Strictly Confidential: (For Internal and Restricted use only)
Senior School Certificate Examination-2020
Marking Scheme – PHYSICS THEORY (042)

(55/3/3)

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. **Evaluation is a 10-12 days mission for all of us. Hence, it is necessary that you put in your best efforts in this process.**
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. **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 marks be awarded to them.**
3. 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. 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.
4. Evaluators will mark(√) wherever answer is correct. For wrong answer 'X"be marked. Evaluators will not put right kind of mark while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
5. 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.
6. 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.
7. If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out.
8. No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
9. A full scale of marks 0-70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
10. 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).
11. 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 a reply.
    - 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.
- 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.

12. 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.

13. 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.

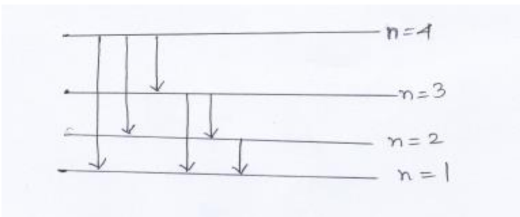
14. The Examiners should acquaint themselves with the guidelines given in the Guidelines for spot Evaluation before starting the actual evaluation.

15. 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.

16. The Board permits candidates to obtain photocopy of the Answer Book on request in an RTI application and also separately as a part of the re-evaluation process on payment of the processing charges.

MARKING SCHEME: PHYSICS			
QUESTION PAPER CODE: 55/3/3			
Q.No.	**Value Points/Expected Answer**	**Marks**	**Total Marks**
SECTION A			
1	(D) Zero	1	1
2	(C) heavily doped n-side as well as p-side	1	1
3	(B) Charge distribution on the sphere is not uniform	1	1
4	(C) $\frac{F}{2}$	1	1
5	(D) $\frac{1}{n^2}$	1	1
6	(C) 4Ω	1	1
7	(D) helix	1	1
8	(D) -F	1	1
9	(A) $\frac{1}{\epsilon_o}$	1	1
10	(B) Mobility	1	1
11	Spherical	1	1
12	Intensity OR $h(\upsilon - \upsilon_o)$	1	1
13	Decrease	1	1
14	Divergent lens/ Concave lens	1	1
15	$\sqrt{3}$	1	1
16	1	1	1
17	Plane of the coil is parallel to the magnetic field / Area vector is perpendicular to the magnetic field	1	1

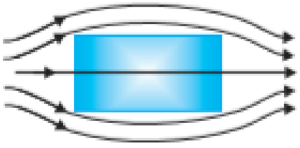
18	J.C Bose observed / produced electromagnetic waves of short wavelength /did very significant job in the production of em waves	1	1
19	Zero Eddy currents are produced in metal block / block gets heated	1	1
20	Ultraviolet radiation- 400nm to 1 nm	½+½	1
	SECTION B		
21	Identification of Maximum relaxation time 1 mark Identification of Minimum relaxation time 1 mark a) $$\sigma = \frac{ne^2\tau}{m}$$ where τ is relaxation time Alternatively, $\tau \propto \frac{\sigma}{n}$ $$\tau_x \propto \frac{2}{4} = \frac{1}{2};\ \ \tau_y \propto \frac{1}{1} = 1;\ \ \tau_z \propto \frac{2}{8} = \frac{1}{4}$$ τ is maximum for conductor Y b) τ is minimum for conductor Z	½ ½ ½ ½	2
22	Determining power of the combination 1 ½ mark Nature of combination ½ mark $$\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2}$$ $$\frac{1}{f} = \frac{f_2 - f_1}{f_1 f_2}$$ $$\therefore P = \frac{f_2 - f_1}{f_1 f_2}$$ Because $f_2 < f_1$ ∴ P is negative ∴ nature is diverging lens OR Writing the formula 1 mark (a) effect of wavelength on Resolving power ½ mark (b) effect of diameter of lens on Resolving power ½ mark Resolving power of compound microscope is $$Resolving\ Power = \frac{2\mu \ sin\theta}{1.22\lambda}$$	½ ½ ½ ½ 1	2

