विद्या सवर्थि साधिका

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PRE-BOARD EXAMINATION
Class: XII

Subject: Physics (042) MM : 70
Date : 24-12-2024 Time: 3 Hrs

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. Section A contains of sixteen questions, 12 MCQ and 4 Assertion Reasoning based questions of 1 mark each, Section B contains of five very short answer type questions of 2 marks each, Section C contains of seven short answer type questions of 3 marks each, Section D contains two case study-based questions of 4 marks each and Section E contains of three long answer type questions of 5 marks each.
4. There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.
6. Some constants that you may need.

$h = 6.67 \times 10^{-34}\,Js$ $e = 1.6 \times 10^{-19}\,C$ $m_e = 9.1 \times 10^{-31}kg$

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ Nm^{2}C^{-2} $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1} $c = 3 \times 10^8$ m/s

SECTION A

1. A conducting sphere of radius r is charged to q coulomb. There are three points A on the surface of the sphere, B inside the sphere and C outside the sphere. The potential at points A, B and C satisfy: (1)
(A) $V_A > V_B > V_C$ (B) $V_A = V_B > V_C$ (C) $V_A > V_B < V_C$ (D) $V_A = V_B < V_C$

2. A conducting wire connects two charged conducting spheres of radii r_1 and r_2 such that they attain equilibrium with respect to each other. The distance of separation between the two spheres is very large. The ratio of the magnitudes of the electric fields at the surfaces of the spheres of r_1 and r_2 is ______________. (1)
(A) $\frac{r_1}{r_2}$ (B) $\frac{r_2}{r_1}$ (C) $\frac{r_2^2}{r_1^2}$ (D) $\frac{r_1^2}{r_2^2}$

3. Two coaxial circular loops of equal radii R, carrying currents I each are separated by a distance 2R from each other. The currents are clockwise in both cases when seen from one side. The magnetic field at the midpoint is _________________. (1)
(A) $\frac{\mu_o I}{2\sqrt{2}R}$ (B) $\frac{\mu_o I}{2R}$ (C) $\frac{\mu_o I}{2\pi R}$ (D) zero

4. The intensities of the two monochromatic sources in a Young's double slit experiment are I each. What is the intensity of bright fringe? (1)
(A) I (B) 2I (C) 4I (D) 8I

5. The dimension of the quantity $\sqrt{\mu_0\varepsilon_0}$ is _____________. (1)
(A) [MLT^{-1}] (B) [M^{0}L^{-1}T] (C) [M^{0}LT^{-1}] (D) [M^{0}LT^{-2}]

6. In a series LCR circuit, the voltage across the resistance, capacitance and inductance is 10 V each. What is the power factor? (1)
(A) 0 (B) ¼ (C) ½ (D) 1

7. If r_1 and r_2 are the radii of the nuclei of mass numbers 4 and 32 respectively, then the ratio $\left(\frac{r_1}{r_2}\right)$ is _____________. (1)

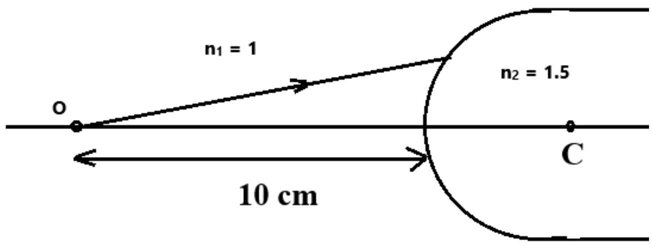
(A) 1:2 (B) 1:3 (C) 1:4 (D) 1:5

8. Match the following: (1)

C-l (waves)	C-ll (Applications)
(i) UV rays	(P) Communication
(ii) Radio waves	(Q) Cancer treatment
(iii) Gamma rays	(R) Heating food
(iv) Microwave	(S) Killing Germs

(A) i-R, ii-P, iii- Q, iv-S (B) i-S, ii-Q, iii-P, iv-R
(C) i-S, ii-P, iii- Q, iv-R (D) i-Q, ii-R, iii- S, iv-P

