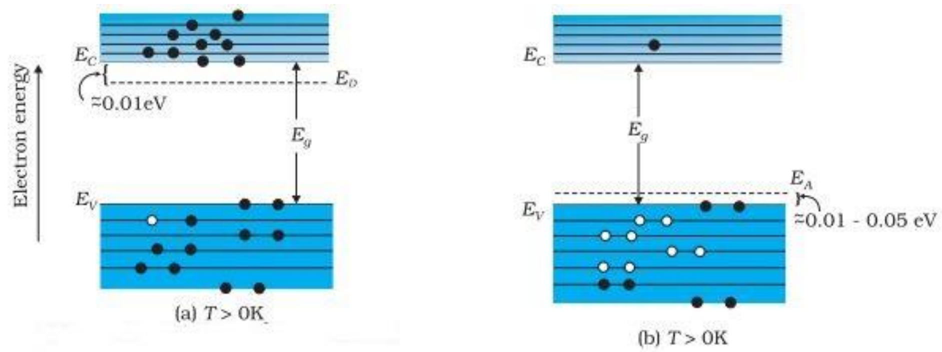

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2023
PHYSICS (SUBJECT CODE 042) (PAPER CODE 55/2/2)

General Instructions: -

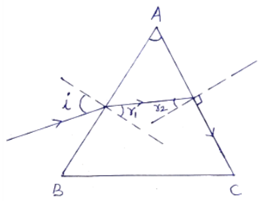
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
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 strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 - 70(example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.

12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer 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/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed 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.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

MARKING SCHEME: PHYSICS(042)			
Code:55/2/2			
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1	(c) c	1	1
2	(b) n=3 to n=2	1	1
3	(c) frequency	1	1
4	(b) Diffusion of both electrons and holes.	1	1
5	(d) 6 m	1	1
6	(d) more stable nucleus than its neighbours.	1	1
7	(b) 5.0×10^{17}	1	1
8	(b) C	1	1
9	(c) 3.6 W	1	1
10	(c) $3.6\times10^{9}\ m^{-3}$	1	1
11	(d) $\left(\frac{E-V}{V}\right)R$	1	1
12	(b) 6.0×10^{-20} J	1	1
13	(b) Repel each other	1	1
14	(b) 1.5	1	1
15	(b) 1	1	1
16	(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion(A).	1	1
17	(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion(A).	1	1
18	(b) Both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of the Assertion (A).	1	1
	SECTION - B		
19	Obtaining relation between d & λ - 2 D=1000 d x_{1d} = d Position of 1st minima. $x_{1d} = \frac{3}{2}.\frac{\lambda D}{d}$ $d = \frac{3}{2}.\frac{\lambda \times 1000d}{d}$ $\therefore \quad d = 1500\lambda$	 ½ 1 ½	 2
20	Drawing of energy band diagrams at T>0 K for • n-type semiconductor - 1 • p-type semiconductor - 1		

	 (a) n-type semiconductor (b) p-type semiconductor	1+1	2
21	Reasons for i) Damage of a p-n junction diode by a strong current - 1 ii) Adding impurities in intrinsic semiconductor - 1 i) Due to strong current, a junction diode gets heated, consequently large number of covalent bonds are broken and the junction is damaged. ii) Deliberate addition of impurity atoms in intrinsic semiconductor increases its conductivity and is suitable for making electronic devices. **Alternatively** Give full credit if a student writes that no electronic device can be developed using intrinsic semiconductor because of their low conductivity.	1 1	2
22	(a) Production of infrared waves - ½ Reason of calling Infrared waves as heat waves - ½ Two uses of Infrared waves - (½ + ½) Infrared waves are produced by hot bodies and vibrations of molecules. They are referred as heat waves because they are readily absorbed by water molecules and increase their thermal energy and heat them. **Uses** 1) Dehydration of fruits. 2) In greenhouse Effect. 3) In remote switches. (any other relevant two uses) OR (b) Production of X- rays - 1 Two uses of X- rays - ½+½ When fast moving electrons strike a heavy target like tungsten, X-rays are produced. Two uses – 1. Used as a diagnostic tool in medicine,	½ ½ ½ + ½ 1	