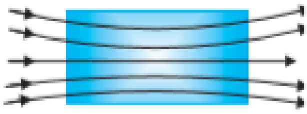
	Justification of the following is based on the above formula: a) If λ decreases, Resolving Power increases. b) If diameter of objective lens is increased, $sin\theta$ increases, Resolving Power increases	½ ½	2
23	a) Definition of SI unit of self inductance 1 b) Finding the new self inductance of the solenoid 1 a) The self inductance of coil is said to be one henry if an induced e.m.f of one volt is set up it when the current in it changes at the rate of one ampere per second Alternatively, The self inductance of a coil is said to be one henry if magnetic flux of one weber is produced when a current of one ampere flows through it. b) $L = \mu_0 \mu_r n^2 A l$ Alternatively, $L \propto n^2 . A$ $L' \propto (2n)^2 . \left(\frac{A}{2}\right)$ i.e. $L' = 2L$	1 ½ ½	2
24	a) Stating the number of spectral lines ½ mark Showing the transitions in energy level diagram 1 mark b) Stating the transition for the shortest wave length emission ½ mark a) number of spectral lines =6 energy level diagram  b) n=4 to n=1	½ 1 ½	2
25	Radiation of electromagnetic wave by an oscillating charge 1 mark Relation between the frequency of radiated wave and the frequency of oscillating charge 1 mark		

	An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field, and so on. The oscillating electric and magnetic fields thus regenerate each other, as the wave propagates through the space. The frequency of the electromagnetic wave equals the frequency of oscillation of the charge. OR a) Explaining the fact that e.m waves carry energy 1 mark b) Correct Explanation 1 mark a) Consider a plane perpendicular to the direction of propagation of the electromagnetic wave. If there are, on this plane, electric charges, they will be set and sustained in motion by the electric and magnetic fields of the electromagnetic wave. The charges thus acquire energy and momentum from the waves. b) When the sun shines on your hand, you feel the energy being absorbed from the electromagnetic waves (your hands get warm). Electromagnetic waves also transfer momentum to your hand but because c is very large, the amount of momentum transferred is extremely small and you do not feel the pressure. [For any other alternative correct explanation also, award full 2 marks]	1 1 1 1	2 2
26	a) Difference between matter waves and electromagnetic waves 1 mark b) Finding the new de Broglie wavelength 1 mark a) <u>Matter waves</u> i) Matter waves are associated with moving particle ii) They travel with a speed less than the speed of light iii) **E** and **B** are not associated with these waves. <u>Electromagnetic waves</u> i) They are produced by accelerated charged particles ii) They travel with the speed of light. iii) **E** and **B** are associated with these waves. (Any one point of difference) b) $\lambda = \frac{h}{\sqrt{2mE_k}}$	½ ½ ½	

<table>
<tr><td></td><td>Alternatively,
$$\lambda \propto \frac{1}{\sqrt{E_k}}$$
$$\frac{\lambda_2}{\lambda_1} = \sqrt{\frac{E_{k1}}{E_{k2}}} = \sqrt{\frac{E_{K1}}{\frac{E_{k1}}{4}}} = \sqrt{4} = 2$$
$$\lambda_2 = 2\lambda_1$$
So, λ becomes two times.</td><td>½</td><td>2</td></tr>
<tr><td>27</td><td>Modification in magnetic field pattern by paramagnetic material 1 mark

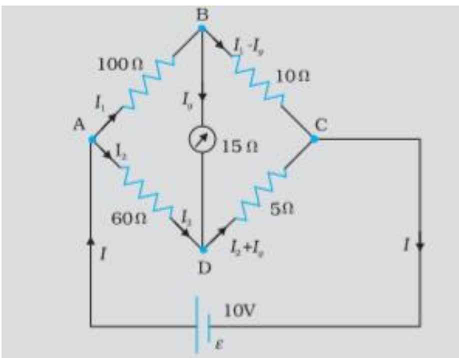
Modification in magnetic field pattern by diamagnetic material 1 mark


