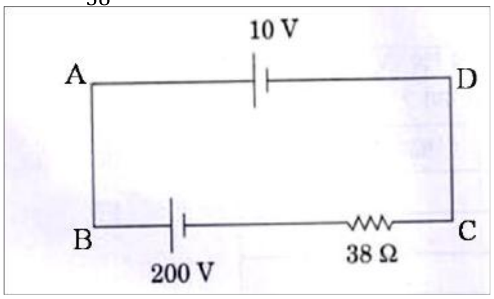
Strictly Confidential (For Internal and Restricted Use only)
Senior School Certificate Examination
Marking Scheme - Physics (Code 55/1, Code 55/2, Code 55/3)
March, 2018

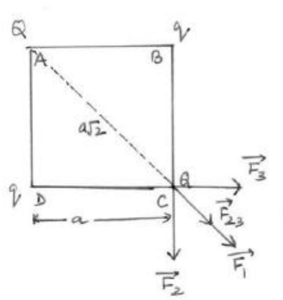
1. The marking scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicated. If a student has given any other answer, which is different from the one given in the marking scheme, but conveys the meaning correctly, such answers should be given full weightage.
2. In value based questions, any other individual response with suitable justification should also be accepted even if there is no reference to the text.
3. 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 adhered to and religiously followed.
4. If a question has parts, please award in the right hand side for each part. Marks awarded for different part of the question should then be totaled up and written in the left hand margin and circled.
5. If a question does not have any parts, marks are to be awarded in the left hand margin only.
6. 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.
7. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.
8. Deduct ½ mark for writing wrong units, missing units, in the final answer to numerical problems.
9. Formula can be taken as implied from the calculations even if not explicitly written.
10. In short answer type question, asking for two features / characteristics / properties if a candidate writes three features, characteristics / properties or more, only the correct two should be evaluated.
11. Full marks should be awarded to a candidate if his / her answer in a numerical problem is close to the value given in the scheme.
12. In compliance to the judgement of the Hon'ble Supreme Court of India, Board has decided to provide photocopy of the answer book(s) to the candidates who will apply for it along with the requisite fee. Therefore, it is all the more important that the evaluation is done strictly as per the value points given in the marking scheme so that the Board could be in a position to defend the evaluation at any forum.
13. The Examiner shall also have to certify in the answer book that they have evaluated the answer book strictly in accordance with the value points given in the marking scheme and correct set of question paper.
14. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title paper, correctly totaled and written in figures and words.
15. In the past it has been observed that the following are the common types of errors committed by the Examiners
    - Leaving answer or part thereof unassessed in an answer script.
    - Giving more marks for an answer than assigned to it or deviation from the marking scheme.
    - Wrong transference of marks from the inside pages of the answer book to the title page.
    - Wrong question wise totaling on the title page.
    - Wrong totaling of marks of the two columns on the title page.
    - Wrong grand total.
    - Marks in words and figures not tallying.
    - Wrong transference to marks from the answer book to award list.
    - Answer marked as correct ( ) but marks not awarded.
    - Half or part of answer marked correct ( ) and the rest as wrong () but no marks awarded.

16. Any unassessed portion, non carrying over of marks to the title page or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
17. **The Marking Scheme carries only suggested value points for the answers. These are only Guidelines and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the marks will be awarded accordingly.**
18. **As per orders of the Hon'ble Supreme Court, the candidates would be now permitted to obtain photocopy of the Answer Book on request on payment of the prescribed fee. All examiners/ Head Examiners are once gain reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.**
19. **All the Head Examiners/Examiners are instructed that while Evaluating the answer scripts, if the answer is found to be totally incorrect, the (x) should be marked on the incorrect answer and awarded '0' marks.**

PHYSICS MARKING SCHEME

Q.NO.	Expected Answer/Value Points	Marks	Total Marks
1	Electron (No explanation need to be given. If a student only writes the formula for frequency of charged particle (or $\nu_c \; \alpha \; \frac{q}{m}$) award ½ mark)	1	1
2	(a) Ultra violet rays (b) Ultra violet rays / Laser	½ ½	1
3	 The graph I_2 corresponds to radiation of higher intensity [Note: Deduct this ½ mark if the student does not show the two graphs starting from the same point.] (Also accept if the student just puts some indicative marks, or words, (like tick, cross, higher intensity) on the graph itself.	½ ½	1
4	Daughter nucleus	1	1
5	Sky wave propagation	1	1
	(SECTION – B)		
6	Formula — ½ mark Stating that currents are equal — ½ mark Ratio of powers — 1mark Power = I^2R The current, in the two bulbs, is the same as they are connected in series. $\therefore \frac{P_1}{P_2} = \frac{I^2R_1}{I^2R_2} = \frac{R_1}{R_2}$ $= \frac{1}{2}$	½ ½ ½ ½	2
7	Writing the equation — 1 mark Finding the current — 1 mark By Kirchoff's law, we have, for the loop ABCD, +200 – 38i– 10 = 0	1	

