Strictly Confidential (For Internal and Restricted Use only)
Senior School Certificate Examination
Marking Scheme - Physics (Code 55/B)

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.

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	Section: A		
Q1	The final image will be formed between optical centre and focus.	1	1
Q2	Any one reason out of the following- 1. Height of Antenna 2. Effective power radiated 3. Mixing of the signals from different transmitters.	1	1
Q3	$\lambda = \frac{h}{\sqrt{2mqV}}$ $\sqrt{8} : 1$	½ ½	1
Q4	Electron revolves only in those orbits in which its angular momentum is the integral multiple of $\frac{h}{2\pi}$.	1	1
Q5	Due to higher concentration of holes in p-region.	1	1
	Section : B		
Q6	Formula 1 Substitution ½ Final Answer ½ $V = \frac{1}{4\pi\varepsilon_0}.\frac{q}{r}$; Net potential at O $V_0 = V_1 + V_2$; $V_1 = -V_2$ $\therefore O = V_1 + V_2$ $\frac{1}{4\pi\varepsilon_0}.\frac{q_1}{x} = -\frac{1}{4\pi\varepsilon_0}.\frac{q_2}{(60-x)}$	1 ½	

	$\Rightarrow \frac{q_1}{q_2} = \frac{x}{(60-x)}$ *on simplification* x = 50 cm ∴ distance from q_2 = (60-50)= 10 cm	½	2
Q7	Definition 1 Reason 1 "Average velocity with which electrons drift in a conductor when potential difference is applied across its ends" From $\rho = \frac{m}{ne^2\tau}$ With the increase in temperature of the conductor, τ decreases. Therefore, resistivity increases.	1 1	2
Q8	Derivation 2 Net Force acting on the loop is equal to zero as opposite sides are acted upon by equal and opposite forces. $\therefore Net\ Torque = (f \times \perp distance)$ $\because F = IlB$ $\lvert\vec{\tau}\rvert = IlB \times (b \sin\theta)$ $\lvert\vec{\tau}\rvert = IB(lb \sin\theta)$ $\vec{\tau} = IB(\overrightarrow{A} \times \vec{B})$ $\vec{\tau} = (\overrightarrow{M} \times \vec{B})$ **OR** Working 2 When a current flows through the coil of a moving coil galvanometer, a torque starts acting on it which is given by $\tau = MB \sin\theta \quad where\ (M = nIA) \because \sin\theta = 1$ $\tau = nIAB ------(1)$ Due to this the coil turns, and the restoring torque, setup in the coil, is $\tau = C\theta ------(2)$	½ ½ ½ ½ ½ ½	2

	$(when\ C = Restoring\ Torque\ Constant)$ $\therefore In\ Equilibrium\ C\theta = nIAB$ $(\because c, n, A, B = constants)$ $\therefore I \propto \theta$	½ ½	2
Q9	Distinguishing between isotopes and isobars 1 One example of each ½ + ½ Isotopes : The atoms of an element which have the same atomic number and different mass number, are called isotopes. Isobar : The elements which have the same mass number but different atomic number are called isobars. Examples: (Isotopes) $_1H^1$, $_1H^2$ $_1H^3$; $_8O^{16}$ $_8O^{17}$; or any other pair (Isobars) $_{20}Ca^{40}$ $_{18}Ar^{40}$; or any other pair	½ ½ ½ ½	2
Q10	Conditions for total Internal Reflection 1 Relation between Critical Angle and Refractive Index 1 i. Light should travel from optically denser to a rarer medium. ii. Angle of incidence must be greater than the critical angle for the pair of media. Relation $\frac{b}{a}\mu / \mu = \frac{1}{\sin i_c}$	½ ½ 1	2
	Section : C		
Q11	(i) Calculation of value of charge 2 (ii) Effect on Flux and its Justification ½+½		