9. A convex surface of radius 20 cm separates air from a medium of refractive index 1.5. An object is placed at a distance of 10 cm from the convex surface in air. Find the position of the image. (1)



(A) 12 cm (B) -12 cm (C) 20 cm (D) -20 cm

10. A diffraction pattern is obtained by using a beam of red light. What will happen, if the red light is replaced by blue light? (1)

(A) Bands become broader and farther apart (B) Bands disappear
(C) Bands become narrower and crowded together (D) No change take place

11. The conductivity of an extrinsic semiconductor increases with ____________. (1)

(A) decrease in temperature (B) increase in doping level
(C) increase in temperature (D) both (B) and (C)

12. Four wires of equal length have the same resistance. They are made of the following materials. Which wire is thicker? (1)

(A) Copper (B) Manganin (C) Iron (D) Aluminium

For question numbers 13 to 16, two statements one assertion (A) and another reason (R) are given. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and Rare true but R is not the correct explanation of A.
(C) A is true but R is false
(D) A is false and R is also false.

13. A: In photoelectric emission the emitted electron can have kinetic energy less than the difference between energy of incident frequency and work function. (1)

R: Some of the energy from the incident photon may be used to overcome other processes or interactions within the material.

14. **A:** According to classical theory the proposed path of an electron in Rutherford atom model will be parabolic. (1)

R: According to electromagnetic theory every accelerated particle continuously emits radiation.

15. **A**: A galvanometer can be converted into an ammeter by connecting a small resistance in parallel. (1)
R: The current sensitivity of a galvanometer depends on the number of turns of the galvanometer coil.

16. **A**: the binding energy per nucleon, is practically independent of the atomic number for nuclei of middle mass number (30 < A < 170). (1)
R: The nuclear force is a short-range force

SECTION B

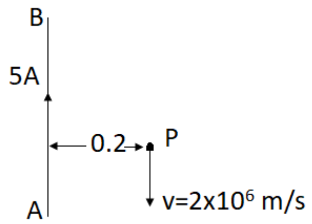
17. Calculate the de Broglie wavelength associated with an electron whose kinetic energy is 1 eV. (2)

18. In Young's double slit experiment the slits are separated by 0.24 mm. The screen is 1.2 m away from the slits. The fringe width is 0.3 cm. Calculate the wavelength of the light used in the experiment. (2)

OR

A plane wavefront is incident on (i) a prism and (ii) a convex lens. Draw the emerging wavefront in each case.

19. A long straight wire AB carries a current of 5A. A proton P travels at 2×10^6 m/s parallel to the wire 0.2 m from it in a direction opposite to the current. Calculate the force exerted by the magnetic field on the proton. Also specify the direction of the force. (2)



20. In the ground state of the hydrogen atom, its Bohr's radius is given as 5.3×10^{-11}m. The atom is excited such that the radius becomes 21.2×10^{-11}m. Find (i) the value of the principal quantum number and (ii) the total energy of the atom in this excited state. (2)

21. A steady current flows through a metallic conductor of non-uniform cross section. Which of these quantities is constant along the conductor: current, current density, electric field, drift speed? Justify your answer. (2)

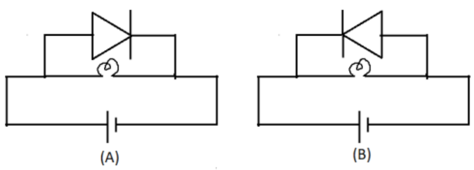
SECTION C

22. How can you convert high voltage AC into low voltage DC? Draw the necessary circuit diagram and explain its working. Draw the input and output waveforms. (3)

23. a) Two large charged plane sheets of charge densities σ and $-\sigma$ C/m^2 are arranged vertically with a separation of d between them. Deduce expressions for the electric field at points (i) to the left of the first sheet, (ii) to the right of the second sheet, and (iii) between the two sheets. (3)
b) Find the capacitance of this setup. The area of the charged sheets is A.