	$\therefore i = \frac{190}{38}$ A= 5A	1	2
			
	Alternatively:		
	Finding the Net emf — 1 mark Stating that I = $\frac{V}{R}$ — ½ mark Calculating I — ½ mark		
	The two cells being in 'opposition', ∴net εmf = $(200 - 10)$V = 190 V	1	
	Now $I = \frac{\text{V}}{R}$	½	
	$\therefore\ I = \frac{190\text{ V}}{38\,\Omega} = 5$ A	½	2
	[**Note**: Some students may use the formulae $\frac{\varepsilon}{r} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}$, and $r = {(r_1 r_2)}/{(r_1 + r_2)}$ For two cells connected in parallel They may then say that r = 0; ε is indeterminate and hence I is also indeterminate Award full marks(2) to students giving this line of reasoning.]		
	OR		
	Stating the formula — 1mark Calculating r — 1mark		
	We have $r = \left(\frac{l_1}{l_2} - 1\right)R \quad = \left(\frac{l_1 - l_2}{l_2}\right)R$	1	
	$\therefore r = \left(\frac{350 - 300}{300}\right) \times 9\Omega$	½	
	$= \frac{50}{300} \times 9\Omega = 1.5\Omega$	½	2
8	a) Reason for calling IF rays as heat rays — 1 mark b) Explanation for transport of momentum — 1 mark		
	a) Infrared rays are readily absorbed by the (water) molecules in most of the substances and hence increases their thermal motion. (If the student just writes that "infrared ray produce heating effects", award ½ mark only)	1	

	b) Electromagnetic waves can set (and sustain) charges in motion. Hence, they are said to transport momentum. (Also accept the following: Electromagnetic waves are known to exert 'radiation pressure'. This pressure is due to the force associated with rate of change of momentum. Hence, EM waves transport momentum)	1	2
9	Calculating the energy of the incident photon — 1 mark Identifying the metals — ½ mark Reason — ½ mark The energy of a photon of incident radiation is given by $E=\frac{hc}{\lambda}$ $\therefore E = \frac{6.63\times10^{-34}\times3\times10^{8}}{(412.5\times10^{-9})\times(1.6\times10^{-19})}$ eV $\cong 3.01$eV Hence, only Na and K will show photoelectric emission [**Note**: Award this ½ mark even if the student writes the name of <u>only one</u> of these metals] <u>Reason:</u> The energy of the incident photon is more than the work function of only these two metals.	½ ½ ½ ½	2
10	Formula for modulation index — 1 mark Finding the peak value of the modulating signal — 1 mark We have $\mu = \frac{A_m}{A_c}$ Here $\mu = 60\% = \frac{3}{5}$ $\therefore A_m = \mu A_c = \frac{3}{5}\times 15$V = 9V	1 ½ ½	2
	Section C		
11	a) Finding the resultant force on a charge Q — 2 marks b) Potential Energy of the system — 1 mark a) Let us find the force on the charge Q at the point C Force due to the other charge Q $F_1 = \frac{1}{4\pi\epsilon_o}\frac{Q^2}{(a\sqrt{2})^2} = \frac{1}{4\pi\epsilon_o}\left(\frac{Q^2}{2a^2}\right)$ (along AC) Force due to the charge q (at B), F_2 $= \frac{1}{4\pi\epsilon_o}\frac{qQ}{a^2}$ along BC Force due to the charge q (at D), F_3 $= \frac{1}{4\pi\epsilon_o}\frac{qQ}{a^2}$ along DC 	½ ½	

Resultant of these two equal forces

$F_{23} = \frac{1}{4\pi\epsilon_o} \frac{qQ(\sqrt{2})}{a^2}$ (along AC) ½

∴Net force on charge Q (at point C)

$F = F_1 + F_{23} = \frac{1}{4\pi\epsilon_o} \frac{Q}{a^2}\left[\frac{Q}{2} + \sqrt{2}q\right]$ ½

This force is directed along AC

(For the charge Q, at the point A, the force will have the same magnitude but will be directed along CA)

[Note : Don't deduct marks if the student does not write the direction of the net force , F]

b) Potential energy of the system

$= \frac{1}{4\pi\epsilon_0}\left[4\frac{qQ}{a} + \frac{q^2}{a\sqrt{2}} + \frac{Q^2}{a\sqrt{2}}\right]$ ½

$= \frac{1}{4\pi\epsilon_0 a}\left[4qQ + \frac{q^2}{\sqrt{2}} + \frac{Q^2}{\sqrt{2}}\right]$ ½ **3**

OR

a) Finding the magnitude of the resultant force on charge q	2 marks
b) Finding the work done	1 mark

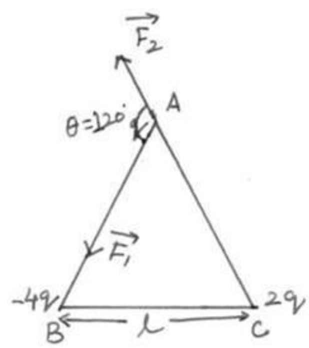
a) Force on charge q due to the charge -4q

