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1 SEM TDC PHY M 1

2014

(November)

PHYSICS

(Major)

Course : 101

(Mechanics and Properties of Matter)

Full Marks : 80

Pass Marks : 32 (Backlog) / 24 (2014–15 Session)

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following : 1×8=8

(a) In case of a linear harmonic oscillator, the potential energy versus displacement curve will have the form of a/an

(i) straight line

(ii) circle

(iii) parabola

(iv) ellipse

(b) Which of the following is not a fictitious force?

(i) Coriolis force

(ii) Lorentz force

(iii) Centrifugal force

(iv) None of the above

(c) What is the maximum angle of scattering for equal masses in laboratory system?

(i) π

(ii) $\frac{\pi}{2}$

(iii) 2π

(iv) $\frac{3\pi}{2}$

(d) For a satellite of mass m in a circular orbit of radius r, the kinetic energy in terms of angular momentum can be written as

(i) $\frac{J^2}{2m}$

(ii) $\frac{J^2}{2mr}$

(iii) $\frac{J^2}{2mr^2}$

(iv) $\frac{J^2}{mr^2}$

(e) In a rigid body, the internal potential

(i) gives rise to forces which perform work

(ii) remains constant

(iii) varies with time

(iv) None of the above

(f) The Poisson's ratio of a material is 0·4. If a force is applied to a wire of this material, there is a decrease of cross-sectional area by 2%. The percentage increase in its length is

(i) 3%

(ii) 2·5%

(iii) 1%

(iv) 0·5%

(g) For a rigid body, the number of degrees of freedom is

(i) 1

(ii) 2

(iii) 3

(iv) 6

(h) An inertial frame is interpreted to stand for

(i) homogeneity of space

(ii) isotropy of space

(iii) homogeneity of time

(iv) All of the above

2. (a) Show that a frame of reference with linear acceleration gives rise to a pseudoforce. 2

(b) Define the centre of mass of a system of particles and hence show that the centre of mass moves as if the total external force were acting on the entire mass of the system concentrated at the centre of mass. 1+1=2

(c) What is radius of gyration? 2

(d) What is a first integral of motion? How is it related to a conservation principle? 1+1=2

(e) What is the physical significance of moment of inertia? 2

(f) What are stress and strain? How are they related to elastic modulus? 2

(g) What is Galilean invariance? 2

(h) What is virtual displacement? 2

3. (a) Discuss the limitations of Newton's laws of motion. 6

(b) Reduce a two-body problem to an equivalent one-body problem and hence obtain the expressions for angular momentum and kinetic energy. 3+2+2=7

(c) Derive the condition for the conservation of the angular momentum of a system of particles. 4

(d) For a particle moving under the influence of a force

$$f(r) = -\frac{k}{r^2}$$

show that the equation of the orbit is a conic section. 6

Or

Obtain a relationship between the scattering angles in the laboratory and centre of mass coordinate system.

4. (a) Derive an expression for the twisting couple per unit twist of a wire and hence find the work done in twisting the wire. 4

(b) Show that the excess pressure inside a curved surface is given by

$$p = T\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

where the symbols have their usual meanings. 6

(c) Obtain the relationship between surface tension and surface energy. 4

Or

Define tensile and compressive stress and strain. 2+2=4

5. (a) What is constraint? What are different types of constraint? 1+4=5

(b) What is d'Alembert's principle? Use this principle to prove that the horizontal acceleration required of an incline to prevent the sliding of a frictionless block is $a = g \tan\alpha$ where α = inclination angle, g = acceleration due to gravity. 2+3=5

Or

What is cyclic or ignorable coordinate? Show that in absence of any non-potential forces, the generalized momentum corresponding to any cyclic coordinate is a conserved quantity. 2+3=5

(c) Derive the equation of motion for a particle moving under the influence of a central force

$$F = -\frac{k}{r^2}$$

5

(d) Set up the Lagrangian for a simple pendulum and obtain the equation of motion. 4

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