BK BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
SENIOR SECONDARY CO-ED DAY CUM BOYS' RESIDENTIAL SCHOOL

PRE BOARD -3 EXAMINATION 2024-25

PHYSICS (042)

Class : XII
Date : 19 /01/2025
Admission No.:

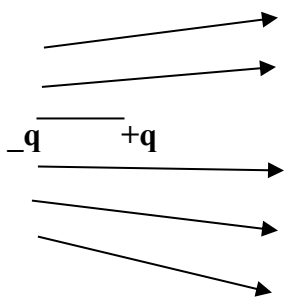
Duration: 3 Hrs
Max. Marks: 70
Roll No.:

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 one mark each.
(5) Section B contains five questions of two marks each.
(6) Section C contains seven questions of three marks each.
(7) Section D contains two case study-based questions of four marks each.
(8) Section E contains three long answer questions of five marks each.
(9) 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.
(10) Use of calculators is not allowed.
(11) 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) $\mu_0 = 4\pi \times 10\text{-}7$ TmA^{-1} (v) $m_p = 1.67 \times 10^{-27}$ kg (vi) $m_n = 1.675 \times 10^{-27}$ kg (vii) $h = 6.63 \times 10\text{-}34$ Js (vii) $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$ (viii) Avogadro's number = 6.023×10^{23} per gram mole

[SECTION – A] (16x1=16 marks)

1. Given Fig. shows electric field lines in which an electric dipole is placed as shown. Which of the following statement is correct.



(a) The dipole will not experience any force
(b) The dipole will experience a force towards right
(c) The dipole will experience a force towards left
(d) The dipole will experience a force upwards.

2. Two parallel infinite line charges with linear charge density $+\lambda$ C/m and $-\lambda$ C/m are placed at a distance of 2R in free space. What is the electric field midway between the two line charges?

   (a) Zero (b) $2\lambda / \pi \varepsilon_0 R$ (c) $\lambda / \pi \varepsilon_0 R$ (d) $\lambda / 2\pi \varepsilon_0 R$

3. When a potential difference V is applied across a conductor at temperature T, the drift velocity of the electrons is proportional to

   (a)T (b) $\sqrt{T}$ (c) V (d) $\sqrt{V}$

4. A circular loop of conducting wire of radius 'a' carries a steady current I. The ratio of magnitudes of the magnetic field at a point along its axis at distances '2a' and '3a' from its centre is:

   (a) 2:1 (b) $2\sqrt{2}$:1 (c) $\sqrt{2}$: 1 (b)3:$\sqrt{2}$

5. The voltage across a resistor, an inductor and a capacitor connected in series to an a..c. source are 20 V, 15 V and 30 V respectively. The resultant voltage in the circuit is

   (a)5 V (b) 20 V (c) 25 V (d) 65 V

6. Correct match of column I with column II is:

Column -l (waves)	**Column -ll (use)**
(1) Infra-red	P . Mobile communication
(2) Radio	Q . Human eye
(3) Light	R . Radar system
(4) Microwave	S . Green Houses

   (a) 1-P, 2-R, 3-S, 4-Q (b) 1-S, 2-P, 3-O, 4-R

   (c) 1-Q, 2-P, 3-S, 4-R (d) 1-S. 2-R, 3-P, 4-Q

7. The wavelength of an electromagnetic wave is 500 nm. It's frequency in free space is-
   (a) 6×10^{14}Hz (b) 3×10^{14} Hz (c) 3×10^{12} Hz (d)9×10^{12} Hz

8. Pencil in a beaker filled with water seems bent due to –
   (a) Reflection (b) Refraction (c) Diffraction (d) Total Internal Reflection
9. A thin convex lens of glass (n=1.5) has focal length+10 cm is immersed in water (n=1.33). The focal length of lens in water is –.

   (a) 12cm (b) 20 cm (c) 40 cm (d) 48 cm

10. In young's double slit experiment the separation between the slits is halved and the distance between the slits and screen is doubled. The fringe width –

(a)Unchanged (b) halved (c) doubled (d) quadrupled

11. The distance of closest approach of an alpha particle is d when it moves with kinetic energy 'K' towards a nucleus. Another alpha particle is projected with higher energy such that the new distance of the closest approach is d/2. What is the kinetic energy of projection of the alpha particle in this case?

