Education Empowers

The Air Force School

presents

'CATALYST'

Exclusively for students of X and XII

Decoding the Sample Paper 2023

Physics
Class XII

Education Empowers

Total Marks : 70

No. of Questions : 35

Education Empowers

1 Marker [MCQ]	2 Marker Ques	3 Marker Ques	4 Marker Ques	5 Marker Ques
18	07	05	02	03

4 Marker are case based:
Case Based are not MCQs

Choice Questions :
7 +ii Parts in case based
[29 Marks : 2+2+3+3+5+5+5+2+2]

Unit Wise Weightage

1 Electrostatics = 10

2 Current Electricity= 06

3 Magnetic Effects = 08

Education Empowers

Unit Wise Weightage

4	EMI & A.C = 09
5	E.M.W = 03
6	OPTICS = 15

Education Empowers

Unit Wise Weightage

7	Dual Nature = 05
8	Atom & Nuclei = 07
9	Semi Conductors = 07

Electrostatics

According to Coulomb's law, which is the correct relation for the following figure?

(i) $q_1 q_2 > 0$
(ii) $q_1 q_2 < 0$
(iii) $q_1 q_2 = 0$
(iv) $1 > q_1 / q_2 > 0$

Electrostatics

The electric potential on the axis of an electric dipole at a distance 'r from it's centre is V. Then the potential at a point at the same distance on its equatorial line will be

(i) 2V

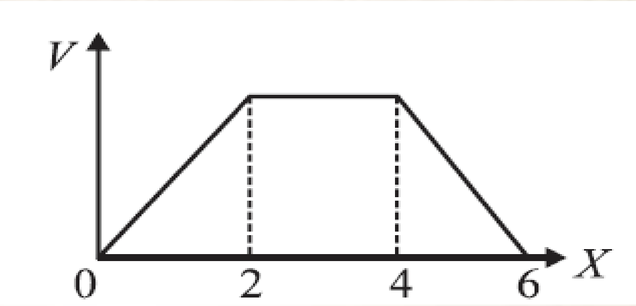
(ii) -V

(iii) V/2

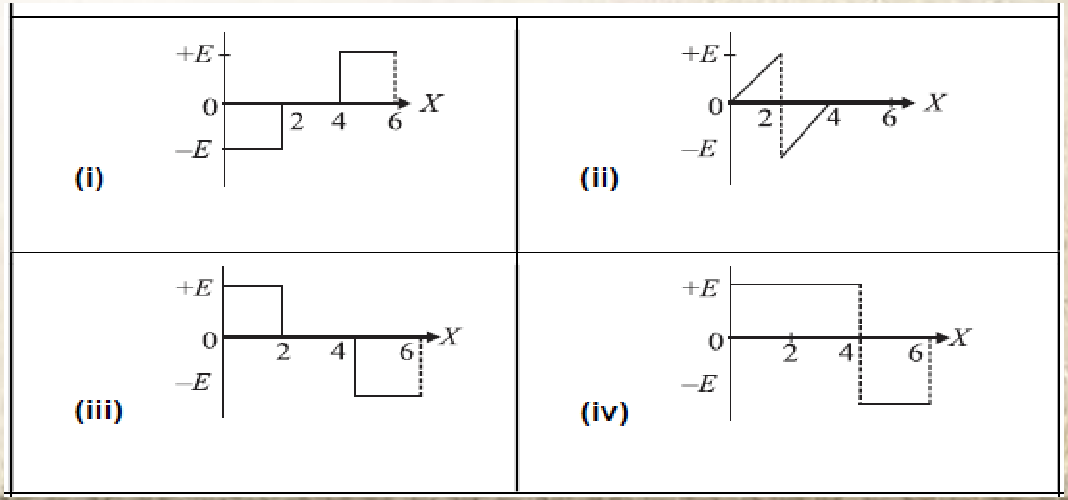
(iv) Zero

Electrostatics

The electric potential V as a function of distance X is shown in the figure.



