APEEJAY SCHOOL, PANCHSHEEL PARK

CLASS – XII
SUBJECT – PHYSICS
PREBOARD II EXAMINATION (2023-24)

Name of the student: Date:
Time Allowed: 3 hours M.M - 70

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.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based 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 two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed
(7) You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
v. $h = 6.63 \times 10^{-34}$ Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
vii. Avogadro's number = 6.023×10^{23} per gram mole

SECTION A

Q. No.		MARKS
		16 X 1
1	A parallel plate air capacitor is charged to a potential difference of V. If distance between the plates is increased, then potential difference between the plates _____. (a) decreases (b) increases (c) becomes zero (d) does not change	1
2	A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then the electric field at Q is proportional to (a) p^2 and r^3 (b) p and r^2 (c) p^{-1} and r^2 (d) p and r^3	1
3	A particle of mass m and charge q is accelerated through a potential V. The De-Broglie wavelength of the particle will be: (a) $\frac{Vh}{\sqrt{2qm}}$ (b) $\frac{q}{\sqrt{2mV}}$ (c) $\frac{h}{\sqrt{2qmV}}$ (d) $\frac{mh}{\sqrt{2qV}}$	1
4	The ground state energy of Hydrogen atom is -13.6 eV. What is the K.E of an electron in the 3rd	1

excited state?

(a) 3.4 eV (b) 1.51 eV

(c) 0.85 eV (d) 0.85 Ev

5 What is the ratio of nuclear radii if the mass numbers of two nuclei are 4 and 32? 1

(a) 1 : 2 (b) 1 : 3 (c) 1: 4 (d) 1 : 5

5 The work function of photoelectric material is 3.3 eV, then the threshold frequency will be 1

(a) 8×10^{14} Hz (b) 8×10^{34} Hz (c) 5×10^{15} Hz (d) 5×10^{19} Hz

7 In Young's double slit experiment the distance between the slit is reduced to half and the distance between the slit and the screen is doubled, then the fringe width 1

(a) will not change (b) will become half (c) will be double (d) will become 4 times

8 If λ_x, λ_m, λ_v represents wavelength of X-Rays, microwaves & visible rays then 1

(a) $\lambda_m > \lambda_x > \lambda_v$

(b) $\lambda_m > \lambda_v > \lambda_x$

(c) $\lambda_v > \lambda_x > \lambda_m$

(d) $\lambda_v > \lambda_m > \lambda_x$

9 In an AC circuit, the current lags behind the voltage by $\pi/3$. The component of the circuit are 1

(a) R and L (b) L and C (c) Only R (d) R and C

10 What is the phase difference between electric and magnetic fields in an electromagnetic wave? 1

(a) 0 (b) π (c) $\pi/2$ (d) $\pi/4$

11 The choke coil is used as a resistance in 1

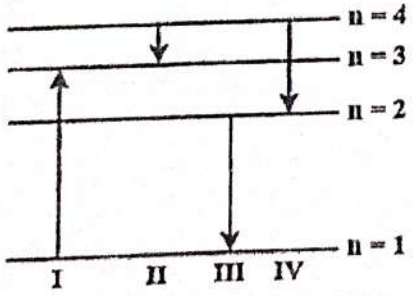
(a) DC circuit

(b) AC circuit

(c) both (a) and (b)

(d) neither (a) nor (b)

12 The diagram shows the energy levels for an electron in a certain atom. Which transition shown represents the emission of photon with the most energy? 1



(a) I (b) II (c) III (d) IV

For Questions 13 to 16, two statements are given –one labeled Assertion (A) and other labeled Reason (R). Select the correct answer to these questions from the options as given below.

a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

c) If Assertion is true but Reason is false.

d) If both Assertion and Reason are false.

13 Assertion: Light of frequency 1.5 times the threshold frequency is incident on photosensitive material. If the frequency is halved and intensity is doubled, the photocurrent remains unchanged. 1

Reason: The photo electric current varies directly with the intensity of light and frequency of light.

14 Assertion : The number of electrons in a p-type silicon semiconductor is less than the number of 1

electrons in a pure silicon semiconductor at room temperature.
Reason : It is due to law of mass action.

