SAHODAYA PRE-BOARD EXAMINATION-2023-2024

Roll No. | | | | | | | | **Code No. 042/2**

- Please check that this question paper contains **'07'** printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **'33'** questions.
- Please write down the serial number of the question before attempting it.

PHYSICS
XII

Time allowed :3hrs. **Maximum Marks: 70**

General Instructions:

(1) There are 33questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A. Section B. Section C, Section D, Section E.
(3All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1mark 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 wherever 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) $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2 N^{-1} m^{-2}$
(vii) Avogadro's number = 6.023×10^{23} per gram mole

SECTION - A

1. Choose the correct example for nuclear fission

(a) ${}^{1}_{0}n + {}^{235}_{92}\text{U} \rightarrow {}^{236}_{92}\text{U} \rightarrow {}^{141}_{56}\text{Ba} + {}^{92}_{36}\text{Kr} + 3\,{}^{1}_{0}n$

(b) ${}^{1}_{0}n + {}^{235}_{93}\text{U} \rightarrow {}^{237}_{92}\text{U} \rightarrow {}^{140}_{52}\text{Ba} + {}^{88}_{34}\text{Kr} + 2\,{}^{1}_{0}n$

(c) ${}^{235}_{92}\text{U} \rightarrow {}^{236}_{92}\text{U} \rightarrow {}^{144}_{56}\text{Ba} + {}^{89}_{36}\text{Kr} + 2\,{}^{1}_{0}n$

(d) $2\,{}^{1}_{0}n + {}^{235}_{92}\text{U} \rightarrow {}^{236}_{92}\text{U} \rightarrow {}^{144}_{56}\text{Ba} + {}^{89}_{36}\text{Kr} + 2\,{}^{1}_{0}n$

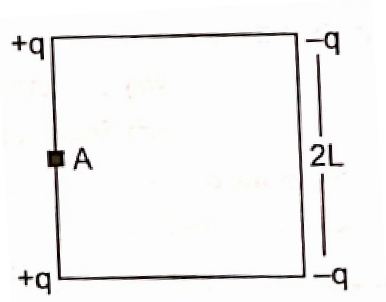
2. Four charges -*q*,-*q*, +*q* and +*q* are placed at the corners of a square of side 2L is shown in figure. The electric potential at point A midway between the two charges +*q* and +*q* is

(a) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

(b) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

(c) $\frac{1}{4\pi\varepsilon_0}\frac{q}{2L}\left(1-\frac{1}{\sqrt{5}}\right)$

(d) zero



3. An electron is moving with an initial velocity $v = v_0\,\hat{\imath}$ over the x - axis is in a magnetic field B = $B_0\hat{\jmath}$. Then, its de Broglie wavelength

(a) remains constant. (b) increases with time.

(c) decreases with time. (d) increases and decreases periodically.

4. A biconvex lens of focal length f is cut into two identical plano convex lenses. The focal length of each part will be

(a) *f* (b) *f*/2 (c) 2*f* (d) 4*f*

5. A coil of 100 turns carries a current of 5 mA and creates a magnetic flux of 10^{-7} weber. The inductance is

(a) 0.2 mH (b) 2.0 mH (c) 0.02 mH (d) 0.002 mH

6. In an LCR series ac circuit, the voltage across each of the component L. C and R is 50 V. The voltage across the LC-combination will be

(a) 50 V (b) $50\sqrt{2}$ V (c) 100 V (d) zero

7. In a bar magnet, magnetic field lines

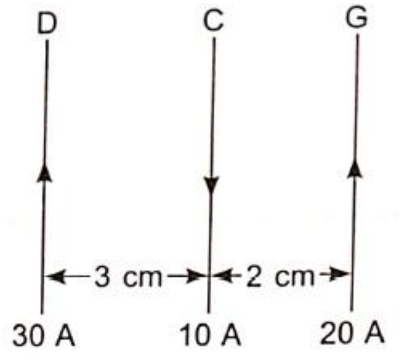
(a) are produced only at north pole like rays of light from a bulb.

(b) starts from north pole and ends at the south pole.

(c) starts from south pole and ends at the north pole.

(d) run continuously through the bar and outside.

