CBSE **Class** 12 Physics Question Paper 2020
Set 5**5**/5/1

Series : HMJ/5

SET – 1

Candidates must write the Code on the title page of the answer-book.

NOTE

(I) Please check that this question paper contains 23 printed pages.

(II) Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.

(III) Please check that this question paper contains 37 questions.

(IV) Please write down the Serial Number of the question in the answer-book before attempting it.

(V) 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

CBSE Physics Class 12 Question Paper 2020

PHYSICS (Theory)

Time allowed : 3 hours | Maximum Marks : 70

.55/5/1. 309A

P.T.O.

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) This question paper comprises four sections – A, B, C and D.

(ii) There are 37 questions in the question paper. All questions are compulsory.

(iii) Section A : Q. no. 1 to 20 are very short-answer type questions carrying 1 mark each.

(iv) Section B : Q. no. 21 to 27 are short-answer type questions carrying 2 marks each.

(v) Section C : Q. no. 28 to 34 are long-answer type questions carrying 3 marks each.

(vi) Section D : Q. no. 35 to 37 are also long answer type questions carrying 5 marks each.

(vii) There is no overall choice in the question paper. However, an internal choice has been provided in two questions of one mark, two questions of two marks, one question of three marks and all the three questions of five marks. You have to attempt only one of the choices in such questions.

(viii) However, separate instructions are given with each section and question, wherever necessary.

(ix) Use of calculators and log tables is not permitted.

(x) You may use the following values of physical constants wherever necessary.

$c = 3 \quad 10^{8}$ m/s

$h = 6.63 \quad 10^{-34}$ Js

$e = 1.6 \quad 10^{-19}$ C

$_0 = 4 \quad 10^{-7}$ T m A^{-1}

$_0 = 8.854 \times 10^{-12}$ C^{2} N^{-1} m^{-2}

$\frac{1}{4 \;\; _0} = 9 \quad 10^{9}$ N m^{2} C^{-2}

Mass of electron (m_e) = $9.1 \quad 10^{-31}$ kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = 1.38×10^{-23} JK^{-1}

SECTION : A

Note : Select the most appropriate option from those given below each question.

1. The relationship between Brewester angle ' ' and the speed of light ' v' in the denser medium is –

   (a) v tan = c   (b) c tan = v

   (c) v sin = c   (d) c sin = v   1

2. Photo diodes are used to detect

   (a) radio waves   (b) gamma rays

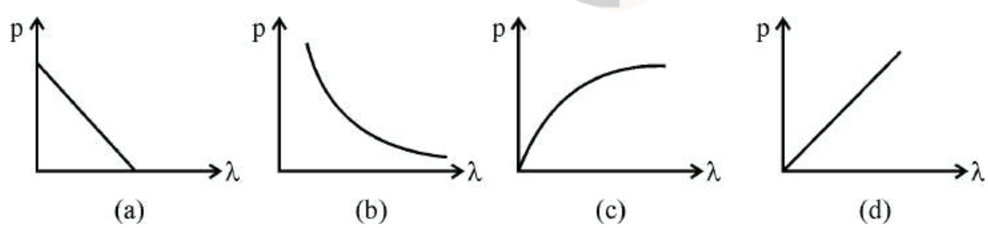
   (c) IR rays   (d) optical signals   1

3. The selectivity of a series LCR a.c. circuit is large, when

   (a) L is large and R is large   (b) L is small and R is small

   (c) L is large and R is small   (d) L = R   1

4. The graph showing the correct variation of linear momentum (p) of a charge particle with its de-Broglie wavelength ( ) is –



1

5. The wavelength and intensity of light emitted by a LED depend upon

   (a) forward bias and energy gap of the semiconductor

   (b) energy gap of the semiconductor and reverse bias

   (c) energy gap only

   (d) forward bias only   1

6. A charge particle after being accelerated through a potential difference 'V' enters in a uniform magnetic field and moves in a circle of radius r. If V is doubled, the radius of the circle will become

(a) 2r (b) $\sqrt{2}$ r

(c) 4r (d) r/ $\sqrt{2}$ 1

7. The electric flux through a closed Gaussian surface depends upon

(a) Net charge enclosed and permittivity of the medium

(b) Net charge enclosed, permittivity of the medium and the size of the Gaussian surface

(c) Net charge enclosed only

(d) Permittivity of the medium only 1

8. If photons of frequency v are incident on the surfaces of metals. A & B of threshold frequencies v/2 and v/3 respectively, the ratio of the maximum kinetic energy of electrons emitted from A to that from B is

(a) 2 : 3 (b) 3 : 4

(c) 1 : 3 (d) $\sqrt{3}$: $\sqrt{2}$ 1

9. The power factor of a series LCR circuit at resonance will be

(a) 1 (b) 0

(c) 1/2 (d) 1/ $\sqrt{2}$ 1

10. A biconcave lens of power P vertically splits into two identical plano concave parts. The power of each part will be

(a) 2P (b) P/2

(c) P (d) P/ $\sqrt{2}$ 1

Note : Fill in the blanks with appropriate answer.

11. The physical quantity having SI unit NC^{-1} m is ________. 1

12. A copper wire of non-uniform area of cross-section is connected to a d.c. battery. The physical quantity which remains constant along the wire is ________ 1

13. A point charge is placed at the centre of a hollow conducting sphere of internal radius 'r' and outer radius '2r'. The ratio of the surface charge density of the inner surface to that of the outer surface will be ________. 1

14. The ________ , a property of materials C, Si and Ge depends upon the energy gap between their conduction and valence bands. 1

15. The ability of a junction diode to ________ an alternating voltage, is based on the fact that it allows current to pass only when it is forward biased. 1

Note : Answer the following :

16. Define the term 'current sensitivity' of a moving coil galvanometer. 1

17. Depict the fields diagram of an electromagnetic wave propagating along positive X-axis with its electric field along Y-axis. 1

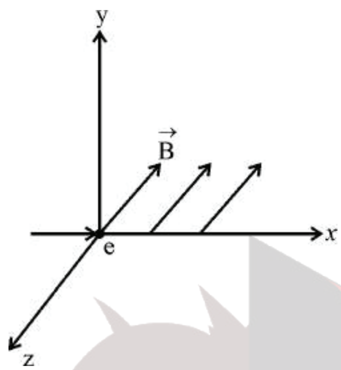
18. Write the conditions on path difference under which (i) constructive (ii) destructive interference occur in Young's double slit experiment. 1