24. Draw the plots showing the variation of the intensity of light in interference and diffraction patterns. Write any two differences between the two patterns. (3)

25. a) Draw V- I characteristic curve of an ideal diode in (i) forward bias and (ii) reverse bias. (3)
b) In the following given circuit diagrams with ideal diodes, in which case the bulb would glow?



26. a) A charged particle q is moving in the presence of a magnetic field B which is inclined to an angle 30° with the direction of the motion of the particle. Draw the trajectory followed by the particle in the presence of the field. Justify your answer. (3)

b) An alpha particle is travelling with a velocity v perpendicular to a uniform magnetic field. The strength of the magnetic field is B. What is change in the magnitude of its velocity? Justify your answer.

27. A light of frequency 6 x 10^{14} Hz from air is reflected and refracted by a medium. What are the frequency, wavelength and speed of (i) reflected light and (ii) the refracted light? (Refractive index 1.5). (3)

28. State Gauss's theorem in electrostatics. Using gauss theorem, derive the expression for the electric field due to a uniformly charged infinitely large plane sheet. (3)

OR

Define electric field. Derive the expression for the electric field at a point on the equatorial line of an electric dipole.

SECTION D

29. Based on the way a material behaves in a external magnetic field we can classify materials as diamagnetic, paramagnetic or ferromagnetic. (4)

Diamagnetic substances are those which have tendency to move from stronger to the weaker part of the external magnetic field. Paramagnetic substances are those which get weakly magnetised when placed in an external magnetic field. Ferromagnetic substances are those which gets strongly magnetised when placed in an external magnetic field.

In terms of the susceptibility χ, a material is diamagnetic if χ is negative, para- if χ is positive and small, and ferro- if χ is large and positive.

(i) Magnetic permeability is maximum for _________.

(A) ferromagnetic substances (B) paramagnetic substances
(C) diamagnetic substances (D) all of the above

(ii) A small bar when placed near a magnet is repelled by it. The bar is made of ______.

(A) Iron (B) Copper (C) Aluminium (D) Nickel

(iii) The relative permeability of a substance X is slightly less than unity and that of substance Y is slightly greater than unit. The substances X and Y are _________ respectively.

(A) paramagnetic and ferromagnetic (B) diamagnetic and paramagnetic
(C) both paramagnetic (D) both diamagnetic

(iv) Magnetic susceptibility remains constant for very large value of temperature change for a substance. The substance is ______.

(A) diamagnetic (B) paramagnetic (C) ferromagnetic (D) both (B) and (C)

OR

(iv) The magnetic susceptibility of a superconductor is ________.

(A) -1 (B) zero (C) +1 (D) infinity

30. The phenomenon of photoelectric emission was discovered in 1887 by Heinrich Hertz (1857-1894), during his electromagnetic wave experiments. In his experimental investigation on the production of electromagnetic waves by means of a spark discharge, Hertz observed that high voltage sparks across the detector loop were enhanced when the emitter plate was illuminated by ultraviolet light from an arc lamp. Wilhelm Hallwachs and Philipp Lenard investigated the phenomenon of photoelectric emission in detail during 1886-1902. In 1905, Albert Einstein (1879-1955) proposed a radically new picture of electromagnetic radiation to explain photoelectric effect. Each quantum of radiant energy has energy hν, where h is Planck's (4)

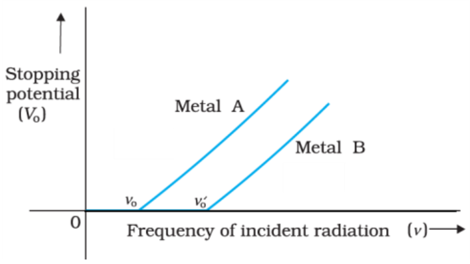
constant and the frequency of light. In photoelectric effect, an electron absorbs a quantum of energy (hν) of radiation. If this quantum of energy absorbed exceeds the minimum energy needed for the electron to escape from the metal surface (work function 0), the electron is emitted with maximum kinetic energy Kmax = hν – φ