(a) K /2 (B) $\sqrt{2}$ K (c) 2 K (d) 4K

12. The p-n junction diode is connected to a battery of e.m.f. 5.5 V and external resistance 5.1 kΩ. The barrier potential in the diode is 0.4 V. The current in the circuit is

(a) 1A (b) 1 mA (c) 2 mA (d) 0.08 mA

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) 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 (A**): The impedance offered by an ideal inductor to the flow of direct current is zero.
Reason(R): The frequency of direct current is zero.
14. **Assertion (A):** The Lyman series of hydrogen atom gives spectral line of wavelength 258 nm.
Reason (R): The Lyman series in hydrogen atom lies in ultra violet region.
15. **Assertion (A):** The binding energy per nucleon for nuclei with atomic mass A>120 decreases with A.
Reason (R): The nuclear force are weak for heavier nuclei.
16. **Assertion (A):** The de Broglie wave length of an electron is greater than proton, when both are moving with same speed.
Reason (R): de Broglie's wavelength of a particle is directly proportional to its linear momentum.

[SECTION – B] (5x2=10 marks)

17. An alpha-particle and a proton are accelerated from rest by the same potential. Find the ratio of their de-Broglie wavelengths.
18. For a plano-concave lens of radius of curvature 10 cm, the focal length in air is 25 cm. Find the refractive index of the material of the lens.

OR

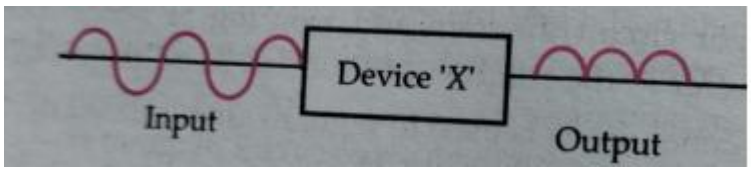
Light from a point source in air falls on a spherical glass surface (n = 1.5 and radius of curvature = 10 cm). The distance of the light source from the glass surface is 100 cm. At what position the image is formed?

19. A straight wire of length 4 m carrying a current of 0.5 A can be turned into either a square or a circular loop of 2 turns, before placing it in a magnetic field of intensity 0.1 T. Which loop do you think will require less counter torque in order to hold it in a position such that the axis of the loop is perpendicular to magnetic field? Justify your answer.
20. Using the curve for the binding energy per nucleon as a function of mass number A, state clearly how the release of energy in the processes of nuclear fission and nuclear fusion be explained.
21. Two wires have same resistance. One is made of copper and other manganin. If they are equally thick which of the two must be longer.

[SECTION – C] (7x3=21 marks)

22. Two semiconductor materials A and B shown are made by doping germanium crystal with arsenic and indium respectively. The two are joined end to end and connected with battery. (a) Will the junction be forward biased or reverse biased, justify (b) Sketch the VI graph for this arrangement.

23. Find the expression for the capacitance of a parallel plate capacitor of plate area A and plate separation d when (I) a dielectric slab of thickness t and (II) a metallic slab of thickness t, where (t < d) are introduced one by one between the plates of the capacitor. In which case would the capacitance be more and why?
24. (a) Draw a ray diagram for the formation of image by a reflecting telescope. (b) Why these types of telescopes are preferred over refracting type telescopes. (Write 2 points)
25. (a) Explain the formation of depletion layer and potential barrier in a p-n junction. (b) In fig input waveform is converted into output waveform by device X. Name the device and draw its circuit diagram.



26. In a moving coil galvanometer. Why is it necessary to use (i) a radial magnetic field and (ii) a cylindrical soft iron core in a galvanometer? Write the expression for current sensitivity of the galvanometer. Can a galvanometer as such be used for measuring the current? Explain.

27. A light ray entering a right-angled prism undergoes refraction at the face AC as shown in Fig. 1.

What is the refractive index of the material of the prism in Fig. 1?

