INDIAN SCHOOL SOHAR **Total No of Printed Pages:7**
PRE BOARD II EXAMINATION (2023-24)
PHYSICS THEORY (042)

CLASS: XII **Maximum Marks: 70**
DATE: 20/01/2024 **SET 1** **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.
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 x 10^8 m/s **ii**. m_e = 9.1 x10^{-31} kg **iii**. e = 1.6 x 10^{-19} C **iv**. $\mu_0 = 4\pi$ x 10^{-7} TmA^{-1}

v. h = 6.63 x10^{-34} Js **vi**. ε_0 = 8.854 x10^{-12}C^{2}N^{-1}m^{-2}

vii. Avogadro's number = 6.023 X 10^{23} per gram mole

viii. m_p = 1.673 x 10^{-27} kg **ix**. m_n = 1.675 x 10^{-27} kg **x**. $(\frac{1}{4\pi\varepsilon o})$ = 9 x 10^9 Nm^{2}C^{-2}

xi. Boltzmann constant =1.38 x 10^{-23} JK^{-1}

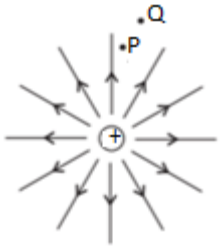
SECTION A

1 A parallel plate capacitor is charged and then isolated. The effect of increasing the plate separation on charge, potential, capacitance respectively are 1

(a) constant, decreases, decreases (b) increases, decreases, decreases

(c) constant, increases, decreases (d) constant, decreases, increases

2 Figure shows the field lines of a positive point charge. The work done by the field in moving a small positive charge from Q to P is 1



(a) zero

(b) positive

(c) negative

(d) data insufficient.

3 The electric field at a point is 1

(a) always continuous

(b) continuous if there is no charge at that point

(c) discontinuous if there is a charge at that point

(d) both (b) and (c) are correct.

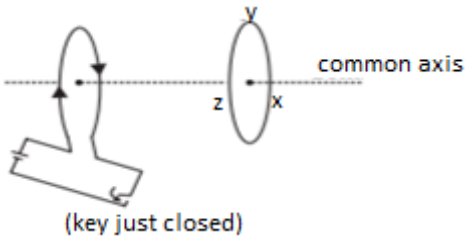
4 The work function for Al, K and Pt is 4.28 eV, 2.30 eV and 5.65 eV respectively. Their respective threshold frequencies would be 1

(a) Pt > Al > K (b) Al > Pt > K (c) K > Al > Pt (d) Al > K > Pt

5 A charged particle is moving on circular path with velocity v in a uniform magnetic field B, if the velocity of the charged particle is doubled and strength of magnetic field is halved, then radius becomes 1

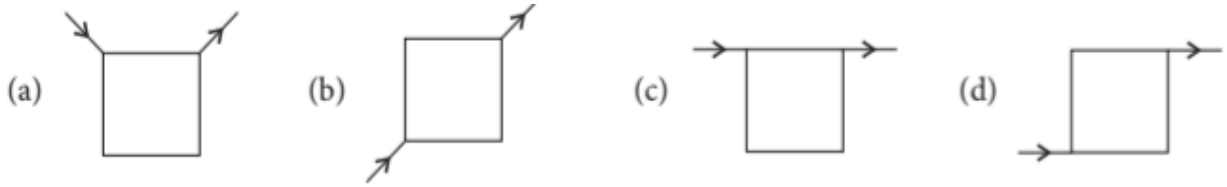
(a) 8 times (b) 4 times (c) 2 times (d) 16 times

6 The direction of induced current in the right loop in the situation shown by the given figure is



(a) along the common axis
(b) along xzy
(c) along xyz
(d) none of these. 1

7 Current flows through uniform, square frames as shown in the figure. In which case is the magnetic field at the centre of the frame is not zero?