The graph of the magnitude of electric field intensity E as a function of X is



Electrostatics

Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.7 \times 10^{-22}\ C/m^2$. What is electric field intensity E:

(a) in the outer region of the first plate, and

(b) between the plates?

Electrostatics

(a)Draw equipotential surfaces for (i)an electric dipole and (ii) two identical positive charges placed near each other.

(b) In a parallel plate capacitor with air between the plates, each plate has an area of $6 \times 10^{-3} m^2$ and the separation between the plates is 3 mm.

(i) Calculate the capacitance of the capacitor.

(ii) If the capacitor is connected to 100V supply, what would be the charge on each plate?

(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 ?

Electrostatics

(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?

(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.

(ii) Draw a graph showing the variation of electric field intensity E with r, for r > R and r < R.

Current Electricity

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.

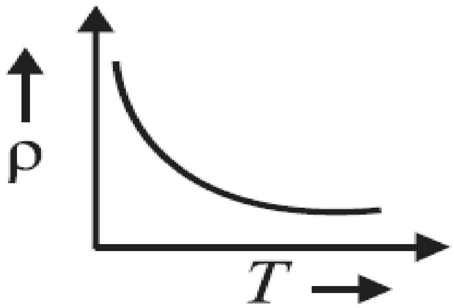


fig. (i)

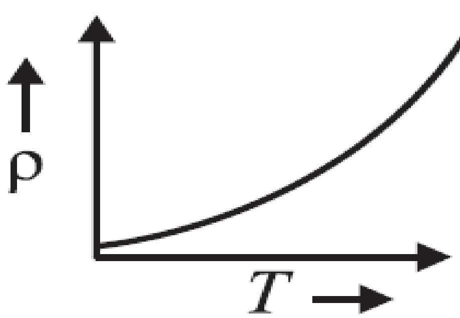


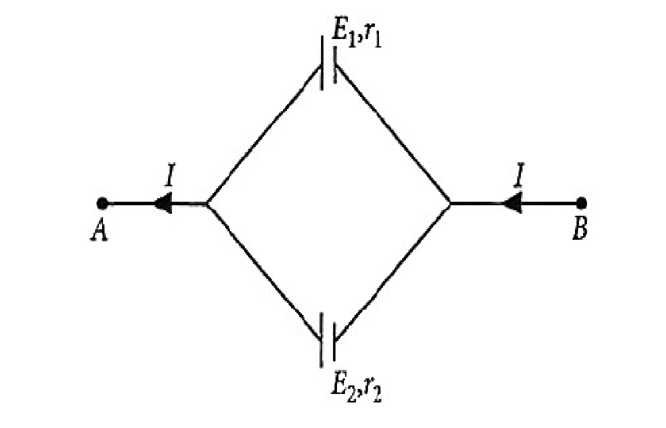
fig. (ii)

(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

Current Electricity

(a)Explain the term drift velocity of electrons in a conductor .Hence obtain the expression for the current through a conductor in terms of drift velocity.

(b) Two cells of emfs E1 and E2 and internal resistances r1and r2 respectively are connected in parallel as shown in the figure.



Deduce the expression for the

(i) equivalent emf of the combination

(ii) equivalent internal resistance of the combination

(iii) potential difference between the points A and B.

Current Electricity

(a)State the two Kirchhoff's rules used in the analysis of electric circuits and explain them.

(b) Derive the equation of the balanced state in a Wheatstone bridge using Kirchhoff's laws.

Magnetism

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

(i) 3A in clockwise direction

(ii) 9A in clockwise direction

(iii) 6 A in anti-clockwise direction

(iv) 6 A in the clockwise direction.

