


Maximum Marks: 70 Marks

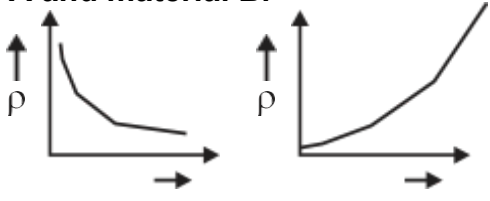
Time Allowed: 3 hours.

General Instructions:

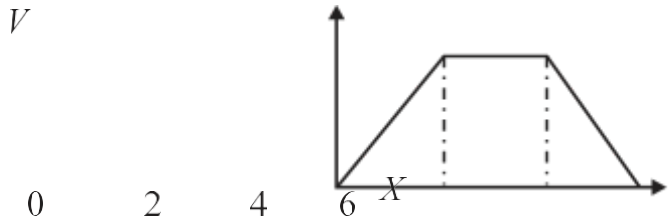
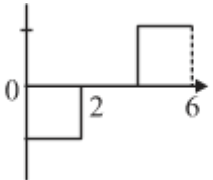
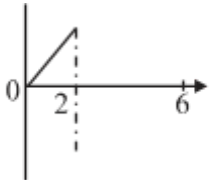
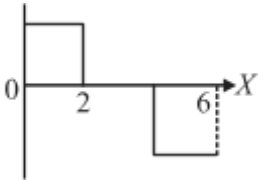
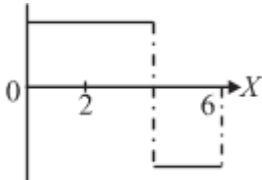
- (1) There are 33 questions in all. All questions are compulsory
- (2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
- (3) Section A contains sixteen questions of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
- (4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION A

Q. NO.		MARKS
1	<p>According to Coulomb's law, which is the correct relation for the following figure?</p>  <p>q_1 \vec{F}_{12} q_2 \vec{F}_{21}</p> <p>(i) $q_1 q_2 > 0$ (ii) $q_1 q_2 < 0$ (iii) $q_1 q_2 = 0$ (iv) $1 > q_1 / q_2 > 0$</p>	1
2	<p>A cylinder of radius r and length l is placed in a uniform electric field parallel to the axis of the cylinder. The total flux for the surface of the cylinder is given by-</p> <p>(i) zero (ii) πr^2 (iii) $E \pi r^2$ (iv) $2 E \pi r$</p>	1

3	<p>The temperature (T) dependence of resistivity of materials A and material B is represented by fig (i) and fig (ii) respectively. Identify material A and material B.</p> <div style="text-align: center;">  <p>fig. (i) fig. (ii)</p> </div> <p>(i) material A is copper and material B is germanium (ii) material A is germanium and material B is copper (iii) material A is nichrome and material B is germanium (iv) material A is copper and material B is nichrome</p>	1
4	<p>Two concentric and coplanar circular loops P and Q have their radii in the ratio 2:3. Loop Q carries a current 9 A in the anticlockwise direction. For the magnetic field to be zero at the common centre, loop P must carry</p> <p>(i) 3A in clockwise direction (ii) 9A in clockwise direction (iii) 6 A in anti-clockwise direction (iv) 6 A in the clockwise direction.</p>	1
5	<p>If the magnetizing field on a ferromagnetic material is increased, its permeability</p> <p>(i) decreases (ii) increases (iii) remains unchanged (iv) first decreases and then increases</p>	1
6	<p>A battery is connected to the conductor of non-uniform cross section area. The quantities or quantity which remains constant is-</p> <p>(i) electric field only (ii) drift speed and electric field (iii) electric field and current (iv) current only</p>	1