$F_1 = \frac{1}{4\pi\epsilon_0}\left(\frac{4q^2}{l^2}\right)$, along AB ½

Force on the charge q, due to the charge 2q

$F_2 = \frac{1}{4\pi\epsilon_0}\left(\frac{2q^2}{l^2}\right)$, along CA

The forces F_1 and F_2 are inclined to each other at an angle of 120°



Hence, resultant electric force on charge q

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2cos\theta}$$ ½

$$= \sqrt{F_1^2 + F_2^2 + 2F_1F_2cos120^0}$$

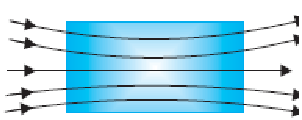
$$= \sqrt{F_1^2 + F_2^2 - F_1F_2}$$ ½

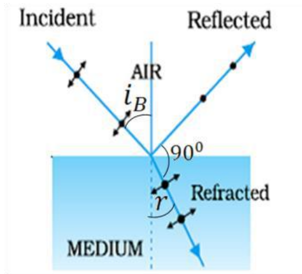
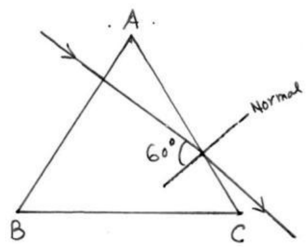
$$= \left(\frac{1}{4\pi\epsilon_0}\frac{q^2}{l^2}\right)\sqrt{16 + 4 - 8}$$

$$= \frac{1}{4\pi\epsilon_0}\left(\frac{2\sqrt{3}\,q^2}{l^2}\right)$$ ½

(b) Net P.E. of the system

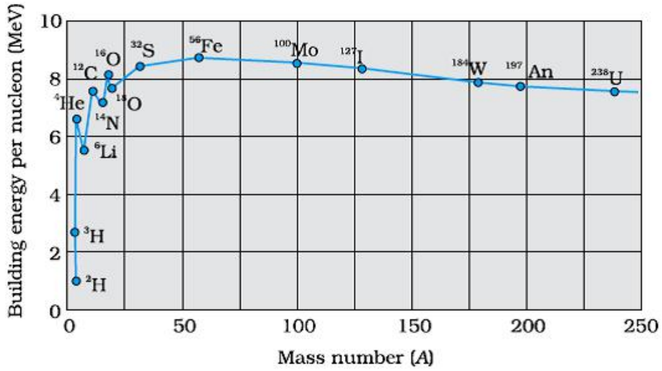
	$= \frac{1}{4\pi\epsilon_0} \cdot \frac{q^2}{l}[-4+2-8]$ $= \frac{(-10)}{4\pi\epsilon_0}\frac{q^2}{l}$ $\therefore$ Work done = $\frac{10\, q^2}{4\pi\epsilon_0 l} = \frac{5q^2}{2\pi\epsilon_0 l}$	½ ½	3
12	a) Definition and SI unit of conductivity ½ + ½ marks b) Derivation of the expression for conductivity 1 ½ marks Relation between current density and electric field ½ mark a) The conductivity of a material equals the reciprocal of the resistance of its wire of unit length and unit area of cross section. **[Alternatively**: The conductivity (σ) of a material is the reciprocal of its resistivity (ρ)] (Also accept $\sigma = \frac{1}{\rho}$) Its SI unit is $\left(\frac{1}{ohm-metre}\right)/ohm^{-1}m^{-1}/(mho\ \text{m}^{-1})/$siemen m^{-1} b) The acceleration, $\vec{a} = -\frac{e}{m}\vec{E}$ The average drift velocity, v_d, is given by $v_d = -\frac{eE}{m}\tau$ (τ = average time between collisions/ relaxation time) If n is the number of free electrons per unit volume, the current I is given by $I = neA\|v_d\|$ $= \frac{e^2 A}{m}\ \tau\, n\|E\|$ But $I = \|j\|$A (j= current density) We, therefore, get $\|j\| = \frac{ne^2}{m}\ \tau\ \|E\|$, The term $\frac{ne^2}{m}\ \tau$ is conductivity. $\therefore\ \sigma = \frac{ne^2\tau}{m}$ ⇨ $J = \sigma E$	½ ½ ½ ½ ½ ½	3
13	a) Formula and Calculation of work done in the two cases (1+ 1) marks b) Calculation of torque in case (ii) 1 mark **(a)** Work done = mB(cos$\theta_1 -$ cosθ_2) (i) $\theta_1 = 60^0, \theta_2 = 90^0$ $\therefore$work done = mB(cos$60^0 -$ cos90^0) $= m\text{B}\left(\frac{1}{2} - 0\right) = \frac{1}{2}m$B	½	

	$= \frac{1}{2} \times 6 \times 0.44$ J =1.32J (ii) $\theta_1 = 60^0, \theta_2 = 180^0$ ∴work done = mB$(\cos60^0 - \cos180^0)$ = $m\text{B}\left(\frac{1}{2} - (-1)\right) = \frac{3}{2}m\text{B}$ $= \frac{3}{2} \times 6 \times 0.44$ J =3.96J [Also accept calculations done through changes in potential energy.] **(b)** Torque = $\lvert \vec{m} \times \vec{B} \rvert = m\text{B} \sin\theta$ For $\theta = 180^0$, we have Torque = $6 \times 0.44 \sin180^0$=0 [If the student straight away writes that the torque is zero since magnetic moment and magnetic field are anti parallel in this orientation, award full 1mark]	½ ½ ½ ½ ½	3
14	a) Expression for Ampere's circuital law — ½ mark Derivation of magnetic field inside the ring — 1 mark b) Identification of the material — ½ mark Drawing the modification of the field pattern — 1 mark a) From Ampere's circuital law, we have, $\oint \vec{B}.d\vec{l} = \mu_o \mu_r I_{enclosed}$ (i) For the field inside the ring, we can write $\oint \vec{B}.d\vec{l} = \oint Bdl = B.2\pi r$ (r = radius of the ring) Also, $I_{enclosed} = (2\pi rn)I$ using equation (i) $\therefore\ B.2\pi r = \mu_o \mu_r.(n.2\pi r)I$ $\therefore\ B = \mu_o \mu_r nI$ [Award these $\left(\frac{1}{2} + \frac{1}{2}\right)$ marks even if the result is written without giving the derivation] b) The material is paramagnetic. The field pattern gets modified as shown in the figure below. 	½ ½ ½ ½ **1**	3
15	a) Diagram — ½ mark Polarisation by reflection — 1 mark b) Justification — 1 mark Writing yes/no — ½ mark a) The diagram, showing polarisation by reflection is as shown. [Here the reflected and refracted rays are at right angle to each other.]		