19. Plot a graph showing variation of induced e.m.f. with the rate of change of current flowing through a coil. 1

OR

A series combination of an inductor (L), capacitor (C) and a resistor (R) is connected across an ac source of emf of peak value E_0 and angular frequency ( ). Plot a graph to show variation of impedance of the circuit with angular frequency ( ). 1

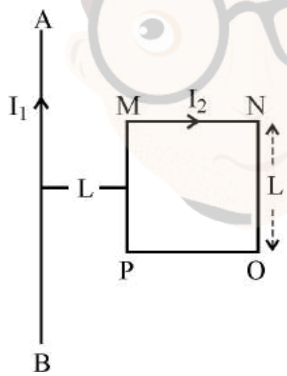
20. An electron moves along + x direction. It enters into a region of uniform magnetic field B directed along –z direction as shown in fig. Draw the shape of trajectory followed by the electron after entering the field.



1

OR

A square shaped current carrying loop MNOP is placed near a straight long current carrying wire AB as shown in the fig. The wire and the loop lie in the same plane. If the loop experiences a net force F towards the wire, find the magnitude of the force on the side 'NO' of the loop.



1

SECTION : B

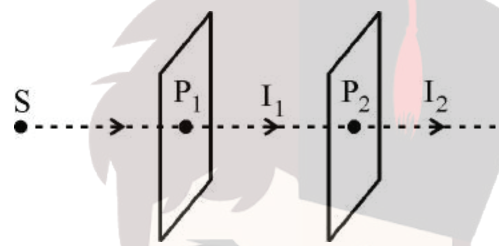
21. Derive the expression for the torque acting on an electric dipole, when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field, in which it attains a stable equilibrium. 2

OR

Obtain the expression for the energy stored in a capacitor connected across a dc battery. Hence define energy density of the capacitor. 2

22. Gamma rays and radio waves travel with the same velocity in free space. Distinguish between them in terms of their origin and the main application. 2

23. Light from a sodium lamp (S) passes through two polaroid sheets P_1 and P_2 as shown in fig. What will be the effect on the intensity of the light transmitted (i) by P_1 and (ii) by P_2 on rotating polaroid P_1 about the direction of propagation of light ? Justify your answer in both cases.

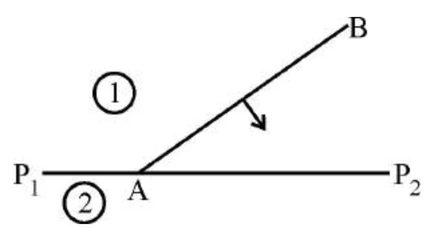


2

OR

Define the term 'wave front of light'. A plane wave front AB propagating from denser medium (1) into a rarer medium (2) is incident on the surface P_1P_2 separating the two media as shown in fig.

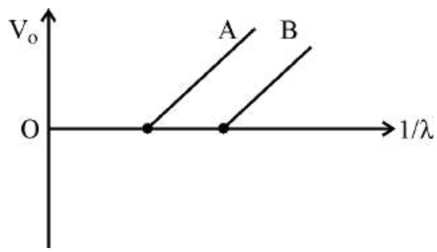
Using Huygen's principle, draw the secondary wavelets and obtain the refracted wave front in the diagram.



2

24. A heavy nucleus P of mass number 240 and binding energy 7.6 MeV per nucleon splits in to two nuclei Q and R of mass numbers 110, 130 and binding energy per nucleon 8.5 MeV and 8.4 MeV, respectively. Calculate the energy released in the fission. 2

25. Figure shows the stopping potential (V_0) for the photo electron versus (1/) graph, for two metals A and B, being the wavelength of incident light.



(a) How is the value of Planck's constant determined from the graph ?

(b) If the distance between the light source and the surface of metal A is increased, how will the stopping potential for the electrons emitted from it be effected ? Justify your answer. 2

26. Use Bohr's model of hydrogen atom to obtain the relationship between the angular momentum and the magnetic moment of the revolving electron. 2

27. In a single slit diffraction experiment, the width of the slit is increased. How will the (i) size and (ii) intensity of central bright band be affected ? Justify your answer. 2

SECTION : C

28. (a) Differentiate between electrical resistance and resistivity of a conductor.

(b) Two metallic rods, each of length L, area of cross A_1 and A_2, having resistivities $_1$ and $_2$ are connected in parallel across a d.c. battery. Obtain the expression for the effective resistivity of this combination. 3

29. Calculate the de-Broglie wavelength associated with the electron revolving in the first excited state of hydrogen atom. The ground state energy of the hydrogen atom is –13.6 eV. 3

30. (a) Define the term decay constant of a radioactive substance.

(b) The half life of $^{238}_{92}U$ undergoing decay is 4.5 10^9 years. Calculate the activity of 10 g sample of $^{238}_{92}U$. 3

31. What is a solar cell ? Draw its V-I characteristics. Explain the three processes involved in its working. 3

OR

Draw the circuit diagram of a full wave rectifier. Explain its working showing its input and output waveforms. 3

32. An optical instrument uses a lens of power 100 D for objective lens and 50 D for its eyepiece. When the tube length is kept at 25 cm. the final image is formed at infinity.

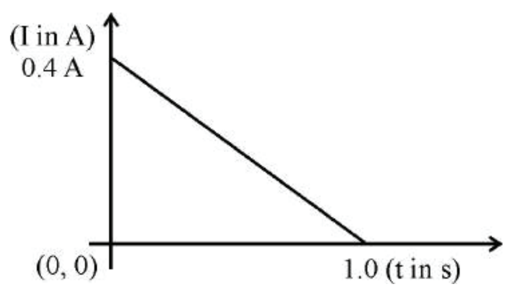
(a) Identify the optical instrument

(b) Calculate the magnification produced by the instrument. 3

33. (a) Two point charges q_1 and q_2 are kept at a distance of r_{12} in air. Deduce the expression for the electrostatic potential energy of this system.

(b) If an external electric field (E) is applied on the system, write the expression for the total energy of this system. 3

34. When a conducting loop of resistance 10 and area 10 cm^2 is removed from an external magnetic field acting normally, the variation of induced current in the loop with time is shown in the figure.



