DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY MADRAS

PH1101- Physics 1 *Semester 1* *Date: 27/08/2023* *Time: 8:00AM-8:50AM*

Mock Quiz

Write your Name, Roll Number and Batch in the following box:

Name:	Roll Number:	Batch:

This is a Mock Quiz! It is being conducted to make you familiar with first quiz and to provide you a blueprint of the question paper. You are not required to submit it. It will not be evaluated.

- **The answers must be written in the respective boxes/space provided.** For Part B, please write your answer in the space provided below the respective questions.
- Unless otherwise specified, all symbols have their usual meaning as defined in class, and all constants are to be understood to have the appropriate physical dimensions.
- Use the backside of the first three pages for rough work. No additional sheet will be provided. You may also use the last page of this booklet for rough work, if required.
- For multiple choice questions full marks are awarded for selecting all correct options, partial marks for selecting some correct and no wrong answers.
- Use a black or blue pen **only**. Answers written in pencil will not be evaluated.
- **No** cellphones and calculators are allowed.

Good Luck!

Q. No.	1	2	3	4	Total
Marks					
Max.	6	6	4	4	20

Part A

1. Fill in the blanks questions! Please write the answers for questions 1(a)–1(c) in the respective boxes as given below. [$3 \times 2 = 6$ marks]

   (a) Consider a particle in motion with the position vector $\boldsymbol{r}(t)$ as a function of time t is given as following: $\boldsymbol{r}(t) = b\sin(\omega t)\ \hat{\boldsymbol{x}} + c\cos(\omega t)\ \hat{\boldsymbol{y}}$. The equation of orbit is given by

   (b) A particle with charge q and mass m, moving with a velocity $\boldsymbol{v}$, is subjected to an electric field $\boldsymbol{E}$ and magnetic field $\boldsymbol{B}$. The force experienced by the particle is $\boldsymbol{F} = q(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B})$. Give the expression for F_i, the i^{th} component of the force, using index notation.

$F_i =$

   (c) Using $\epsilon_{ijk}\epsilon_{ipq} = (\delta_{jp}\delta_{kq} - \delta_{jq}\delta_{kp})$, find an expression for $\epsilon_{ijk}\epsilon_{ijq}$ in terms of δ_{kq}.

$\epsilon_{ijk}\epsilon_{ijq} =$

2. Multiple choice questions! For questions 2(a)–2(c) tick the appropriate boxes to select all the correct options and no incorrect option. [$3 \times 2 = 6$ marks]

   (a) A ball is thrown straight up and collected from the point of release. Considering air friction, which of the following options are correct?

   - ☐ It takes longer for the ball to go up.
   - ☐ It takes longer for the ball to come down.
   - ☐ The magnitude of the net acceleration is higher when going upward.
   - ☐ The magnitude of the net acceleration is higher when coming downward.

   (b) The position of a mass exhibiting simple harmonic motion in one dimension is described by the function: $x(t) = \sqrt{3}\cos(\omega t) + \sin(\omega t)$ for $t \geq 0$. The particle crosses the origin at the times ($n = 0, 1, 2, \ldots$)

- [ ] $t = \frac{(3n+2)\pi}{3\omega}$

- [ ] $t = \frac{(3n+1)\pi}{6\omega}$

- [ ] $t = \frac{n\pi}{2\omega}$

- [ ] $t = \frac{n\pi}{\omega}$

(c) Let $\boldsymbol{A}$ and $\boldsymbol{B}$ are two polar vectors and $\boldsymbol{C}$ is an axial vector. Then

- [ ] $\boldsymbol{A} \times \boldsymbol{B}$ and $\boldsymbol{A} \times \boldsymbol{C}$ are both axial vectors.

- [ ] $\boldsymbol{A} \times \boldsymbol{B}$ is an axial vector and $\boldsymbol{A} \times \boldsymbol{C}$ is a polar vector.

- [ ] $(\boldsymbol{A} \times \boldsymbol{B}) \cdot \boldsymbol{C}$ is a pseudoscalar.

- [ ] $\boldsymbol{A} \cdot \boldsymbol{C}$ and $\boldsymbol{B} \cdot \boldsymbol{C}$ are pseudoscalars.

Part B

3. A body is projected vertically upwards with speed u in a medium that exerts a drag force $-mKv$, where $K > 0$ and $\mathbf{v}$ is the velocity of the body. Find the maximum height and the time taken to reach it. [4 marks]

4. A critically damped oscillator of unit mass with natural frequency ω is subjected to an external force $f(t) = f_0 e^{-\alpha t}$, where α is a positive constant and $\alpha \neq \omega$. The equation of motion has the form

$$\ddot{x} + 2\omega\dot{x} + \omega^2 x = f(t) \ .$$

(a) Determine a particular solution $x_p(t)$ to the above equation. [1 mark]

(b) Write down the general solution $x_h(t)$ to the corresponding homogeneous differential equation. [1 mark]

(c) Find the complete solution $x(t)$ using the initial conditions $x(0) = 0, \dot{x}(0) = 0$. [1 mark]

(d) Find the limiting form of the solution in (c) when $\alpha \to \omega$. Your answer should involve only f_0, ω and t. [1 mark]