	i. From Gauss's Law $\varphi_E = \frac{q}{\varepsilon_0}$ $\therefore q = \varepsilon_0 \varphi_E$ $\therefore q = 8.85 \times 10^{-12} \times (-4\pi \times 10^3)$ $q = -0.111 \times 10^{-6} C$ $q = -0.111\ \mu C$ ii. Flux would remain same .i.e. $-4\pi \times 10^3\ Nm^2/c$, as flux depends on charge enclosed, not on the dimensions of Gaussian surface.	1 ½ ½ ½ ½	3
Q12	Statement 1 Derivation 2 The line integral of magnetic field around a closed loop is μ_0 times the current threading the loop. (Give full credit if the student just writes: $\oint \vec{B}.\vec{dl} = \mu_0 I$) Expression for magnetic field:- Around a current carrying wire. For a circle of radius r with it's center on the wire:- From Ampere's circuital law- $\oint \vec{B}.\vec{dl} = \mu_0 I$ ($\because \vec{B} \parallel \vec{dl} \therefore \theta = 0\ and\ \lvert\vec{B}\rvert = constant$) $\oint B.dl.\cos 0 = \mu_0 I$ $\therefore B \oint dl = \mu_0 I$ $\therefore B = \frac{\mu_0 I}{2\pi r}$	1 ½ ½ ½ ½	3
Q13	(a) Production of X-rays 1 (b) Use and frequency range of microwaves and Infrared rays ½ × 4 = 2 (a) X-rays are produced when a metal target is bombarded by high energy electrons.	1	

	(b) (i) Uses of microwave: Radar, satellites, microwave oven (or any other). $frequency: 3 \times 10^9 Hz \; to \; 3 \times 10^{11} Hz$ (ii) Uses of Infrared: Green House effect, to see through haze and fog or any other. $frequency: 3 \times 10^{11} Hz \; to \; 4 \times 10^{14} Hz$	½ + ½ =1 ½ + ½ =1	3
Q14	Explanation of working principle 2 Definition of current amplification factor 1 Working Principle: The a.c. signal in the input (Base-Emitter) circuit will change the base emitter voltage, which in turn will change base current and hence collector current. Due to this collector voltage $V_{CE} = V_{CC} - I_C R_L$ will change sinusoidally. The variation in the collector voltage will appear in the amplified form. Current amplification factor: Change in collector current (I_C) per unit change in base current (I_B), is called current amplification factor. $\beta = \frac{\Delta I_C}{\Delta I_B}$ **OR** Principle of full wave rectifier 1 Explanation of its working 2 Principle: Current in a diode flows only when it is forward biased. Working: A full wave rectifier uses two diodes. In one half of a.c. signal if one of the diodes is forward biased, it will conduct and the second diode being reverse biased,	½ ½ ½ ½ 1 1 1	3

	will not conduct. In second half of a.c. signal reverse will happen so other diode will conduct and give output across the load resistance.	1	3
Q15	(a) Required formula ½ Calculation of energy stored 1 (b) Common potential ½ Calculation 1 a. $U_i = \frac{1}{2} C_1 {V_1}^2 \qquad C_1 = 500 \times 10^{-12} F$ $V_1 = 500V$ $= \frac{1}{2} \times 500 \times 10^{-12} \times 100 \times 100$ $= 2.5 \times 10^{-6} J$ b. Energy stored by the system $U = \frac{1}{2}(C_1 + C_2)V^2$ $V = \frac{q_1 + q_2}{C_1 + C_2} = \frac{CV_1 + C_2V_2}{C_1 + C_2}$ $= \frac{500 \times 100 + 0}{1000}$ $= 50\, Volt$ $\therefore U = \frac{1}{2} \times (500 + 500) \times 10^{-12} \times 50 \times 50$ $= 1.25 \times 10^{-6} J$ (Give full marks to the students if they calculate the final energy by the formula $U = \frac{Q^2}{2C}$)	½ ½ ½ ½ ½	3

Q16	Distinguish between unpolarised light and plane polarized light 1 Condition for reflected light to be plane polarized 1 Expression for angle of incidence 1 Unpolarised light is that in which vibration of electric vectors are randomly distributed in a plane perpendicular to direction of propagation and polarized light is that in which vibrations of electric vector are confined in one direction in the plane <u>Condition</u> for reflected light to be plane polarized: Reflected and refracted beams are mutually perpendicular <u>Expression</u> $\mu = \tan i_p$ $\therefore i_p = \tan^{-1} \mu$	1 1 1	3
Q17	Reason for compound microscope preferred over simple microscope 1 Calculation of length of tube of microscope 2 Compound microscope has larger magnifying power as compared to simple microscope <u>Length of Tube</u> – $f_0 = 1.0\ cm, f_e = 2\ cm$ $Magnifying\ Power = \frac{L}{f_0}\frac{D}{f_e}$ $250 = \frac{L \times 25}{1 \times 2}$ $L = 20\ cm$	1 ½ + ½ ½ ½	3
Q18	Principle of cyclotron 1 Working 1 ½ Use of cyclotron ½		

