BK BIRLA CENTRE FOR EDUCATION

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

PRE BOARD - 1 EXAMINATION 2023-24

PHYSICS (042)

Class : XII
Date : 15/12/2023
Admission No.:

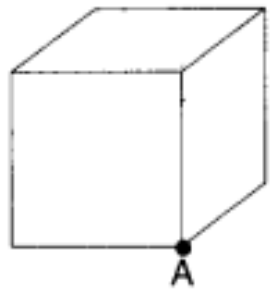
Duration: 3 Hrs
Max. Marks: 70
Roll No.:

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 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

1. In a region of constant potential:
   (a) the electric field is uniform (b) the electric field is zero
   (c) there can be no charge inside the region (d) both (b) and (c) are correct
2. The total flux through the faces of the cube with side of length 'a' if a charge ''q is placed at corner A of the cube is:



   (a) $q/4\varepsilon_0$ (b) $q/2\varepsilon_0$ (c) $q/8\varepsilon_0$ (d) q/ε_0
3. The work function for a metal surface is 2.14 eV. The threshold frequency for this metal surface is:
   (a) 5.16×10^{14} Hz (b) 4.16×10^{14}Hz (c) 3.22×10^{14} Hz (d) 3.16×10^{14}Hz

4. An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true?
   (a) The electron will be accelerated along the axis.
   (b) The electron path will be circular about the axis.
   (c) The electron will experience a force at 45° to the axis and hence execute a helical path.
   (d) The electron will continue to move with uniform velocity along the axis of the solenoid.
5. The Rutherford α-particle experiment shows that most of the α-particles pass through almost un-scattered while some are scattered through large angles. What information does it lead to?
   (a) Atoms are hollow.
   (b)The whole mass of the atom is concentrated in a small centre called nucleus
   (c) Nucleus is positively charged
   (d) All of the above
6. The substances which are having tendency to move from stronger part to weaker part of the external magnetic field are called as:
   (a) Paramagnetic materials (b) Diamagnetic materials
   (c) Ferromagnetic material (d) None
7. A short bar magnet has a magnetic moment of 0. 65 J T^{-1}, then the magnitude and direction of the magnetic field produced by the magnet at a distance 8 cm from the centre of magnet on the axis is:
   (a) 2.5×10^{-4} T, along NS direction (b) 2.5×10^{-4} T along SN direction
   (c) 4.5×10^{-4} T, along NS direction (d) 4.5×10^{-4} T, along SN direction
8. The angular speed of the electron in the nth orbit of Bohr hydrogen atom is:
   (a) directly proportional to n (b) inversely proportional to n
   (c) inversely proportional to n^2 (d) inversely proportional to n^3
9. A capacitor has capacitance C and reactance X, if capacitance and frequency become double, then reactance will be:
   (a) 4X (b) X/2 (c) X/4 (d) 2X
10. Electromagnetic waves travelling in a medium having relative permeability $\mu_r = 1.3$ and relative permittivity $E_r = 2.14$. The speed of electromagnetic waves in medium must be:
   (a) 1.8×10^8 ms^{-1} (b) $1.8 \times 10^4 ms^1$ (c) $1.8 \times 10^6 ms^1$ (d) 1.8×10^2 ms^{-1}
11. A coil having 500 square loops of side 10 cm is placed normal to magnetic flux which increases at a rate of 1 T/s. The induced emf is:
   (a) 0.1 V (b) 0.5 V (c) 1 V (d) 5 V
12. In a hydrogen atom, which of the following electronic transitions would involve the maximum energy change
   (a) n = 2 to n = 1 (b) n = 3 to n = 1 (c) n = 4 to n = 2 (d) n = 3 to n = 2

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 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: Energy of incident photons increases with increase in frequency and as a result photoelectric current increases.
   Reason: Photoelectric saturation current increases with the increase in frequency of incident light.

14. Assertion: In semiconductors, thermal collisions are responsible for taking a valence electron to the conduction band.
    Reason: The number of conduction electrons go on increasing with time as thermal collisions continuously take place.
15. Assertion (A): Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface.
    Reason (R): Refractive index of the material of the core of the optical fibre is greater than that of the cladding.
16. Assertion : For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.
    Reason : The net work done by a conservative force on an object moving along a closed loop is zero.

Section-B

17. (a) What do you understand by reverse biasing of p-n junction diode? 2
    (b) Draw the circuit diagram to obtain characteristic curve of p-n junction diode in reverse biasing.
18. A silver wire has a resistance of 2.1 Ω, at 27.5°C and a resistance of 2.7 Ω at 100°C. Determine the temperature coefficient of resistivity of silver. 2
19. How does the angle of minimum deviation of a glass prism of refractive index 1.5 change, if it is immersed in a liquid of refractive index 1.33? 2
20. An α-particle and a proton are accelerated from rest by the same potential. Find the ratio of their de-Broglie wavelengths. 2
21. A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12 cm from P. At what point does the beam converge if the lens is a convex lens of focal length 20 cm. 2

    OR

    A small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece?