(a)
diamagnetic


(b)
paramagnetic</td><td>1+1</td><td>2</td></tr>
<tr><td colspan="4">SECTION C</td></tr>
<tr><td>28</td><td>Diagram showing the direction of current in the circuit diagram 1 mark

Forming the three equations 1 ½ marks

Finding the value of I_g ½ mark



Considering the mesh BADB, we have
$100 I_1 + 15 I_g - 60 I_2 = 0$

$20I_1 + 3I_g - 12 I_2 = 0$ -------------------------------------- eq1
Considering the mesh BCDB, we have
$10(I_1 - I_g) - 15I_g - 5(I_2 + I_g) = 0$

$10I_1 - 30I_g - 5I_2 = 0$

$2I_1 - 6I_g - I_2 = 0$ ------------------------------------ eq 2</td><td>½

½

½</td><td></td></tr>
</table>

<table>
<tr><td></td><td>Considering the mesh ADCEA, we have
$60I_2 + 5(I_2+I_g) = 10$

$65I_2 + 5I_g = 0$

$13I_2 + I_g = 2$ -------------------------------------- eq 3

Multiplying eq2 by 10
$20I_1 - 60I_g - 10I_2 = 0$ ------------------------------------ eq 4

From eq 4 and eq 1, we have
$63I_g - 2I_2 = 10$

$I_2 = 31.5\ I_g$ ------------------------- eq 5

Substituting the value of I2 in eq 3, we get
$13(31.5I_g) + I_g = 2$

$410.5I_g = 2$

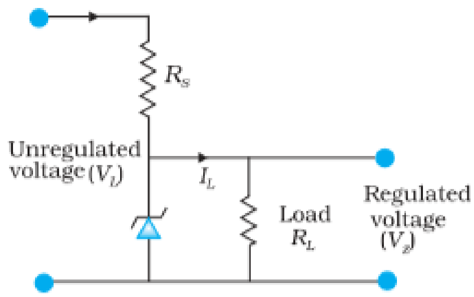
$I_g = 4.87$ mA</td><td>½

1</td><td>

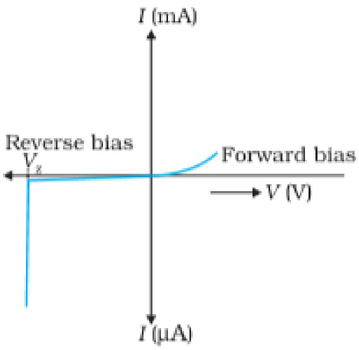
3</td></tr>
<tr><td>29</td><td>

Naming the diode	½ mark
Labelled circuit diagram	1 mark
Working	1 mark
V-I characteristics	½ mark

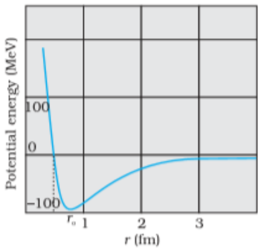
Zener diode



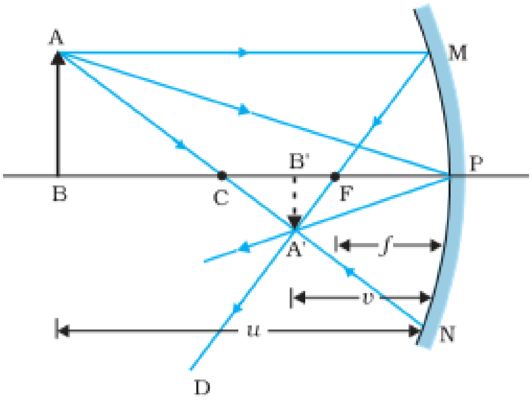
If the input voltage increases, the current through R_s and Zener diode also increases. This increases the voltage drop across R_s without any change in the voltage across the Zener diode. This is because in the breakdown region, Zener voltage remains constant even though the current through the Zener diode changes.