	2. Treatment for certain forms of cancer. 3. To study crystal structure. (Any two uses from above or other uses)	½ + ½	2
23	Explanation of conversion of galvanometer into an ammeter • Why 1 • How 1 • Due to very high sensitivity **Alternatively** It has large resistance and hence will change the value of current in circuit. • A galvanometer can be converted into an ammeter of desired range by connecting a shunt of proper value across its coil.	1 1	2
24	(a) Meaning of ionization energy - 1 Value of ionization energy for hydrogen atom - 1 Ionization energy is the minimum energy required to remove an electron from an isolated atom of an element. **Alternatively** It is the energy required to excite an electron from energy level n = 1 to n = ∞ from an isolated atom of an element. The ionization energy for hydrogen atom is 13.6 eV. **OR** (b) Definition of mass defect - 1 Its relation with stability - 1 Mass defect is the difference between the actual mass of the nucleus and the sum of the masses of its nucleons. Greater the mass defect, greater will be the binding energy and the nucleus will be more stable **Alternatively** Give full credit (1 mark) if a candidate writes, mass defect ∝ stability of the nucleus.	1 1 1 1	2
25	Finding position of image - 2 $\mu = 1.5$, $u = -60$ cm , $R = -20$ cm , v=? $\frac{\mu}{v} - \frac{1}{u} = \frac{\mu - 1}{R}$ $\frac{1.5}{v} - \frac{1}{(-60)} = \frac{1.5 - 1}{(-20)}$ $v = -36$ cm	½ 1 ½	2
	SECTION - C		
26	Calculation of (a) Impedance - 1 (b) Phase angle - 1 (c) Voltage drop across the inductor - 1		

	(a) $Z = \sqrt{R^2 + X_L^2}$, $X_L = \omega L$ $= \sqrt{100 + \left(100\pi \times \frac{100}{\pi} \times 10^{-3}\right)^2}$ $= 10\sqrt{2}\ \Omega$ (b) $\tan\phi = \frac{X_L}{R}$ $= 1$ $\therefore\ \phi = \frac{\pi}{4}\ or\ 45^0$ (c) $V_{rms} = I_{rms} X_L$ $= \frac{141 \times 10}{\sqrt{2} \times 10\sqrt{2}}$ $= \frac{141}{2}$ V = 70.5 V	½ ½ ½ ½ ½ ½	 3
27	Obtaining a relation between angle of incidence , angle of prism and critical angle - 3  $\because$ the light ray just suffers total internal reflection $\therefore\ \angle r_2 = \angle i_c$ $A = r_1 + r_2$ $A = r_1 + i_c$ From Snell's law at surface AB $\sin i = \mu.\sin r_1$ $\sin i = \mu.\sin(A - i_c)$	 1 ½ ½ ½ ½	 3
28	(a) (i) Difference between nuclear fission and nuclear fusion 1 Examples of each ½ + ½ (ii) Explanation of release of energy in nuclear fission & fusion ½ + ½ **Nuclear fission** – It is a process in which a heavy nucleus when excited (say on bombarding by a slow moving neutron) splits into two lighter nuclei of nearly comparable masses with a release of large amount of energy. Example of nuclear fission	 ½	

$${}_{0}^{1}n + {}_{92}^{235}U \rightarrow {}_{92}^{236}U \rightarrow {}_{56}^{144}Ba + {}_{36}^{89}Kr + 3\,{}_{0}^{1}n + Q$$ ½

Nuclear Fusion - It is a process in which two lighter nuclei fuse (at extremely high temperature) to form a heavy nucleus and large amount of energy is released. ½

