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(October)

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)* The gravitational potential at a point on the surface of a planet is $-1 \cdot 78 \times 10^9 \, \text{J/kg}$. The radius of the planet is $7 \cdot 13 \times 10^7 \, \text{m}$ and $G = 6 \cdot 6 \times 10^{-11} \, \text{SI}$ units. Calculate the mean density of the planet assuming it to be a solid sphere. **4**

   (b) An incompressible fluid flows through a horizontal tube with non-uniform cross section. At a particular point, the flow velocity is $0 \cdot 4 \, \text{m/s}$ and the pressure is $1245 \, \text{N/m}^2$. Find the pressure at the point where the flow velocity is $0 \cdot 55 \, \text{m/s}$. **4**

(Turn Over)

(c) An achromatic objective of focal length 0.25 m is made by combining two lenses in contact whose dispersive powers are in the ratio 2 : 3. Calculate the focal lengths of the two lenses. 4

(d) The intensity of sound increases to 10^3 times the initial value. Express the change in intensity in decibel. 3

2. (a) Obtain the radial and transverse components of velocity and acceleration of a particle moving in a plane. 2+3=5

(b) What are non-inertial frames of reference? Deduce the equation of motion showing the fictitious forces when motion of a particle is described in a rotating frame of reference. 1+6=7

(c) Show that a central force is conservative. 3

3. (a) Show that the motion of the centre of mass is same as that of a single particle of mass equal to the total mass of the system under the action of a force which is equal to the vector sum of all external forces acting on the system. 3

(b) Obtain the Lorentz transformation equations. 6

(c) Give the detailed explanations on (i) length contraction and (ii) time delation. 3+3=6

4. (a) State perpendicular axes theorem for a lamina and hence use the theorem to find moment of inertia of a circular disc about one of its diameter. 2+3=5

(b) What is modulus of rigidity of a substance? A cylinder of length l and radius a is clamped at one end and a torque is applied at the other end. Show that torsional rigidity τ of the cylinder is

$$\tau = \frac{\eta \pi a^4}{2l}$$

where η is the rigidity of modulus of the material of the cylinder. 1+4=5

(c) Derive Poiseuille's formula for flow of a liquid through a horizontal narrow tube. 5

5. (a) State Fermat's principle of extremum path. Using it, prove the laws of refraction when two media are seperated by a plane boundary. 1+5=6

(b) What are cardinal points? Draw a diagram illustrating the cardinal points of a coaxial lens system. 2+2=4

(c) Derive the lens maker's formula by matrix method. 5

6. (a) Describe the working and construction of oil immersion objective. 5

(b) Compute the conditions for maxima and minima in the interference of transmitted light in a thin wedge-shaped film. 6

(c) Name the types of fringes produced by Michelson interferometer. Explain how the difference in the wavelengths of two waves can be determined with a Michelson's interferometer. 1+3=4

7. *(a)* Give the theory of plane diffraction grating. 6

(b) What is elliptically polarized light? Describe a method to produce it. 1+4=5

(c) What are Fresnel half-period zones? Obtain the equation of the area of a zone. 4

8. *(a)* Derive the expression for velocity of sound in isotropic solid. 4

(b) What are the requirements of a good auditorium? 4

(c) Derive Sabine's formula for reverberation time. 7

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