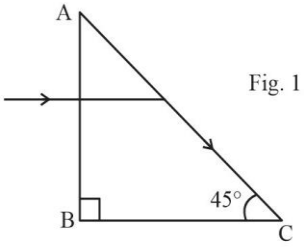


Fig. 1

(a) If the side AC of the above prism is now surrounded by a liquid of refractive index 2/√3 shown in Fig. 2, determine if the light ray continues to graze along the interface AC or undergoes total internal reflection or undergoes refraction into the liquid.

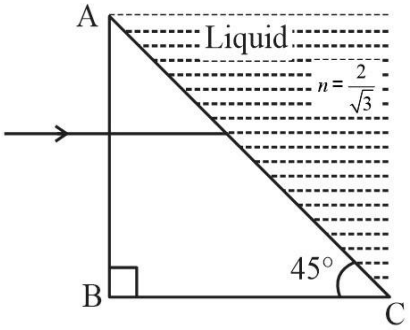


Fig. 2

(b) Draw the ray diagram to represent the path followed by the incident ray with the corresponding angle values. (Given, $sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^{\circ}$)

28. (a) Define electric flux and write its SI unit.
(b) Using Gauss theorem, derive an expression for the electric field due to an infinitely long straight wire of linear charge density λ.

OR

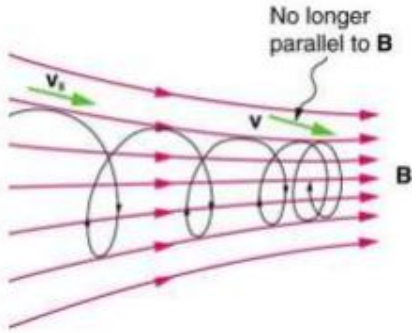
(a) State Gauss theorem in electrostatics

(b) Use Gauss theorem to obtain the expression for the electric field due to a uniformly charged infinite plane sheet of charge of surface charge density σ

[SECTION D]

Case Study Based Question **(2x4=08marks)**

29.



A point charge q (moving with a velocity v and located at r at a given time t) in the presence of both the electric field E and magnetic field B. The force on an electric charge q due to both of them can be written as $F = q [E + v \times B] = Fe + Fm$ It is called Lorentz force.

(i). If the charge q is moving under a field, the force acting on the charge depends on the magnitude of field as well as the velocity of the charge particle, what kind of field is the charge moving in?

(a) Electric field (b) Magnetic field (c) Both electric and magnetic field perpendicular to each other (d) None of these

(ii). The magnetic force acting on the charge 'q' placed in a magnetic field will vanish if

(a) if v is small (b) If v is perpendicular to B

(c) If v is parallel to B (d) None of these

(iii). If an electron of charge –e is moving along +X direction and magnetic field is along +Z direction then the magnetic force acting on the electron will be along

(a) + X axis (b) - X axis (c) –Y axis (d) +Y axis

(iv). The vectors which are perpendicular to each other in the relation for magnetic force acting on a charge particle are

(a) F and v (b) F and B (c) v and B (d) Both (a) and (b)

OR

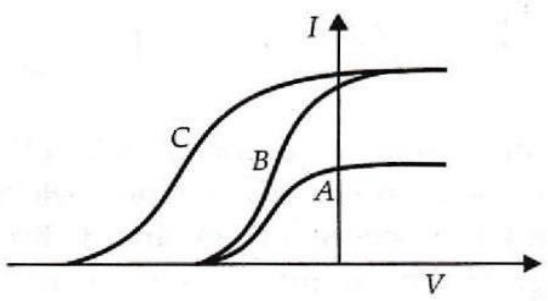
(iv) A particle moves in a region having a uniform magnetic field and a parallel, uniform electric field. At some instant, the velocity of the particle is perpendicular to the field direction. The path of the particle will be

(a) A straight line (b) A circle

(c) A helix with uniform pitch. (d) A helix with non-uniform pitch

30. It is the phenomenon of emission of electrons from a metallic surface when light of a suitable frequency is incident on it. The emitted electrons are called photoelectrons. Nearly all metals exhibit this effect with ultraviolet light but alkali metals like lithium, sodium, potassium, cesium etc. show this effect even with visible light. It is an instantaneous process i.e. photoelectrons are emitted as soon as the light is incident on the metal surface. The number of photoelectrons emitted per second is directly proportional to the intensity of the incident radiation. The maximum kinetic energy of the photoelectrons emitted from a given metal surface is independent of the intensity of the incident light and depends only on the frequency of the incident light. For a given metal surface there is a certain minimum value of the frequency of the incident light below which emission of photoelectrons does not occur.

