BUDHA DAL PUBLIC SCHOOL, PATIALA

Pre-Board Examination

Class – XII

PHYSICS (042)

Time Allowed : 3 hours **Maximum Marks : 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 16 questions, 12 MCQ and 4 Assertion Reasoning based of 1 mark each, **Section B** contains 5 questions of two marks each, **Section C** contains 7 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) Use of calculators is not allowed.

i) $c = 3 \times 10^8$ m/s
ii) $me = 9.1 \times 10^{-31}$ 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) $\varepsilon 0 = 8.854 \times 10^{-12}$ $C^2 N^{-1} m^{-2}$
vii) Avogadro's number = 6.023×10^{23} per gram mole

SECTION-A

1. A certain charge Q is first divided into two parts q and q'. Later on, the charges are placed at a certain distance. If the force of attraction between two charges in maximum, then : (1)

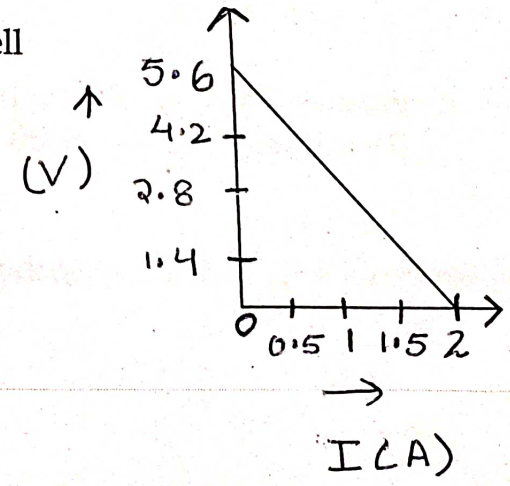
a) $q/q' = 2$ b) $q/q' = 1$ c) $q/q' = 4$ d) $q/q' = 3$

2. A charge q is enclosed by a Gaussian surface of radius R. If the radius is doubled, then outward electric flux will (1)

a) be doubled b) increase four times c) be reduced to half d) remains the same

A straight line plot showing the terminal potential difference (V) of a cell as a function of current (I) drawn from it, is shown in the figure. The internal resistance of the cell would be then

a) 2.8 ohms
b) 1.4 ohms
c) 1.2 ohms
d) zero



4. An electron having mass m, charge q and kinetic energy E enters a uniform magnetic field B perpendicularly. Then its frequency of rotation will be (1)

a) $^{qB}/_{\pi m}$ b) $^{qB}/_{2\pi m}$ c) $^{qBE}/_{\pi m}$ d) $^{qB}/_{2\pi E}$

5. A current of 10 A is flowing from east to west in a long straight wire kept on a horizontal table. The magnetic field developed at a distance of 10 cm due north on the table is: (1)

a) 2×10^{-5} T, acting downward
b) 2×10^{-5} T, acting upward
c) 4×10^{-5} T, acting downward
d) 4×10^{-5} T, acting upward

6. Magnetic susceptibility for paramagnetic and diamagnetic materials is respectively (1)

a) small, positive and small, positive
b) large, positive and small, negative
c) small, positive and small, negative
d) large, negative and large, positive

7. In a circuit the phase difference between the alternating current and the source voltage is $^{\pi}/_{2}$. Which of the following cannot be the element (s) of the circuit? (1)

a) only C b) only L c) L and R d) L or C

8. What is the name given to that part of the electromagnetic spectrum which is used for taking photographs of earth under foggy conditions from great heights? (1)

a) Ultraviolet rays b) Visible rays c) Infrared rays d) Microwaves

A thin circular ring of area A is held Perpendicular to a uniform magnetic field of induction B. A small cut is made in the ring and a galvanometer is connected across its end in such a way that the total resistance of the circuit is R. When the ring is suddenly squeezed to zero area, the charge flowing through the galvanometer is (1)

a) BR/A b) AB/R c) ABR d) B^2A/R^2

In Young's double slit experiment, with fringe width W, if the entire arrangement is placed in a liquid of refractive index μ, then fringe width becomes. (1)

a) $\frac{W}{(\mu+1)}$ b) μW c) $\frac{W}{\mu}$ d) $\frac{W}{(\mu-1)}$

A photon of energy 4eV is incident on a metal surface whose work function is 2eV The minimum reverse potential to be applied for stopping the emission of electrons is (1)

a) 2 V b) 4 V c) 6 V d) 8 V

The K.E. of the electron in an orbit of radius r in hydrogen atom is (e = electronic charge) proportional to (1)

a) e^2/r^2 b) $e^2/2r$ c) e^2/r d) $e^2/2r^2$

The following questions (Q17 & Q20) consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

a) **Both A and R are true and R is the correct explanation of A.**
b) **Both A and R are true but R is not the correct explanation of A.**
c) **A is true but R is false**
d) **A is false but R is also false**

13. **Assertion (A) :** To observe diffraction of light, the size of obstacle/aperture should be of the order of 10^{-7} m. (1)

Reason (R) : 10^{-7} m is the order of wavelength of visible light.

