Range Forest Officer (Main / Written) Examination, 2021

PHYSICS

Time Allowed: Three Hours | Maximum Marks: 200

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions:

1. There are 08 (eight) questions in all, out of which FIVE are to be attempted.
2. Question Nos.1 and 5 are compulsory. Out of the remaining SIX questions, THREE are to be attempted selecting at least ONE question from each of the two Sections I and II.
3. Answers must be written in legible handwriting. Each part of the question must be answered in sequence and in the same continuation.
4. All questions carry equal marks. The number of marks carried by a question / part is indicated against it.
5. Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Answer Booklet must be clearly struck off.
6. Unless otherwise mentioned, symbols and notations have their usual standard meanings. Assume suitable data, if necessary and indicate the same clearly.
7. Neat sketches may be drawn, wherever required.
8. Re-evaluation / Re-checking of answer book is not allowed.

SECTION-I

1. (a) What do you understand by time-dilation? Also explain proper interval of time. (10)

   (b) If $\vec{F} = (2xy + z^2)\hat{\imath} + x^2\hat{\jmath} + 2xz\hat{k}$ Newton, then show that it is conservative. Also calculate the amount of work done by this force in moving a particle from (5, 2, 7) to (0, 1, 2) meter. (10)

   (c) What is origin of Coriolis forces? Calculate the impact of the Coriolis force on the free fall of a body on the Earth's surface. (20)

2. (a) Explain the adiabatic demagnetization technique to achieve low temperature. What is the order of temperature achieved by this method? (10)

   (b) Explain irreversible processes with suitable illustrations. What are the methods used for their quantitative description? (10)

(c) Derive Plank's law for black body radiations. Under what conditions it reduces to Wein's law and Rayleigh-Zean's law. (20)

3. (a) A particle is moving with simple harmonic motion in a straight line. When the distance of the particle from equilibrium position has values x_1 and x_2, the corresponding values of velocities are u_1 and u_2 respectively. Find the expressions for the time period and the maximum velocity in terms of x_1, x_2, u_1, and u_2. (10)

(b) What is principle of Fabry-Perot interferometer? Briefly describe its construction and also list its basic applications. (10)

(c) What is diffraction? Discuss the phenomenon of diffraction at a straight edge and state how you would determine the wavelength of light from the study of fringes in the above case. (20)

4. (a) What do you understand by a quarter-wave plate and a half-wave plate? Calculate their thicknesses and explain what will happen when they are placed in the path of a plane polarized light. (10)

(b) A body is projected from the ground at an angle of 30^0 with the horizontal at an initial speed of 130m/s. Ignoring air friction; determine the maximum height it will attain and its range. Take g = $10m/s^2$. (10)

(c) What is surface tension and how it is measured experimentally? Also discuss a few applications of it. (20)

SECTION-II

5. (a) What is diamagnetism? Discuss Langevin's theory of diamagnetism. (10)

(b) An electric dipole of moment $2x10^{-8}$ coulomb-meter is placed in a uniform field of intensity $1.5x10^5$ newton/coulomb. What maximum torque does the field exert on the dipole and how much work is done on turning dipole end to end? (10)

(c) Describe the principle, construction and working of a dc motor and determine its electrical efficiency. Also list various types of dc motors. (20)

6. (a) A surface has light of wavelength λ_1=550nm incident on it, causing the ejection of photoelectrons for which the stopping potential is V_1=0.19V. Suppose that irradiation of

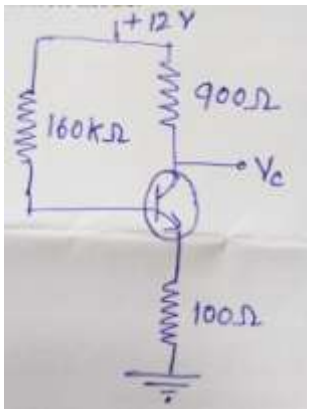
wavelength λ_2=190nm were incident on the surface, then calculate the stopping potential V_2 and threshold frequency for the surface. (10)

(b) A particle is in a state $<\psi| = (\pi)^{-1/4}\ e^{-x2/2}$. Evaluate the uncertainty product $\Delta x \Delta p$ for the particle in this state. (10)

(c) What are normal and anomalous Zeeman effects? Explain normal Zeeman effect using classical ideas. (20)

7. (a) Explain the input, output and transfer V-I characteristics of a triode in common-cathode configuration. What information we get from these V-I characteristics? (10)

(b) A Silicon BJT with $\beta = 100$ is used in the circuit shown below. Determine the collector voltage when the transistor is in (i) active mode and (ii) saturation mode. (10)



(c) What is a Barkhausen criterion for sustained oscillations? Draw the circuit diagram of a BJT phase-shift sinusoidal oscillator and determine the frequency of oscillations and the condition to start oscillation for it. (20)

8. (a) Discuss the principle, construction and applications of electron microscope. (10)

(b) Elaborate, suitable illustrations, the Noether's statement, "every conservation principle corresponds to a symmetry in nature." (10)

(c) Describe the variation of average binding energy / nucleon with mass number. How does it account for attractive nature and saturation effects of nuclear forces? (20)

*****