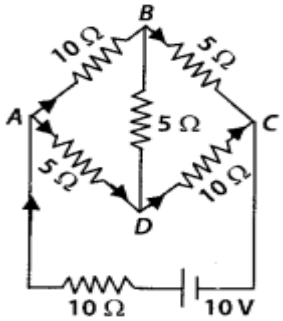
Section-C

22. Obtain the binding energy per nucleon of the nuclei $_{26}Fe^{56}$ and $_{83}Bi^{209}$ in units of MeV from the following data: 3
    $m(_{26}Fe^{56}) = 55.934939$ u, $m(_{83}Bi^{209}) = 208.980388$ u, $m(_{1}H^{1}) = 1.007825$u, $m\ (_{0}n^{1}) = 1.008665$u
23. In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is, however, not constant but increases uniformly along the positive z-direction, at the rate of 10^5 NC^{-1} per metre. What are the force and torque experienced by a system having a total dipole moment equal to 10^{-7} Cm in the negative z-direction? 3
24. A 12.75 eV electron beam is used to bombard gaseous hydrogen at room temperature. What series of wavelengths will be emitted? 3
25. A square loop of side 12 cm with its sides ‘r parallel to X and Y axes is moved with a velocity of 8 cm s^{-1} in the positive x-direction in an environment containing a magnetic field in the positive z-direction. The field is neither uniform in space nor constant in time. It has a gradient of 10^{-3} T cm^{-1} along the negative x-direction that is it increases by 10^{-3} T cm^{-1} as one moves in the negative x-direction and it is decreasing in time at the rate of 10^{-3} T s^{-1}. Determine the direction and magnitude of the induced current in the loop if its resistance is 4.50 mΩ. 3
26. Define self-inductance and write its SI unit. Obtain the expression of back emf developed in an inductor and hence for the coefficient of self-inductance. 3

    OR

With the help of suitable diagram state working principle and explain working of a step-up transformer.

27. Identify the part of the electromagnetic spectrum which: 3
    (a) is used in radar system, (b) is used for sterilisation, (c) is used for studying crystal structure. Write any one method of the production and detection of each of the above radiations.
28. Determine the current in each branch of the network shown in figure. 3



Find the amount of currents passing through each branches of the above circuit.

Section-D

29. Case Study: Read the following paragraph and answer the questions.
    A number of optical devices and instruments have been designed and developed such as periscope, binoculars, microscopes and telescopes utilising the reflecting and refracting properties of mirrors, lenses and prisms. Most of them are in common use. Our knowledge about the formation of images by the mirrors and lenses is the basic requirement for understanding the working of these devices. Compound microscope and telescope are designed by using two coaxial convex lenses of different focal lengths, one of the lenses is objective lens and the other one is eye lens. Eye lens acts as simple microscope and there are two cases of image formation in both. Telescope is of two type refracting type and reflecting type in reflecting type objective lens is replaced by concave mirror.
    (a) What is the role of objective lens in a compound microscope and telescope? 1
    (b) What do you understand by tube length of telescope? 1
    (c) Write two advantages of using reflecting telescope. 1
    (d) Draw the ray diagram of image formation by reflecting type telescope. 1

    OR

    Draw the ray diagram of image formation by refracting type telescope.

30. Case study:
    Read the following paragraph and answer the questions.
    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. It can be operated in forward biasing and reverse biasing. 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
    (a) Why a diode does not emit light under forward biasing while LED does emit light in forward biasing? 1

(b) A student wants to convert a.c. into d.c. using half wave rectifier with the help of p-n junction diode draw the circuit diagram necessary for the purpose. 1

(c) What is the effect of forward and reverse biasing on the width of depletion layer? Give reason for your answer. 1

(d) If frequency of input signal in half wave rectifier is 50 Hz, what will the frequency of output? 1

OR

If frequency of input signal in full wave rectifier is 50 Hz, what will the frequency of output?

Section-E

31. (a) Derive an expression for the energy of a parallel plate capacitor with air present between the two plates.

(b) In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-3} m^2 and the distance between the plates is 3 mm. Calculate the capacitance of the capacitor. What will be the capacitance if the distance between the plates is reduced by half, and the space between them is filled with a substance of dielectric constant 6? 5

OR

(a) Using Gauss' law in electrostatics, derive an expression for the electric field due to a uniformly changed Spherical shell (i) At a point outside the shell and (ii) At a point inside the shell. Show that at a point outside the shell it behaves as if entire charge is located at its centre.

(b) A conducting sphere of radius 10 cm has an unknown charge. If the electric field 20 cm from the centre of the sphere is 1.5×10^3 N/C and points radially inward, what is the net charge on the sphere?

32. (a) Use Huygen's principle to verify the laws of reflection. 5

(b) A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes in a Young's double-slit experiment. Distance between two slits is 2mm and screen is placed at distance 1.2 m from the plane of slits.

(i) Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.

(ii) What is the least distance from the central maximum where the bright fringes due to both the wavelengths coincide?

OR

(a) Draw a schematic diagram of refraction at spherical surface and using it find the relation between object distance, image distance and refractive indices in terms of radius of curvature.

(b) Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20 cm?

33. (a) Draw the phasor diagram for a series LRC circuit connected to an AC source. Using the phasor diagram, derive the expression for the impedance of the circuit and phase difference between V and I.

(b) A coil of inductance 0.50 H and resistance 100 Ω is connected to a 240 V. 50 Hz ac supply.

(i) What is the maximum current in the coil?

(ii) What is the time lag between the voltage maximum and the current maximum? 5

OR

(a) State the Faraday's law of electromagnetic induction. Using it find the expression for motional e.m.f developed in a conductor of length 'L' rotated in uniform magnetic field 'B' with angular velocity 'ω'.

(b) A rectangular wire loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the loop. What is the e.m.f developed across the cut if velocity of loop is 1 cm s^{-1} in a direction normal to the (i) longer side (ii) shorter side of the loop? For how long does the induced voltage last in, each case?

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