SESSION: 2022-2023
SAMPLE QUESTION PAPER (THEORY)
SUBJECT: PHYSICS

Maximum Marks: 70 Marks Time Allowed: 3 hours.

General Instructions:

(1) There are 35 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. All the sections are compulsory.

(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study-based questions of 4 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.

SECTION A

Q1. A cell of internal resistance r connected across an external resistance R can supply maximum current when 1

(A) R = r

(B) R > r

(C) R = 2 r

(D) R = 0

Q2. In a current carrying conductor, the ratio of the electric field and the current density at a point is called 1

(A) Resistivity

(B) Conductivity

(C) Resistance

(D) Mobility

Q3. An electron is released from rest in a region of uniform electric and magnetic fields acting parallel to each other. The electron will 1

(A) move in a straight line.

(B) move in a circle.

(C) remain stationary.

(D) move in a helical path.

Q4. Above Curie temperature, a 1

(A) ferromagnetic material becomes diamagnetic.

(B) ferromagnetic material becomes paramagnetic.

(C) paramagnetic material becomes ferromagnetic.

(D) paramagnetic material becomes diamagnetic.

Q5. Displacement current exists only when 1

(A) electric field is changing.

(B) magnetic field is changing.

(C) electric field is not changing.

(D) magnetic field is not changing.

Q6. Electromagnetic waves used as a diagnostic tool in medicine are 1

(A) X-rays.

(B) ultraviolet rays.

(C) infrared radiation.

(D) ultrasonic waves.

Q7. At equilibrium, in a p-n junction diode the net current is 1

(A) due to diffusion of majority charge carriers.

(B) due to drift of minority charge carriers.

(C) zero as diffusion and drift currents are equal and opposite.

(D) zero as no charge carriers cross the junction.

Q8. In an n-type semiconductor, the donor energy level lies 1

(A) at the centre of the energy gap.

(B) just below the conduction band.

(C) just above the valance band.

(D) in the conduction band.

Q9. When two nuclei ($A \leq 10$) fuse together to form a heavier nucleus, the 1

(A) binding energy per nucleon increases.

(B) binding energy per nucleon decreases.

(C) binding energy per nucleon does not change.

(D) total binding energy decreases.

Q10. In β – decay, a 1

(A) neutron converts into a proton emitting antineutrino.

(B) neutron converts into a proton emitting neutrino.

(C) proton converts into a neutron emitting antineutrino.

D) proton converts into a neutron emitting neutrino.

Q11 If the electric flux entering and leaving a closed surface in air are ϕ_1 and ϕ_2 respectively, the net electric charge enclosed within the surface is: 1

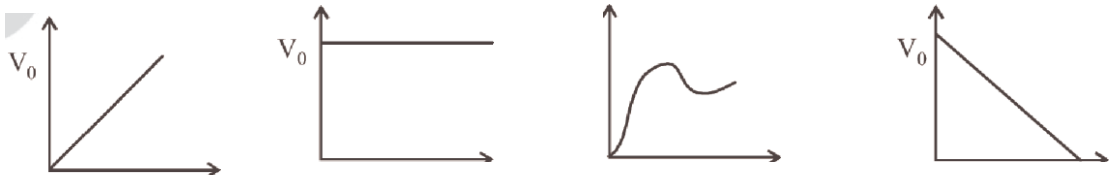
a) 0

b) ϕ_1/ε_0

c) $(\phi_2 - \phi_1)/ \varepsilon_0$

d) $(\phi_2 + \phi_1)/ \varepsilon_0$

Q12. The correct graph between the stopping potential (V0) and intensity of incident light (I) is 1



a b c d

Q13. If E_1, E_2, E_3 are the respective kinetic energies of an electron, an alpha-particle and a proton, each having the same de-Broglie wavelength, then 1

a) $E_1 > E_3 > E_2$

(b) $E_2 > E_3 > E_1$

c) $E_1 > E_2 > E_3$

(d) $E_1 = E_2 = E_3$

Q14. A particle is dropped from a height H. The de-Broglie wavelength of the particle as a function of height is proportional to 1

(a) H

(c) H^0

(b) $H^{1/2}$

(d) $H^{-1/2}$

Q15. A charged particle is free to move in an electric field. It will travel 1

(a) always along a field line

(b) along a field line, if its initial velocity is zero

c) along a field line, if it has some initial velocity in the direction of an acute angle with the field line

d) none of the above

Each of these questions contains an assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

(a) if both Assertion and Reason are correct and the Reason is the correct explanation of the Assertion.

(b) If both Assertion and Reason are correct but Reason is not the correct explanation of

the Assertion.

(c) If the Assertion is correct but Reason is incorrect.

d) If the Assertion is incorrect but the Reason is correct.

Q16. Assertion: The inductive reactance limits amplitude of the current in a purely inductive circuit. 1

Reason: The inductive reactance is independent of the frequency of the current.

Q17. Assertion: The air bubble shines in water. 1

Reason: Air bubble in water shines due to refraction of light.