Find the

(i) total charge passed through the loop.

(ii) change in magnetic flux through the loop.

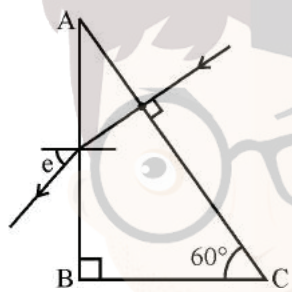
(iii) magnitude of the magnetic field applied. 3

SECTION : D

35. (a) Define the term 'focal length of a mirror'. With the help of a ray diagram, obtain the relation between its focal length and radius of curvature.

(b) Calculate the angle of emergence (e) of the ray of light incident normally on the face AC of a glass prism ABC of refractive index $\sqrt{3}$.

How will the angle of emergence change qualitatively, if the ray of light emerges from the prism into a liquid of refractive index 1.3 instead of air ?



5

OR

(a) Define the term 'resolving power of a telescope'. How will the resolving power be effected with the increase in

(i) Wavelength of light used.

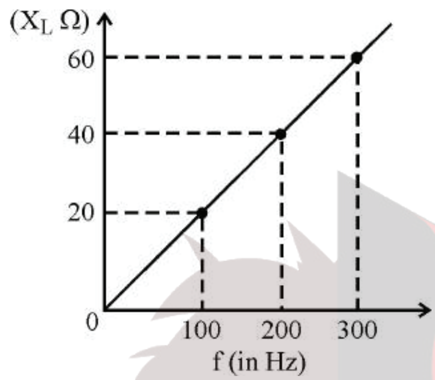
(ii) Diameter of the objective lens.

Justify your answers.

(b) A screen is placed 80 cm from an object. The image of the object on the screen is formed by a convex lens placed between them at two different locations separated by a distance 20 cm. Determine the focal length of the lens. 5

36. (a) Show that an ideal inductor does not dissipate power in an ac circuit.

(b) The variation of inductive reactance (X_L) of an inductor with the frequency (f) of the ac source of 100 V and variable frequency is shown in the fig.



(i) Calculate the self-inductance of the inductor.

(ii) When this inductor is used in series with a capacitor of unknown value and a resistor of 10 at 300 s^{-1}, maximum power dissipation occurs in the circuit. Calculate the capacitance of the capacitor. 5

OR

(a) A conductor of length 'l' is rotated about one of its ends at a constant angular speed ' ' in a plane perpendicular to a uniform magnetic field B. Plot graphs to show variations of the emf induced across the ends of the conductor with (i) angular speed and (ii) length of the conductor l.

(b) Two concentric circular loops of radius 1 cm and 20 cm are placed coaxially.

(i) Find mutual inductance of the arrangement.

(ii) If the current passed through the outer loop is changed at a rate of 5 A/ms, find the emf induced in the inner loop. Assume the magnetic field on the inner loop to be uniform. 5

37. (a) Write two important characteristics of equipotential surfaces.

(b) A thin circular ring of radius r is charged uniformly so that its linear charge density becomes . Derive an expression for the electric field at a point P at a distance x from it along the axis of the ring. Hence, prove that at large distances (x >> r), the ring behaves as a point charge. 5

OR

(a) State Gauss's law on electrostatics and derive an expression for the electric field due to a long straight thin uniformly charged wire (linear charge density) at a point lying at a distance r from the wire.

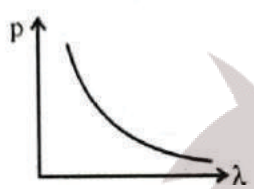
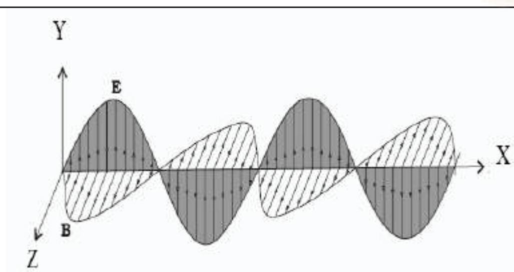
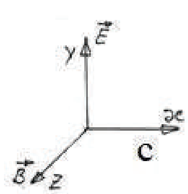
(b) The magnitude of electric field (in NC^{-1}) in a region varies with the distance r(in m) as

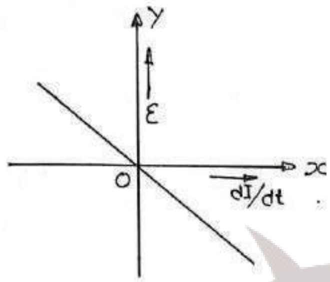
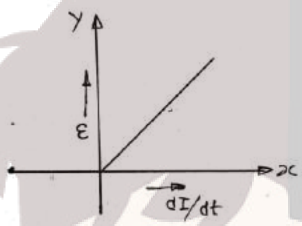
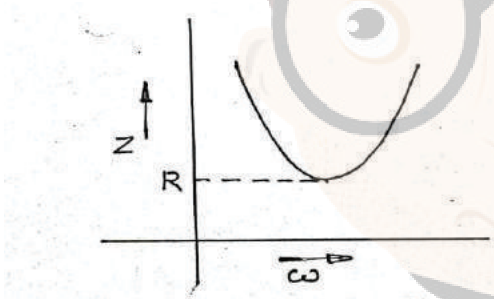
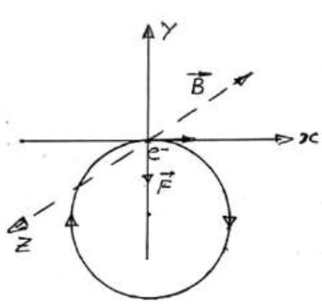
$$E = 10\,r + 5$$

By how much does the electric potential increase in moving from point at r = 1 m to a point at r = 10 m. 5

Marking Scheme: Physics (042)

