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Reg. No :

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M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2013.

First Semester

Physics

CLASSICAL MECHANICS AND RELATIVITY

(For those who joined in July 2012 onwards)

Time : Three hours

Maximum : 75 marks

SECTION A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. For a conservative system, generalized force has the dimension of
 - (a) Force
 - (b) energy
 - (c) torque
 - (d) pressure
2. A particle is constrained to move along the inner surface of a fixed hemispherical bowl. The number of degrees of freedom of the particle is
 - (a) 1
 - (b) 2
 - (c) 3
 - (d) 4

3. The eccentricity of the orbit is a function of
 - (a) Total energy
 - (b) linear momentum
 - (c) kinetic energy
 - (d) time
4. Rutherford's differential scattering cross section has the dimension of
 - (a) Solid angle
 - (b) area
 - (c) length
 - (d) volume
5. A example of stable equilibrium is
 - (a) Hanging spring-mass system
 - (b) pendulum at rest
 - (c) egg standing on one end
 - (d) book placed flat on a table
6. In δ variation, which quantity is not involved
 - (a) Length
 - (b) velocity
 - (c) time
 - (d) mass

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7. For conservative system, Hamilton's principle function S and Hamilton's characteristic function W are related as

- (a) $S=W$ (b) $S = W - Et$
(c) $S = W + Et$ (d) $S = W - E$

8. For one dimensional harmonic oscillator, the representative point in two dimensional phase space traces

- (a) an ellipse
(b) parabola
(c) hyperbola
(d) Straight line

9. The law of conservation of momentum, is valid at relativistic

- (a) Mass (b) speed
(c) velocity (d) time

10. The relativistic mass of a photon of frequency V is

- (a) $h\nu$ (b) $h\nu/c$
(c) $h\nu/c^2$ (d) $h\nu^2/c$

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Show that the shortest distance between two points in a plane is a straight line.
(b) Discuss and obtain ^{Or} Hamilton's equation of motion.

12. (a) State and prove Virial theorem.

Or

- (b) Explain and obtain the motion in time in the Kepler problem.

13. (a) Discuss about inertia tensor and the principle moments of inertia.

Or

- (b) Obtain Euler's equations of motion for a rotating rigid body.

14. (a) Show that the transformation $Q = 1./p$ and $P = qp^2$ is canonical.

Or

- (b) Show that the fundamental Poisson brackets are invariant under canonical transformation.



15. (a) Show by direct application of Lorentz transformation that $x^2 + y^2 + z^2 - c^2 t^2$ is invariant.

Or

- (b) Explain about relativistic angular momentum.

SECTION C — (5 × 8 = 40 marks)

Answer ALL the questions, choosing either (a) or (b).

16. (a) What is Hamilton's principle? Derive Lagrange's equations of motion from it. How will the result be modified if the force is non-conservative?

Or

- (b) Discuss the advantages of variational principle formulation.

17. (a) Derive the differential equation for the orbit of a particle moving under central force.

Or

- (b) Obtain the differential equation for a particle undergoing a central force motion and use it to verify Kepler's law of planetary motion.

18. (a) Obtain from Euler's equation of motion the condition for the uniform precession of heavy symmetrical top with one point fixed in a gravitational field.

Or

- (b) State and prove the principle of least action.

19. (a) What are action-angle variables? Explain how they can be used to obtain the frequencies of periodic motion. Hence determine the frequency of linear harmonic oscillator.

Or

- (b) Outline Hamilton-Jacobi theory and apply it to solve the problem of one dimensional Harmonic oscillator.

20. (a) Discuss the principle of relativity and the invariance of speed of light. Use this principle to deduce Lorentz transformations.

Or

- (b) Enunciate the principle of the special theory of relativity and derive Lorentz transformation.