14. **Assertion (A) :** Kinetic energy of photoelectrons emitted by a photosensitive surface depends upon the intensity of incident light. (1)

Reason (R) : The ejection of electrons from a metallic surface is possible with frequency of incident photon below the threshold frequency.

15. **Assertion (A):** Silicon is preferred over germanium for making semiconductor devices.
Reason (R): The energy gap for germanium is more than the energy gap of silicon.

16. **Assertion (A):** Magnetic moment of an atom is due to both the orbital motion and spin motion of every electron.

Reason (R): A charged particle produces a magnetic field.

SECTION-B

17. Write the relation between following: (2)

a) Direction of propagation and direction of oscillation of the electronic field and magnetic field vectors in an electromagnetic wave.
b) Velocity of e.m. wave in vacuum and the permeability and permittivity of free space.

18. Identify the following magnetic materials (2)

a) A material having susceptibility (Xm) = – 0.00015
b) A material having susceptibility (Xm) = 10^{-5}

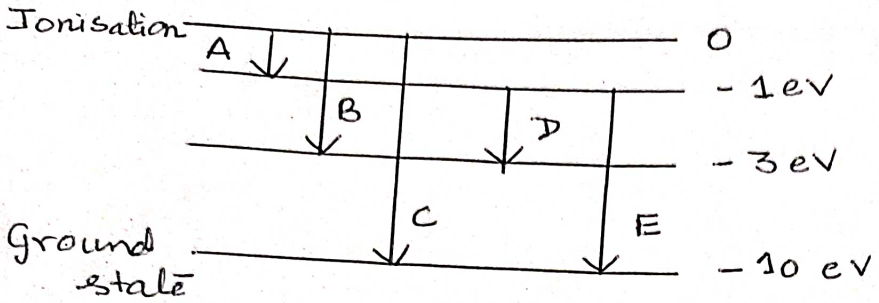
OR

Two identical bars, one of paramagnetic material and other of diamagnetic material are kept in a uniform external magnetic field parallel to it. Draw diagrammatically the modifications in the magnetic field pattern in each case.

19. If the wavelength of the second line of the Balmer series in the hydrogen spectrum is 486 1 ^{0}A. Calculate wavelength of first line. (2)

OR

The energy levels of an atom of element X are as shown in figure. Which one of the level transitions will result in the emission of photons of wavelength 620 nm? Support your answer with mathematical calculations.



20. Use the mirror equation to deduce that: (2)

a) An object placed between f and 2f a concave mirror produces a real image beyond 2f.
b) A convex mirror always produces a virtual image independent of the location of the object.

21. Distinguish between intrinsic and extrinsic semiconductors and draw their energy band diagram. (2)

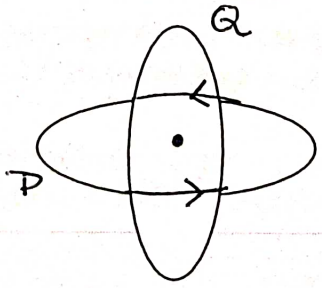
SECTION-C

22. A parallel beam of light of wavelength 500 nm falls on a narrow slit and resulting diffraction patterns is observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find the width of the slit. (3)

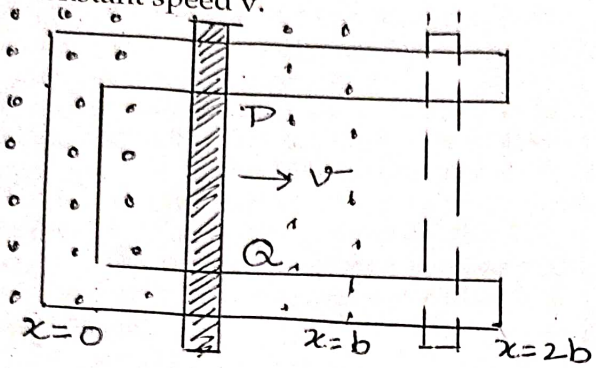
23. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q. (3)

a) A charge q is placed at the centre of the shell. What is the surface charge density on the inner and outer surfaces of the shell?
b) Is the electric field inside a cavity (with no charge) zero, even if the shell is not spherical, but has any irregular shape? Explain.

