

SECOND SEMESTER B.Sc. DEGREE EXAMINATION, MAY 2018

(CUCBCSS-UG)

Complementary Course

PHY 2C 02—MECHANICS, RELATIVITY, WAVES AND OSCILLATIONS

Time : Three Hours

Maximum : 64 Marks

Section A

*Answer all questions.**Each question carries 1 mark.**Answer in a word or phrase.*

1. The centrifugal force acting on a particle of mass m , rotating with angular velocity $\vec{\omega}$ is :

(a) $-m(\vec{\omega} \times \vec{r})$. (b) $-m\left(\vec{\omega} \times \frac{d\vec{r}}{dt}\right)$.

(c) $-m\left(\frac{d\vec{\omega}}{dt} \times \vec{r}\right)$. (d) $-2m\left(\vec{\omega} \times \frac{d\vec{r}}{dt}\right)$.

2. When speed of rod along its length is increased, the length of rod :

- (a) Increases. (b) Decreases.
(c) Remains unchanged. (d) Becomes zero.

3. The mass of an electron is double its rest mass then the velocity of the electron :

(a) $\frac{c}{2}$. (b) $2c$.
(c) $\frac{\sqrt{3}}{2}c$. (d) $\sqrt{\frac{3}{2}}c$.

4. Energy density for a plane harmonic wave is _____.

5. A train moving with constant velocity is :

- (a) An inertial frame.
(b) A non-inertial frame.
(c) Something inertial and sometimes non-inertial frame.
(d) Neither inertial nor-inertial frame.

Turn over

6. The total energy of a particle executing SHM is proportional to :
- Displacement from equilibrium position.
 - Frequency of oscillation.
 - Velocity in equilibrium position.
 - Square of amplitude of motion.
7. The relativistic relation between momentum p and energy E is :
- $E = \frac{p^2}{2m}$.
 - $E = p^2 c^2 + m_0^2 c^4$.
 - $E = \sqrt{p^2 c^2 + m_0^2 c^4}$.
 - $E = \frac{p^2}{2m} + m_0 c^2$.
8. Which of the following is a Galilean invariant :
- Velocity.
 - Acceleration.
 - Both of these.
 - None of these.
9. The motion of one projectile as seen from another projectile is :
- A straight line.
 - A parabola.
 - A circle.
 - An ellipse.
10. At what speed the length of rod becomes half of its proper length :
- $\frac{c}{2}$.
 - $\frac{c}{\sqrt{2}}$.
 - $\frac{\sqrt{3}}{2}c$.
 - $\sqrt{\frac{3}{2}}c$.

(10 × 1 = 10 marks)

Section B

Answer all questions.

Each question carries 2 marks.

Answer in a short paragraph — three or four sentences.

- Name the types of frames of reference. Differentiate between them.
- Give two examples of conservative and two examples of non-conservative forces.
- What do you mean by time dilation ?
- Explain the hypothesis of Galilean invariance.
- What is centrifugal force ? Illustrate with example.
- What is the significance of wave function ?
- Why was the Michelson Moreley experiment performed ?

(7 × 2 = 14 marks)

Section C

Answer any three questions.

Each question carries 4 marks.

Answer in a paragraph of about half a page to one page.

18. Derive an equation for the energy density of a wave.
19. Write a note on electron microscope.
20. Show that motion of a particle under a central force takes place in a plane.
21. Explain the twin paradox.
22. Explain Lorentz Fitzgerald contraction and derive an expression for the same.

(3 × 4 = 12 marks)

Section D

Answer any three questions.

Each question carries 4 marks.

Problems-write all relevant formulas.

All important steps carry separate marks.

23. A particle of rest mass m is moving with a velocity $0.9c$, calculate (i) its relativistic mass ; (ii) its kinetic energy.
24. The potential energy possessed by a particle moving under the influence of a conservative force is given by $U(x) = x^3 - 9x^2 + 24x$. Find the force on the particle.
25. A pendulum is of length 50 cm. Find its period when it is suspended in (i) a lift falling at a constant velocity of 5 m/s. (ii) a lift rising at a constant acceleration of 2 m/s.²
26. Consider a ship moving with a uniform velocity of 18 m/s relative to the earth. Let a ball be rolled at a speed of 2 m/s. relative to the ship, in the direction of motion of the ship. Find the speed of the ball relative to the earth, according to Galilean transformations.
27. A young man goes to the pole star and comes back to the earth on a rocket. Calculate the age difference between him and his twin brother who preferred to stay on the earth. The rocket velocity $v = (4/5)c$ and the distance between the earth and the pole star is 40 light years. (Light year is a unit of distance, 1 light year = $3 \times 10^8 \times 60 \times 60 \times 24 \times 365$ m.)

(3 × 4 = 12 marks)

Section E

Answer any two questions.

Each question carries 8 marks.

(Essays. Answer in about two pages).

28. What is ether hypothesis ? Explain the Michelson Morley experiment.
29. Derive the time dependent Schrödinger equation.
30. Derive the differential equation of a particle executing simple harmonic motion. Also derive expression for its period, velocity and acceleration.
31. Mention the consequences of special theory of relativity and derive Einstein's mass energy relation.

(2 × 8 = 16 marks)