(i) The minimum frequency needed for photoelectric effect to take place is known as ______.
(A) incident frequency (B) threshold frequency
(C) angular frequency (D) orbital frequency

(ii) The maximum kinetic energy of photoelectrons emitted from a surface when photons of 6 eV fall on it is 4 eV. What is the work function of the surface?
(A) 2 eV (B) 4 eV (C) 6 eV (D) 10 eV

(iii) The frequency of the incident photon on a surface is 2×10^{14} Hz. What is the quantum of energy each photon has?
(A) 1.32 eV (B) 0.66 eV (C) 1.32×10^{-20} eV (D) 1.32×10^{-19} eV

(iv) The plotted between stopping potential Vs incident frequency for two metal surfaces A and B is shown below. Which of the following is correct inference from the graph?



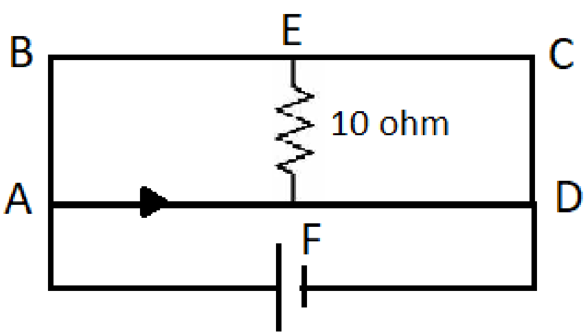
(A) Both metal A and B have same threshold frequency
(B) For the same incident frequency electrons emitted from metal B would have greater kinetic energy
(C) The work function of A is less than that of metal B
(D) Metal A requires more energy to emit photoelectron than metal B

OR

(iv) When a certain metal surface is illuminated with a light of frequency ν, the stopping potential of the photoelectrons is V_0. When the same surface is illuminated with light of frequency $\frac{\nu}{2}$, the stopping potential is $\frac{V_0}{4}$. What is the threshold frequency of the surface?
(A) $\frac{\nu}{6}$ (B) $\frac{2\nu}{3}$ (C) $\frac{\nu}{3}$ (D) $\frac{4\nu}{3}$

SECTION E

31. a) Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge. (5)
b) A wire of 12 Ω resistance of length 24 cm is bent into a rectangular loop ABCD of length 8 cm and breadth 4 cm. A cell of voltage 8 V is connected across A and B and a resistance 10 Ω is connected across E and F where E and F are midpoints of BC and AD. Determine the current flowing through AF.



OR

a) On what factors does the resistance of a wire depend if the external conditions like temperature and pressure are maintained constant?
b) Plot a graph to show the resistance variation with temperature in (i) copper wire and (ii) nichrome wire.
c) 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.

32. Two infinitely long current (I_1 and I_2) carrying conductors are placed parallel separated by a distance 'd'. Derive an expression for the force acting between them. What is the direction of the force? Define 1 A based on the derivation. (5)

OR

a) Draw the phasor diagram of an LCR series circuit. From the phasor diagram, obtain the impedance of the circuit.
b) A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which resistance is 3 Ω, inductive reactance is 8 Ω, and capacitive reactance is 4 Ω. Find (i) the impedance of the circuit; (ii) the power dissipated in the circuit; and (iii) the power factor.

33. a) Draw a ray diagram of refracting type telescope in its normal adjustment. (5)
b) A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eyepiece of focal length 1.0 cm is used, what is the angular magnification of the telescope in normal adjustment? What is the tube length of the telescope?
c) If this telescope is used to view the moon, what is the diameter of the image formed by the objective lens? The diameter of the moon is $3.48 \times 10^6\ m$, and the radius of the lunar orbit is 3.8×10^8m.

OR

a) Draw a ray diagram of a compound microscope when the image is formed at least distance of distinct vision.
b) A person with a normal near point (25 cm) using a compound microscope with objective of focal length 8.0 mm and an eyepiece of focal length 2.5cm can bring an object placed at 9.0mm from the objective in sharp focus. What is the separation between the two lenses? Calculate the magnifying power of the microscope.