	Principle of cyclotron: Charged particles acquire large amount of energy by passing through electric field again and again with the help of magnetic field. Working: Cyclotron consists of two hollow semicircular disc like metal containers in the form of Dees connected to high frequency oscillating electric field and uniform magnetic field acting perpendicularly. Charged particle describes semicircular path inside each dee and its radius keeps on increasing with the increase of velocity. The frequency of revolution will match with that of applied field. Thus, the particle keeps accelerating till it comes out. Use: To bombard nuclei with energetic particles accelerated by it to carry out nuclear reactions/ any other application.	1 1½ ½	3
Q19	(a) Formation of barrier potential 2 (b) Effect on width of depletion layer in i. Forward bias ii. Reverse bias ½ + ½ Formation of Potential Barrier: Due to difference in the concentration of charge carriers across the junction in p and n sides holes diffuse from p side to n side and electron diffuse from n side to p side which give rise to diffusion current across the junction. Near the junction electrons diffuse from n to p side to create positive space charge region in n-side and holes diffused from p to n side create negative space charge region in p-side. The positive and negative space charge region near the junction is called depletion layer. Due to deficiency of holes and electrons in p and n sides a potential barrier is setup across the junction. Electric field is set up in the layer which is directed from n to p side and gives rise to drift current.	½ ½ ½ ½	

	Effect on width of depletion layer decreases/ becomes less in forward bias increases/ becomes more in reverse bias.	½ ½	3
Q20	Identification of W_0 and K.E. ½ Formula required ½ Calculation of energy of photon ½ Calculation of frequency 1 $W_0 = 2.5\ eV$; K.E. = $4.1\ eV$ $K.E = eV_0 = 4.1\ eV$ $\therefore E = w_0 + K.E$ $= 2.5 + 4.1 = 6.6\ eV$ $E = hv = 6.6 \times 1.6 \times 10^{-19}$ $v = \frac{6.6 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$ $or = 1.6 \times 10^{15}\ Hz$	½ + ½ ½ + ½ ½ ½	3
Q21	Principle of a step up transformer 1 Derivation for Secondary voltage 1 Derivation for Secondary current 1 Principle: Change of electric current in one coil(primary) changes the magnetic flux in the secondary coil; this in turn induces an emf in it. (If the students only write that transformer works on mutual induction, award half mark only)	1	

	Derivation for <u>Secondary Voltage</u> for step up transformer $N_s > N_p$ $\phi_s = N_s\,\phi \quad \therefore \frac{d\phi_s}{dt} = N_s \frac{d\,\phi}{dt}$ $-e_s = N_s \frac{d\,\phi}{dt}$ Similarly, $-e_p = N_p \frac{d\,\phi}{dt}$ $\frac{e_s}{e_p} = \frac{N_s}{N_p}$ $e_s = e_p \frac{N_s}{N_p} \qquad (e_s > e_p)$ <u>Secondary current</u> for an ideal transformer $P_0 = P_i$ $e_s I_s = e_p I_p$ $\frac{e_s}{e_p} = \frac{I_s}{I_p} = \frac{N_s}{N_p}$ $I_s = I_p \times \frac{N_s}{N_p} \qquad (I_s < I_p)$	½ ½ ½ ½	3
Q22	a. Characteristic properties (Any two) ½ + ½ b. Explanation for release of Energy in nuclear fission and fusion 1+1 a. i. These are short ranged, strongest forces of nature. ii. These are charge independent/ spin dependant/ saturated/ non central forces. **(or any two)** b. In the nuclear fission, a very heavy nucleus, because of its lower B.E. per nucleon, breaks into two lighter nuclei having higher B.E. per nucleon.	½ ½ ½	