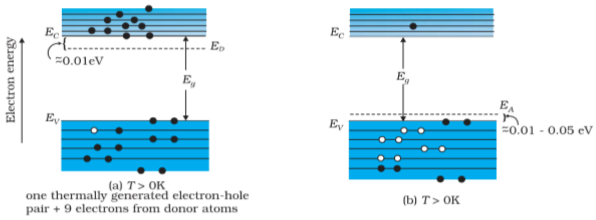


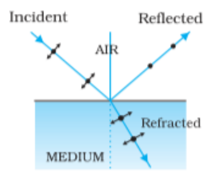
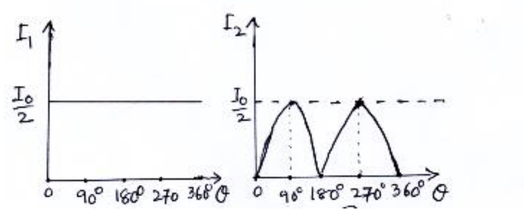
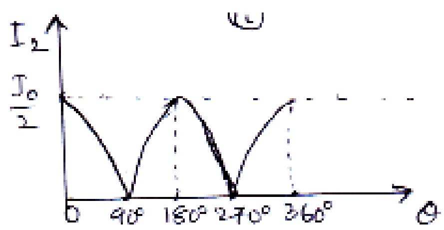
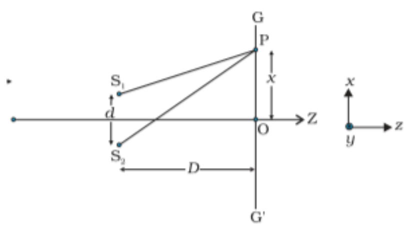
</td><td>½
1
1
½</td><td>3</td></tr>
</table>

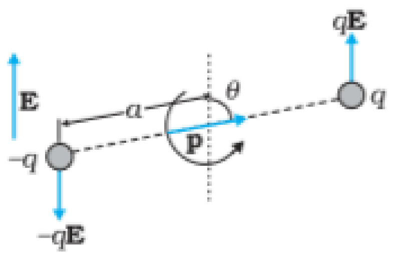
30	a) Explaining the high nuclear density 1 mark b) Explaining the non-Colombian nature 1 mark c) Drawing the graph 1 mark a) Volume of Nucleus is very small but its mass is almost the total mass of the atom $Now \quad density = \frac{Mass}{Volume}$ That is why density of nucleus is very high. **Alternatively**, the matter consisting of atoms, has a very large amount of empty space.	1	
	b) Nuclear forces are very strong, attractive and independent of charge and are short ranged. Whereas Colombian Force are charge dependent and long range. (Accept any one point of difference)	1	
		1	3
31	Meaning of Matter Waves 1 mark Finding the ratio of de Broglie wavelengths associated with proton and alpha particle, when both:- (a) accelerated through same potential difference 1 mark (b) have same velocity 1 mark The de Broglie waves associated with moving particles are called matter waves.	1	
	a) (i) $\lambda = \frac{h}{\sqrt{2mE_k}}$	½	
	$\lambda_\alpha = \frac{h}{\sqrt{2m_\alpha q_\alpha V}}$ $\lambda_p = \frac{h}{\sqrt{2m_p q_p V}}$ $\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha q_\alpha}{m_p q_p}} = \sqrt{\frac{4m_p 2q_p}{m_p q_p}}$ $= \frac{2\sqrt{2}}{1}$	½	
	b)		