15 Assertion: Two equipotential surfaces can be orthogonal.
Reason: Electric field lines are normal to the equipotential surface.

16 Assertion : In optical fibers, the diameter of the core is kept small. 1
Reason : This smaller diameter of the core ensures that the fiber should have incident angle more than the critical angle required for total internal reflection.

SECTION B

2x5 =10

17 Draw the graph showing the variation of the current with voltage for a PN junction diode in forward and reverse bias both. 2

18 The work function of Cs is 2.14 eV. Find 2
(a) threshold frequency for Cs.
(b) Wavelength of incident light if the photo current is brought to zero by stopping potential of 0.6 V.

19 A ray of monochromatic light passes through an equilateral glass prism in such a way that the angle of incidence is equal to the angle of emergence and each of these angles is 3/4 times the angle of the prism. Determine the angle of deviation and the refractive index of the glass prism. 2

20 Write a relation between the current and drift velocity of electrons in a conductor. Use this relation to explain how the resistance of a conductor changes with the rise of temperature. 2

21 Show that the least possible distance between an object and its real image in a convex lens is $4f$, where f is the focal length of the lens. 2

OR

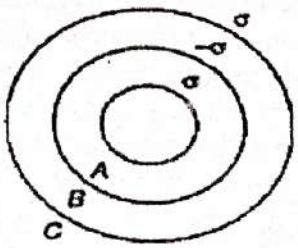
Calculate the radius of curvature of an equi-concave lens of refractive index 1.5, when it is kept in a medium of refractive index 1.4, to have a power of $-5D$?

SECTION C

3x7=21

22 The total energy of an electron in the first excited state of the hydrogen atom is about -3.4 eV. 3
(a) What is the kinetic energy of the electron in this state?
(b) What is the potential energy of the electron in this state?
(c) Which of the answers above would change if the choice of the zero of potential energy is changed?

23 Three concentric spherical metallic shells A, B and C of radii a, b and c ($a < b < c$) have surface charge densities σ, $-\sigma$ and σ respectively as shown in the figure. 3
(a) Obtain the expression of the potential of three shell A, B and C.
(b) If shell A and C are at the same potential, obtain the relation between a, b and c.

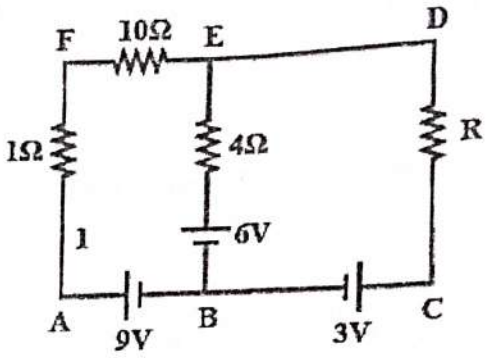


24 When four hydrogen nuclei combine to form a helium nucleus, estimate the amount of energy in MeV released in this process of fusion (Neglect the masses of electrons and neutrinos) Given: 3
(i) mass of $1^1H = 1.007825u$
(ii) mass of helium nucleus = 4.002603u, $1u = 931 MeV/c^2$

OR

A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n=4th level. Determine the wavelength and frequency of photon. 3

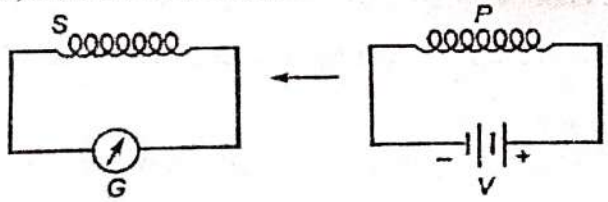
25 Using Kirchhoff's rules, determine the value of unknown resistance R in the circuit as shown in figure so that no current flows through 4 Ohms resistance. Also find the potential difference between A and D



26 Two long straight parallel current carrying conductors are kept at a distance d from each other in air. The direction of current in both the conductors is the same. Find the magnitude and direction of the force between them. Define one Ampere. 3

27 (a) Name the e.m. waves which are suitable for radar systems used in aircraft navigation. Write the range of frequency of these waves. 3
(b) If the earth did not have an atmosphere, would its average surface temperature be higher or lower than what it is now? Explain.
(c) An e.m. wave exerts pressure on the surface on which it is incident. Justify.

