

SHIV NADAR

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INSTITUTION OF EMINENCE DEEMED TO BE
UNIVERSITY

DELHI NCR

TEST ANSWER BOOK

Name ADYA SINGHAL

Roll No. 2410110027 Major B.Tech CSE

Course Code PHY101 Course Title PHY101: Introduction to Physics-I

Date 5/9/24 No. of Continuation Sheets Used

INSTRUCTIONS FOR THE STUDENTS

1. It is mandatory to fill all the entries on the answer sheet such as Roll No., Name, Course code etc.
2. Any identification mark at any other place inside the answer sheet will make it liable to be cancelled.
3. Student should take their seats at least ten minutes before the commencement of the exam. Student will not be allowed to leave the examination hall prior to 30 minutes after the commencement of the examination. Candidates arriving late will not be permitted to enter the Examination Hall 15 minutes after the schedule commencement of the examination.
4. Carrying the Identity Card is mandatory, failing which the student will not be permitted to appear for the examination. The student is required to sign in the space provided for signature on the attendance sheet in the presence of the invigilator in the Examination Hall.
5. Student should follow the instructions given by the invigilator at all the stages of the examination. Violation may lead to disciplinary action.
6. Any textual material, written or printed, notebooks, notes, programmable calculators, pagers, mobile phones or other electronic devices are not allowed inside the examination hall. Any student who is found either copying or receiving or giving assistance shall be disqualified.
7. Please handle your answer sheet with care. After the exam is over, the answer sheet must be handed over to the invigilator before leaving the exam hall. Any candidate who does not return the answer sheet or is found to take it outside the examination hall will be disqualified from the exam and the Proctoral Board may take further action against him/her as per university rules.
8. The answer book contains 12 pages.

Adya
Signature of Student

Kirti
Signature of Invigilator

Q. No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Sub Total	TOTAL
Marks	03	03	03	03	03									
Q. No.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	Sub Total	TOTAL
Marks														

Kirti
Signature of Examiner

Ans 1) (a) $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$
 $\vec{B} = \hat{i} + 2\hat{j} - 3\hat{k}$

$$|\vec{A}| = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{1+4+9} = \sqrt{14}$$

$$|\vec{B}| = \sqrt{1^2 + 2^2 + (-3)^2} = \sqrt{1+4+9} = \sqrt{14}$$

(b) $\vec{A} \cdot \vec{B} = (\hat{i} + 2\hat{j} + 3\hat{k}) \cdot (\hat{i} + 2\hat{j} - 3\hat{k})$

$$= 1 + 4 - 9 = -4$$

$$\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$$

$$-4 = \sqrt{14} \sqrt{14} \cos \theta$$

$$\cos \theta = \frac{-4}{14} = -\frac{2}{7}$$

$$\theta = \cos^{-1}\left(-\frac{2}{7}\right)$$

$$\theta = \cancel{106.6^\circ} 106.6^\circ$$

(c) $\vec{A} \times \vec{B} =$

\hat{i}	\hat{j}	\hat{k}
1	2	3
1	2	-3

$$= \hat{i}(-6-6) - \hat{j}(-3-3) + \hat{k}(2-2)$$

$$= -12\hat{i} + 6\hat{j}$$

Ans 2) $F = \frac{k q_1 q_2}{r^2}$ $I = \frac{q}{t}$ (Current = $\frac{\text{charge}}{\text{time}}$)