1

8 The radius of a spherical nucleus as measured by electron scattering is 3.6 fm. What is the mass number of the nucleus most likely to be? 1

(a) 27 (b) 40 (c) 56 (d) 120

9 The depletion layer in the p-n junction is caused due to

a) drift of electrons b) migration of impurity ions 1

c) diffusion of charge carriers d) drift of holes

10 The source of electromagnetic waves can be charge, when

(a) moving with a constant velocity (b) moving in a circular orbit 1

(c) Falling in an electric field (d) both (b) and (c).

11 Two thin lenses of power –4 D and 2 D are placed in contact coaxially. Find the focal length of the combination. 1

(a) –10 cm (b) –50 cm (c) +50 cm (d) +10 cm

12 The SI unit of magnetic field induction is

(a) AmN^{-1} (b) $NA^{-1}m^{-2}$ (c) $NA^{-2}m^{-2}$ (d) $NA^{-1}m^{-1}$ 1

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

a) Both Assertion and Reason are true and Reason is correct explanation of Assertion.

b) Both Assertion and Reason are true but Reason is NOT the correct explanation of Assertion.

c) Assertion is true but Reason is false.

d) Both Assertion and Reason are false

13 **Assertion (A):** The alternating current lags behind the e.m.f. by a phase angle of ($\pi/2$) , when ac flows through an inductor**.** 1

Reason (R): The inductive reactance increases as the frequency of ac source decreases

14 **Assertion (A):** The kinetic energy of photoelectrons emitted from metal surface does not depend on the intensity of incident photon**.**

Reason (R): The ejection of electrons from metallic surface is not possible with the frequency of incident photons below the threshold frequency 1

15 **Assertion (A):** An alternating current shows magnetic effect**.**

Reason (R): Magnitude of alternating current varies with time. 1

16 **Assertion (A):** Energy is released in a nuclear reaction**.**
Reason (R): In any nuclear reaction the reactants and resultant products obey the law of conservation of charge and mass only**.** 1

SECTION B

17 Define the term 'drift velocity' of electrons in a current carrying conductor. Obtain the relationship between the current density and the drift velocity of electrons. 2

18 Write the production methods of "microwaves" and "infrared waves". 2

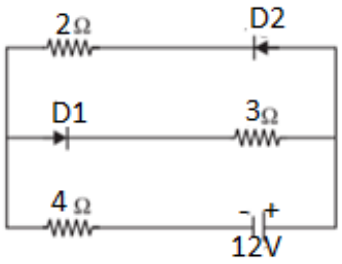
19 Light of wavelength 6×10^{-5} cm falls on a screen at a distance of 100 cm from a narrow slit. Find the width of the slit if the first minima lies 1 mm on either side of the central maximum.

OR

Define wavefront and state Huygen's principle. Consider a plane wavefront incident on a thin convex lens. Draw a proper diagram to show how the incident wavefront traverses through the lens and after refraction focusses on the focal point of the lens, giving the shape of the emergent wavefront. 2

20 The wavelength λ of a photon and the de-Broglie wavelength of an electron of mass 'm' have the same value. Show that the energy of the photon is $(2\lambda mc/h)$ times the kinetic energy of the electron, where 'c' and 'h' have their usual meanings. 2

21 The circuit shown in the figure has two oppositely connected ideal diodes connected in parallel. Find the current flowing through each diode in the circuit.



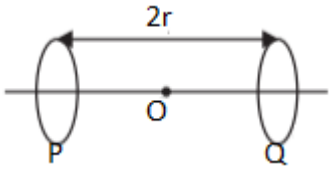
2

SECTION C

22 In a Geiger-Marsden experiment, what is the distance of closest approach to the nucleus of a 7.7 MeV α-particle before it comes momentarily to rest and reverses its direction? 3

23 A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. Find the area of the surface of water through which light from the bulb can emerge out. Refractive index of water is 1.33. Consider the bulb to be a point source. [$\sin^{-1}(0.75) = 48.6°$ and $\tan 48.6° = 1.134$] 3

24 Two identical circular loops, P and Q, each of radius r and carrying equal currents are kept in the parallel planes having a common axis passing through O. The direction of current in P is clockwise and in Q is anti-clockwise as seen from O which is equidistant from the loops P and Q. Find the magnitude of the net magnetic field at O.