8. Three long, straight parallel wires, carrying current are arranged as shown in the figure. The force experienced by a 25 cm length of wire C is



(a) 10^{-3} N

(b) $2 \cdot 5 \times 10^{-3}$ N

(c) zero

(d) $1 \cdot 5 \times 10^{3}$ N

9. A galvanometer has a resistance of 100Ω. A potential difference of 100 mV between its terminals gives a full scale deflection. The shunt resistance required to convert it into an ammeter reading up to 5 A is

(a) 0.01 Ω (b) 0.02 Ω (c) 0.03Ω (d) 0.04 Ω

10. Two students A and B calculate the charge flowing through a circuit. A concludes that 300 C of charge flows in 1 minute. B concludes that 3.125×10^{19} electrons flow in 1 second. If the current measured in the circuit is 5 A, then the correct calculation is done by

(a) A (b) B (c) both A and B (d) neither A nor B

11. What is the electric field at a point 18 cm away from the centre of spherical conductor of radius 12 cm and has a charge of 1.6×10^{-7} C distributed uniformly on its surface?

(a) $5.6 \times 10^4\ NC^{-1}$ (b) $6.6 \times 10^4\ NC^{-1}$

(c) $5.9 \times 10^4\ NC^{-1}$ (d) $4.4 \times 10^4\ NC^{-1}$

12. The electric field intensity due to an infinite cylinder of radius R and having charge q per unit length at a distance $r(r > R)$ from its axis is

(a) directly proportional to r^2 (b) directly proportional to r^3

(c) inversely proportional to r (d) inversely proportional to r^2

For Q. 13 to Q. 16 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.

(a) If both Assertion and Reason are true and Reason is 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 (A):** Density of all nuclei is same.

Reason (R): The radius of nucleus is directly proportional to the cube root of mass number.

14. **Assertion (A):** For identical coherent waves, the maximum intensity is four times the intensity due to each wave.

Reason (R): Intensity is proportional to the square of amplitude.

15. **Assertion (A):** Conductivity of a semiconductor increases on doping with pentavalent atoms

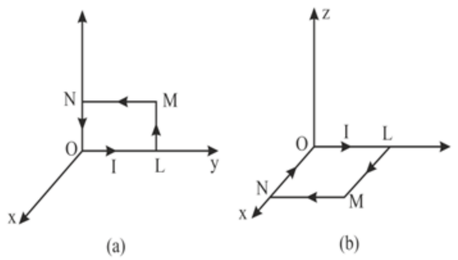
Reason (R): Pentavalent atoms can easily donate electrons due to their less ionisation energy.

16. **Assertion (A):** The alternating current lags behind the emf by a phase angle of $\frac{\pi}{2}$ when AC flows through an inductor,

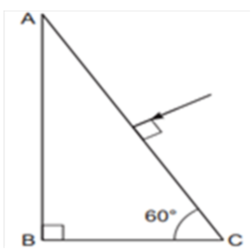
Reason (R): The inductive reactance increases as the frequency of AC decreases

SECTION - B

17. A given rectangular coil OLMN of area A, carrying a given current I, is placed in a uniform magnetic field $\vec{B} = B\hat{k}$, in two different orientations (a) and (b) as shown. What is the magnitude of torque experienced by this coils in the two cases ?



18. Trace the path of a ray of light passing through a glass prism (ABC) as shown in the figure. If the refractive index of glass is $\sqrt{3}$, find out the value of the angle of emergence from the prism.



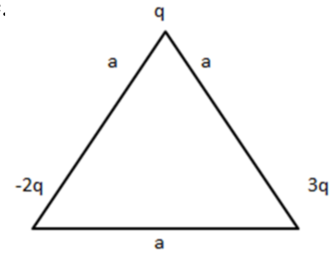
19. Draw a circuit diagram of a half wave rectifier? If the time period of input waveform is 0.04 seconds, then what is the time period of output waveform?

Or

Draw energy band diagrams of n-type semi conductor at temperature T > 0 K, mark the donor energy level. Explain why conductivity of this semiconductor increase with small increase of temperature.

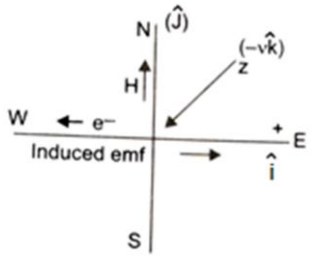
20. A convex lens is in contact with concave lens. The magnitude of the ratio of their powers is 2/3. Their equivalent focal length is 30 cm. What are their individual focal lengths in cm?

21. Obtain an expression for the work done to dissociate the system of three charges placed at the vertices of an equilateral triangle of side 'a' as shown in the figure.



SECTION - C

22. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 ms^{-1} at right angles to the horizontal component of earth's magnetic field equal to 0.30×10^{-4} Wbm^{-2}.
    (a) What is the instantaneous value of the emf induced in the wire?
    (b) What is the direction of emf?
    (c) Which end of the wire is at the higher electrical potential?