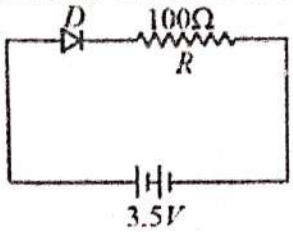
28 (i) When primary coil P is moved towards secondary coil S (as shown in the figure), the galvanometer shows momentary deflection. What can be done to have larger deflection in the galvanometer with the same battery? 3
(ii)State the related law.



SECTION D
CASE STUDY BASED QUESTIONS 4X2=8

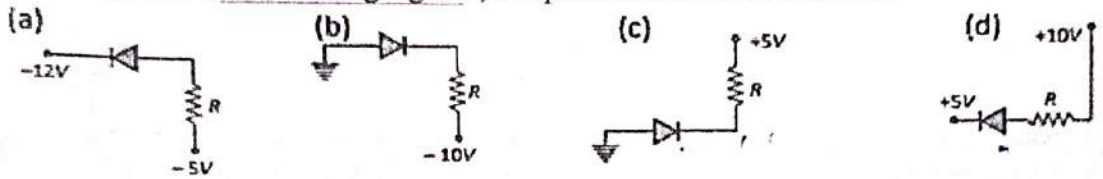
29 **Read the following paragraph and answer the questions that follow.**
A semiconductor diode is basically a PN junction with metallic contacts provided at the ends for the application of an external voltage. It is a two terminal device. When an external voltage is applied across a semiconductor diode 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. This small current is reverse saturation 1x4
(i) In the given figure, a diode D is connected to an external resistance R = 100 Ω 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:



(a) 40 mA (b) 20 mA (c) 35 mA (d) 30 mA

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



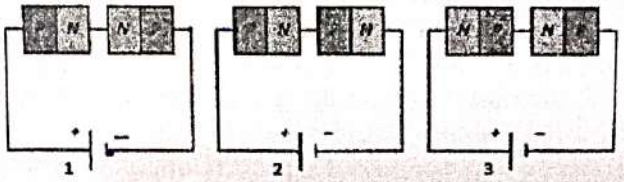
(iii) Based on the V-I characteristics of the diode, we can classify diode as

(a) bilateral device (b) ohmic device

(c) non-ohmic device (d) passive element

OR

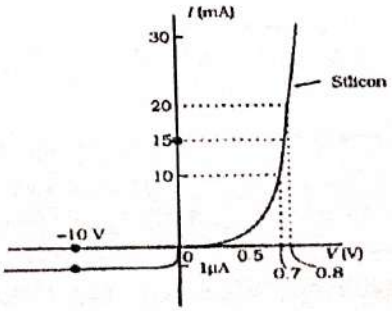
Two identical pn junctions can be connected in series by three different methods as shown in the figure. If the potential difference in the junctions is the same, then the correct connections will be



(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)

(iv)

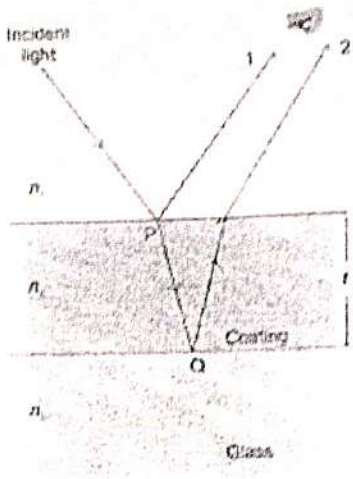


The V-I characteristic of a diode is shown in the figure. The ratio of the resistance of the diode at I = 15 mA to the resistance at V = -10 V is

(a) 100 (b) 10^6 (c) 10 (d) 10^{-6}

30 Read the following paragraph and answer the questions that follow. 1x4

When light rays fall on glass, about 4% of the light gets reflected. To eliminate this reflection, the glass display cases in museums usually have an anti-reflective coating. This works on the principle of interference. When light falls on the coated glass, the light gets reflected from the top and bottom surfaces of the coating and these two reflected light rays can interfere. To reduce reflection, the thickness and refractive index of the coating are adjusted such that the light rays undergo destructive interference.