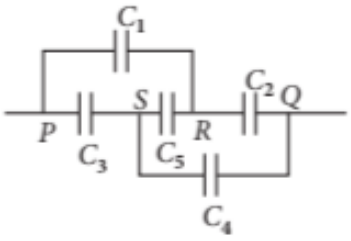
3

25 Show that the nuclear matter density is nearly constant. 3

26 AB, BC, CD and DA are resistors of 1Ω, 1 Ω, 2 Ω and 2 Ω respectively connected in series. Between A and C is a 1 volt cell of resistance 2 Ω, A being positive. Between B and D is a 2 V cell of 1 Ω resistance, B being positive. Find the current in each branch of the circuit. 3

27 How does the mutual inductance of a pair of coils change when
(a) the distance between the coil is increased?
(b) the number of turns in each coil is decreased? 3
(c) a thin iron sheet is placed between the two coils, other factors remaining the same?
Justify your answer in each case.

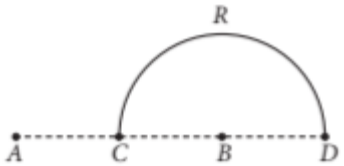
28 In the figure, the values of capacitance are as follows:
$C_1 = C_2 = C_3 = C_4 = 4\mu F$, $C_5 = 4\mu F$. Calculate the equivalent capacitance between the points P and Q. If a battery of 10V is connected between these points, what will be the charge on each capacitor?



3

OR

Charges (+q) and (–q) are placed at the points A and B respectively which are a distance "2L" apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD.

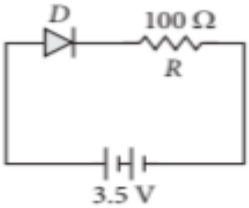


SECTION D

29 **Read the following paragraph and answer the questions that follow**.

A semiconductor diode is basically a p-n 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 current. 4

(i) In the given figure, a diode D is connected to an external resistance R = 100 Ω and an emf of 3.5V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit is:



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

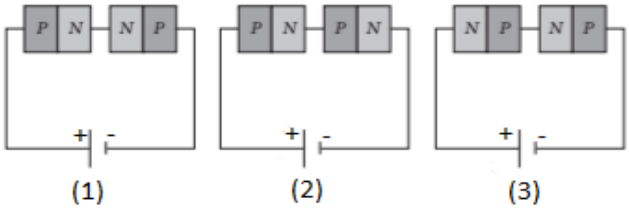
(ii) In which of the following figures, the pn diode is reverse biased?

(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

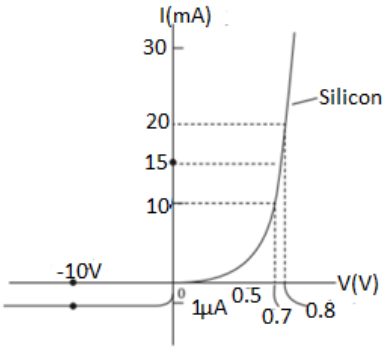
(iii) Two identical PN junctions can be connected in series by three different methods as shown in the figure. If the potential difference in the junctions is the same, then the correct connections will be



(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)

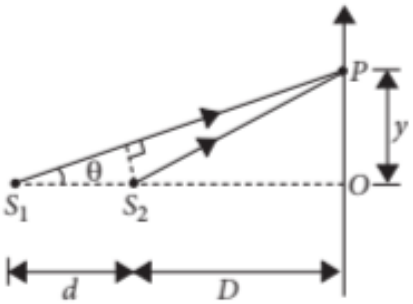


The V-I characteristic of a diode is shown in the figure. The ratio of the resistance of the diode at I = 15 mA to the resistance at V = -10 V is

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

30 **Read the following paragraph and answer the questions that follow.** 4

Interference Pattern: In Young's double slit experiment, the width of the central bright fringe is equal to the distance between the first dark fringes on the two sides of the central bright fringe. In given figure below a screen is placed normal to the line joining the two point coherent source S_1 and S_2. The interference pattern consists of concentric circles.