Magnetism

A long straight wire of circular cross section of radius a carries a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnitudes of magnetic field at a point distant a/2 above the surface of wire to that at a point distant a/2 below its surface is

(i) 4 :1

(ii) 1:1

(iii) 4: 3

(iv) 3 :4

Magnetism

If the magnetizing field on a ferromagnetic material is increased, its permeability

(i) decreases

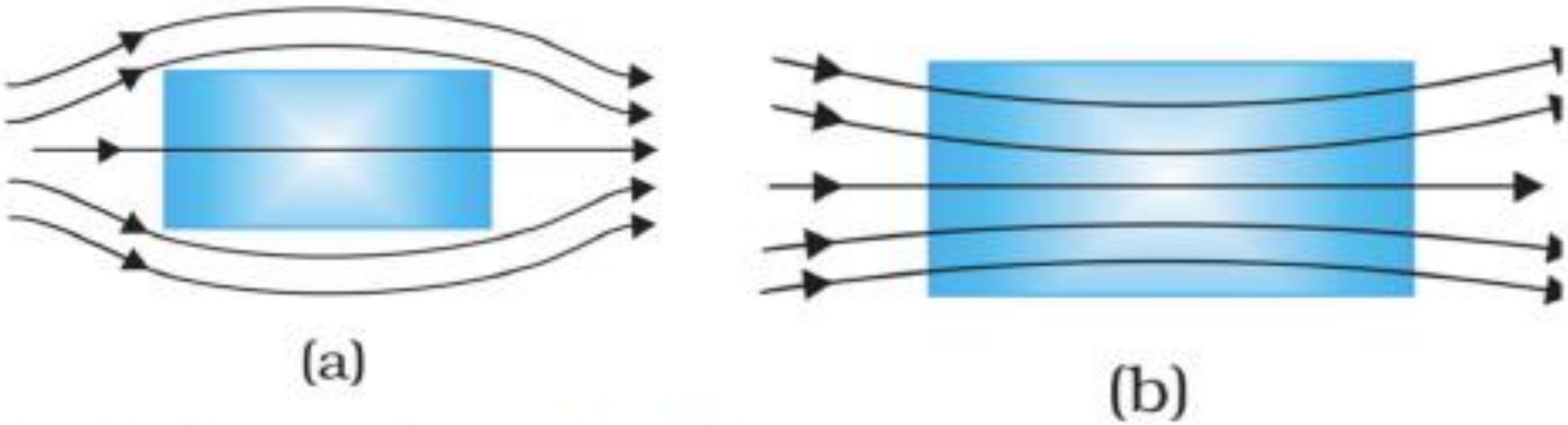
(ii) increases

(iii) remains unchanged

(iv) first decreases and then increases

Magnetism

A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it.



(i)Identify the specimen A and B.
(ii) How is the magnetic susceptibility of specimen A different from that of specimen B?

Magnetism

Two long straight parallel conductors carrying currents I_1 and I_2 are separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field produced by one exerts an attractive force on the other. Obtain the expression for this force and hence define 1 ampere.

EMI & AC

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

(i) any of the four loops

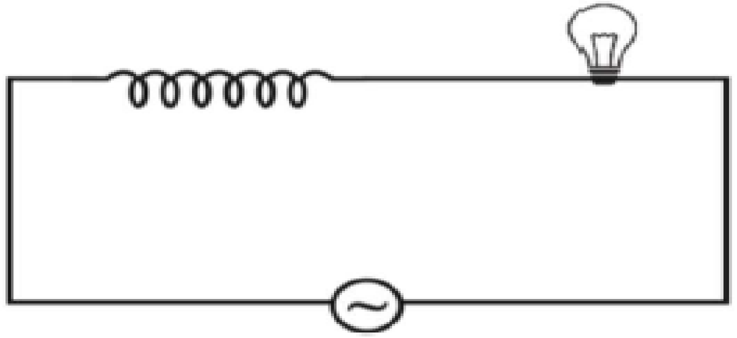
(ii) the circular and elliptical loops

(iii) the rectangular, circular and elliptical loops

(iv) only the elliptical loops

EMI & AC

An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure. When iron piece is taken out of the coil, the brightness of the bulb will