Code :55/5/1

Q.No.	VALUE POINTS/ EXPECTED ANSWERS	Marks	Total Marks
	SECTION A		
1.	(a) $v \tan \quad = c$	1	1
2.	(d) Optical Signals	1	1
3.	(c) L is large and R is small	1	1
4.	(b) 	1	1
5.	(a) Forward bias and energy gap of the semiconductor	1	1
6.	(b) $\sqrt{2}\,r$	1	1
7.	(a) Net Charge enclosed and permittivity of the medium	1	1
8.	(b) 3:4	1	1
9.	(a) 1	1	1
10.	(b) P/2	1	1
11.	Electrostatic potential difference/ Electric potential	1	1
12.	Electric current	1	1
13.	4:1	1	1
14.	Conductivity/ Resistivity (Also give full credit if a student writes semiconducting nature)	1	1
15.	Rectify	1	1
16.	Angular deflection of the galvanometer coil per unit current./deflection per unit current Alternatively $I_s = \frac{\;}{I}$ alternatively $\frac{NAB}{K}$	1	1
17.	 Alternatively 	1	1

18.	(i) for constructive interference path difference, $p = n$ (ii) for destructive interference path difference, $p = (2n+1)\frac{}{2}, n = 0,1,2,3--$ Alternatively $p = (2n-1)\frac{}{2}, n = 1,2,3--$	½ ½	1
19.	 Induced e.m.f. in a coil, $= -L\frac{dI}{dt}$ [Award one full mark even if the student just draws the graph without writing the expression of induced emf] (Note: Award this one mark if a student draws the graph in first quadrant as shown below.)  **OR** $Z = \sqrt{R^2 + (X_L - X_C)^2}$  [Award one full mark even if the student just draws the graph without writing expression of impedance]	½ ½ ½ ½	**1** **1**
20	 **Alternatively:** Circular path in the X-Y plane in clockwise sense.	1 ½+½	

[Note: If the student just writes, force on the electron will be along negative Y axis, i.e. $F = -e(v\,\hat{i})\ \ (B(-\hat{k}) = evB(-\hat{j})$ *award* $\frac{1}{2}$ *mark only*)

OR

Magnitude of force on side NO is $= F$

Alternatively

Let force on side MP be $= F_1$

Force on side $NO = \frac{F_1}{2}$ ½

Magnitude of net force $= F_1 - \frac{F_1}{2} = \frac{F_1}{2} = F$

Therefore force on side NO $= \frac{F_1}{2} = F$ ½

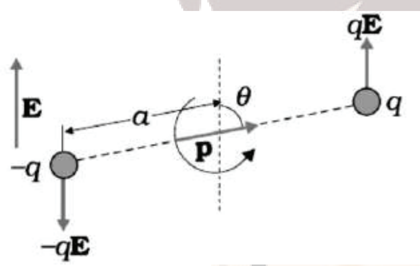
Give full credit if a student calculates the force as shown below.

$F = \frac{\ _0}{2} I_1 I_2$ **1**

SECTION B

21.

Derivation of the expression for the torque	1½
Identification of the orientation of stable equilibrium	½



½

Force on q is q**E** and a force on –q is –q**E**.

Hence torque

$= qE\ \ 2a\sin$ ½

$= PE\sin$ ½

$\bar{\ } = \vec{P}\ \ \vec{E}$

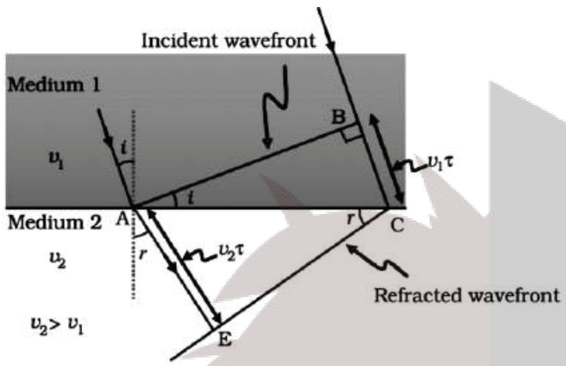
For stable equilibrium $\theta = 0^0$ ½

OR

Obtaining the expression for the energy stored	1½
Definition of energy density	½

Let the charge on the capacitor plates at any instant, during charging process be q, amount of work done to supply further charge dq to the capacitor

	$dW = Vdq$ *where V is the potential difference and equals to* $\frac{q}{C}$ *Total work done to* charge *the capacitor upto* charge *Q* $W = {}_{0}^{Q} Vdq$ $= {}_{0}^{Q} \frac{q}{C} dq = \frac{Q^2}{2C} \quad \frac{1}{2}CV^2 = \frac{1}{2}QV$ Since *Energy stored = work done* $U = \frac{Q^2}{2C} \quad \frac{1}{2}CV^2 = \frac{1}{2}QV$ Energy density: Electrical energy stored per unit volume is known as energy density. Alternatively: Energy density $= \frac{1}{2} \,{}_{0}E^2 = \frac{1}{2} \frac{{}^{2}}{{}_{0}}$	½ ½ ½ ½	 2
22.	Origin of gamma rays and radio waves ½+½ Main application of each ½+½ Gamma rays are emitted by radioactive nuclei/produced in nuclear reactions. Radio waves are produced by accelerated /oscillating charges/LC circuit. Gamma rays are used for the treatment of cancer/in nuclear reactions. Radio waves are used in communication systems/radio or television communication systems/cellular phones. (or any other correct applications)	 **½** **½** **½** **½**	 **2**
23.	Effect and justification ½+½ Effect and justification ½+½ **(i)** Intensity of light transmitted by P_1 remains unaffected when P_1 is rotated about the direction of propagation of light. **Justification:** The intensity of unpolarized light transmitted by a Polaroid does not depend on the orientation of the Polaroid with respect to the direction of propagation of light. **(ii)** The intensity of light transmitted by P_2 will vary from I_1 to zero. **Justification:** As per Malus' Law $I = I_0 \cos^2$ Where θ is the angle between the pass axis of the polaroid P_2 and the pass axis of polaroid P_1. As varies from 0^0 *to* ${}_{2}$ will vary from I_1 *to* zero.	 ½ ½ ½ ½	 2

