1/EH–24 (i) (Syllabus–2015)

2018

(October)

PHYSICS

(Elective/Honours)

(Mechanics, Optics, Acoustics)

[Phy–01 (T)]

Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer Question No. **1** which is compulsory and *any* **four** from the rest

1. *(a)* Calculate the rest mass energy of an electron in MeV. Given mass of electron, $m_e = 9 \cdot 1 \times 10^{-31}$ kg. 4

(b) In a certain experiment to determine the coefficient of viscosity of a liquid the following data was obtained :

Volume of the liquid collected per minute = 7·08 cc

Pressure difference at the two ends of the capillary is equal to 34·1 cm of water column

Length of the capillary tube = 56·45 cm

Radius of the tube = 0·0514 cm

Calculate the coefficient of viscosity of the liquid. 4

(c) Two thin lenses are placed 4 cm apart to form an achromatic combination. Find the focal length of each lens, if the combination reduces the spherical aberration to the minimum level. 4

(d) Refractive index of glass is 1·5. Find the angle of polarization and corresponding angle of refraction. 3

2. (a) Write the expression for total force experienced by an object in a uniformly rotating frame and identify the different terms. Also find an expression for the centrifugal acceleration at a place on earth surface. What will be its value at a place on 60° N latitude? 1+2+3+1=7

(b) Prove that the gravitational force is a conservative force. 3

(c) Calculate the gravitational potential and field at a point inside a solid sphere of mass M and radius R. From the result, make an inference on the value of g at the centre of earth. 4+1=5

(Continued)

3. (a) Two particles stick together after collision. Prove that the collision is inelastic. Also calculate the loss in kinetic energy. [Consider one particle is at rest before collision] 3+1=4

(b) State the basic postulates of special theory of relativity. 2

(c) Write Lorentz transformation equations. Use Lorentz transformation equations to show that length is not an absolute quantity. 2+3=5

(d) Establish Einstein velocity addition theorem. 4

4. (a) State and prove parallel axes theorem of moment of inertia. 1+3=4

(b) Calculate the moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane. Also find its moment of inertia about diameter. 3+1=4

(c) A system of particles is rotating about a fixed axis. Write the expression for total angular momentum of the system. Prove that if the total torque acting on the system is zero, total angular momentum of the system remains constant. 1+3=4

(d) Prove that the value of Poisson's ratio lies between -1 and $\frac{1}{2}$. 3

(Turn Over)

5. (a) State and prove Bernoulli's theorem. 1+4=5

(b) Find the expression for excess pressure within a spherical soap bubble. Calculate the excess pressure inside a soap bubble of radius 3 cm if the surface tension of the soap solution is 45 dynes/cm. 3+2=5

(c) Define principal point and nodal point of a lens system. Show that the distance between the principal points and the nodal points are equal. 2+1+2=5

6. (a) Discuss the working principle of an oil immersion objective. 4

(b) Describe in brief how Michelson interferometer is used to determine the wavelength of monochromatic light. 4

(c) In a Newton's ring experiment, the diameters of 3rd and 23rd dark fringes are 0·2 cm and 0·6 cm respectively. If the radius of curvature of the plano-convex lens is 92 cm, find the wavelength of light. 3

(d) What are the fringes of equal thickness and equal inclination? Give one example of each. 3+1=4

(Continued)

7. (a) Explain the difference between Fraunhofer diffraction and Fresnel diffraction. 4

(b) Explain in brief how a plane transmission grating can be used to find the wavelength of a monochromatic light. 3

(c) What are circularly and elliptically polarized light? Describe one method each to produce circularly and elliptically polarized light. 2+3+3=8

8. (a) What are ultrasonic waves? Describe one method used to detect it. Mention two of its uses. 1+3+1=5

(b) Derive the expressions for growth and decay of sound intensity in an auditorium. Also represent this variation graphically. 6+1=7

(c) The amplitude of a sound wave is doubled; by how many decibels will the loudness increase? 3

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