(i) decrease

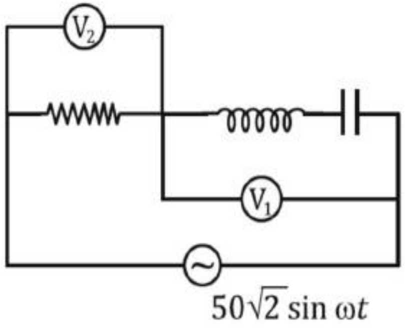
(ii) increase

(iii) remain unaffected

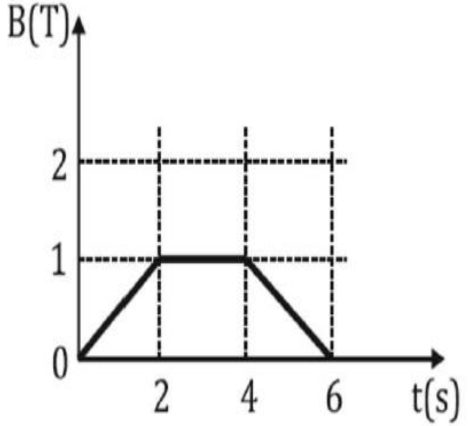
(iv) fluctuate

EMI & AC

If the reading of the voltmeter V_1 is 40 V, then the reading of voltmeter V_2 is



The magnetic field through a circular loop of wire, 12cm in radius and 8.5 Ω 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.



EMI & AC

An a.c. source generating a voltage $\varepsilon = \varepsilon_0 \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. Plot a graph of ε and I versus wt to show that the current is ahead of the voltage by $\pi/2$.

An ac voltage $V = V_0 \sin wt$ 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 $\pi/2$. Also draw graphs of V and i versus wt for the circuit.

EMI & AC

Which of the following statement is NOT true about the properties of electromagnetic waves?

(i) These waves do not require any material medium for their propagation

(ii) Both electric and magnetic field vectors attain the maxima and minima at the same time

(iii) The energy in electromagnetic wave is divided equally between electric and magnetic fields

(iv) Both electric and magnetic field vectors are parallel to each other

EMW

Electromagnetic waves with wavelength

(i) λ_1 is suitable for radar systems used in aircraft navigation.

(ii) λ_2 is used to kill germs in water purifiers.

(iii) λ_3 is used to improve visibility in runways during fog and mist conditions.

Identify and name the part of the electromagnetic spectrum to which these radiations belong. Also arrange these wavelengths in ascending order of their magnitude.

OPTICS

In a Young's double slit experiment, the path difference at a certain point on the screen between two interfering waves is $1/8^{th}$ wavelength. The ratio of intensity at this point to that at the centre
of a bright fringe is close to
(i) 0.80 (ii) 0.74 (iii) 0.94 (iv) 0.85

ASSERTION:
In an interference pattern observed in Young's double slit experiment, if the separation (d) between coherent sources as well as the distance (D) of the screen from the coherent sources both are reduced to $1/3_{rd}$, then new fringe width remains the same.

REASON:
Fringe width is proportional to (d/D).

OPTICS

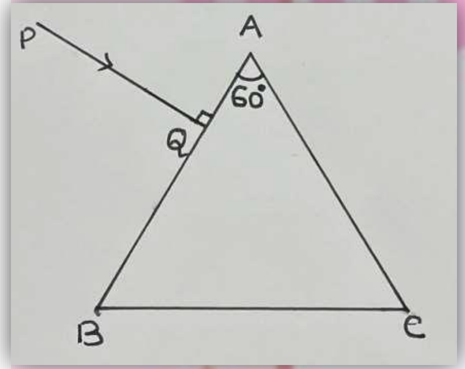
A biconvex lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Justify your answer.

A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equal to 6000 Å and the angular width of the central maximum in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ', the angular width decreases by 30%. Calculate the value of the wavelength λ'.