	OR Definition of wave front 1 Obtaining refracted wave front 1 The wave front is a surface of constant phase. **Alternatively** The wave front is the locus of all points that are oscillating in phase.  	1 1	2
24.	Finding Binding Energy of P, Q and R ½+½+½ Finding energy released ½ B.E. of heavy nucleus P $= 240 \quad 7.6$ MeV=1824 MeV B.E. of nucleus Q $= 110 \quad 8.5$ MeV=935 MeV B.E. of nucleus R $= 130 \quad 8.4$ MeV=1092 MeV Energy released $= [(935 + 1092) - 1824]$ MeV $= [2027 - 1824]$ MeV $= 203$ MeV	½ ½ ½ ½	2
25.	Finding Planck's constant from the graph 1 Effect on stopping potential ½ Justification ½ According to Einstein's Photo electric equation $h \quad = \quad _0 + eV_s$ $eV_s = h \quad - \quad _0$ $V_s = \frac{h}{e} - \frac{_0}{e}$ since $\quad = c\,/$	½	

	$V_s = \frac{hc}{e} - \frac{\ _0}{e}$ $= \frac{hc}{e}\ \frac{1}{\ } + \frac{-\ _0}{e}$ Comparing with the equation of straight line y=mx +c (a) The slope of the line $m = \frac{hc}{e}$. Hence, Planck's constant $h = \frac{me}{c}$ (b) Stopping potential will remain same **Justification** Variation of distance of light source from the metal surface will alter the intensity while the stopping potential however depends only on the frequency and not on the intensity of the incident light.	½ ½ ½	2
26.	Expression for angular momentum ½ Expression for magnetic moment 1 Relation between the two ½ According to Bohr's model $L = Angular\ momentum = mvr = \frac{nh}{2}$ $= \quad agnetic\ moment = current \quad area\ of\ the\ orbit$ $= \|e\| \qquad r^2 = \frac{\|e\|vr}{2}$ $\frac{L}{\ } = \frac{mvr \quad 2}{\|e\|vr} = \frac{2m}{\|e\|}$ $= \frac{\|e\|}{2m} L$	½ ½ ½ ½	2
27.	Effect and justification ½+½ Effect and justification ½+½ (i) On increasing the width of the slit, the size of the central bright band will decrease (ii) **Justification:** Angular width $= \frac{2}{a}$, i.e. angular width is inversely proportional to the width of the slit (iii) The intensity of central bright band will increase **Justification:** The amplitude/intensity of light passing through slit has increased.	½ ½ ½ ½	2
	SECTION C		
28.	(a) Difference between electrical resistance and resistivity 2 (b) Obtaining the expression for effective resistivity 1		

	(a) Electrical resistance (R) of a conductor equals the ratio of the potential difference (V) applied across it, to the resulting current (I) flowing through it. (Alternatively: $R = \frac{V}{I}$)	1	
	The resistivity of a conductor equals the resistance of a wire of unit length and unit area of cross section, drawn from the material of that conductor. (Alternatively: $R = \frac{l}{A}$ or $= \frac{RA}{l}$) (or any other one relevant difference)	1	
	(b) For the parallel combination equivalent resistance is given by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{A_1 + A_2}{{}_{eq}L} = \frac{A_1}{{}_1L} + \frac{A_2}{{}_2L}$	½	
	Where $(A_1 + A_2)$ *is* the effective area of cross section of combined rod in parallel combination of the rods. $\frac{{}_1\;{}_2}{({}_2A_1 + {}_1A_2)} = \frac{{}_{eq}}{(A_1 + A_2)}$ ${}_{eq} = \frac{{}_1\;{}_2(A_1 + A_2)}{({}_2A_1 + {}_1A_2)}$	½	
	(Note : If a student just writes the expression of equivalent resistance, award half mark of this part)		3
29.	Finding the energy in the first excited state 1 Finding the associated kinetic energy 1 Finding the associated de-Broglie wavelength 1		
	Energy of the electron in the first excited state $E_1 = -\frac{13.6}{2^2} eV = -3.4 eV$	½	
	$= -3.4 \;\; 1.6 \;\; 10^{-19} J$ $= -5.44 \;\; 10^{-19} J$	½	
	Associated kinetic energy =Negative of total energy	½	
	$K = 5.44 \;\; 10^{-19} J$	½	
	de-Broglie wavelength, $= h/p$ $= \frac{h}{\sqrt{2mK}}$	½	

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$$= \frac{6.63 \quad 10^{-34}}{(2 \quad 9.1 \quad 10^{-31} \quad 5.44 \quad 10^{-19})^{1/2}} \text{ m}$$

$$= \frac{6.63 \quad 10^{-34}}{(99.008)^{1/2} \quad 10^{-25}} \text{ m}$$

$$0.663 \quad 10^{-9} \text{ m} = 0.663\text{nm} = 6.63 A^{\circ}$$

</td><td>½</td><td>3</td></tr>
<tr><td>30.</td><td>

(a) Definition of decay constant	1
(b) Calculation of the activity	2

(a) The decay constant ( ) of a given radioactive sample is the constant of proportionality between its instantaneous decay rate $-\frac{dN}{dt}$ and the total number of its decaying nuclei (N) at that instant.

Alternatively

decay constant, $= \frac{|dN/dt|}{N}$

Alternatively

decay constant, $= \ln 2 / T_{1/2}$

where $T_{1/2}$ is the half life of the radioactive substance

Alternatively

decay constant, $= 1 / T_m$

where T_m is the mean life of the radioactive substance

(b) Activity, $R =$

$ere \quad = \frac{0.6931}{4.5 \quad 10^9} \text{ years}^{-1}$

also N = number of atoms in the 10g sample of ${}^{238}_{92}\text{U}$

$N = \frac{10}{238} \quad 6.023 \quad 10^{23} \text{ atoms}$

$R = \frac{0.6931}{4.5 \quad 10^9} \quad \frac{10}{238} \quad 6.023 \quad 10^{23} \text{ atoms / year}$

$R = 0.039 \quad 10^{16} \text{ atoms / year}$

$= 3.9 \quad 10^{14} \text{ atoms / year}$

$= 1.24 \quad 10^{7} \text{ atoms/second}$

(Note: Do not deduct any mark if a student does not write answer in atoms per second.)

</td><td>1

½

½

½

½</td><td>3</td></tr>
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Solar cell	1
V-I characteristics	½
Three processes involved	½+½+½

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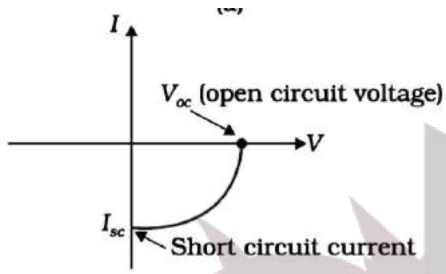
A solar cell is basically a p-n junction which generates emf when solar radiation falls on the p-n junction. 1

Alternatively:
A solar cell works on the same principle as the photodiode, however, no external bias applied to it and its junction area is much larger than that of a photodiode.