7	<p>A rectangular, a square, a circular and an elliptical loop, all in the (x-y) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{v} = v\hat{i}$. The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for</p> <p>(i) any of the four loops (ii) the circular and elliptical loops (iii) the rectangular, circular and elliptical loops (iv) only the elliptical loops</p>	1
8	<p>The work function for a metal surface is 4.14 eV. The threshold wavelength for this metal surface is:</p> <p>(i) 4125 Å (ii) 2062.5 Å (iii) 3000 Å (iv) 6000 Å</p>	1
9	<p>The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. The radius of the n =3 orbit is</p> <p>(i) 1.01×10^{-10} m (ii) 1.59×10^{-10} m (iii) 2.12×10^{-10} m (iv) 4.77×10^{-10} m</p>	1
10	<p>Which of the following statements about nuclear forces is not true?</p> <p>(i) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres. (ii) The nuclear force is much weaker than the Coulomb force. (iii) The force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm. (iv) The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.</p>	1

11	<p>Which of the following transitions in a hydrogen emits the photon of the highest frequency?</p> <p>(i). $n = 1$ to $n = 2$</p> <p>(ii). $n = 6$ to $n = 2$</p> <p>(iii). $n = 2$ to $n = 6$</p> <p>(iv). $n = 2$ to $n = 1$</p>	
12	<p>The electric potential V as a function of distance X is shown in the figure.</p>  <p>The graph of the magnitude of electric field intensity E as a function of X is</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="332 1039 803 1312"> <p>(i) </p> </div> <div data-bbox="803 1039 1328 1312"> <p>(ii) </p> </div> </div> <div style="display: flex; justify-content: space-around;"> <div data-bbox="332 1312 803 1591"> <p>(iii) </p> </div> <div data-bbox="803 1312 1328 1591"> <p>(iv) </p> </div> </div>	1
13	<p>Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.</p> <p>a) Both A and R are true and R is the correct explanation of A</p> <p>b) Both A and R are true and R is NOT the correct explanation of A</p>	1

$+E$

44 X

$-E$

	<p>c) A is true but R is false d) A is false and R is also false</p> <p>ASSERTION(A): The electrical conductivity of a semiconductor increases on doping. REASON: Doping always increases the number of electrons in the semiconductor.</p>	
14	<p>Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.</p> <p>a) Both A and R are true and R is the correct explanation of A b) Both A and R are true and R is NOT the correct explanation of A c) A is true but R is false d) A is false and R is also false</p> <p>ASSERTION: Capacitor serves as a block for DC and offer an easy path to AC. REASON: Capacitive reactance is inversely proportional to frequency d</p>	1
15	<p>Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.</p> <p>a) Both A and R are true and R is the correct explanation of A b) Both A and R are true and R is NOT the correct explanation of A c) A is true but R is false d) A is false and R is also false</p> <p>Assertion(A) :The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies. Reason(R): The energy of electrons emitted from inside the metal surface, is lost in collision with the other atoms in the metal.</p>	1

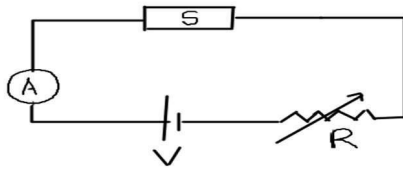
16.	<p>Assertion(A) :</p> <p>In the absence of an externally applied electric field, the displacement per unit volume of a polar dielectric is always zero.</p> <p>Reason(R): In polar dielectric molecules already have permanent dipole moment but are randomly oriented.</p>	
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SECTION B

17	<p>Electromagnetic waves with wavelength</p> <p>(i) λ_1 is suitable for radar systems used in aircraft navigation.</p> <p>(ii) λ_2 is used to kill germs in water purifiers.</p> <p>(iii) λ_3 is used to improve visibility in runways during fog and mist conditions.</p> <p>Identify and name the part of the electromagnetic spectrum to which these radiations belong. Also arrange these wavelengths in ascending order of their magnitude.</p>	2
18	<p>Differentiate between the Random velocity and the drift velocity of electrons in an electrical conductor.</p>	2
19	<p>What is the nuclear radius of ^{125}Fe, if that of ^{27}Al is 3.6 fermi?.</p> <p style="text-align: center;">OR</p> <p>The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 \AA. Calculate the short wavelength limit for the Balmer series of the hydrogen spectrum.</p>	2
20	<p>A biconvex lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Justify your answer.</p>	2