24. Two identical circular wires P and Q, each of radius R and carrying current I are kept in perpendicular, plane such that they have a common centre. Find the magnitude and direction of the net magnetic field at the common centre of two coil. (3)



25. In the following diagram, the arm PQ of the rectangular conductor is moved from x = 0 outwards. The uniform magnetic field is perpendicular to the plane and extends from x = 0 to x = B and is zero for x > b. Only the arm PQ possesses substantial resistance 'r'. Consider the situation when the arm PQ is pulled outward from x = 0 to x = 2b and then moved back to x = 0 with constant speed v. (3)



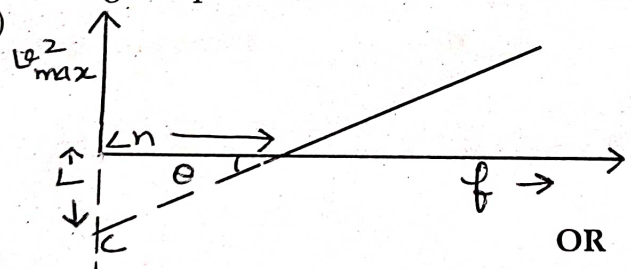
Obtain expression for (i) Flux (ii) induced e.m.f. (iii) the force necessary to pull the arm. Sketch the variation of these quantities with distance.

26. A series LCR circuit is connected to an a.c. source having voltage $E = E_0 \sin \omega t$. Derive an expression for the impedance, instantaneous current and its phase relationship to applied voltage. Also find phase angle between voltage and current. Find condition when current will be in phase with the voltage. (3)

OR

Obtain the resonant frequency ω of a series LCR circuit with L = 2.0 H, C = 32 μF and R = 10Ω. What is the Q-value of this circuit?

27. When a given photosensitive material is irradiated with light of frequency f, the maximum speed of the emitted photoelectrons equals v_{max}. The square of v_{max} is observed to vary with f as per the graph shown in figure. Obtain expressions for (i) Planck's constant and (ii) the work function of the given photosensitive material in terms of the parameters L, n, and m (mass of electron) (3)



OR

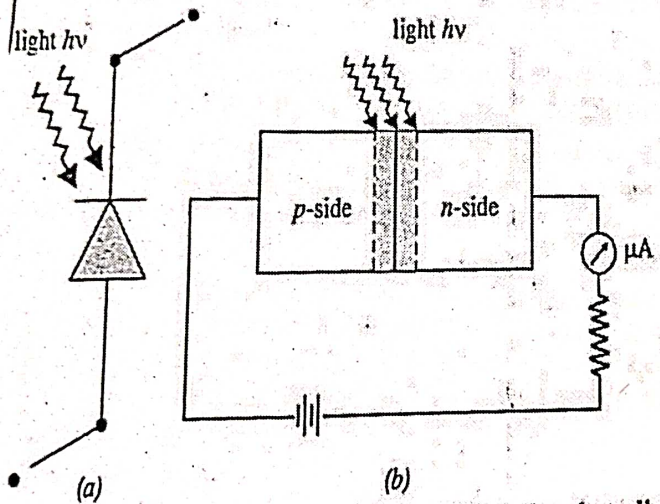
Plot the graph showing variation of de-Broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where V is accelerating potential for two particles A and B carrying same charge but of masses m_1 and m_2 ($m_1 > m_2$). Which one of the two represents a particle of smaller mass and why?

28. What do you mean by wave nature of an electron? How was quantisation of angular momentum of the orbiting electron in Bohr's model of hydrogen atom explained by de Broglie hypothesis? (3)

29. SECTION-D

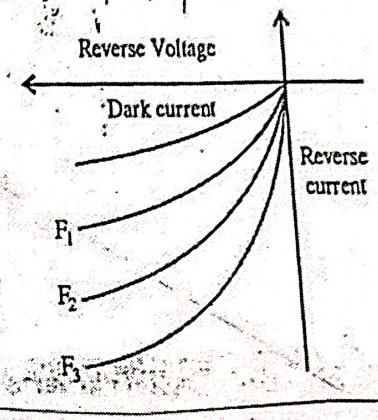
(4)

Photodiode : *A photodiode is a p-n-junction diode which is made from light sensitive semiconductor material and always operated in reverse bias* (below the breakdown voltage). Its **function is controlled by the light allowed to fall on it.** In fact a **photodiode detect and convert light into an energy signal** through the use of **photodetector.** The **conductivity** of *p-n* junction photodiode is **modulated by the absorption of the incident light in or near the depletion** layer which exist at the *p-n* junction. *The conductivity of the photodiode increases with increase in the intensity of light falling on it.* Symbolic representation of photodiode as shown in Fig., whereas the experimental arrangement for the study of (V – I) characteristics of photodiode is shown in Fig.*(b).*



V-I characteristics of photodiode : When the photodiode is reverse biased with a voltage less than the breakdown voltage, and no light is incident on it (junction) then a small reverse saturated current flows through the junction. *This current is due to thermally generated electron hole-pairs and is called dark current.*

When the light of energy (E = *hν*) greater than the forbidden energy gap falls on the photodiode, then valence electron absorb this energy and they may jump from valence band to conduction band. So an electron hole pair is produced in the depletion layer. These charge carriers will be separated by the junction field and made to flow across the junction. The *value of reverse saturation current increases with the increase in the intensity of incident light.* It must be noted that the reverse saturation current through the photodiode varies almost linearly with the light intensity.