	 $\therefore\ r = \left(\frac{\pi}{2} - i_B\right)$ $\therefore\ \mu = \left(\frac{\sin i_B}{\sin r} = \tan i_B\right)$ Thus light gets totally polarised by reflection when it is incident at an angle i_B(Brewster's angle), where $i_B = \tan^{-1}\mu$ b) The angle of incidence, of the ray, on striking the face AC is i= 60^0(as from figure) Also, relative refractive index of glass, with respect to the surrounding water, is  $\mu_r = \frac{3/2}{4/3} = \frac{9}{8}$ Also $\sin i = \sin 60^0 = \frac{\sqrt{3}}{2} = \frac{1.732}{2}$ =0.866 For total internal reflection, the required critical angle, in this case, is given by $\sin i_c = \frac{1}{\mu} = \frac{8}{9} \simeq 0.89$ $\therefore\ i < i_c$ Hence the ray would not suffer total internal reflection on striking the face AC [The student may just write the two conditions needed for total internal reflection without analysis of the given case. The student may be awarded (½ + ½) mark in such a case.]	½ ½ ½ ½ ½ ½	3
16	a) Finding the (modified) ratio of the maximum and minimum intensities — 2 marks b) Fringes obtained with white light — 1mark a) After the introduction of the glass sheet (say, on the second slit), we have $\frac{I_2}{I_1} = 50\ \% = \frac{1}{2}$ $\therefore$ Ratio of the amplitudes $= \frac{a_2}{a_1} = \sqrt{\frac{1}{2}} = \frac{1}{\sqrt{2}}$	½	

	Hence $\frac{I_{max}}{I_{min}} = \left(\frac{a_1 + a_2}{a_1 - a_2}\right)^2$	½	
	$= \left(\frac{1+\frac{1}{\sqrt{2}}}{1-\frac{1}{\sqrt{2}}}\right)^2$	½	
	$=\left(\frac{\sqrt{2}+1}{\sqrt{2}-1}\right)^2$ $(\simeq 34)$	½	
	b) The central fringe remains white. No clear fringe pattern is seen after a few (coloured) fringes on either side of the central fringe. [Note : For part (a) of this question, The student may (i) Just draw the diagram for the Young's double slit experiment. Or (ii) Just state that the introduction of the glass sheet would introduce an additional phase difference and the position of the central fringe would shift. For all such answers, the student may be awarded the full (2) marks for this part of this question.]	**1**	**3**
17	Lens maker's formula — ½ mark Formula for 'combination of lenses' — ½ mark Obtaining the expression for μ — 2 marks		
	Let μ_l denote the refractive index of the liquid. When the image of the needle coincides with the lens itself ; its distance from the lens, equals the relevant focal length.	½	
	With liquid layer present, the given set up, is equivalent to a combination of the given (convex) lens and a concavo plane / plano concave 'liquid lens'.		
	We have $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	½	
	and $\frac{1}{f} = \left(\frac{1}{f_1} + \frac{1}{f_2}\right)$	½	
	as per the given data, we then have $\frac{1}{f_2} = \frac{1}{y} = (1.5 - 1)\left(\frac{1}{R} - \frac{1}{(-R)}\right)$ $= \frac{1}{R}$	½	
	$\therefore \frac{1}{x} = (\mu_l - 1)\left(-\frac{1}{R}\right) + \frac{1}{y} = \frac{-\mu_l}{y} + \frac{2}{y}$	½	
	$\therefore \frac{\mu_l}{y} = \frac{2}{y} - \frac{1}{x} = \left(\frac{2x-y}{xy}\right)$ $or\ \mu_l = \left(\frac{2x - y}{x}\right)$	½	**3**

18	a) Statement of Bohr's postulate — 1 mark Explanation in terms of de Broglie hypothesis — ½ mark b) Finding the energy in the $n = 4$ level — 1 mark Estimating the frequency of the photon — ½ mark		
	a) Bohr's postulate, for stable orbits, states "The electron, in an atom, revolves around the nucleus only in those orbits for which its angular momentum is an integral multiple of $\frac{h}{2\pi}$ (h = Planck's constant),"	½	
	[Also accept $mvr = n.\frac{h}{2\pi}$ $(n = 1,2,3, \dots \dots)$ As per de Broglie's hypothesis $\lambda = \frac{h}{p} = \frac{h}{mv}$ For a stable orbit, we must have circumference of the orbit= $n\lambda$ $(n = 1,2,3, \dots \dots)$ $\therefore 2\pi r = n.mv$ or $mvr = \frac{nh}{2\pi}$	½	
	Thus de –Broglie showed that formation of stationary pattern for intergral 'n' gives rise to stability of the atom. This is nothing but the Bohr's postulate	½	
	b) Energy in the $n = 4$ level = $\frac{-E_o}{4^2} = -\frac{E_o}{16}$	½	
	$\therefore$ Energy required to take the electron from the ground state, to the $n = 4$ level = $\left(-\frac{E_o}{16}\right) - (-E_o)$ $= \frac{-1+16}{16}$ $= \frac{15}{16}E_o$ $= \frac{15}{16} \times 13.6 \times 1.6 \times 10^{-19}$J	½	
	Let the frequency of the photon be v, we have $hv = \frac{15}{16} \times 13.6 \times 1.6 \times 10^{-19}$ $\therefore v = \frac{15 \times 13.6 \times 1.6 \times 10^{-19}}{16 \times 6.63 \times 10^{-34}}$ Hz $\simeq 3.1 \times 10^{15}$Hz (Also accept 3×10^{15}Hz)	½	**3**
19	a) Drawing the plot — 1 mark Explaining the process of Nuclear fission and Nuclear fusion — ½ + ½ marks b) Finding the required time — 1 mark		
	a) The plot of (B.E / nucleon) verses mass number is as shown.		