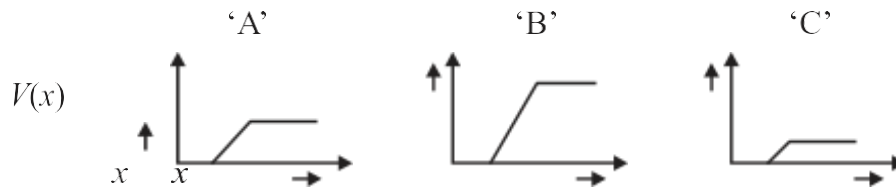
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The figure shows a piece of pure semiconductor S in series with a variable resistor R and a source of constant voltage V. Should the value of R be increased or decreased to keep the reading of the ammeter constant, when semiconductor S is heated? Justify your answer



OR

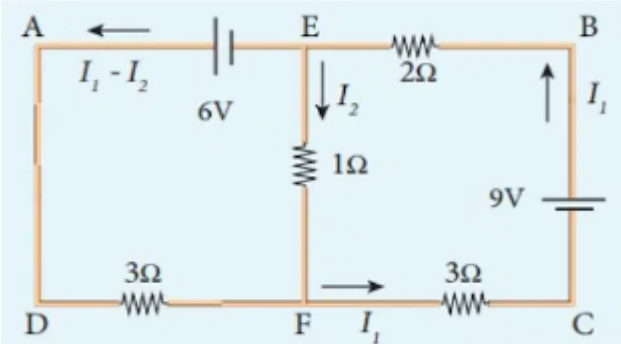
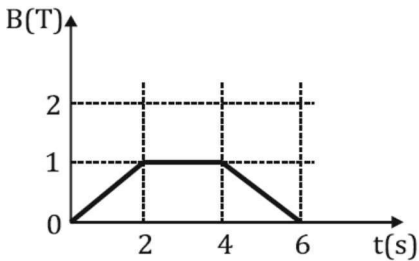
The graph of potential barrier versus width of depletion region for an unbiased diode is shown in graph A. In comparison to A, graphs B and C are obtained after biasing the diode in different ways. Identify the type of biasing in B and C and justify your answer.



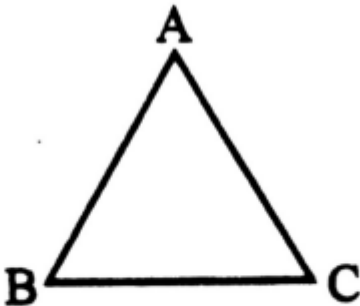
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SECTION C

- (i) In hydrogen atom, an electron undergoes transition from 2nd excited state to the first excited state and then to the ground state. Identify the spectral series to which these transitions belong.
 (ii) Find out the ratio of the wavelengths of the emitted radiations in the two cases.

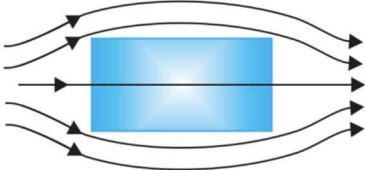
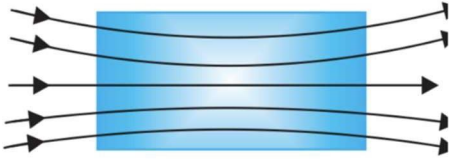
23	<p>Calculate the current that flows in the 1Ω resistor in the following circuit.</p> 	3
24.	<p>The magnetic field through a circular loop of wire, 12cm in radius and 8.5Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the current induced in the loop and plot a graph showing induced current as a function of time.</p> 	3
25	<p>An a.c. source generating a voltage $\mathcal{E} = \mathcal{E}_0 \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. Plot a graph of \mathcal{E} and I versus ωt to show that the current is ahead of the voltage by $\pi/2$.</p> <p style="text-align: center;">OR</p> <p>An ac voltage $V = V_0 \sin \omega t$ is applied across a pure inductor of inductance L. Find an expression for the current i, flowing in the circuit and show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\frac{\pi}{2}$. Also draw graphs of V and</p>	3

