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

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

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

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) $\dfrac{c}{2}$.

    (b) $2c$.

    (c) $\dfrac{\sqrt{3}}{2}c$.

    (d) $\sqrt{\dfrac{3}{2}}c$.

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.

6. The total energy of a particle executing SHM is proportional to :

    (a) Displacement from equilibrium position.

    (b) Frequency of oscillation.

    (c) Velocity in equilibrium position.

    (d) Square of amplitude of motion.

7. The relativistic relation between momentum p and energy E is :

    (a) $E = \dfrac{p^2}{2m}$.

    (b) $E = p^2 c^2 + m_0^2 c^4$.

    (c) $E = \sqrt{p^2 c^2 + m_0^2 c^4}$.

    (d) $E = \dfrac{p^2}{2m} + m_0 c^2$.

8. Which of the following is a Galilean invariant :

    (a) Velocity.

    (b) Acceleration.

    (c) Both of these.

    (d) None of these.

9. The motion of one projectile as seen from another projectile is :

    (a) A straight line.

    (b) A parabola.

    (c) A circle.

    (d) An ellipse.

10. At what speed the length of rod becomes half of its proper length :

    (a) $\dfrac{c}{2}$.

    (b) $\dfrac{c}{\sqrt{2}}$.

    (c) $\dfrac{\sqrt{3}}{2} c$.

    (d) $\sqrt{\dfrac{3}{2}} c$.

$(10 \times 1 = 10 \text{ marks})$

Section B

Answer all questions.

Each question carries 2 marks.

Answer in **a short paragraph** — *three or four sentences.*

11. Name the types of frames of reference. Differentiate between them.

12. Give two examples of conservative and two examples of non-conservative forces.

13. What do you mean by time dilation ?

14. Explain the hypothesis of Galilean invariance.

15. What is centrifugal force ? Illustrate with example.

16. What is the significance of wave function ?

17. Why was the Michelson Moreley experiment performed ?

$(7 \times 2 = 14 \text{ marks})$

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.

$(3 \times 4 = 12 \text{ marks})$

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.)

$(3 \times 4 = 12 \text{ marks})$

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.

$(2 \times 8 = 16 \text{ marks})$