V-I Characteristics



½

Three processes involved in the working of the solar cell are

Generation: Light (*h* $_g$) generates electron-hole pairs. ½

Separation: Electric field, of the depletion region, separates the electron and the holes. ½

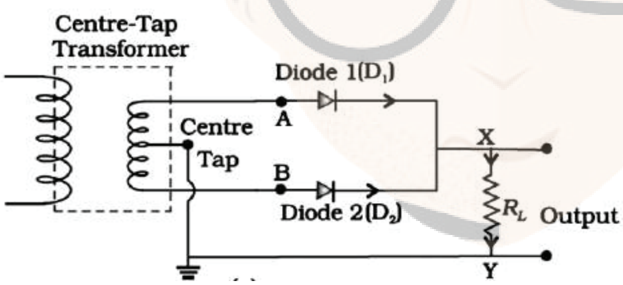
Collection: The front contact collects the electrons reaching the n-side and back contact collects holes reaching the p-side. ½

[**Note:** For the last part, award one mark if the student just writes the three names of three processes without giving any explanation.]

OR

Circuit diagram	1
Working	1
Input and output waveform	1

3



1

During one half cycle of the input a.c. signal, only diode 1 is forward biased and conducts. ½

During the next half cycle of the input ac signal only diode 2 is forward biased and conducts.

However, due to the use of the centre tapped transformer, the current in the load flows in the same direction during both these half cycles. The current through the load is therefore unidirectional. ½

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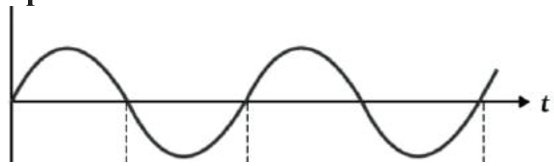
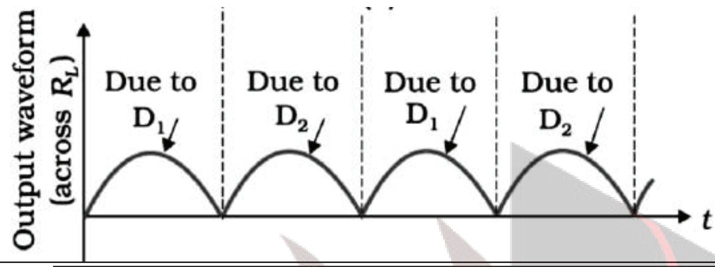
Input waveform



Output waveform



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½</td>
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Identification	1
Calculation of magnifying power	2

Objective lens with a power of 100 D, has a focal length of 1cm (very short focal length)
Eye piece, with a power of 50 D, has a focal length of 2cm (short focal length)
The optical instrument is therefore a compound microscope.
(**Note:** Award this one mark if a student writes directly compound microscope without justifying.)
When the final image is formed at infinity, the magnification of a compound microscope equals

$$m = \frac{L}{f_0} \quad \frac{D}{f_e}$$

$$L = 25\ cm,\ D = 25\ cm$$

$$f_0 = 1\ cm,\ f_e = 2\ cm$$

$$m = \frac{25}{1} \quad \frac{25}{2}$$

$$= 312.5$$

</td>
<td>½
½

1

½

½</td>
<td>3</td>
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(a) Deducing the expression for potential energy	1½
(b) Expression for energy in the presence of an external electric field	1½

(a) Work done in bringing the charge q_2, from infinity, to a point

$= q_2$ potential at the point due to charge q_1

$$= q_2 \quad \frac{1}{4 \quad _0} \frac{q_1}{r_{12}}$$

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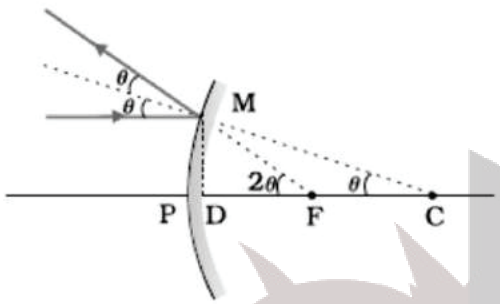
	potential energy of the system = $\frac{1}{4 \ \ _{0}} \frac{q_1 q_2}{r_{12}}$ (b)Let the potentials, at two points, due to an external electric field (E) be V_1 and V_2 respectively. Now the total energy of the system is: $q_1V_1 + q_2V_2 + \frac{1}{4 \ \ _{0}} \frac{q_1 q_2}{r_{12}}$	1 1½	 3
34.	Finding (i) The charge passed through the loop 1 (ii) Change in magnetic flux through the loop 1 (iii) Magnitude of the magnetic field applied 1 (i) Total charge passed through the loop (Q) Q = area under the I-t graph $= \frac{1}{2} \ \ 0.4 \ \ 1$ coulomb $= 0.2C$ (ii) Change in magnetic flux Total charge passing = $\frac{\text{change in magnetic flux}}{R}$ Change in magnetic flux = $R \ \ 0.2C$ $= 10 \ \ 0.2$ Wb = Wb (iii) Magnitude of magnetic field applied Let B be the magnitude of the magnetic field applied Initial magnetic flux = $(10 \ \ 10^{-4})\ Wb$ Final magnetic flux = zero Change in magnetic flux = ($^{-3}$ − 0)= 2 $B = 2 \ \ 10^{3}\ Wb/m^2$ (**Note:** Award two marks to a student who only calculates charge and not able to calculate correctly the remaining two parts of this question)	½ ½ ½ ½ ½ ½	 3
	SECTION D		
35.	(a)Definition of focal length 1 Obtaining the relation between focal length and radius of curvature 1½ (b)Calculation of angle of emergence 2 Qualitative change in the angle of emergence ½		

(a) **Focal length of mirror**: It is the distance of the point from the pole of mirror through which ray of light moving parallel to its principle axis passes (or appear to come from). 1

Alternatively: It is half of the distance of its centre of curvature from the pole of a mirror.