	i versus ωt for the circuit.	
26	<p>Radiation of frequency 10^{15} Hz is incident on three photosensitive surfaces A, B and C. Following observations are recorded:</p> <p>Surface A: no photoemission occurs</p> <p>Surface B: photoemission occurs but the photoelectrons have zero kinetic energy.</p> <p>Surface C: photo emission occurs and photoelectrons have some kinetic energy.</p> <p>Using Einstein's photo-electric equation, explain the three observations.</p>	3

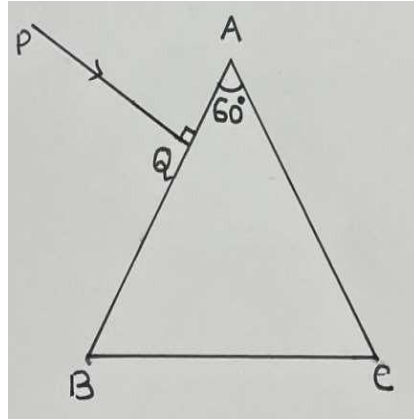
27	<p>(i) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.</p> <div style="text-align: center;">  </div> <p>(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.</p>	
28	<p>(i) Write two characteristic features of nuclear force.</p> <p>(ii) Draw a plot of potential energy of a pair of nucleons as a function of their separation.</p>	

SECTION D

29	<p>(a) Draw equipotential surfaces for (i)an electric dipole and (ii) two identical positive charges placed near each other.</p> <p>(b) In a parallel plate capacitor with air between the plates, each plate has an area of $6 \times 10^{-3}\text{m}^2$ and the separation between the plates is 3 mm.</p> <p>(i) Calculate the capacitance of the capacitor.</p> <p>(ii) If the capacitor is connected to 100V supply, what would be the the charge on each plate?</p> <p>(iii) How would charge on the plate be affected if a 3 mm thick mica sheet of $k=6$ is inserted between the plates while the voltage supply remains connected ?.</p>	5
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	<p style="text-align: center;">OR</p> <p>(a) Three charges $-q$, Q and $-q$ are placed at equal distances on a straight line. If the potential energy of the system of these charges is zero, then what is the ratio $Q:q$?</p> <p>(b)(i) Obtain the expression for the electric field intensity due to a uniformly charged spherical shell of radius R at a point distant r from the centre of the shell outside it.</p> <p>(ii) Draw a graph showing the variation of electric field intensity E with r, for $r > R$ and $r < R$.</p>	
30	<p>(a) Explain the working and construction of moving coil galvanometer.</p> <p>(b) Identify the specimen A and B.</p> <p>(c) How is the magnetic susceptibility of specimen A different from that of specimen B?</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>(a)</p> </div> <div style="text-align: center;">  <p>(b)</p> </div> </div>	5
31	<p>a) Draw a ray diagram showing the image formation for normal adjustment of a distant object by a refracting telescope.</p> <p>b) A ray PQ is incident normally on the face AB of a</p>	5

triangular prism of refracting angle 60° as shown in figure. The prism is made of a transparent material of refractive index $\frac{2}{\sqrt{3}}$. Trace the path of the ray as it passes through the prism. Calculate the angle of emergence and the angle of deviation.



SECTION E

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Case Study :

Read the following paragraph and answer the questions.

A number of optical devices and instruments have been designed and developed such as periscope, binoculars, microscopes and telescopes utilizing the reflecting and refracting properties of mirrors, lenses and prisms. Most of them are in common use. Our knowledge about the formation of images by the mirrors and lenses is the basic requirement for understanding the working of these devices.