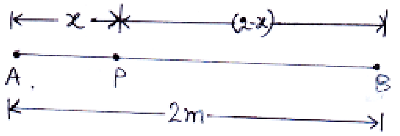
	$\lambda = \frac{h}{mv}$ $\lambda_p = \frac{h}{m_p v}$ & $\lambda_\alpha = \frac{h}{m_\alpha v}$ $\frac{\lambda_p}{\lambda_\alpha} = \frac{m_\alpha}{m_p} = \frac{4}{1}$	½ ½	3
32	a) writing the formula for resonant angular frequency ½ mark calculating this angular frequency 1 mark b) writing the formula for Q value ½ mark calculating Q value 1 mark a) $\omega_o = \frac{1}{\sqrt{LC}}$ $= \frac{1}{\sqrt{2 \times 32 \times 10^{-6}}}$ =125 rad/s b) $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ *or* $Q = \frac{L\omega}{R}$ $Q = \frac{1}{10}\sqrt{\frac{2}{32\times10^{-6}}} = 25$ Alternatively Q=$\frac{2\times125}{10} = 25$ OR a) Calculating rms value of current 1 mark calculating peak value of current 1 mark b) Phase difference between current through inductor and applied voltage ½ mark change in phase difference ½ mark a) $X_L = \omega L = 2\pi\nu L$ $\therefore X_L = 2\pi \times 50 \times \frac{5}{\pi} = 500\ \Omega$ $I_{rms} = \frac{200}{500} = \frac{2}{5} = 0.4A$	½ ½ ½ ½ 1 ½ ½	3

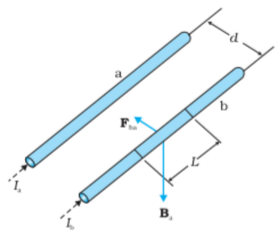
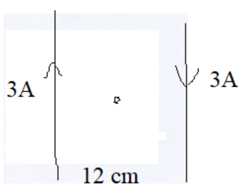
	$$I_0 = \sqrt{2}\, I_{rms}$$ $$= \sqrt{2} \times 0.4$$ $$= 0.56\ A$$ [Even if student expresses the answer as $(0.4\sqrt{2})A$ give the last ½ marks] b) $\frac{\pi}{2}$ $or\ 90^0$ decreases	½ ½ ½ ½	3
33	a) Ray diagram for concave mirror — ½ mark derivation of mirror formula — 2 marks b) Correct explanation — ½ mark a) Ray diagrams for concave mirror  Derivation of Mirror Formula From the diagram, $\Delta A'B'F\ \&\ \Delta MPF$ are similar $$\therefore \frac{B'A'}{PM} = \frac{B'F}{FP}$$ $$\frac{B'A'}{BA} = \frac{B'F}{FP}\ (\because PM = AB) - - - - - - - eq1$$ Since $$\angle APB = \angle A'PB'$$ $\Delta A'B'P\ \&\ \Delta ABP$ are also similar $$\frac{B'A'}{BA} = \frac{B'P}{BP}\ - - - - - - - - - eq\ 2$$ Comparing eq. 1 and eq. 2 $$\frac{B'P}{BP} = \frac{B'P - FP}{FP}$$	 ½ ½ ½	

	As per the sign convention $B'P = -v, \quad FP = -f,$ BP = -u $$\frac{-v+f}{-f} = \frac{-v}{-u} = \frac{v}{u}$$ $$-vu + uf = -vf$$ Dividing by uvf $$\Rightarrow \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$ b) Magnification is different for different object distances	1 ½	3
34	a) Formation of energy bands in a crystalline solid 1 mark b) Drawing the energy band diagram for p-type and n-type semiconductors ½ + ½ Significance of donor/ acceptor energy level 1 mark a) Isolated atoms have discrete energy levels. In a crystalline solid, due to the presence of large number of atoms, interatomic interactions take place. Due to this, energy levels get modified to energy bands. [Even if the student writes about valence band, conduction band and energy gap, award full mark] b) n type p type  c) Significance The number of electrons/ holes per unit volume increases. Alternatively, conductivity increases. Alternatively, electron easily gets promoted to conduction band.	1 ½ + ½ 1	3
SECTION D			
35	a) Meaning of plane polarised light 1 mark Diagram ½ mark Derivation of the relationship between μ and θ 1 ½ marks b) Each graph 1+1 marks a) A light whose electric vector direction does not change with time is a plane polarised light. Alternatively, if electric vector is confined to one particular plane, containing direction of propagation it is referred to as plane polarized light.	1	