23. What do you mean by mutual inductance of two nearby coils? Find an expression for mutual inductance of two co-axial solenoids.

24. In a series LCR circuit, obtain the conditions under which
    (i) the impedance of the circuit is minimum, and
    (ii) wattless current flows in the circuit.

Or

Show that the current leads the voltage in phase by $\pi/2$ in an *ac* circuit containing an ideal capacitor.

25. (a) Write Einstein's photoelectric equation. State clearly any two salient features observed in photoelectric effect which can be explained on the basis of this equation.

    (b) The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ_1 to λ_2. Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface.

26. The total energy of an electron in the first excited state of the hydrogen atom is about -3.4 eV.
    (i) What is the kinetic energy of the electron in this state?
    (ii) What is the potential energy of the electron in this state?
    (iii) Which of the answers above would change if the choice of the zero of potential energy is changed?

27. Draw the energy level diagram for hydrogen atom. Mark the transitions corresponding to the series lying in the ultraviolet region.

28. (a) Arrange the following electromagnetic radiation in the ascending order of their frequencies: X-rays, microwaves, gamma rays, radio waves.
    (b) Write two uses of any two of these radiation.

SECTION - D

29. **Case Study**

Read the following paragraph and answer the questions those follow.

When the diode is forward biased it is found that beyond forward voltage V_K (called knee voltage), the conductivity is very high. At this value of battery biasing for *p*-*n* junction, 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.

(i) Application of a forward bias to a *p*-*n* junction

(a) increases the number of donors on *n*-side.

(b) increases the electric potential difference across the depletion zone.

(c) increases the electric field in the depletion zone.

(d) widens the depletion zone.

(ii) Which is incorrect statement regarding reverse saturation current in *p*-*n* junction diode?

(a) Current is due to minority carriers.

(b) Current doubles for every 100°C rise in temperature.

(c) Current carriers are produced by thermal agitation.

(d) Reverse saturation current is also known as leakage current.

(iii) If the forward voltage in a diode is increased, the width of the depletion region

(a) increases. (b) decreases. (c) fluctuates. (d) remains unchanged.

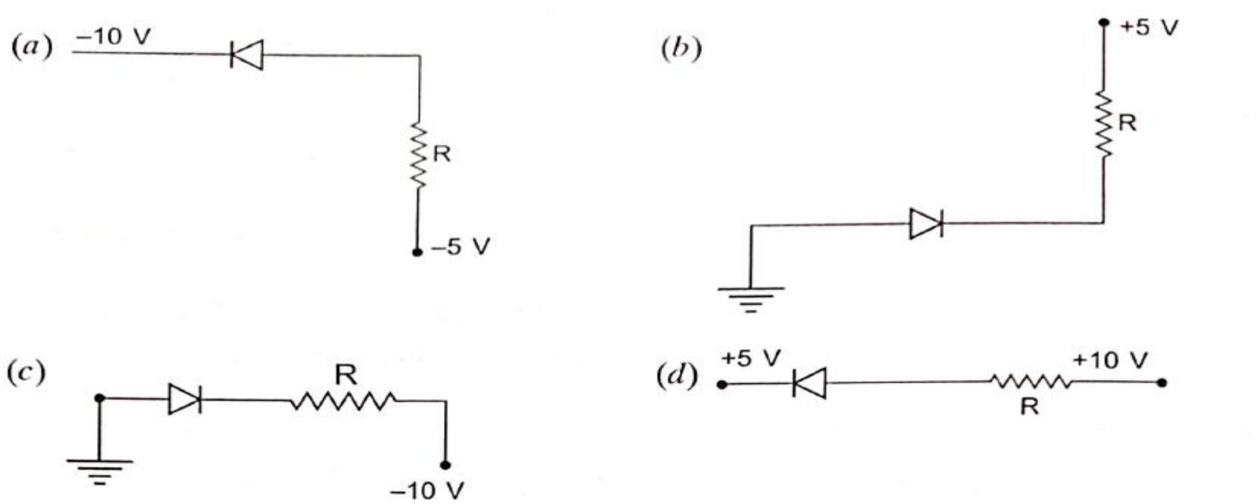
(iv) The depletion layer in the p-n junction region is caused by

(a) drift of holes. (b) diffusion of charge carriers.

(c) migration of impurity ions. (d) drift of electrons.

Or

Of the diodes shown in the following diagrams, which one is reverse biased?