Examples of nuclear fusion

(i) ${}_{1}^{1}H + {}_{1}^{1}H \rightarrow {}_{1}^{2}H + e^{+} + \nu + Q_1$

(ii) ${}_{1}^{2}H + {}_{1}^{2}H \rightarrow {}_{2}^{3}H + n + Q_2$

(iii) ${}_{1}^{2}H + {}_{1}^{2}H \rightarrow {}_{1}^{3}H + {}_{1}^{1}H + Q_3$

(any other possible reaction equation) ½

(ii) The binding energy per nucleon of the products in the nuclear reactions (nuclear fission and nuclear fusion) is greater than that of the reactants . 1

OR

(b)

(i) Experimental determination of size of nucleus of an atom	-	½
Relation between radius and mass number of nucleus	-	1
(ii) Proof of independence of density of nucleus on its mass number	-	1 ½

(i) Size of nucleus of an atom is determined by scattering experiments in which fast electrons are used to bombard targets. ½

Relation between radius and mass number of nucleus.

$R = R_0 A^{1/3}$ 1

(ii) Density of nucleus

$$\rho = \frac{mass}{volume}$$ ½

$$\rho = \frac{m \times A}{\frac{4}{3}\pi R^3}$$

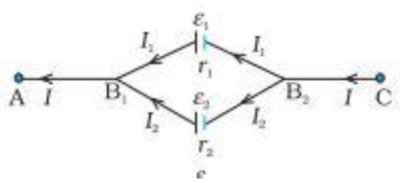
$$\rho = \frac{m\,A}{\frac{4}{3}\pi\left(R_0 A^{1/3}\right)^3}$$ ½

$$\rho = \frac{3m}{4\pi {R_0}^3}$$

Hence, density of nucleus is independent of mass number (A). ½ 3

29

Obtaining expression for equivalent emf of two cells in parallel	-	3



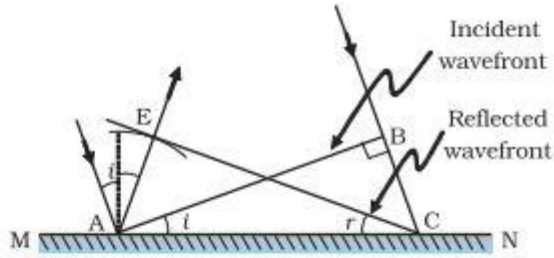
½

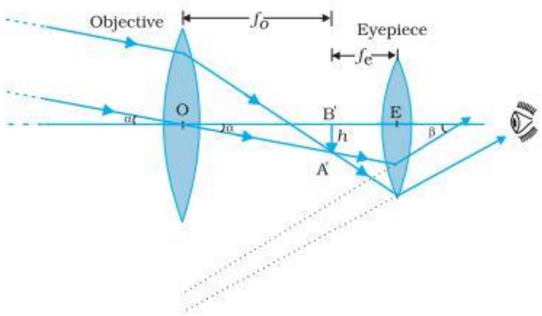
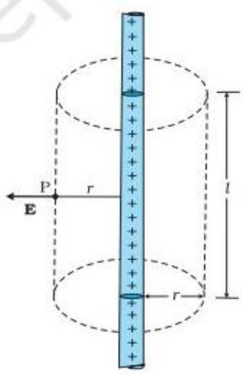
$V \equiv V(B_1) - V(B_2) = \varepsilon_1 - I_1 r_1$ ½