½

Let C be the centre of curvature of mirror, MD be the perpendicular from M to the principal axis.

$MCP = \quad and \quad MFP = \ 2$

$\tan \ = \frac{MD}{CD}$, $\tan 2 \ = \frac{MD}{FD}$ (1) ½

For small angles, tan and tan2 2

From equation 1, $\frac{MD}{FD} = 2\frac{MD}{CD}$

$FD = \frac{CD}{2}$ ----equation (2)

For small the point D is very close to the point P

$\therefore$ FD $\simeq$ FP $= f$ and CD $\simeq$ CP $= R$

from equation 2, we get $f = \frac{R}{2}$ ½

(b) Applying Snell's law at face AB, we get

$\sqrt{3}\sin 30 = 1 \ \sin e$ ½

$\sqrt{3} \ \ \frac{1}{2} = \sin e$ ½

$\frac{\sqrt{3}}{2} = \sin e$

$\sin 60 = \sin e$

$e = 60^0$ ½

When the medium (the air) in which the prism is kept is replaced with a liquid of refractive index 1.3 the angle of emergence would decrease. It is because bending in the ray of light will be lesser. ½ ½

OR

(a) Definition of resolving power	1
(i) Effect and justification	½+½
(ii) Effect and justification	½+½
(b) Calculation of focal length	2

Resolving power of a telescope is defined as the reciprocal of the smallest angular separation between two distinct objects whose image can be just resolved by it. 1

Alternatively: Resolving power $= \frac{1}{d} = \frac{D}{1.22}$

Alternatively

It is the reciprocal of the limit of resolution.

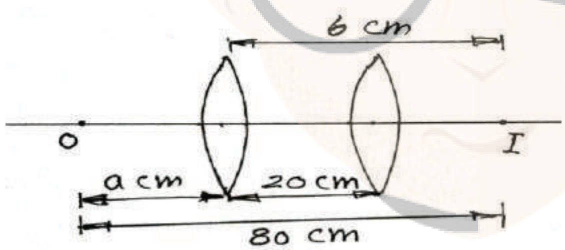
(i) As increases, R.P. decreases ½

Reason R.P.$= \frac{D}{1.22}$ *i.e. R.P.* $\frac{1}{\ }$ ½

(*ii*) As D increases, R.P. increases ½

Reason R.P.$= \frac{D}{1.22}$ *i.e. R.P.* D ½

The two positions of the lens are as shown



for position 1

$u = -a\ cm$

$v = b = +(80 - a)\ cm$ ½

for position 2

$u = -(a + 20)\ cm$

$v = +(b - 20) = +(\quad - a)\ cm$ ½

	By lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ $\frac{1}{(80-a)}+\frac{1}{a}=\frac{1}{(60-a)}+\frac{1}{(20+a)}$ This gives a(80-a)=(a+20)(60-a) or 80a-a$^2 = 40a+1200-a^2$ *or* a = *cm* $\frac{1}{f}=\frac{1}{50}+\frac{1}{30}=\frac{3+5}{150}=\frac{8}{150}$ f= $\frac{150}{8}cm = 18.75cm$ **Alternatively** $F=\frac{D^2-x^2}{4D}=\frac{80^2-20^2}{4\ \ 80}=18.75\,cm$ **Alternatively** The values of $a=\lvert u\rvert$ *and* $b=\lvert v\rvert$ simply get interchanged in the two positions. b+a = *cm* b-a = *cm* *This gives* $b=50cm$ *and* $a=30cm$ $\frac{1}{f}=\frac{1}{50}\ \ \frac{1}{-30}=\frac{8}{150}$ f = *cm*	½ ½ 1+1 ½ ½ ½ ½	5
36.	(a) Showing No dissipation of power — 2 (b) (i) Calculation of self inductance — 1 (ii) Calculation of capacitance — 2 (a)		

$V = V_0 \sin \quad t$

$I = \quad _0 \sin(\quad t - \qquad)$

The instantaneous power supplied to the inductor ½

$P_L = IV$ ½

$= I_0 \sin(\quad t - \qquad)(V_0 \sin \quad t)$

$= -I_0 V_0 \cos \quad t \sin \quad t$

$= -\frac{I_0 V_0}{2} \sin 2 \quad t$ ½

Now average power over a completer cycle,

$\langle P_L \rangle = \left\langle -\frac{I_0 V_0}{2} \sin 2 \quad t \right\rangle$

$= -\frac{I_0 V_0}{2} \langle \sin 2 \quad t \rangle = 0$ ½

Average value of sin2 t over a complete cycle is zero.

Thus average power dissipated over a complete cycle is zero.

(b) (i) $X_L = 2 \quad fL$ ½

$L = \frac{X_L}{2 \quad f} = \frac{40}{\quad 200} = 0.1 / \quad henry = 0.032H$ ½

Maximum power dissipation takes place at resonance ½

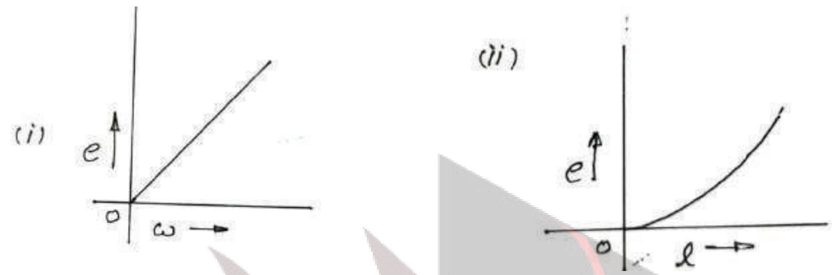
$= \frac{1}{2 \quad \sqrt{LC}}$ ½

$C = \frac{1}{L \quad 300^2 \quad 4 \quad ^2} F$ ½ 5

$C = \frac{}{0.1 \quad 9 \quad 10^4 \quad 4 \quad ^2} F = 8.8 \quad F$ ½

OR

(a) Formula	1
Plot of two graphs	½+½
(b) (i) Finding the coefficient of mutual induction	1½
(ii)Finding the induced emf	1½