(iii) In a photoelectric experiment plate current is plotted against anode potential.



(a) A and B will have same intensities while B and C will have different frequencies

(b) B and C will have different intensities while A and B will have different frequencies

(c) A and B will have different intensities while B and C will have equal frequencies
(d) B and C will have equal intensities while A and B will have same frequencies.

(ii) Photoelectrons are emitted when a zinc plate is

(a)Heated (b) hammered

(c) Irradiated by ultraviolet light (d) subjected to a high pressure

(iii) The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 500 nm. Its work function is about

(a) $4x10^{-19}J$ (b) 1 J (c) $2x10^{-19}$ J (d) $3x10^{-19}J$

(iv) The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential is:

(a) 2 V (b) 4 V (c) 6 V (d) 10 V

OR

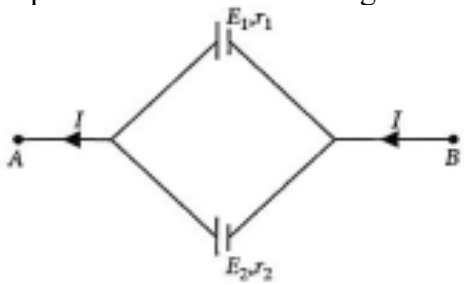
(iv) The minimum energy required to remove an electron from a substance is called its

(a) work function (b) kinetic energy (c) stopping potential (d) potential energy

[SECTION E] **(3X5=15)**

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

(b) Two cells of emf E1 and E2 and internal resistances $r_1$and r_2 respectively are connected in parallel as shown in the figure. Deduce the expression for

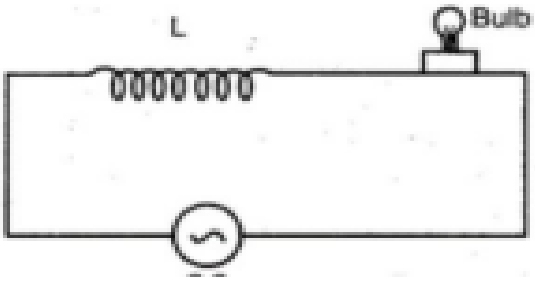


(i) equivalent emf of the combination.
(ii) equivalent internal resistance of the combination
(iii) potential difference between the points A and B.

OR

(a) Write two limitations of ohm's law. Plot their I-V characteristics.
(b) A heating element connected across a battery of 100 V having an internal resistance of 1 Ω draws an initial current of 10 A at room temperature 20.0 °C which settles after a few seconds to a steady value. What is the power consumed by battery itself after the steady temperature of 320.0 °C is attained? Temperature coefficient of resistance averaged over the temperature range involved is 3.70×10^{-4} °C^{-1}.

32. (a) State the working principle of an AC generator. With the help of a neat and labelled diagram, explain its working and obtain the expression for the emf generated in the coil.
(b) An inductor L of reactance XL is connected in series with a bulb B to an ac source as shown in the figure. Explain briefly how the brightness of the bulb changes when



(i) number of turns of the inductor is reduced

(ii) an iron rod is inserted in the inductor.

OR

(a) With the help of a diagram, explain the principle of a device which changes a low ac voltage into a high voltage. Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding. For an ideal transformer, obtain the ratio of primary and secondary currents in terms of the ratio of the voltages in the secondary and primary coils.

(b)Write any two sources of the energy losses which occur in actual transformers.

(c) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.

33. (a) State Huygens principle.

(b) A plane wave front is incident obliquely from denser to a rarer medium. Draw suitable Huygens construction for the same and hence deduce the Snell's law of refraction

(c) Also show using the above that the frequency of the wave does not change with change in the medium

OR

(a) Draw a labeled diagram of compound microscope when final image is formed at least distance of distinct vision.

(b) A compound microscope 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. How far from the objective should an object be placed in order to obtain the final image at:

(i) The least distance of distinct vision (25 cm)?

(ii) Infinity? What is the magnifying power of the microscope in each case?

----------ALL THE BEST----------