$V \equiv V(B_1) - V(B_2) = \varepsilon_2 - I_2 r_2$ ½

$I = I_1 + I_2$ ½

	$I = \frac{\varepsilon_1 - V}{r_1} + \frac{\varepsilon_2 - V}{r_2}$ $I = \left(\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}\right) - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$ $V = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} - I\frac{r_1 . r_2}{r_1 + r_2}$ $\because \quad V = \varepsilon_{eq} - I r_{eq}$ $\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$	½ ½	3
30.	(a) Finding ratio of the electric fields at their surfaces - 3 When connected by a conducting wire both spheres will be at the same potential. $\therefore \quad k\frac{q_1}{a} = k\frac{q_2}{b}$ $\therefore \frac{q_1}{q_2} = \frac{a}{b}$ $\frac{E_1}{E_2} = \frac{k\frac{q_1}{a^2}}{k\frac{q_2}{b^2}}$ $\frac{E_1}{E_2} = \frac{b}{a}$ **OR** (b) Finding the ratio of final charges on two capacitors A & B - ½ + ½ Ratio of electrostatic energy stored in A initially and in A and B finally - 1+1 i) Initially $Q= CV$ Finally $q_A = C_A V_1$ & $q_B = C_B V_1$ $\frac{q_A}{q_B} = \frac{C_A}{C_B} = \frac{1}{2}$ ii) $q_A + q_b = Q$ $\therefore \quad q_A = \frac{Q}{3}$ & $q_B = \frac{2Q}{3}$ $\frac{U_f}{U_i} = \frac{U_A + U_B}{U_{Ai}}$ $= \frac{\frac{q_A^2}{2C_A} + \frac{q_B^2}{2C_B}}{\frac{Q^2}{2C_A}}$ $= \frac{1}{3}$ **Alternatively ,** Common potential	 ½ ½ ½ 1 ½ ½ ½ ½ 1 ½	

	$V_1 = \frac{Q_1+Q_2}{C_1+C_2}$ $= \frac{Q}{3C} = \frac{V}{3}$ $\left[\because \frac{Q}{C} = V\right]$ $\frac{U_f}{U_i} = \frac{\frac{1}{2}C_{eq}V_1^2}{\frac{1}{2}C_A V^2}$ $= \frac{\frac{1}{2}3C\times\left(\frac{V}{3}\right)^2}{\frac{1}{2}CV^2} = \frac{1}{3}$	1 ½ ½	3
SECTION - D			
31	(a) (i) Statement of Huygen's principle - 1 Diagram showing reflected wavefront - 1 Verification of law of reflection - 1 (ii) Finding distance of object from the mirror - 2 **(i) Huygen's principle** Each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are usually referred to as secondary wavelets, a common tangent to all these spheres gives the new position of the wavefront at a later time.  **Verification of law of reflection** In ΔAEC & ΔCBA EC = AB (c x t each) ∠ AEC = ∠ CBA (90^0 each) AC = AC (common side) By RHS congruency ΔAEC ≅ ΔCBA $\Rightarrow \angle i = \angle r$ (ii) $m = +3$, f = -12 cm , u = ? $m = -\frac{v}{u} = 3 \Rightarrow v = -3u$ using mirror formula $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ $\frac{1}{-3u}+\frac{1}{u}=\frac{1}{-12}$	1 1 ½ ½ ½ ½ ½	

	$u = -8$ cm	½	
	OR		
	(b) (i) Labelled diagram - 1½ Definition of magnifying power - 1 Two limitations - ½ + ½ (ii) Finding tube length of microscope - 1½		
	(i) 	1½	
	(Note deduct ½ mark if a student does not show the direction of propagation of the light.) **Alternatively** Give full credit for ray diagram if a candidate draws ray diagram for final image at the near point.		
	<u>Magnifying power of a telescope</u> – It is defined as the ratio the angle subtended at the eye by the final image to the angle subtended by the object at the lens or the eye.	1	
	Two limitations of a refracting telescope over a reflecting telescope. (i) Less resolving power. (ii) Difficult mechanical support. (iii) Less bright image. (iv) Suffers chromatic aberration. (v) Image suffers with spherical aberration. (Any two of the above)	½ + ½	
	$f_0 = 1.0$ cm , $f_e = 2.5$ cm , m = 300 , D=25 cm , L=?		
	$\lvert m \rvert = \frac{L}{f_0} \cdot \frac{D}{f_e}$	½	
	$300 = \frac{L}{1.0} \cdot \frac{25}{2.5}$	½	
	$L = 30$ cm	½	5
32	(a) (i) Derivation of the expression - 2 (ii) Finding kinetic energy of electron - 2 (iii)Graph - 1		
	(i) 	½	