OPTICS

a) Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through a single slit. What is the width of the central maximum in comparison to that of a secondary maximum?

b) A ray PQ is incident normally on the face AB of a triangular prism of refracting angle 60° as shown in figure.
The prism is made of a transparent material of refractive index
$2/\sqrt{3}$
Trace the path of the ray as it passes through the prism. Calculate the angle of emergence and the
angle of deviation.

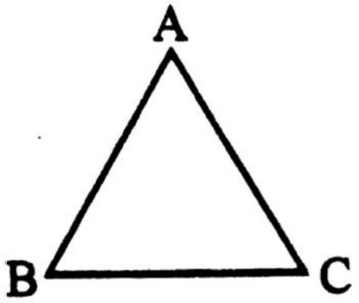


OPTICS

a) Write two points of difference between an interference Pattern and a diffraction pattern.

b) (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.

(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.



OPTICS

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 utilising 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) Why the image formed at infinity is often considered most suitable for viewing. Explain.

(ii) In modern microscopes multicomponent lenses are used for both the objective and the eyepiece. Why?

(iii) Write two points of difference between a compound microscope and an astronomical telescope

OR

(iii) Write two distinct advantages of a reflecting type telescope over a refracting type telescope.

Dual Nature

The work function for a metal surface is 4.14 eV. The threshold wavelength for this metal surface is:

(i) 4125 Å (ii) 2062.5 Å (iii) 3000 Å (iv) 6000 Å

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.

Dual Nature

Radiation of frequency 10^{15} Hz is incident on three photosensitive surfaces A, B and C. Following observations are recorded:

Surface A: no photoemission occurs

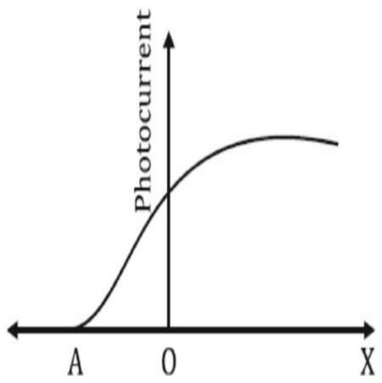
Surface B: photoemission occurs but the photoelectrons have zero kinetic energy.

Surface C: photo emission occurs and photoelectrons have some kinetic energy.

Using Einstein's photo-electric equation, explain the three observations.

Dual Nature

The graph shows the variation of photocurrent for a photosensitive metal.



(a)What does X and A on the horizontal axis represent?

(b)Draw this graph for three different values of frequencies of incident radiation υ_1, υ_2 and υ_3 ($\upsilon_3 > \upsilon_2 > \upsilon_1$) for the same intensity.

(c) Draw this graph for three different values of intensities of incident radiation I_1, I_2 and I_3 ($I_3 > I_2 > I_1$) having the same frequency.

Atom & Nuclei

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

(i) 1.01×10^{-10} m

(ii) 1.59×10^{-10} m

(iii) 2.12×10^{-10} m

(iv) 4.77×10^{-10} m

Atom & Nuclei

Which of the following statements about nuclear forces is not true?

(i) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femto metres.

(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.

Atom & Nuclei

What is the nuclear radius of ^{125}Fe ,if that of ^{27} Al is 3.6 fermi?.

OR

The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 **A**^{0}. Calculate the short wavelength limit for the Balmer series of the hydrogen spectrum.

Atom & Nuclei

The ground state energy of hydrogen atom is -13.6 eV. The photon emitted during the transition of electron from n=3 to n=1 state, is incident on a photosensitive material of unknown work function .The photoelectrons are emitted from the material with the maximum kinetic energy of 9eV.Calculate the threshold wavelength of the material used.

Semiconductors

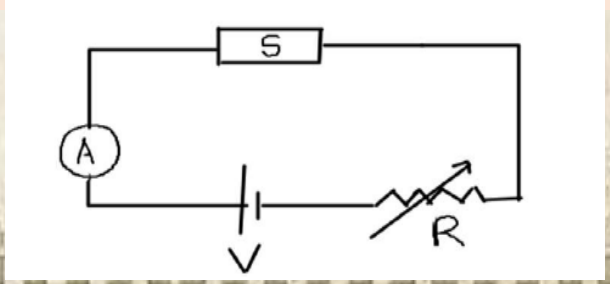
ASSERTION(A):

The electrical conductivity of a semiconductor increases on doping.