Q18. Assertion: No interference pattern is detected when two coherent sources are extremely close to each other. 1

Reason: The fringe width is inversely proportional to the distance between the two sources.

SECTION B

Q19. Define the term 'mobility' of charge carriers in a current carrying conductor. Obtain the relation for mobility in terms of relaxation time. 2

OR

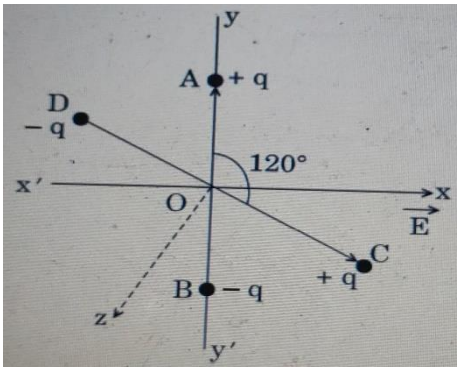
Define the term 'drift velocity' of electrons in a current carrying conductor. Obtain the relationship between the current density and the drift velocity of electrons.

Q20. An ammeter of resistance 0·8 Ω can measure a current up to 1·0 A. Find the value of shunt resistance required to convert this ammeter to measure a current up to 5·0 A. 2

Q21. An object is kept 20 cm in front of a concave mirror of radius of curvature 60 cm. Find the nature and position of the image formed. 2

Q22. Draw V-I characteristics of a p-n junction diode. Explain, why the current under reverse bias is almost independent of the applied voltage up to the critical voltage. 2

Q23 Two small identical electric dipoles AB and CD, each of dipole moment $\vec{p}$ are kept at an angle of 120° to each other in an external electric field $\vec{E}$ pointing along the x-axis as shown in the figure. 2



Find the

(a) dipole moment of the arrangement, and

(b) magnitude and direction of the net torque acting on it

Or

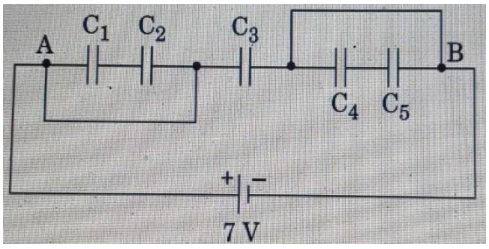
In the figure given below, find the

a) equivalent capacitance of the network between points A and B.

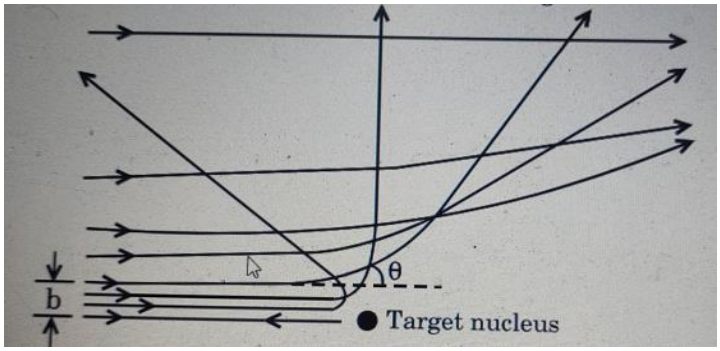
Given : $C_1 = C_5 = 8\ \mu F$, $C_2 = C_3 = C_4 = 4\ \mu F$.

(b) maximum charge supplied by the battery, and

(c) total energy stored in the network.



Q24. In Geiger-Marsden scattering experiment, the trajectory of α-particles in Coulomb's field of a heavy nucleus is shown in the figure. 2



(a) What do 'b' and 'θ' represent in the figure ?

(b) What will be the value of 'b' for (i) θ = 0°, and (ii) θ = 180° ?

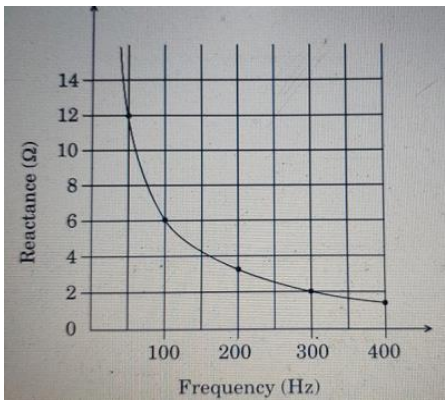
Q25. ` The frequency of incident light on a metal surface is doubled. How will this affect the value of kinetic energy of emitted photoelectrons if the work function is Ø. Establish a relationship between frequency and KE. 2

SECTIONC

Q26. (a) Derive the condition of balance for Wheatstone bridge. (b) Draw the circuit diagram of a meter bridge to explain how it is based on Wheatstone bridge. 3

Q27. The figure shows the graphical variation of the reactance of a capacitor with frequency of ac source.

(a) Find the capacitance of the capacitor. 3
(b) An ideal inductor has the same reactance at 100 Hz frequency as the capacitor has at the same frequency. Find the value of inductance of the inductor.
(c) Draw the graph showing the variation of the reactance of this inductor with frequency.