(a) $[F] = [MLT^{-2}]$

$[q] = [AT]$

(b) $k = \frac{1}{4\pi\epsilon}$ $[\epsilon] = \frac{1}{[k]}$ as 4π is constant

$$[k] = \frac{[F][r^2]}{[q_1][q_2]} = \frac{[MLT^{-2}][L^2]}{[AT]^2} = \frac{[ML^3T^{-2}]}{[A^2T^2]}$$

$$[k] = [ML^3A^{-2}T^{-4}]$$

$$[\epsilon] = [M^{-1}L^{-3}A^2T^4]$$

Ans 3) (a) Rectangular coordinates are given by:-

$$\begin{aligned} x &= \rho \cos \phi \\ y &= \rho \sin \phi \\ z &= z \end{aligned}$$

$$x = 1 \cos \frac{\pi}{4} = \frac{1}{\sqrt{2}}$$

$$y = 1 \sin \frac{\pi}{4} = \frac{1}{\sqrt{2}}$$

$$z = 2$$

\therefore Rectangular coordinates are $(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 2)$

(b) Spherical polar coordinates are given by:-

$$r = \sqrt{x^2 + y^2 + z^2}$$

$$\theta = \frac{\sqrt{x^2 + y^2}}{z} \tan^{-1} \left(\frac{\sqrt{x^2 + y^2}}{z} \right)$$

$$\phi = \tan^{-1} \left(\frac{y}{x} \right)$$

$$r = \sqrt{\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2 + 2^2} = \sqrt{5}$$

$$\theta = \frac{\tan^{-1} \left(\frac{\sqrt{\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2}}{2} \right)}{2} = \frac{1}{2} \tan^{-1} \left(\frac{1}{2} \right) \approx 27^\circ$$

$$\phi = \tan^{-1} \left(\frac{1/\sqrt{2}}{1/\sqrt{2}} \right) = 45^\circ = \frac{\pi}{4}$$

\therefore Spherical coordinates are $(\sqrt{5}, 27^\circ, 45^\circ)$

Ans 4) (a) $\vec{r} = e^{-t} \hat{i} + 2 \cos 3t \hat{j} + t^2 \hat{k}$

(b) $\vec{v} = \frac{d\vec{r}}{dt} = -e^{-t} \hat{i} + 2(-\sin 3t)(3) \hat{j} + 2t \hat{k}$

$\vec{v} = -e^{-t} \hat{i} - 6 \sin 3t \hat{j} + 2t \hat{k}$

$\vec{a} = \frac{d\vec{v}}{dt} = e^{-t} \hat{i} - 6 \cos 3t(3) \hat{j} + 2 \hat{k}$

$\vec{a} = e^{-t} \hat{i} - 18 \cos 3t \hat{j} + 2 \hat{k}$

(c) At $t=0$,

$\vec{v} = -e^0 \hat{i} - 0 \hat{j} + 0 \hat{k}$
 $= -\hat{i}$

$|\vec{v}| = 1$

$\vec{a} = \hat{i} - 18 \hat{j} + 2 \hat{k}$

$|\vec{a}| = \sqrt{1^2 + (-18)^2 + 2^2} = \sqrt{329}$

Ans 5) (a) $\vec{v}_r = \dot{r} \hat{r}$

$\vec{v}_\theta = r \dot{\theta} \hat{\theta}$

$\vec{v}_r = -2e^{-2t}$

At $t=0$, $\vec{v}_r = -2$

At $t=\frac{1}{2}$, $\vec{v}_r = -2e^{-1} = -\frac{2}{e}$

$$(b) \vec{V}_\theta = r \dot{\theta} \hat{\theta}$$

~~At $t=0$,~~

$$\vec{V}_\theta = e^{-2t} (2t)$$

At $t=0$, $\vec{V}_\theta = 0$

At $t=\frac{1}{2}$, $\vec{V}_\theta = e^{-1} = \frac{1}{e}$

(c) ~~At $t=0$~~ $V = \sqrt{(\vec{V}_r)^2 + (\vec{V}_\theta)^2}$

At $t=0$, $\vec{V} = \sqrt{(-2)^2 + 0^2} = 2$

At $t=\frac{1}{2}$, $\vec{V} = \sqrt{\left(\frac{-2}{e}\right)^2 + \left(\frac{1}{e}\right)^2} = \frac{\sqrt{5}}{e}$