(i) What is a photodiode ? Write its function. 1

(ii) Define dark current ? How the energy band gap 'E_g' of photodiode related to the maximum wavelength λ_m, that can be detected by it ? 1

(iii) Explain briefly how a photodiode operates ? 2

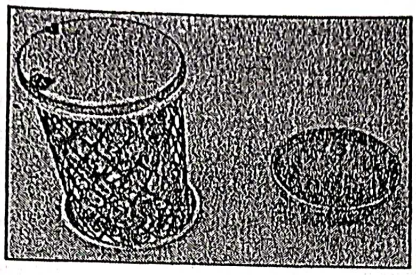
OR

Even though the current in the forward bias is known to be more than in the reverse bias, yet the photodiode works in reverse bias. What is reason ?

30. (4)

◆ Faraday Cage

A **Faraday** cage or **Faraday shield** is an enclosure made of a **conducting material.** The fields with in a conductor cancel out with any external fields, so the **electric field within** the enclosure **is zero.** These Faraday cages act as big hollow conductors, you can put **things** in to **shield them** from electric fields. Any electrical shock the cage **receives,** pass harmlessly around the **outside** of the cage.



(i) Which material can be used to make a Faraday cage ? (1)

(ii) How much will be the electric field inside a Faraday cage when it is struck by lightening? (1)

(iii) When an isolated point charge $+q$ is placed inside the **Faraday cage,** how much charge will be there on its **inner surface ?**

Or

A point charge of $2\mu C$ is placed at the centre of **Faraday cage** in the shape of a **cube** with surface of **10 cm** edge. Calculate the **number** of electric field lines **passing normally** through the surface. (2)

SECTION – E

31. (5)

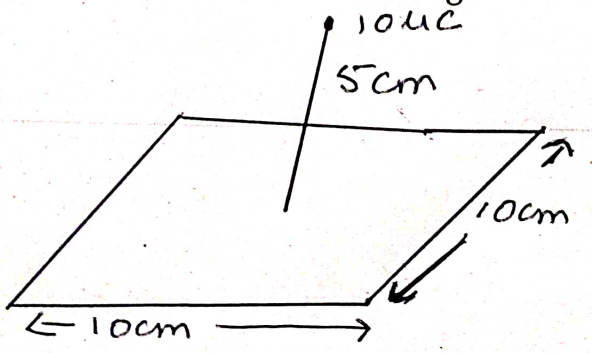
i) Three capacitors of capacitance 2 pF, 3 pF and 4 pF are connected in parallel.
   a) What is the total capacitance of the combination?
   b) Determine the charge on each capacitor if the combination is connected to a 100 V supply.

ii) Plot a graph comparing the variation of potential 'V' and electric field 'E' due to a point charge 'Q' as a function of distance 'R' from point charge.

OR

a) State Gauss theorem in electrostatics. Using this theorem find an expressions for the electric field at a point due to an infinitely long, then uniformly charged straight wire of linear charge density λCm^{-1}.

b) A point charge $= 10\mu C$ is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in figure. What is the magnitude of the electric flux through the square?



32. a) Deduce ohm's law using the concept of drift velocity. Use this relation to deduce expression for the electrical resistivity of material. (5)

b) Plot the graph showing the variation of resistance of a conducting wire as function of its radius, keeping the length of wire and its temperature as constant.

OR

What do you mean by internal resistance of a cell? On what factors it depend. Obtain a relation between terminal potential difference, e.m.f. of cell and internal resistance of cell. Discuss the special cases and draw characteristic curve between V and R for a cell.

33. What do you mean by diffraction of light? Describe the diffraction of light due to a single slit. Explain the formation of a pattern of fringes obtained on the screen and plot showing variation of intensity with angle θ in single slit diffraction. (5)

a) Show that the intensity of secondary maxima goes on decreasing with order of maxima.

b) Width of central maxima is twice the other secondary maxima or minima.

OR

a) Draw a graph showing the variation of angle of deviations (δ) with angle of incidence (i) for a monochromic ray of light passing through a prism of refracting angle A. Deduce the relation.

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

b) A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. What is the magnifying power of the telescope for viewing distant objects when the telescope is in normal adjustment (i.e., when the final image is at infinity)?