[Note : Also accept the diagram that just shows the general shape of the graph.] **1**

From the plot we note that

i) During nuclear fission

A heavy nucleus in the larger mass region (A>200) breaks into two middle level nuclei, resulting in an increase in B.E/ nucleon. This results in a release of energy. **½**

ii) During nuclear fusion

Light nuclei in the lower mass region (A<20) fuse to form a nucleus having higher B.E / nucleon. Hence Energy gets released. **½**

[Alternatively: As per the plot: During nuclear fission as well as nuclear fusion, the final value of B.E/ nucleon is more than its initial value. Hence energy gets released in both these processes.]

b) We have

$$3.125\% = \frac{3.125}{100} = \frac{1}{32} = \frac{1}{2^5}$$ **½**

Half life = 10 years

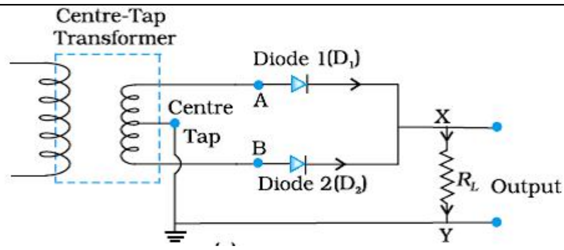
∴ Required time = 5x 10 years

= 50 Years **½** **3**

20

a) Drawing the labeled circuit diagram	1 mark
Explanation of working	1 mark
b) Circuit Symbol and	½ + ½ marks
Truth table of NAND gate	

a) The labeled circuit diagram, for the required circuit is as shown.



1

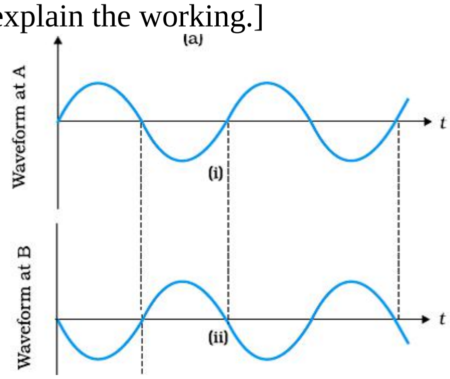
The working of this circuit is as follows:

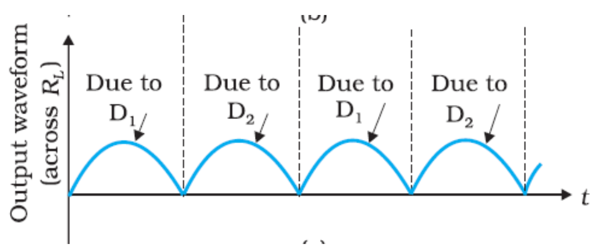
i) During one half cycle(of the input ac) diode D_1 alone gets forward biased and conducts. During the other half cycle, it is diode D_2 (alone) that conducts. ½

ii) Because of the use of the center tapped transformer the current though the load flows in the same direction in both the half cycles. ½

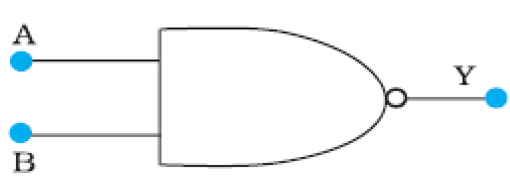
Hence we get a unidirectional/ direct current through the load, when the input is alternating current.

[Alternatively: The student may just use the following diagrams to explain the working.]





b) The circuit symbol, and the truth table, for the NAND gate, are given below.



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

½ + ½

3

<table>
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<td>21</td>
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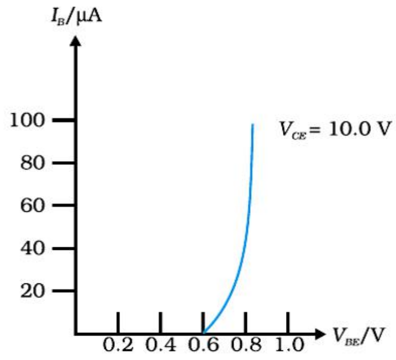
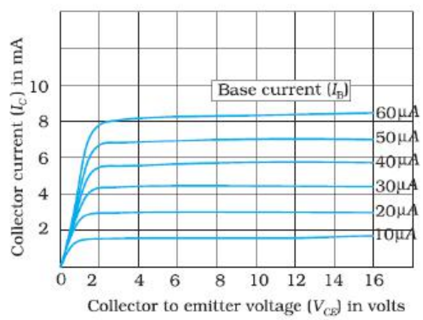
Input and Output characteristics — 1+1marks
Determination of
a) Input resistance — ½ mark
b) Current amplification factor — ½ mark

The input and output characteristics, of a *n-p-n* transistor, in its CE configuration, are as shown.