Q28. a)Which of the following electromagnetic waves has minimum wavelength. 3

Infrared waves, Microwaves, γ-rays and X-rays

b) Consider interference between waves from two sources of intensities I and 4I . Find the intensities at points where the phase difference is (a) 0 (b) π /2 and (c) π .

Q29. Consider two different hydrogen atoms. The electron in each atom is in an excited state. Is it possible for the electrons to have different energies but same orbital angular momentum according to the Bohr model? Justify your answer. 3

OR

Explain how does (i) photoelectric current and (ii) kinetic energy of the photoelectrons emitted in a photocell vary if the frequency of incident radiation is doubled, but keeping the intensity same? Show the graphical variation in the above two cases.

Q30. Explain with a proper diagram how an ac signal can be converted into dc (pulsating)signal with output frequency as double than the input frequency using pn junction diode. Give its input and output waveforms. 3

SECTIOND

Q31. a) Use Gauss's law to show that due to a uniformly charged spherical shell of radius R, the electric field at any point situated outside the shell at a distance r from its centre is equal to the electric field at the same point, when the entire charge on the shell were concentrated at its centre. Also plot the graph showing the variation of electric field with r, for $r \leq R$ and $r \geq R$.

(b) Two point charges of + 1 μC and + 4 μC are kept 30 cm apart. How far from the + 1 μC charge on the line joining the two charges, will the net electric field be zero ? 5

OR

(a) Two point charges q1 and q2 are kept r distance apart in a uniform external electric field $\vec{E}$. Find the amount of work done in assembling this system of charges.

(b) A cube of side 20 cm is kept in a region as shown in the figure. An electric field $\vec{E}$ exists in the region such that the potential at a point is given by V = 10x + 5, where V is in volt and x is in m.

Find the (i) electric field $\vec{E}$, and

(ii) total electric flux through the cube.

Q32. (a) A circular loop of radius R carries a current I. Obtain an expression for the magnetic field at a point on its axis at a distance x from its centre.

(b) A conducting rod of length 2 m is placed on a horizontal table in north-south direction. It carries a current of 5 A from south to north. Find the direction and magnitude of the magnetic force acting on the rod. Given that the Earth's magnetic field at the place is $0{\cdot}6 \times 10{-}4$ T and angle of dip is 6 π . 5

OR

(a) Obtain the expression for the deflecting torque acting on the current carrying rectangular coil of a galvanometer in a uniform magnetic field. Why is a radial magnetic field employed in the moving coil galvanometer ?

(b) Particles of mass $1{\cdot}6 \times 10{-}27$ kg and charge $1{\cdot}6 \times 10{-}19$ C are accelerated in a cyclotron of dee radius 40 cm. It employs a magnetic field 0·4 T. Find the kinetic energy (in MeV) of the particle beam imparted by the accelerator. 5

Q33. (a) Derive lens maker's formula for a biconvex lens.

(b) A point object is placed at a distance of 12 cm on the principal axis of a convex lens of focal length 10 cm. A convex mirror is placed coaxially on the other side of the lens at a distance of 10 cm. If the final image coincides with the object, sketch the ray diagram and find the focal length of the convex mirror. 5

OR

(a) What is a wavefront ? How does it propagate ? Using Huygens' principle, explain reflection of a plane wavefront from a surface and verify the laws of reflection.

(b) A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is obtained on a screen 1 m away. If the first minimum is formed at a distance of 2·5 mm from the centre of the screen, find the

(i) width of the slit, and

(ii) distance of first secondary maximum from the centre of the screen.

SECTION-E

Q34 All types of waves, be it sound waves, light waves, water waves exhibit the phenomenon of diffraction. The size of the obstacle or opening should be comparable to the wavelength of the wave for the diffraction to be pronounced. Since the wavelength of light is much smaller than the dimensions of most obstacles; the diffraction of light is not easily observed. Sound waves having larger wavelength can be easily diffracted. 4

A) The diffraction effects in a microscopic specimen become significant when the separation between two points is ----------

B) The phenomenon of diffraction can be treated as interference phenomenon if the number of coherent sources are----------

C) Write down two features about diffraction pattern formed.

Or

Draw a graph showing intensity variation with path difference also specify the region of umbra and penumbra in diffraction pattern.

Q35. Self-inductance of a long solenoid: 4

Self-inductance of a long, air-cored solenoid of length l, having n turns per unit length of cross-sectional area A is given by $L = \mu_O n^2 A l$. When a magnetic material of relative permeability μ_r is inserted into the solenoid as a core, then the self-inductance becomes $L = \mu_O \mu_r n^2 Al$

i) What will be the self-inductance of the coil if current in a coil change from 5 A to 2 A in 0.1 s, and an average voltage of 50 V is produced?

ii) Write down two factors on which the self-inductance associated with a coil dependent.

iii) Define self-inductance of a coil and write down its SI unit? Or

Write down two applications of self-inductance in daily life we are using