	The mass defect appears as the energy released. In nucleon fusion very light nuclei fuse together to form a comparatively heavier nucleus with higher B.E. per nucleon. The mass defect appears as the energy released.	½ 1	 3
	Section: D		
Q23	Any two values ½ + ½ Harmful effect of long use of mobile 1 Calculation of Range 2		
	a. Values: Caring, Scientific aptitude (or any other two values.)	1	
	b. Overexposure of electromagnetic radiation can cause skin cancer, memory loss, insomania (any other harmful effects)	1	
	c. $h = 320\,m$ $R = 64 \times 10^5\,mts$		
	$range\ x = \sqrt{2Rh}$	1	
	$= \sqrt{2 \times 64 \times 10^5 \times 320}$	½	
	$= 64000\,m$		4
	$= 64\,km$	½	
	Section: E		
Q24	Identification of three elements 1 ½ Expression for net impedance 1 for current 2 ½		
	Identification a) Resistor b) Inductor c) Capacitor	 ½ ½ ½	
	Let $i = I_m \sin(\omega t + \theta)$ be the current flowing in the		

	series combination of elements X, Y and Z. Also let $V_X, V_Y \text{ and } V_Z$ be the voltage across the elements , respectively, where $V_X = IR$ $V_Y = IX_L;\ where\ X_L = \omega L$ $V_Z = IX_C; when\ X_C = \frac{1}{\omega C}$ Effective voltage across the series combination $V^2 = {V_X}^2 + (V_Y - V_Z)^2$ $= I^2[R^2 + (X_L - X_C)^2]$ $= I^2[R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2]$ $I = \frac{V}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$ $As\ I = \frac{V}{Z}$ $\therefore Impedance\ Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$ **OR** Definition of Self inductance and its S.I unit ½ +½ Expression of self inductance of a long solenoid 2 Definition of eddy currents 1 Two Applications ½ + ½ a) <u>Self Inductance</u> is numerically equal to magnetic flux linked with a coil when unit current flows through it. Alternatively <u>Self Inductance</u> is numerically equal to induced e.m.f	½ ½ ½ ½ ½ ½ 1 ½	5

	produced in a coil when rate of change of current in it is unity. S.I unit – henry (H)	½	
	b) Expression for <u>Self – Inductance</u> Let a long solenoid of length l, area of cross section A has n number of turns per unit length. If I is current passed, then magnetic field produced in solenoid $B = \mu_0 nI$ $\therefore Magnetic\ Flux\ \varphi = BA \times N = \mu_0 nIA \times nl$ $(\because N = nl\ for\ a\ solenoid)$ $Since\ \varphi = L\ I$ $\mu_0 n^2 AlI = L\ I$ $or\ L = \mu_0 n^2 Al$ $or\ L = \mu_0 \frac{N^2 A}{l}$	½ ½ ½ ½	
	c) <u>Eddy currents</u> – are the induced currents in the bulk pieces of conductors due to change of magnetic flux in them. <u>Applications</u> (any two) 1. Dead beat galvanometer 2. Induction motor 3. Induction brakes 4. Induction furnace 5. Diathermy 6. Speedometer	1 ½ + ½	5

Q25	Principle of device 1 Definition of potential gradient and its S.I unit ½ + ½ Method of increasing sensitivity 1 Difference in this method and that of voltmeter for the same purpose 2		
	<u>Principle of the device</u> (potentiometer) When a constant current flows in a wire of uniform area of cross-section, the potential drop across any part of the wire is directly proportional to its length (If a student only writes $V \alpha L$ then award only ½ mark)	1	
	<u>Potential gradient:</u> It is defined as the potential difference per unit length of the wire	½	
	$$S.I\ unit = \frac{V}{m}$$	½	
	Method of increasing sensitivity by decreasing the value of potential gradient: i. By increasing length of potentiometer wire. ½ ii. By decreasing current flowing in the wire ½		
	<u>Difference from Voltmeter</u>: Potentiometer is based on the principle of null deflection, so it does not draw any current from the circuit at balanced condition and hence it gives accurate reading.	1	
	Voltmeter always draws some current and hence gives less reading.	1	5

OR

(a) Obtaining balanced condition in a Wheat Stone bridge	2 ½
(b) Use of balanced condition in Wheat Stone bridge to find unknown resistance	1 ½
Condition	1

a) Consider four resistances P Q R & S connected to form a rectangular loop ABCD with a source of emf is connected across two diagonally opposite vertices and a galvanometer is connected between rest of the two vertices. ½

