

1/EH-24 (i) (Syllabus-2015)

2 0 1 7

(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 radius of gyration of a thin rod of mass 1 kg and length 1 m about an axis passing through its centre of gravity and perpendicular to its length. 3
- (b) A small hollow sphere which has a small hole in it, is immersed in water to a depth of 0.4 m before any water penetrates into it. If the surface tension of water is 0.073 newton/metre, find the radius of the hole. 3

(Turn Over)

(2)

- (c) How fast would a rocket have to go relative to an observer for its length to be contracted to 99% of its length at rest? 3
- (d) Two thin converging lenses of 0.2 m and 0.3 m focal lengths are placed coaxially 0.1 m apart in air. An object is located 0.6 m in front of the lens of smaller focal length. Find the position of the two principal planes and that of the final image from the second lens. Also find the size of the image. $1\frac{1}{2}+1\frac{1}{2}+2\frac{1}{2}+\frac{1}{2}=6$
2. (a) Show that the total linear momentum in the centre of mass system is zero. 4
- (b) In a uniformly rotating frames of reference, obtain the acceleration of a particle in inertial frame. 5
- (c) Show that central force is conservative. Also show that angular momentum is conserved under central force. $3+3=6$
3. (a) Show that if (x_1, y_1, z_1, t_1) and (x_2, y_2, z_2, t_2) are the coordinates of one event in S_1 and the corresponding event in S_2 respectively, then the expression $dS_1^2 = dx_1^2 + dy_1^2 + dz_1^2 - C^2 dt_1^2$ is invariant under a Lorentz transformation of coordinates. 3

8D/25

(Continued)

(3)

- (b) Briefly describe Michelson-Morley experiment with neat diagram. $2+4=6$
- (c) Derive Einstein's mass-energy relation. 4
- (d) At what speed is a particle moving, if the mass is equal to three times its rest mass? 2
4. (a) Explain the term 'surface tension' and give its unit and dimensions. Describe one laboratory method of determining the surface tension of a liquid giving necessary theory. $2+3=5$
- (b) Explain why a liquid is either raised or depressed in a capillary tube. Find an expression for the magnitude of this effect. 5
- (c) Calculate the moment of inertia of a thin spherical shell about a diameter. 5
5. (a) Describe with a relevant theory, how a cantilever may be used to determine Young's modulus of the material of the bar. 6
- (b) Show that axial chromatic error for parallel rays is equal to ωf , where the symbols have their usual meaning. 4

8D/25

(Turn Over)

(4)

- (c) Describe the construction and working of Ramsden or Huygens' eyepiece. $2+3=5$
6. (a) Describe the construction, working principle and application of Fabry-Perot interferometer. $3+2+2=7$
- (b) Describe how you would use Newton's rings to measure the wavelength of light. Give an outline of the necessary theory along with its diagram. $4+3+1=8$
7. (a) What is a zone plate? Derive an expression for its focal length and compare it with that of a converging lens. $1+4+1=6$
- (b) Develop the theory of dispersion of light. 5
- (c) What do you understand by a quarter-wave plate and a half-wave plate? Calculate the thickness of a quarter-wave plate for light of wavelength 6000 Å. The refractive index for the ordinary ray is 1.544 and for extraordinary ray is 1.553. $2+2=4$

8D/25

(Continued)

(5)

8. (a) Describe briefly one method of producing ultrasonic waves. What are its uses? $4+1=5$
- (b) What are live and dead room? Define reverberation time and hence obtain an expression for it. $1+1+2+6=10$

8D—2500/25

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