2022

(February)

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 and any four from the rest

(a) Two solid spheres of masses 100 kg and 1000 kg are at a distance of 10 m apart. Calculate the gravitational potential and field intensity at the middle point of the line joining them.

 $(G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2}) = 5$

(b) A flywheel in the form of a circular disc has a radius 40 cm and mass 1 kg. Calculate the work which must be done on the flywheel to increase its speed of rotation from 10 to 20 revolutions per second.

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(2)

- (c) Two thin converging lenses of 0.2 m (1st lens) and 0.3 m (2nd lens) focal lengths are placed co-axially 0.1 m apart in air. An object is located 0.6 m in front of the 1st lens. Find the position of the two principal planes and that of the final image from the second lens. 1¹/₂+1¹/₂+2=5
- 2. (a) A reference frame S rotates with respect to an inertial frame S with a uniform angular velocity $\vec{}$. If the position, velocity and acceleration of a particle in frame S are represented by \vec{r} , \vec{v} and \vec{a} respectively, then show that the acceleration of the particle in frame S is given by \vec{a} a \vec{a} $\vec{2}$ \vec{v} $\vec{(r)}$. 6
 - (b) Define 'centre of mass' of a system. Show that in the absence of an external force acting on a body, the acceleration of the centre of mass is zero and its velocity is constant. $1\frac{1}{2}+3\frac{1}{2}=5$
 - (c) What is central force? Show that for a particle moving under the action of a central force, its aerial velocity remains constant.
 1+3=4
- 3. (a) Show that there is a loss of kinetic energy due to direct impact of inelastic collision of two rigid bodies.3
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- (b) Describe the Michelson-Morley experiment and discuss its significance. 6+2=8
- (c) Derive Einstein's mass-energy relation. 4
- 4. (a) State parallel axes theorem for a lamina and hence use the theorem to find moment of inertia of a solid sphere about one of its tangent. 2+3=5
 - (b) What is a cantilever? If l is the length of a cantilever which is rigidly clamped at one end and on the other end, a load Wis applied, show that the deflection (y)due to the load applied to the free end of the cantilever is equal to $y = \frac{Wl^3}{3YI}$, where the symbols have their usual meanings. 1+4=5
 - (c) State and prove Bernoulli's theorem.

1+4=5

- 5. (a) State and explain Fermat's principle. Using this principle, prove the laws of refraction for a plane boundary separating two media. 2+4=6
 - (b) What are aplanatic points? Derive the aplanatic points of a sphere. 1+3=4

- (c) Obtain the system matrix of a thick lensand hence derive the thin lens formula.
- 6. (a) What are Newton's rings? Describe the construction and formation of Newton's rings. How is the wavelength of sodium light determined by Newton's rings method? 1+4+3=8
 - (b) Explain the construction of Fresnel's half period zones. Show that the area of each zone of a plane wavefront is equal to b, where b is the distance of the external point on the screen from the wavefront. Show that the total amplitude at an external point mainly come from the first half period zone.
 - 3+2+2=7
- (a) Give the construction, principle of action and production of fringes of Fabry-Perot interferometer. 2+3+2=7
 - (b) Discuss the electromagnetic theory of double refraction in uniaxial crystals. 3
 - (c) What is quarter-wave plate? Distinguish between a quarter-wave plate and a half-wave plate. Calculate the thickness of a half-wave plate for light of

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wavelength 6000 Å. The refractive index of the material of the plate for the ordinary ray is 1.544 and that for extra-ordinary ray is 1.553. 1+2+2=5

- 8. (a) Distinguish between 'normal' and 'anomalous' dispersions. Briefly explain Rayleigh scattering. 2+3=5
 - (b) What is meant by ultrasonics? Describe one method of production of ultrasonic waves. 1+3=4
 - (c) What is reverberation time? Derive Sabine's formula for reverberation time.

1+5=6

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