30. **Case Study: Read the following paragraph and answer the questions that follow the paragraph.**

A compound microscope is an optical instrument used for observing highly magnified images of tiny objects. Magnifying power of a compound microscope is defined as the ratio of the angle subtended at the eye by the final image to the angle subtended at the eye by the object, when both the final image and the object are situated at the least distance of distinct vision from the eye. It can be given that: $m = m_e \times m_0$ where m_e is magnification produced by

eyepiece and m_0 is magnification produced by objective lens.
Consider a compound microscope that consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm.

(*i*) What is the magnifying power of the microscope when the final image is at the least distance of distinct vision?

(a) 10 (b) 15 (c) 20 (d) 25

(*ii*) What is the size and nature of the intermediate image formed by the objective of a compound microscope?

(a) Real, erect and magnified (b) Virtual, erect and magnified
(c) Real, inverted and magnified (d) None of these

(*iii*) What can be done to increase the magnifying power of a compound microscope?

(a) By increasing the focal length of both the objective lens and eyepiece.
(b) By reducing the focal length of both the objective lens and eyepiece.
(c) By increasing the focal length of objective and decreasing the focal length of eyepiece.
(d) By reducing the focal length of objective and increasing the focal length of eyepiece.

(*iv*) Find the object distance for eyepiece, so that final image is formed at the least distance of distinct vision.

(a) -2.5 cm (b)-5 cm (c) 5 cm (d) -4 cm

Or

How far from the objective should an object be placed in order to obtain the final image at least distance of distinct vision?

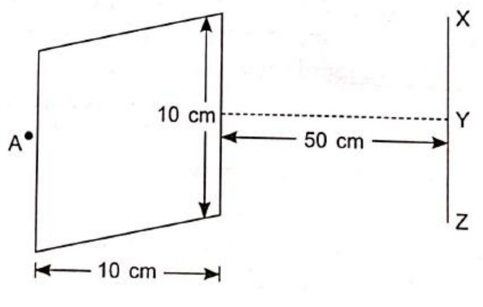
(a) -2.5 cm (b) -0.25 cm (c) - 25 cm (d) None of these

SECTION - E

31. (a) Use Gauss's theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density $+\sigma\ C/m^2$

(b) An infinitely large thin plane sheet has a uniform surface charge density $+\sigma$. Obtain an expression for the amount of work done in bringing a point charge q from infinity to a point at a distance '*r*' in front of the charged plane sheet.

(c) Given a uniformly charged plane sheet of surface charge density $\sigma = 2 \times 10^{17}$ C/m^2, find the electric field intensity at a point 'A' 3.5 mm away from the sheet on the left side. A straight line with three points X, Y and Z is placed 50 cm away from the charged sheet on the right side. At which of these points, the field due to the sheet remains the same as that of point A and why?



Or

(a) Derive an expression for the electric force experienced by an electric charge Q due to a dipole of length '$2a$' consisting of charges $+q$ and $-q$ at a point distant r from the centre of the dipole on the axial line.

(b) Draw a graph of E versus r for $r >> a$.

(c) If this dipole is placed in a uniform electric field (***E***) with its axis parallel to the electric field, determine the work required to rotate a dipole so that its axis makes an angle of 60° with **E**.

32. (a) Define a wavefront. How is it different from a ray?

(b) Using Huygens's construction of secondary wavelets draw a diagram showing the passage of a plane wave front from a denser to a rarer medium. Using it verify Snell's law.

(c) Show the shape of a refracted wavefront when a plane wavefront is incident on a convex lens.

OR

(a) What is diffraction? What is the relation between width of central bright fringe and the width of secondary maximum. Justify with formula.

(b) The fringe pattern on the screen is actually due to superposition of family of waves. Explain.

(c) What should be the width of each slit be to obtain ten maxima of the double slit pattern within the central maximum of the single slit pattern, for green light of wavelength 500 nm, if the separation between two slits is 1 mm?

33. (a) Find the relation between drift velocity and relaxation time of charge carriers in a conductor.

(b) A conductor of length L, diameter D is connected across a supply of V volts. Find if any effects are seen in the following physical quantities: (*i*) electric field (*ii*) drift speed (*iii*) current density when

I. length of the conductor is increased without stretching.

II. potential difference (V) is halved.

Or

(a) State Kirchhoff's laws for electric circuit.

(b) Use Kirchhoff's to obtain the balance condition in terms of the resistances of four arms of Wheatstone Bridge.

(c) The given network has two cells of emfs E_1 and E_2 and two resistances R_1 and R_2. The ammeter A reads zero. What would the voltmeter V read?