REASON (R):

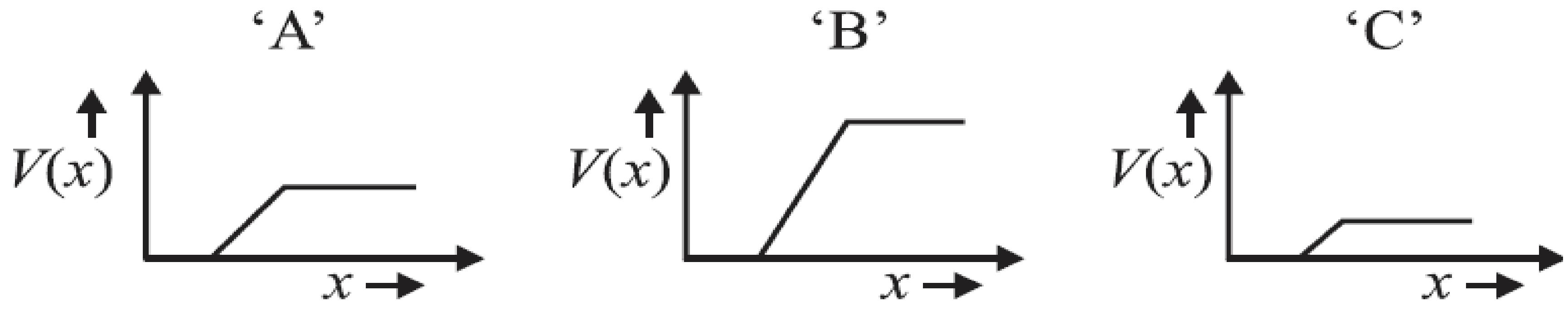
Doping always increases the number of electrons in the semiconductor.

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.



Semiconductors

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.



Semiconductors

CASE STUDY: LIGHT EMITTING DIODE

Read the following paragraph and answer the questions.

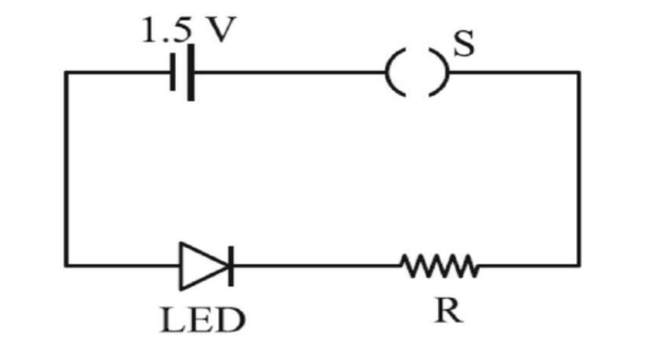
LED is a heavily doped P-N junction which under forward bias emits spontaneous radiation. When it is forward biased, due to recombination of holes and electrons at the junction, energy is released in the form of photons. In the case of Si and Ge diode, the energy released in recombination lies in the infrared region. LEDs that can emit red, yellow, orange, green and blue light are commercially available. The semiconductor used for fabrication of visible LEDs must at least have a band gap of 1.8 eV. The compound semiconductor Gallium Arsenide – Phosphide is used for making LEDs of different colours.

Semiconductors

(i) Why are LEDs made of compound semiconductor and not of elemental semiconductors?
(ii) What should be the order of bandgap of an LED, if it is required to emit light in the visible range?
(iii) A student connects the blue coloured LED as shown in the figure. The LED did not glow when switch S is closed. Explain why ?

OR

(iii) Draw V-I characteristic of a p-n junction diode in
(i) forward bias and (ii) reverse bias



PHYSICS DEPARTMENT

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THANK YOU!