Flux through the Gaussian surface

$\phi = E.2\pi rl$ ½

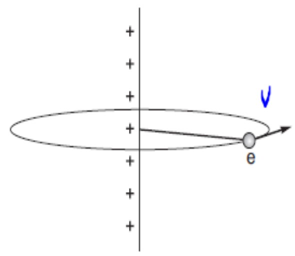
According to Gauss's law

$$E.2\pi rl = \frac{q}{\epsilon_0}$$ ½

$\because \quad q = \lambda l$

$$E = \frac{\lambda}{2\pi \epsilon_0 r}$$ ½

(i) $$E = \frac{\lambda}{2\pi \epsilon_0 r}$$



½

$$\frac{mv^2}{r} = eE$$ ½

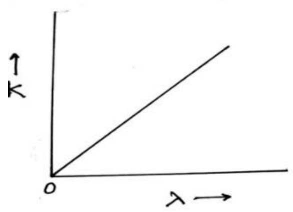
$\therefore$ Kinetic energy $K = \frac{1}{2}mv^2$

$$= \frac{1}{2}eEr$$ ½

$$= \frac{1}{2}e\frac{\lambda.r}{2\pi \epsilon_0 r} = \frac{e\lambda}{4\pi \epsilon_0}$$ ½

(ii) Kinetic energy $K = = \frac{e\lambda}{4\pi \epsilon_0}$

$\therefore \; K \propto \lambda$



1

OR

(b)

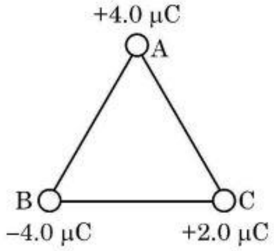
(i) Answers of (1) and (2) with justification	-	2
(ii) Significance of negative value	-	1
Determining electric potential energy	-	2

(i) (1) Yes , electric field is zero at mid point.
Electric field being a vector quantity , its resultant is zero. ½
(2) No, potential cannot be zero on line joining the charges. ½
Electric potential being a scalar quantity, the net potential due to two identical charges cannot be zero. ½

(ii) Negative value of electrostatic potential energy of a system signifies that the system has attractive forces. ½

Alternatively

Give full credit , if a candidate writes the system is stable /bound. 1

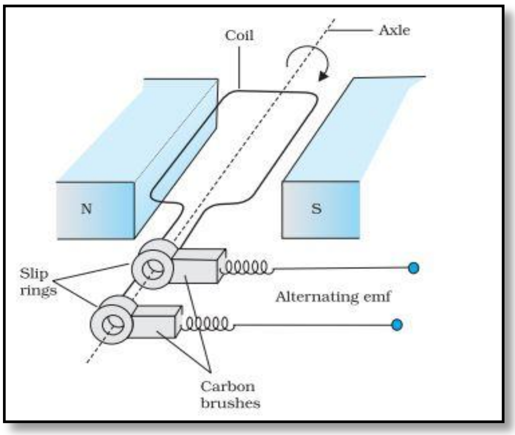
	 		
	$U = \frac{1}{4\pi \in_0} \times \frac{q_1 q_2}{r}$	½	
	$U = \frac{1}{4\pi \in_0}\left[\frac{q_A q_B}{r} + \frac{q_B q_c}{r} + \frac{q_c q_A}{r}\right]$	½	
		½	
	$= \frac{9\times 10^9}{2}[-16-8+8]\times 10^{-12}$	½	5
	$= -7.2\times 10^{-2} J$		
33	(a) (i) Definition of coefficient of self induction - 1 Derivation of expression for coefficient of self induction - 2 (ii) Determining coefficient of self induction - 2		
	(i) Coefficient of self induction is defined as the amount of magnetic flux associated with a coil when unit current flows through it.	1	
	Alternatively It is defined as the magnitude of emf induced in a coil when current changes at the rate of 1 A/s through it.		
	(ii) The magnetic field due to a current *I* flowing in solenoid is $B = \frac{\mu_0 N I}{l}$	½	
	The total magnetic flux linked with solenoid $N\phi_B = (N)\left(\frac{\mu_0 N I}{l}\right)(A)$ $= \frac{\mu_0 N^2 I A}{l}$	½	
	The self inductance is $L = \frac{N\phi_B}{I}$	½	
	$L = \frac{\mu_0 N^2 A}{l}$	½	
	(iii)From the table , Z=6 Ω , R = 4Ω $Z^2 = R^2 + X_L^2$	½	
	$X_L^2 = Z^2 - R^2 = 36 - 16 = 20$ $X_L = 2\sqrt{5} \approx 4.5\ \Omega$	½	
	$2\pi\nu L = 4.5$	½	
	$L = \frac{4.5}{2\times\pi\times\frac{200}{\pi}}$	½	
	$L = 1.1\times 10^{-2} H = 11 mH$ Note : Please do not deduct marks if a student writes answer as $0.5\sqrt{5}\times 10^{-2}$ H		