(i)The optical path difference at P is

(a)$d[1+(y^2/2D)]$ (b) $d[1+(2D/y^2)]$ (c) $d[1-(y^2/2D^2)]$ (d) $d[2D-(1/y^2)]$

(ii) Find the radius of the n^{th} bright fringe,

(a) $D\sqrt{1[1-\left(\frac{n\lambda}{d}\right)]}$ (b) $D\sqrt{2[1-\left(\frac{n\lambda}{d}\right)]}$ (c) $2D\sqrt{2[1-\left(\frac{n\lambda}{d}\right)]}$ (d) $D\sqrt{2[1-\left(\frac{n\lambda}{2d}\right)]}$

(iii) The coherence of two light sources means that the light waves emitted have

(a)same frequency (b) same intensity (c) constant phase difference (d) same velocity.

OR

(iii) The phenomenon of interference is shown by

(a) longitudinal mechanical waves only (b) transverse mechanical waves only

(c) electromagnetic waves only (d) all of these

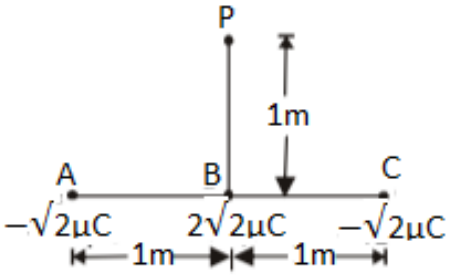
(iv) If d = 0.5 mm, l = 5000 Å and D = 100 cm, find the value of n for the closest second bright fringe

(a) 888 (b) 830 (c) 914 (d)998

SECTION E

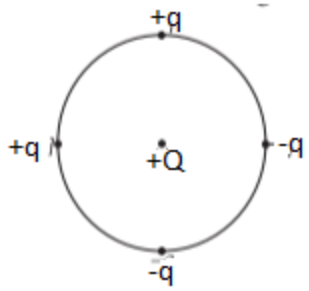
31 (a) Obtain the formula for the electric field due to a long thin wire of uniform linear charge density "λ" using Gauss's law.

(b) Three charges($-\sqrt{2}\mu C$), ($2\sqrt{2}\mu C$) and ($-\sqrt{2}\mu C$) are arranged along a straight line as shown in the figure. Calculate the total electric field due to all three charges at the point P.



OR

a) Four charges, +q, +q, –q, –q are placed on the circumference of a circle of radius r as shown in the figure. What is the force on the charge +Q placed at the centre of the circle? 5



b) An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of ($4\sqrt{3}$)N m. Calculate the magnitude of the electric field.

32 (a) Draw a ray diagram for the formation of image of a point object by a thin double convex lens having radii of curvature R_1 and R_2. Hence derive lens maker's formula.

(b) A converging lens has a focal length of 10 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, find its new focal length. 5

OR

a) A ray of light passing from air through an equilateral glass prism undergoes minimum deviation when the angle of incidence is $3/4^{th}$ of the angle of prism. Calculate the speed of light in the prism.

b) A convex lens of focal length 20 cm is placed coaxially with a convex mirror of radius of curvature 20 cm and they are kept 15 cm apart. A point object lies 60 cm in front of the convex lens. Draw a ray diagram to show the formation of the image by the combination. Determine the nature and position of the image formed.

33 (a) In a series LCR circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with frequency of the ac source.

(b) What is the phase difference between the voltages across inductor and the capacitor at resonance in the LCR circuit?

(c) When an inductor is connected to a 200 V dc voltage, a current of 1 A flows through it. When the same inductor is connected to a 200 V, 50 Hz ac source, only 0.5 A current flows. Explain, why? Also, calculate the self-inductance of the inductor. 5

OR

(a) A series LCR circuit is connected to an ac source of variable frequency. Draw a suitable phasor diagram to deduce the expressions for the amplitude of the current and phase angle.

(b) Obtain the condition of resonance. Draw a plot showing the variation of current with the frequency of a.c. source for two resistances R_1 and R_2 ($R_1 > R_2$).