<u>Input resistance</u>
$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$


The relevant values can be read from the input characteristics.
Current amplification factor
$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)$$
The relevant values can be read from the output characteristics, corresponding to a given value of V_{CE}.
</td>
<td>1

½

1

½</td>
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<td>22</td>
<td>
a) Stating the three reasons — ½ + ½ + ½ mark
b) Graphical representation of the audio signal, carrier wave and the amplitude modulated wave — ½ + ½ + ½ mark

a) The required three reasons are :
(i) A reasonable length of the transmission antenna.
(ii) Increase in effective power radiated by the antenna.
(iii)Reduction in the possibility of ‘mix-up’ of different signals.
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<td>½
½
½</td>
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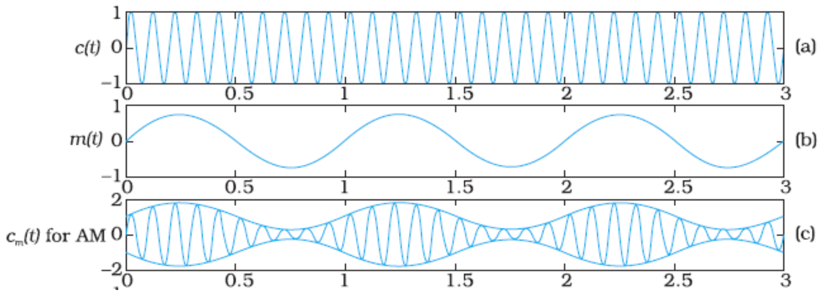
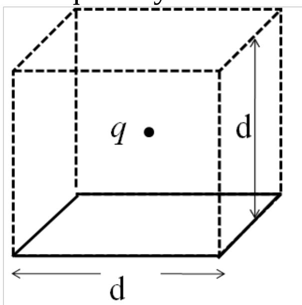
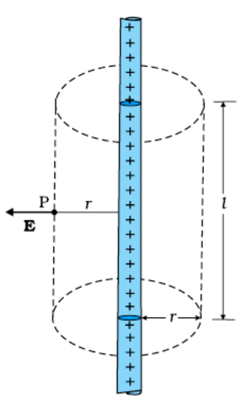
	b) The required graphical representation is as shown below  	½ ½ ½	3
	SECTION D		
23	a) Name of device ½ mark One cause for power dissipation ½ mark b) Reduction of power loss in long distance transmission 1 mark c) Two values each displayed by teacher and Geeta (½ x 4=2)marks a) Transformer Cause of power dissipation i) Joule heating in the windings. ii) Leakage of magnetic flux between the coils. iii) Production of eddy currents in the core. iv) Energy loss due to hysteresis. [Any one / any other correct reason of power loss] b) ac voltage can be stepped up to high value, which reduces the current in the line during transmission, hence the power loss(I^2R) is reduced considerably while such stepping up is not possible for direct current. [Also accept if the student explains this through a relevant example.] c) Teacher : Concerned, caring, ready to share knowledge . Geeta : Inquisitive, scientific temper, Good listener, keen learner (any other two values for the teacher and Geeta)	½ ½ **1** ½+ ½ ½+ ½	**4**
	SECTION E		
24	a) Definition of electric flux 1 mark Stating scalar/ vector ½ mark Gauss's Theorem ½ mark Derivation of the expression for electric flux 1 marks b) Explanation of change in electric flux 2 marks a) Electric flux through a given surface is defined as the dot product of electric field and area vector over that surface. Alternatively $\phi = \int_s \vec{E}.\vec{dS}$ Also accept Electric flux, through a surface equals the surface integral of the	 **1**	

	electric field over that surface.		
	It is a scalar quantity	½	
		½	
	Constructing a cube of side 'd' so that charge 'q' gets placed within of this cube (Gaussian surface)		
	According to Gauss 's law the Electric flux $\emptyset = \frac{Charge\ enclosed}{\varepsilon_0}$ $= \frac{q}{\varepsilon_0}$	½	
	This is the total flux through all the six faces of the cube. Hence electric flux through the square $\frac{1}{6} \times \frac{q}{\varepsilon_0} = \frac{q}{6\varepsilon_0}$	½	
	b) If the charge is moved to a distance d and the side of the square is doubled the cube will be constructed to have a side 2d but the total charge enclosed in it will remain the same. Hence the total flux through the cube and therefore the flux through the square will remain the same as before.	**1+1**	**5**
	[Deduct 1 mark if the student just writes No change /not affected without giving any explanation.]		
	OR		
	a) Derivation of the expression for electric field $\vec{E}$ — 3 marks b) Graph to show the required variation of the electric field — 1 mark c) Calculation of work done — 1 mark		
	a) 	½	

To calculate the electric field, imagine a cylindrical Gaussian surface, since the field is everywhere radial, flux through two ends of the cylindrical Gaussian surface is zero. ½

At cylindrical part of the surface electric field $\vec{E}$ is normal to the surface at every point and its magnitude is constant.

Therefore flux through the Gaussian surface.

= Flux through the curved cylindrical part of the surface.