OR

(b)

(i) Labelled diagram	-	1
Principle	-	½
Working	-	½
Obtaining expression of emf	-	1
(ii) Determining		
Maximum emf	-	1
Power dissipated	-	1

(i) Diagram



1

Principle – It is based on the principle of electromagnetic induction.
Whenever there is a change in magnetic flux linked with a coil , an emf is induced in the coil.

Alternatively
Give full credit if a candidate writes ,it is based on the principle of electromagnetic induction. ½

Working - When a rectangular coil is rotated in a magnetic field, the magnetic flux changes continuously which induces an emf and the direction of current changes periodically. ½

$$\varepsilon = \frac{-Nd\phi}{dt}$$ ½

$$= -NBA\frac{d}{dt}(\cos\omega t)$$

$$\varepsilon = NBA\omega\sin\omega t$$ ½

(ii) $\varepsilon_0 = NBA\omega$ ½

$= 100\times0.8\times0.5\times60$

$= 2400$ V ½

Power dissipated , $P = \frac{\varepsilon_{rms}^2}{R}$ ½

$$= \frac{\left(\frac{2400}{\sqrt{2}}\right)^2}{100}$$

$= 28.8$ kW ½

Alternatively
Give full credit if a candidate calculates power dissipated using formula $\varepsilon_{rms}I_{rms}$ or I_{rms}^2R .

5

SECTION - E

34	(i) Identification of highest frequency beam and reason - ½ + ½ (ii) Identification of longest wavelength beam and reason - ½ + ½ (iii) Identification of beam ejecting photoelectrons with maximum momentum and reason - 1+1 **OR** (b) Effect on threshold frequency and stopping potential on the increasing frequency and justification - 1+1 (i) The light beam B because it requires maximum retarding potential to reduce the photoelectric current to zero. (ii) The light beam C because it requires minimum retarding potential to reduce photoelectric current to zero. (iii)The light beam B ejects photoelectrons with maximum momentum. because highest frequency light beam ejects photoelectrons with highest kinetic energy and hence highest momentum. **OR** There is no effect on threshold frequency since it is characteristic of the metal. With increase in freqquency of incidents beam of light , stopping potential increases because to stop the photoelectrons of higher kinetic energy, larger retarding potential is required. **Alternatively** Give full credit if a candidate explains the effect of frequency on stopping potential using the following formula. $eV_0 = h(\nu - \nu_0)$	½ + ½ ½ + ½ 1 1 ½ + ½ ½ + ½	4
35.	(i) Explanation of a jumping of ring - 1 (ii) Explanation of outcome on changing terminals of battery - 1 (iii) Explanation of two laws - 1+1 OR (b) Two ways to increase strength of magnetic field produced by solenoid - 1+1 (i) The direction of induced current in the ring is such that the polarity developed in the ring is same as that of the polarity on the face of the coil , hence it will jump up due to repulsive force. (ii) The polarity of the induced current in the ring will get reversed on changing the terminals of the battery, so the ring will jump again. (iii) **Lenz's law** It states that the polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produces it. **Faraday's law of EMI** Whenever there is change in magnetic flux through a coil, an emf is induced. The magnitude of the induced emf in a coil is equal to the time rate of change of magnetic flux through the coil. **OR** Ways to increase strength of magnetic field produced by a solenoid. • By inserting soft iron core inside the solenoid. • By increasing current in the solenoid.	1 1 1 1 1 1	4