		½	
	$$\mu = \frac{\sin i}{\sin r}$$	½	
	$$= \frac{sin\theta}{\sin\left(\frac{\pi}{2} - \theta\right)} = \quad if\ i = \theta$$	½	
	$$= \frac{sin\theta}{cos\theta} = \tan\theta$$	½	
	b) (i) (ii) 	1+1	5
	[Note: also accept if a student plots (ii) graph as follows] 		
	OR		
	a) description of experiment with diagram — 1 mark derivation of the expression for fringe width — 2 marks b) finding the wavelength of refracted light — 1 mark finding the speed of refracted light — 1 mark		
	a) 	½	
		½	

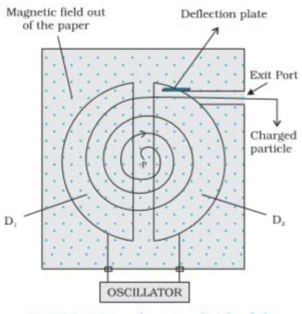
	S is a monochromatic source of light. S_1 and S_2 are two pinholes separated by a distance d. GG' is the screen placed at the distance D from the pinholes. P is a general point on the screen. Derivation $(S_2P)^2 - (S_1P)^2 = \left[D^2 + \left(x + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(x - \frac{d}{2}\right)^2\right]$ $= D^2 + x^2 + \frac{d^2}{4} + xd - D^2 - x^2 - \frac{d^2}{4} + xd$ $= 2xd$ $path\ difference = S_2P - S_1P = \frac{2xd}{S_2P + S_1P} \approx \frac{2xd}{2D}$ $Path\ difference = \frac{xd}{D}$ For maxima $\frac{xd}{D} = n\lambda, \quad n = 0,1,2 \ldots$ $or \quad x_n = \frac{n\lambda D}{d}$ $x_{n+1} = \frac{(n+1)\lambda D}{d}$ $\beta = x_{n+1} - x_n$ $\beta = \frac{\lambda D}{d}$ b) $\mu_w = \frac{c_0}{c_w} = \frac{\upsilon\lambda_0}{\upsilon\lambda_w} = \frac{\lambda_0}{\lambda_w}$ $\lambda_w = \frac{\lambda_0}{\mu_w} = \frac{588 \times 3}{4} = 441\ nm$ $c_w = \frac{c_0}{\mu_w} = \frac{3 \times 10^8 \times 3}{4} = 2.25 \times 10^8\ m/s$	½ ½ ½ ½ ½ ½ ½ + ½	5
36	a) Diagram ½ mark Derivation 1 ½ mark Orientation for maximum and half of the maximum torque ½ + ½ mark b) Formula ½ mark Calculation 1 mark Result ½ mark a)  From diagram Magnitude of Torque= $(qE)(2a\ sin\theta)$ $= (2qa)(E\ sin\theta)$ $= pEsin\theta$	½ ½ ½	

	For direction $$\vec{\tau} = \vec{p} \times \vec{E}$$	½	
	i) for maximum Torque, dipole should be placed perpendicular to the direction of electric field $$\theta = 90^0 = \frac{\pi}{2}$$	½	
	ii) For the torque to be half the maximum, $$\theta = 30^0 = \frac{\pi}{6}$$	½	
	(b)  		
	$$E_{PA} = E_{PB} \quad ; \quad E = \frac{kq}{r^2}$$	½	
	$$\frac{kq_A}{x^2} = \frac{kq_B}{(2-x)^2}$$ $$\frac{1}{x^2} = \frac{4}{2-x)^2}$$	½	
	$$\frac{1}{x} = \frac{2}{2-x}$$	½	
	$$x = \frac{2}{3}\ m$$	½	5
	OR		
	a) Derivation of expression for energy stored 2 ½ marks Form of energy stored ½ mark b) formula 1 mark calculation ½ mark result ½ mark		
	a) Work done in adding a charge dq $= dW$ $= Vdq$		
	$= \frac{q}{c}dq$	½ ½	
	∴Total Amount of work(W)in charging a capacitor $$W = \int dW = \frac{1}{C}\int_0^Q qdq$$	½	
	$$W = \frac{Q^2}{2C}$$	½	
	$$= \frac{(CV)^2}{2C} = \frac{1}{2}CV^2$$	½	

