Odd Semester, 2020

(Held in March, 2021)

PHYSICS

(Elective/Honours)

[PHY–01 (T)]

(Mechanics, Optics, Acoustics)

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 magnitude and direction of Coriolis acceleration of a rocket moving with a velocity of 2 km/s at 60° South latitude. 4

(b) What amount of energy will be liberated if 1000 droplets of water, each of 10^{-8} m in diameter, coalesce to form one large spherical drop? Surface tension of water $= 75 \times 10^{-3}$ N/m. 4

(c) Dispersive powers of crown and flint glass are 0·25 and 0·50 respectively. Determine the focal lengths of an achromatic combination of two lenses in contact having equivalent focal length 30 cm. 4

(d) Calculate the thickness of the quarter-wave plate for sodium light of wavelength 5893Å. Given $\mu_e = 1{\cdot}553$ and $\mu_o = 1{\cdot}544$. 3

2. *(a)* In a uniformly rotating frame of reference, obtain the acceleration of a particle in the inertial frame. 5

(b) What is central force? Prove the conservative nature of central forces. 1+3=4

(c) Calculate the gravitational potential and field at a point inside a solid sphere of mass *M* and radius *R*. 5+1=6

3. *(a)* Show that in a one-dimensional perfectly elastic collision between two bodies, the loss of kinetic energy is zero. 5

(b) Derive the Lorentz transformation equations. Show that within the classical limit, Lorentz transformation equations become Galilean transformation equations. 5+1=6

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

(d) Calculate the mass of a particle, if the particle moves with a velocity of 0·8 C, where rest mass of the particle,

$$m_0 = 2{\cdot}67 \times 10^{-27}\ \text{kg}$$

and velocity of light, $C = 3 \times 10^8$ m/s. 2

4. (a) Calculate the moment of inertia a solid sphere about its diameter. 4

(b) Show that the couple required per unit angular twist in the case of a solid cylinder of radius r and length l is

$$C = \frac{\pi \eta r^4}{2l}$$

where η is the coefficient of rigidity of the cylinder. 5

(c) Derive Poiseuille's formula for steady flow of a liquid through a narrow tube. 6

5. (a) State Fermat's principle of extremum path. Using the principle, establish the laws of reflection at a plane boundary. 1+3=4

(b) What are the cardinal points of an optical lens system? Define them. 1+4=5

(c) Give the construction and working principle of a Ramsden's eyepiece. Give two important advantages of Ramsden's eyepiece over Huygens'. 4+2=6

6. (a) Describe the theory of Newton's rings with the help of a diagram. Derive the formula required to determine the wavelength of light by Newton's rings method. 3+1+4=8

(b) With the help of a diagram, describe the construction and working principle of the Michelson interferometer. 1+2+2=5

(c) Explain the meaning of Fresnel's half-period zones. 2

7. (a) Explain the theory of Fraunhofer's diffraction at a double slit. 5

(b) Discuss Fresnel's theory of optical rotation. 5

(c) Distinguish between 'normal' and 'anomalous' dispersion. Discuss in brief, the theory of Rayleigh scattering. 2+3=5

8. (a) What are ultrasonic waves? Describe one method to produce ultrasonic waves. 1+3=4

(b) Explain the term 'intensity of sound'. Show that a 26% change in intensity alters the sound level of 1dB. 2+3=5

(c) Derive Sabine's formula for the reverberation time of a live room. 6

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