= E$\times 2\pi rl$ ------------------(i) ½

Applying Gauss's Law

Flux $\phi = \frac{q_{enclosed}}{\varepsilon_0}$

Total charge enclosed

= Linear charge density $\times\, l$

= λl

$\therefore \phi = \frac{\lambda L}{\varepsilon_0}$ ------------------(ii) ½

Using Equations (i) & ii

$E \times 2\,\pi\, rl = \frac{\lambda l}{\varepsilon_o}$

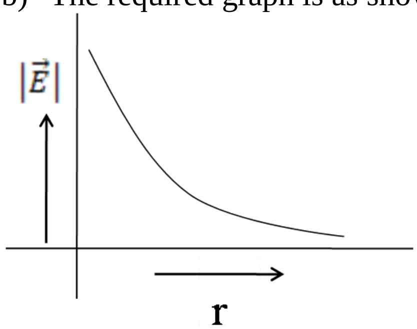
⇨ $E = \frac{\lambda}{2\pi\varepsilon_o r}$ ½

In vector notation ½

$\vec{E} = \frac{\lambda}{2\pi\varepsilon_o r}\ \hat{n}$

(where $\hat{n}$ is a unit vector normal to the line charge)

b) The required graph is as shown:



1

a) Work done in moving the charge 'q'. Through a small displacement 'dr'

$dW = \vec{F}.\vec{dr}$

$dW = q\vec{E}.\vec{dr}$

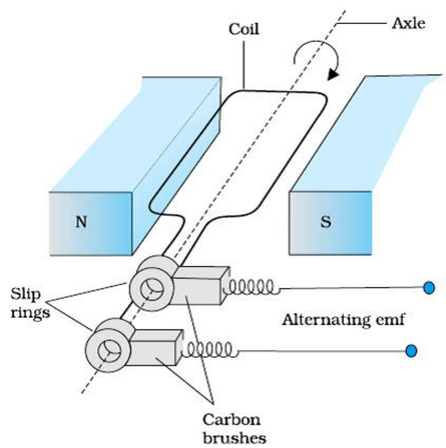
$= qEdrcos0$

$dW = q \times \frac{\lambda}{2\pi\varepsilon_o r} dr$ ½

Work done in moving the given charge from r_1 to $r_2 (r_2 > r_1)$

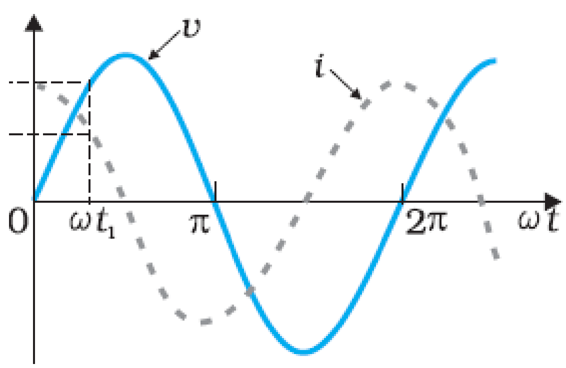
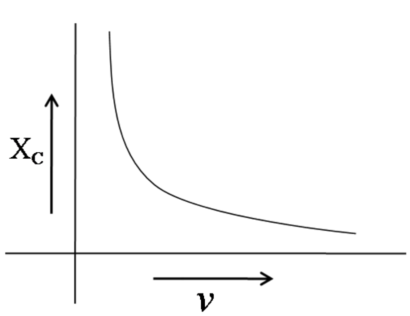
$W = \int_{r_1}^{r_2} dW \int = \int_{r_1}^{r_2} \frac{\lambda q dr}{2\pi\varepsilon_o r}$

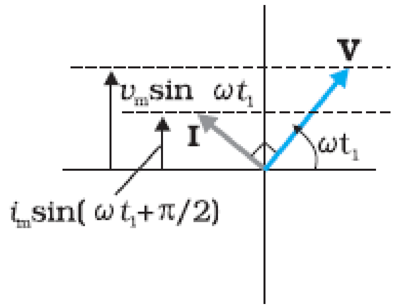
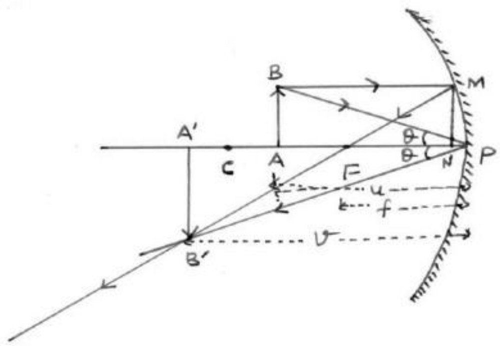
$W = \frac{\lambda q}{2\pi\varepsilon_o}[log_e r_2 - log_e r_1]$ ½

