

## SECOND SEMESTER B.Sc. DEGREE EXAMINATION, MAY 2017

(CUCBCSS—UG)

Complementary Course

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

Time : Three Hours

Maximum : 64 Marks

*Symbols used in this question paper have their usual meanings.*

## Section A

*(Answer in a word or phrase)**Answer all questions. Each question carries 1 mark.*1. Which of the following relations between force  $\vec{F}$  and potential energy  $V$  is correct :

(a)  $\vec{F} = -\text{grad } V.$

(b)  $\vec{F} = -\text{div } V.$

(c)  $\vec{F} = -\text{curl } V.$

(d)  $\vec{F} = -\int v \, dx.$

2. The rest mass of particle is  $m_0$ . If it moves with velocity  $v$ , its mass becomes  $m$ , then :

(a)  $m = m_0.$

(b)  $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}.$

(c)  $m = m_0 \sqrt{1 - \frac{v^2}{c^2}}.$

(d)  $m = \frac{m_0}{1 - \frac{v^2}{c^2}}.$

3. The rest mass of a particle is zero; then its relation between momentum ( $p$ ) and energy ( $E$ ) is :

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

(b)  $E = pc.$

(c)  $E = \frac{p}{c^2}.$

(d)  $E = pc^2.$

Turn over

4. What do you mean by energy density ?
5. A Physical system is invariant under rotation about a fixed axis. Then the following quantity is conserved ———.
- (a) Linear momentum. (b) Angular momentum.  
(c) Kinetic energy. (d) Potential energy.
6. The deviation of a freely falling body from the vertical in northern hemisphere is towards:
- (a) East. (b) West.  
(c) South. (d) Zero.
7. The rest mass of an electron is  $m_0$  when it moves with a velocity  $v = 0.6c$ , then its rest mass is
- (a)  $m_0$ . (b)  $\frac{5}{4}m_0$ .  
(c)  $\frac{4}{5}m_0$ . (d)  $2m_0$ .
8. Earth is :
- (a) An inertial frame. (b) A non-inertial frame.  
(c) An absolute frame. (d) Inertial and rotational.
9. The graph between square of period and the length of simple pendulum is a :
- (a) Straight line. (b) Circle.  
(c) Parabola. (d) Hyperbola.
10. The time interval between two events in rest frame is  $\Delta t$ . If it is measured from a moving frame it is  $\Delta t'$ , then :
- (a)  $\Delta t' = \Delta t$ . (b)  $\Delta t' < \Delta t$ .  
(c)  $\Delta t' > \Delta t$ . (d)  $\Delta t' = \sqrt{2} \Delta t$ .

(10 × 1 = 10 marks)

## Section B

*(Answer in a short paragraph- three or four sentences)*  
*Answer all questions. Each question carries 2 marks.*

11. What do you mean by length contraction?
12. State the law conservation of angular momentum.
13. Write a short note on Coriolis's force.
14. Explain the significance of mass energy relation.
15. Write Galilean transformations for space and time.
16. Distinguish between transverse and longitudinal waves.
17. Explain the properties of a wavefunction.

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

## Section C

*(Answer in a paragraph of about half a page to one page)*  
*Answer any three questions. Each question carries 4 marks.*

18. What are the postulates of quantum mechanics ?
19. Show that the curl of a conservative force vanishes.
20. Show that when  $v/c \ll 1$ , the Lorentz transformation equations get converted to the Galilean transformation equations.
21. Explain the working of an electron microscope.
22. Prove that a moving clock always runs slower than a clock at rest.

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

## Section D

*(Problems- write all relevant formulas. All important steps carry separate marks)*  
*Answer any three questions. Each question carries 4 marks.*

23. Calculate the length of the rod moving with velocity  $0.8c$ . Given proper length of the rod = 100cm.
24. Find the mass of electron and kinetic energy of an electron moving with a velocity is  $0.99c$ .
25. A body having a mass of 4g executes S.H.M. The force acting on the body when the displacement is 8 cm is 24g. Find the period. If the maximum velocity is 500cm/s, find the amplitude and maximum acceleration.

**Turn over**

26. A pendulum is of length 50cm. Find its period when it is suspended in :
- A stationary lift.
  - A lift falling at a constant acceleration of  $2 \text{ m/s}^2$ .
27. A mass of 50g is moving with linear velocity of 100 cm/s normal to the axis of rotation in a rotating frame of reference. The mass is at a distance of 10 cm from the axis of rotation. Calculate the Coriolis force experienced by the mass.

(3 × 4 = 12 marks)

### Section E

*(Essays - Answer in about two pages)*

*Answer any two questions. Each question carries 8 marks.*

28. Derive the time dependent Schrodinger equation of matter waves. Give the Physical interpretation of wave function.
29. Mention the consequences of Special theory of relativity and derive Einstein's mass energy relation.
30. Derive the differential equation for a damped harmonic oscillator. Explain the three cases of damping and give the graphical representation.
31. Derive Lorentz transformation equations.

(2 × 8 = 16 marks)