	The electrostatic Energy/ potential energy is stored in the electric field between the plates.	½	
	b) $C = 1\mu F = 1 \times 10^{-6} F; \quad V = 10\, volt$		
	$Q = CV$	1	
	$= 1 \times 10^{-6} \times 10$	½	
	$= 10^{-5} coulomb$	½	5
37	a) Diagram showing direction — ½ mark Derivation of expression — 1 ½ marks Definition of 1 ampere — 1 mark b) Magnetic fields of the wires — ½ mark Net magnetic field and its direction — 1 + ½ mark		
	a)		
		½	
	$B_1 = \frac{\mu_o I_1}{2\pi d}$		
	$\vec{F} = I(\vec{l} \times \vec{B})$	½	
	$F_{21} = I_2 l_2 B_1 sin 90^o$		
	$= I_2 l_2 \frac{\mu_o I_1}{2\pi d}$	½	
	Force per unit length $f_{21} = \frac{F_{21}}{l_2} = \frac{\mu_o I_1 I_2}{2\pi d}$	½	
	<u>Definition of 1 ampere</u> – One ampere is defied as that steady current which, when maintained in each of the two very long, straight parallel conductors of negligible cross section, and placed at a distance 1 meter apart in vacuum, will produce on each of the conductors a force equal to $2 \times 10^{-7} N$ per metre of length.	1	
	Alternatively, $I_1 = I_2 = IA,\ d = 1m, \frac{F}{l} = 2 \times 10^{-7} N/m$		
	b)		
			
	$\vec{B} = \vec{B_1} + \vec{B_2}$		
	$B = \frac{\mu_o I_1}{2\pi r_1} + \frac{\mu_o I_2}{2\pi r_2}$	½	

	$$= \frac{\mu_o}{2\pi}\left(\frac{3}{6\times10^{-2}}+\frac{3}{6\times10^{-2}}\right)$$ $$= \frac{4\pi\times10^{-7}\times3}{\pi\times6\times10^{-2}}$$ $$= 2\times10^{-5}\ tesla$$		
	Direction of $\vec{B}$ at midpoint is perpendicular to the plane containing the two conductors and pointing downwards.	1	
	(Note: give full credit of this direction if student takes direction opposite to the shown in fig and answer accordingly)	½	5
	OR		

a) Diagram	1 mark
explaining the shape of the path	2 marks
b) formula	½ mark
calculation	1 mark
result	½ mark

	a)  	1	
	Inside the dee, the magnetic field makes the charged particle to move in semi-circular path.	½	
	Electric field between the dees accelerates the charged particle.	½	
	The sign of Electric field is changed in tune with the circular motion of the particle.	½	
	Each time, the acceleration increases the energy of the particle. As the energy increases, radius of circular path increases. So, the path is spiral.	½	
	b) $$R = \frac{V}{i_g} - G$$	½	
	$$R_1 = \frac{2V}{i_g} - G = R_o - G$$ $$R_1 + G = 2R_o$$ $$\left[Where\ R_o = \frac{V}{i_g}\right]$$	½	
	Similarily $$R_2 + G = R_o$$ $$R_3 + G = R_o/2$$	½	
	From the above equations, $$R_1 - R_2 = 2(R_2 - R_3$$ $$R_1 - 3R_2 + 2R_3 = 0$$	½	5