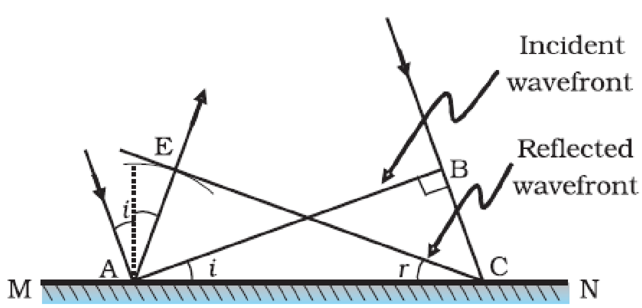
	$W = \frac{\lambda q}{2\pi\varepsilon_o}\left[log_e \frac{r_2}{r_1}\right]$		5
25	a) Principle of ac generator ½ mark working ½ mark Labeled diagram 1 mark Derivation of the expression for induced emf 1 ½ mark b) Calculation of potential difference 1 ½ mark a) The AC Generator works on the principle of electromagnetic induction. when the magnetic flux through a coil changes, an emf is induced in it. As the coil rotates in magnetic field the effective area of the loop, (i.e. A $\cos\theta$) exposed to the magnetic field keeps on changing, hence magnetic flux changes and an emf is induced.  When a coil is rotated with a constant angular speed 'ω' , the angle 'θ' between the magnetic field vector $\vec{B}$ and the area vector $\vec{A}$, of the coil at any instant 't' equals ωt; (assuming $\theta = O^0$ at t=o) As a result, the effective area of the coil exposed to the magnetic field changes with time ; The flux at any instant 't' is given by $\phi_B = NBA\cos\theta$ = NBA $\cos\omega t$ ∴ The induced emf e = - N $\frac{d\phi}{dt}$ = -NBA$\frac{d\phi}{dt}$ ($\cos\omega t$) e = NBAω $\sin\omega t$ b) Potential difference developed between the ends of the wings 'e' = Blv Given Velocity v= 900km/hour = 250m/s	½ ½ 1 ½ ½ ½ ½	

	Wing span (l) = 20 m		
	Vertical component of Earth's magnetic field $B_V = B_H \tan\delta$ $= 5\times10^{-4}\ (\tan 30^o)$ tesla	½	
	∴ Potential difference $= 5\times10^{-4}\ (\tan 30^o) \times 20 \times 250$ $= \frac{5\times20\times250\times10^{-4}}{\sqrt{3}}\ V$ = 1.44 volt	½	5
	Or		

a)	Identification of the device X	½
	Expression for reactance	½
b)	Graphs of voltage and current with time	1+1
c)	Variation of reactance with frequency	½
	(Graphical variation)	½
	d) Phasor Diagram	1

	a) X : capacitor	½	
	Reactance $X_c = \frac{1}{\omega C} = \frac{1}{2\pi \upsilon C}$	½	
	b) 	½ + ½	
	c) Reactance of the capacitor varies in inverse proportion to the frequency i.e. , $X_c \propto \frac{1}{\upsilon}$	1	
		1	

	 	1	5
26	(a) Ray diagram to show the required image formation 1 mark (b) Derivation of mirror formula 2 ½ marks Expression for linear magnification ½ mark (c) Two advantages of a reflecting telescope over a refracting telescope ½+½ marks		
	a)  	1	
	(b) In the above figure Δ BAP and ΔB'A'P are similar $\Rightarrow \frac{BA}{B'A'} = \frac{PA}{PA'}$ (i)	½	
	Similarly, Δ MNF and ΔB'A'F are similar $\Rightarrow \frac{MN}{B'A'} = \frac{NF}{FA'}$ (ii) As MN = BA NF≈ PF FA' = PA' – PF ∴ equation (ii) takes the following form $\frac{BA}{B'A'} = \frac{PF}{PA'-PF}$ (iii)	½	
	Using equation (i) and (iii) $\frac{PA}{PA'} = \frac{PF}{PA' - PF}$	½	
	For the given figure, as per the sign convention, PA =-u PA' = - v PF= -f $\Rightarrow \frac{-u}{-v} = \frac{-f}{-v-(-f)}$	½	

	$$\frac{u}{v} = \frac{f}{v-f}$$ uv –uf =vf Dividing each term by uvf, we get $$\frac{1}{f} - \frac{1}{v} = \frac{1}{u}$$ $$\Rightarrow \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$	½	
	Linear magnification = - $^{v}/_{u}$, (alternatively m = $\frac{h_i}{h_o}$)	½	
	c) Advantages of reflecting telescope over refracting telescope (i) Mechanical support is easier (ii) Magnifying power is large (iii) Resolving power is large (iv) Spherical aberration is reduced (v) Free from chromatic aberration (any two)	½ + ½	5
	OR		
	(a) Definition of wave front ½ mark Verification of laws of reflection 2 marks (b) Explanation of the effect on the size and intensity of central maxima 1+ 1marks (c) Explanation of the bright spot in the shadow of the obstacle ½ mark		
	(a)The wave front may be defined as a surface of constant phase. (Alternatively: The wave front is the locii of all points that are in the same phase)	½	
		1	
	Let speed of the wave in the medium be ‘v’ Let the time taken by the wave front, to advance from point B to point C is ‘τ’ Hence BC = $v\,\tau$ Let CE represent the reflected wave front Distance AE = $v\,\tau = BC$ $\Delta\, AEC$ and $\Delta\, ABC$ are congruent $\therefore\ \angle BAC = \angle ECA$	½	

	$\Rightarrow \angle i = \angle r$ (b) Size of central maxima reduces to half, (∵ Size of central maxima = $\frac{2\lambda D}{a}$) Intensity increases. This is because the amount of light, entering the slit, has increased and the area, over which it falls, decreases. (Also accept if the student just writes that the intensity becomes four fold) (c) This is because of diffraction of light. [Alternatively: Light gets diffracted by the tiny circular obstacle and reaches the centre of the shadow of the obstacle.] [Alternatively: There is a maxima, at the centre of the obstacle, in the diffraction pattern produced by it.]	½ ½ ½ ½ ½ ½	5