Roll No. .... **Total No. of Pages : 7**

1(CCE.M)3

Physics–I

(18)

Time : Three Hours] [Maximum Marks : 300

INSTRUCTIONS

(i) Answers must be written in English.

(ii) The number of marks carried by each question is indicated at the end of the question.

(iii) The answer to each question or part thereof should begin on a fresh page.

(iv) Your answer should be precise and coherent.

(v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.

(vi) Candidates should attempt **all** the questions.

(vii) If you encounter any typographical error, please read it as it appears in the text-book.

(viii) Candidates are in their own interest advised to go through the General Instructions on the back side of the title page of the Answer Script for strict adherence.

(ix) No continuation sheets shall be provided to any candidate under any circumstances.

(2) Frequency

(3) Velocity

(4) Wavelength. 10

OR

(a) What are group and phase velocities ? Derive the relation between them. 20

(b) Give Fresnel's theory of diffraction at straight edge. 20

(c) Calculate the fringe width of interference pattern produced in Young's double slit experiment with two slits 10^{-3}m apart on a screen 1 m away. Wavelength of light used is 5893 Å. 10

6. (a) Explain the production and detection of linearly, circularly and elliptically polarised light. 30

(b) A diffraction grating used at normal incidence gives a line (5400Å) in certain order superimposed on another line (4050Å) of the next higher order. If the angle of diffraction is 30º, how many lines/cm are there in the grating ? 20

OR

(a) Explain the construction and working of Helium-Neon gas laser with energy level diagram. 20

(b) Distinguish between Fresnel's and Fraunhoffer diffraction. 15

2. (a) A frame of reference 's' rotates with respect to another frame of reference 's^1' with an angular velocity $\vec{w}$. If the position, velocity and acceleration of a particle in frame 's' are represented by $\vec{r}, \vec{v}$ and $\vec{a_0}$. Show that the acceleration of a particle in the frame s^1 is given by

$$\vec{a} = a_0 + 2(\vec{w}\times\vec{v}) + \vec{w}(\vec{w}\times\vec{r}) + \frac{d\vec{w}}{dt}\times\vec{r}$$ 30

(b) What is a central force ? Give the characteristics of a central force. Show that in a central force field the angular momentum of a particle is conserved. 10

(c) An artificial satellite moves in a circular orbit around the earth at a height ½R, from the surface of earth, where R is the radius of the earth. Calculate the period of revolution.

[Given : R = 6.38×10^6m, g = 9.8 m/s^2] 10

OR

(a) Show that $x^2 + y^2 + z^2 - c^2 t^2$ is invariant under Lorentz transformation. 15

(b) Starting from Lorentz transformation equation, for space and time co-ordinates derive equation for relativistic addition of velocities. 25

(c) A rocket of mass 20 kg has 180 kg of fuel. The exhaust velocity of fuel is 1.6 kms^{-1}. Calculate the ultimate vertical speed gained by the rocket when the rate of consumption of fuel is 2 kgs^{-1}. 10

3. (a) Obtain the expression for work done during adiabatic process. 15

(b) Obtain the expression for Efficiency (η) of a Carnot's engine in terms of temperature of source (T_1) and sink (T_2). 25

(c) Show that change in entropy during reversible process is zero. 10

OR

(a) Derive Maxwell's thermodynamic relations. 20

(b) Derive the expression for the pressure of an ideal gas on the basis of Kinetic theory of gases. 20

(c) Find the pressure at which Water would boil at 100ºC, if the change specific volume when 1 kg of water is converted into steam is 1.676 m^3. 1 atmosphere = $10^5 Nm^{-2}$ and latent heat of vapourisation of steam = 2.2268×10^6 JKg^{-1}. 10

4. (a) Derive the expression for specific heat of solids on the basis of Einstein theory. 25

(b) Discuss Maxwell's law of distribution of velocities for gas molecules. 15

(c) Gold has the same structure of copper. The velocity of sound in gold is 2100 m/s and that in copper is 3800 m/s. If the Debye temperature of gold is 170 K, determine the Debye temperature of copper.

[Given : density of gold = 1.93×10^4 kg/m^3; density of copper = 8.96×10^3 kg/m^3. Atomic weight of gold =197.0 amu and atomic weight of copper = 63.54 amu.] 10

OR

(a) Derive Planck's Law of radiation using Einstein 'A' and 'B' coefficients. 25

(b) What is adiabatic demagnetisation ? Deduce thermodynamic expression for cooling produced by adiabatic demagnetization of a paramagnetic salt. 15

(c) Calculate the wavelength of the radiation coming out of a furnace at 1500 K that will have maximum intensity. Also specify the type of radiation. Assume Wein's displacement constant to be 2.9×10^{-3} mK. 10

5. (a) Derive the expression for the total energy of particle executing simple harmonic motion. 15

(b) What are forced vibrations ? Obtain an expression for displacement in case of forced oscillatory motion. 25

(c) A progressive wave travelling along x-axis is given by

$y = 2 \sin 2\pi (15t - 10x)$.

Calculate :

(1) Amplitude

(x) Candidates shall put a cross (x) on blank pages of Answer Script.

(xi) No blank page be left in between answer to various questions.

(xii) No programmable Calculator is allowed.

(xiii) No stencil (with different markings) is allowed.

1. (a) Give the theory of Rutherford α-particle scattering. 20

(b) Derive Kepler's First Law of planetary motion on the basis of Newton's law of gravitation. 20

(c) A rocket of mass 5000 kg is fired vertically upward from a place at the equator with a velocity of 1200 ms^{-1}. If the angular velocity of the earth is 7.3×10^{-5} $rads^{-1}$. Calculate the Coriolis force acting on it. 10

OR

(a) Derive the relation $m = \dfrac{m_o}{\sqrt{1 - \dfrac{v^2}{c^2}}}$, where the symbols have their usual meaning. 25

(b) Derive Einstein mass energy relation $E = mc^2$. 15

(c) Water flows through a horizontal pipe of non-uniform cross-section; the pressure is 1 cm of mercury where velocity of flow is 0.35 ms^{-1}. Find the pressure at a point where the velocity is 0.65 ms^{-1}. 10

(c) When light is incident at an angle of 60º to the normal, the reflected light is plane polarised. What is the refractive index of the transparent refracting medium ? What is the angle of refraction corresponding to the angle of incidence of 60º ? What is the angle between the refracted and reflected components ? 15