Let I_1 *and* I_2 be the current in upper & lower branch consisting of two resistances each P & R and Q and S. ½

Using Kirchhoff's Law in the loop – ABDA ½

$$PI_1 - RI_2 = 0$$

i.e. $PI_1 = RI_2$ --- (1)

{As $I_g = 0$ *in balanced condition*}

Similarly, using Kirchhoff's Law in the loop BCDB

$$QI_1 - SI_2 = 0 \quad ½$$

$$QI_1 = SI_2 \quad \text{---(2)}$$

Dividing (1) by (2)

$$\frac{PI_1}{QI_1} = \frac{RI_2}{SI_2} \Rightarrow \frac{P}{Q} = \frac{R}{S} \quad \text{---(A)} \quad ½$$

b) As meter bridge is the application part of wheat stone bridge where resistance P shows the resistance of the wire having balanced length l and Q is for length (100-l).
Let R = Resistance from Resistance Box and S = Unknown Resistance ½

	Let k be the resistance per unit length of the wire. Therefore, $$\frac{lk}{(100-l)k} = \frac{R}{S}$$ $$\therefore S = \left(\frac{100-l}{l}\right) R \quad \ldots (B)$$ Condition: When null point is obtained near mid point of the wire.	½ ½ 1	5
Q26	Kind of pattern 1 How it is obtained 1 Change in angular width and linear width when screen is moved ½ + ½ Two differences between diffraction pattern and interference pattern 1+1 <u>Kind of pattern</u> : Diffraction pattern consists of a central bright(maxima) on both sides of which dark and bright fringes formed whose intensity decreases with respect to distance from center. It is formed due to the superposition of secondary wavelets of the same wave front. <u>Reason</u>: i. Central maximum lies on both the sides of centre upto the position of Ist minima so its width is double. ii. Intensity of secondary maxima keeps on decreasing with the order as the contribution of wavelets for formation of Ist, 2nd ,3rd and successive maxima keeps on decreasing. Change in angular width and linear width, of a slit of width d $$angular\ width = \pm\frac{\lambda}{d}$$ will not change if screen is moved away $$linear\ width = \frac{2\lambda D}{d}$$	1 ½ ½ ½ ½	

will increase if D increases.

2

Difference in the pattern (any two)

Interference	Diffraction
1. All bright fringes are of same width	Not of same width
2. Intensity of all bright bands is same	Not same or decreasing with order

OR

5

(a) Definition of coherent sources	1
Necessity of coherent sources for sustained interference	1
(b) Derivation of $I = 4a^2\cos^2\frac{\phi}{2}$	2
Conditions for appearance of dark and bright fringes	1

(a) Coherent sources are those sources which emit the waves continuously, of same frequency and having a constant phase difference. 1

Necessity of coherent sources for sustained interference-If sources are coherent then phase difference between the waves from two sources will not change with time. 1

(b) $y_1 = \cos\omega t$, $y_2 = \cos(\omega t + \phi)$ due to superposition.

$$\therefore y = y_1 + y_2$$
$$= a\cos\omega t + a\cos(\omega t + \phi)$$
$$= a\,[\cos\omega t + \cos(\omega t + \phi)]$$
$$= a \times 2\cos\left(\omega t + \frac{\phi}{2}\right)\cos\frac{\phi}{2} \quad \text{½}$$
$$= 2a\cos\frac{\phi}{2}\cos\left(\omega t + \frac{\phi}{2}\right)$$

Where $2a\cos\frac{\phi}{2}$ is the resulting amplitude (A) ½

Since $I \propto A^2$ $\therefore I = KA^2$

$$= 4a^2\cos^2\frac{\phi}{2}\ (if\ k = 1) \quad \text{½}$$

	Condition for bright bands I is maximum if $\cos^2\frac{\phi}{2} = 1$ *or* $\cos\frac{\phi}{2} = \pm 1$ $\phi = 0, 2\pi, 4\pi \ldots$ $= 2n\pi [n = 0,1,2 \ldots]$ I is minimum if $\cos^2\frac{\phi}{2} = 0$ *or* $\frac{\phi}{2} = \frac{\pi}{2}, \frac{3\pi}{2}..$ $\phi = \pi, 3\pi, 5\pi \ldots$ $= (2n-1)\pi$ $(n = 1,2,3 \ldots)$	½ ½ ½	5