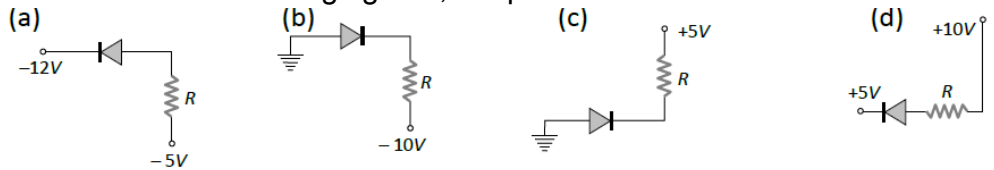
- (i) Image formation at which position is considered most suitable for viewing.
 - (a) infinity
 - (b) Distance of distinct vision
 - (c) least distance of viewing
 - (d) very close to objective lens
- (ii) In modern microscopes multicomponent lenses are used for both the objective and the eyepiece in order to increase
 - (a) focal length
 - (b) magnification and focal length
 - (c) power and focal length
 - (d) magnification and clarity
- (iii) What combination of lens are preferred for compound microscope
 - (a) objective of large focal length and eyepiece of small focal

	<p>length</p> <p>(b) objective of small focal length and eyepiece of large focal length</p> <p>© objective and eyepiece of small focal lengths</p> <p>(d) objective and eyepiece of large focal lengths</p> <p>(iv) The reflecting type telescope are preferred on astronomical telescope because</p> <p>(a) its low in cost</p> <p>(b) it has less chromatic aberration</p> <p>© images formed are much brighter</p> <p>(d) all the above</p>
33	<p style="text-align: center;">Case study: Light emitting diode.</p> <p>Read the following paragraph and answer the questions</p> <p>A semiconductor diode is basically a pn junction with metallic contacts provided at the ends for the application of an external voltage. It is a two terminal device. When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal, it is said to be forward biased. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased. An ideal diode is one whose resistance in forward biasing is zero and the resistance is infinite in reverse biasing. When the diode is forward biased, it is found that beyond forward voltage called knee voltage, the conductivity is very high. When the biasing voltage is more than the knee voltage the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias.</p> <p>i. A diode D is connected in forward bias to an external resistance $R = 300 \Omega$ and an emf of $3.5 V$. If the barrier potential developed across the diode is $0.5 V$, the current in the circuit will be:</p>

पायल रामपुरिया
अध्यापक, श्री शिक्षायतन स्कूल

(a) 30 mA (b) 20 mA (c) 15 mA (d) 10 mA

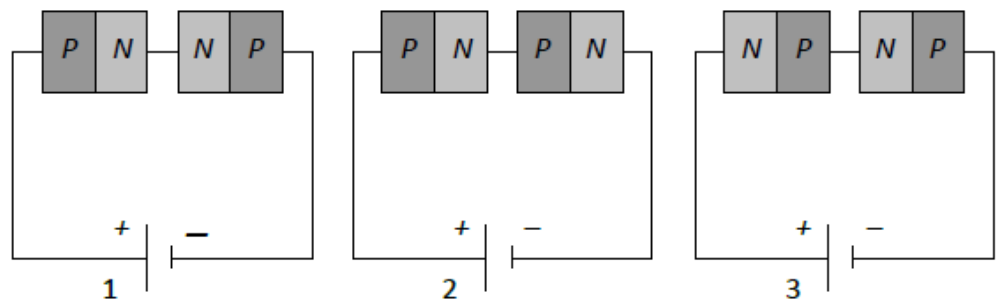
ii. In which of the following figures, the pn diode is reverse biased?



iii. The small current is reverse saturation current, when diode is reverse biased is mainly due to:

- (a) drift of majority charge carriers
- (b) diffusion of majority charge carriers
- (c) drift of minority charge carriers
- (d) diffusion of minority charge carriers.

iv. Two identical *PN* junctions can be connected in series by three different methods as shown in the figure.



If the potential difference in the junctions is the same, then the correct connections will be

- (a) in the circuits (1) and (2)
- (b) in the circuits (2) and (3)
- (c) in the circuits (1) and (3)
- (d) only in the circuit (1)