	e.m.f. induced in the rod $= \left\| -\frac{d}{dt} \right\|$	½	
	$e = \frac{1}{2} Bl^2$	½	
		½+½	
	(i) Imagine a current I to flow through the larger coil.		
	Magnetic flux linked with linked with the smaller coil $= MI$		
	$= B_{centre}\quad 10^{-4}\text{Wb}$	½	
	$= \frac{_0 I}{2\quad 20\quad 10^{-2}}\quad 10^{-4}\text{Wb}$		
	$M = \frac{_0}{4}\quad 10^{-3}\text{H}$	½	
	$= \frac{4\quad 10^{-7}\quad 10^{-3}}{4} H$		
	$= 9.9\quad 10^{-10} H$		
	$= 10^{-9} H$	½	
	(ii)		
	$e.m.f.\ induced = -M \frac{dI}{dt}$	½	
	$= -10^{-9}\quad \frac{5}{10^{-3}} V$	½	
	$= -5\quad 10^{-6} V$	½	
	Alternatively		
	$e.m.f.\ induced = -\frac{d}{dt}$		
	$= -\frac{d}{dt}(B_c A_i) = -A_i \frac{dB_c}{dt}$	½	

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$= -A_i \frac{d}{dt}\ \frac{{}_0 I}{2R}$

$= -\frac{A_{i\ 0}}{2R}\frac{dI}{dt}$

$= \frac{-\quad {}^{-4}\quad 4\quad 10^{-7}\quad 5}{2\ \left(20\quad 10^{-2}\right)\ 10^{-3}}V$

$= -\frac{20\ {}^{2}\quad 10^{-6}}{2\quad 20}V$

$= -5\quad 10^{-6}V$

</td><td>½

½</td><td>5</td></tr>
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(a) Two important characteristics	1+1
(b) Derivation of the expression of the electric field	2½
Showing the behaviour as point charge	½

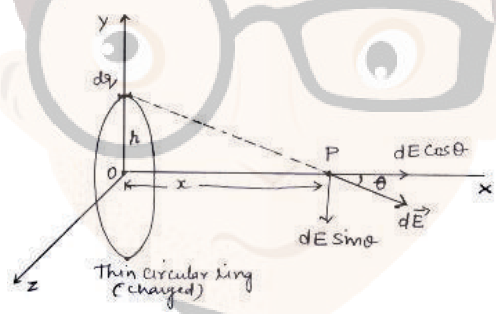
(a) For equipotential surfaces

(i) Potential has the same value at all points on the surface.

(ii) Electric field is normal to the equipotential surface at all points

(iii) Work done in moving any charge between any two points on the equipotential surface is zero (any two)

(b)



Electric field due to any elemental (point) charge dq, at point P.

$= dE = \frac{1}{4\quad {}_0}\ \frac{dq}{(x^2 + r^2)}$

This is directed along AP

Its component along the axis OP of the ring is

$= dE\ \cos\quad = dE\frac{x}{\sqrt{x^2 + r^2}}$

</td><td>1+1

½

½</td><td></td></tr>
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The component, perpendicular to the axis gets cancelled by the elemental electric field due to another elemental charge symmetrically located on the other side of the axis.

Hence total electric field

$E = \quad \text{dE cos}$ ½

$= \frac{1}{4 \quad _0} \frac{\text{dq}}{(x^2 + r^2)} \frac{x}{\sqrt{x^2 + r^2}}$

$= \frac{1}{4 \quad _0} \frac{x}{(x^2 + r^2)^{3/2}} \quad \text{d}l$

$= \frac{1}{4 \quad _0} \frac{x}{(x^2 + r^2)^{3/2}} \quad 2 \quad r$ ½

$= \frac{Q}{4 \quad _0} \frac{x}{(x^2 + r^2)^{3/2}}$ ½

Where $Q = \quad 2 \quad r$ = total charge on the ring

This field is directed along the axis.

When x much larger than r, we have

$E = \frac{Q}{4 \quad _0} \frac{x}{(x^2)^{3/2}} = \frac{1}{4 \quad _0} \frac{Q}{x^2}$ ½ | 5

This corresponds to the expression for the electric field due to a point charge. Thus at large distances the ring behaves like a point charge.

(**Note:** Award these three marks even if a student tries to attempt this part)

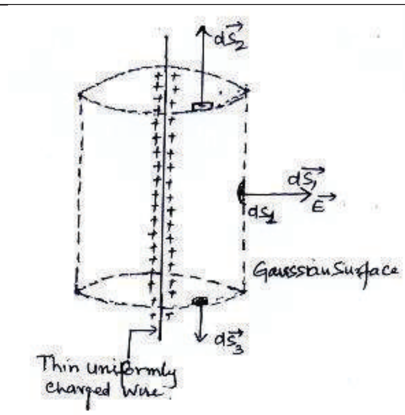
OR

(a)	Statement of Gauss's law	1
	Derivation of the expression of the electric field	2½
(b)	Finding the increase in potential	1½

(a) Gauss law: Electric flux through of a closed surface is $\frac{1}{\quad _0}$ times the charge enclosed by the surface.

Alternatively

$_E = \frac{q}{\quad _0}$ 1

		½	
	Let the charge be uniformly distributed on a wire $\phi = \oint d\phi = \int_{s_1} \vec{E} \cdot \mathrm{ds}_1 + \int_{s_2} \vec{E} \cdot \mathrm{ds}_2 + \int_{s_3} \vec{E} \cdot \mathrm{ds}_3$	½	
	$= \int_{s_1} Eds_1 \cos 0^0 + \int_{s_2} Eds_2 \cos 90^0 + \int_{s_3} Eds_3 \cos 90^0$	½	
	$= E \int_{s_1} ds_1 = E.2\pi rl$ $byGauss'slaw$	½	
	$\frac{q}{\varepsilon_0} = E \cdot 2\pi rl$ $\mathrm{E}=\frac{q}{2\pi\varepsilon_0 rl} = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$	½	
	(b) $E = 10r+5$ $dV = -E\ dr$ $\int dV = -\int_1^{10} \vec{E}\, d\vec{r}$	½	
	$= -\int_1^{10} (10r+5)dr$ $V = -\left[\int_1^{10} 10r\, dr + \int_1^{10} 5dr\right]$	½	
	$V = 10\left[\frac{r^2}{2}\right]_1^{10} + 5(r)_1^{10}$ $V = -[100-1]+5[10-1]$ $V = - \quad 99+5 \quad 9 = -540V$	½	5