Reflected light undergoes a 180° phase shift when it falls on a denser medium from a rarer medium and no phase shift when it falls on a rarer medium from a denser medium. (Note: The thickness of coating is much less than the glass.) To answer the questions below, consider a monochromatic light of wavelength λ incident on the coating of thickness t at a small angle of incidence and $n_1 < n_2 < n_3$. Also consider PQ $\approx$ t.

(i) Which of the following occurs, if there is no coating on the glass?
(a) The object behind the case looks distorted.
(b) The colors of the object behind the glass case appear dull.
(c) A reflection of the objects in front of the glass case is seen on the case.
(d) Multiple reflections of the object behind the glass case are seen on the case

(ii) What is the path difference between rays 1 and 2? (Consider PQ $\approx$ t.)
(a) t
(b) 2t
(c) λ
(d) 2 λ

(iii) For what minimum thickness of the coating, do the two rays 1 and 2 undergo destructive interference? (Remember the wavelength of the light ray changes as it moves from one media to another.)
(a) $n_2 \lambda/2$
(b) $n_2 \lambda/4$
(c) $\lambda/(2n_2)$
(d) $\lambda/(4n_2)$

OR

For what minimum thickness of the coating, do the two rays 1 and 2 undergo constructive interference? (Remember the wavelength of the light ray changes as it moves from one media to another.)
(a) $n_2 \lambda$
(b) $n_2 \lambda/2$
(c) $\lambda/(n_2)$
(d) $\lambda/(2n_2)$

(iv) If the material of the coating is changed such that $n_2 > n_3$, what will be the additional path difference compared to the path difference identified in question (ii)?
(a) t
(b) π
(c) $\lambda/2$
(d) There will be NO additional path difference.

SECTION E 5x3=15

(a) Define a wavefront. Using Huygen's principle, verify the laws of reflection at a plane surface.
(b) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction bond? Explain.
(c) When a tiny circular obstacle is placed in the path of light coming from a distant source, a bright spot is seen at the centre of the obstacle. Explain why?

OR

(a) Draw the ray diagram of an astronomical telescope when the final image is formed at infinity. Find the magnifying power of astronomical telescope.
(b) An astronomical telescope has an objective lens of focal length 20 m and eyepiece of focal length 1 cm.

i. Find the angular magnification of the telescope.
ii. If this telescope is used to view the Moon, find the diameter of the image formed by the objective lens. Given the diameter of the Moon is 3.5×10^6 m and radius of lunar orbit is 3.8×10^8 m.

32 (i) If two similar large plates, each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, find the expressions for
(a) field at points between the two plates and on outer side of the plates. Specify the direction of the field in each case.
(b) the potential difference between the plates.
(c) the capacitance of the capacitor so formed.
(ii) two metallic spheres of radii R and 2R are charged so that both of these have same surface charge density a. If they are connected to each other with a conducting wire, in which direction will the charge flow and why?

OR

a) Use Gauss' law to derive the expression for the electric field (E) due to a straight uniformly charged infinite line of charge density λ C/m.
(b) Draw a graph to show the variation of E with perpendicular distance r from the line of charge.
(c) Find the work done in bringing a charge q from perpendicular distance r_1 to r_2($r_2 > r_1$).

33 A series LCR circuit is connected to an AC source having voltage $V = V_0 \sin \omega t$. Derive the expression for the instantaneous current and its phase relationship to the applied voltage. Obtain the condition for resonance to occur. Define 'power factor'. State the conditions under which it is (i) maximum, (ii) minimum

OR

(a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source.
(b) Draw the phasor diagram for a series LRC circuit connected to an AC source.
(c) When an alternating voltage of 220V is applied across a device X, a current of 0.25A flows which lags behind the applied voltage in phase by $\pi/2$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.
(i) Name the devices X and Y.
(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.