Kuwait University Physics Department

Physics 101

Summer Semester

First Midterm Exam

Saturday, June 29, 2024

10:30 AM – 12:00

Student's Name: ……. Serial Number: ……

Student Number: ……Section: ……

Choose your Instructor's Name:

Instructors: Drs. Al Dosari, Al Jassar, Al Qattan, Salameh

For Instructors use only

Grades:

#	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Q1	Q2	Q3	Q4	Total
Pts	2	2	2	2	2	3	3	1		1	1	20

Important:

1. Answer all questions and problems (No solution = no points).
2. Full mark = 20 points as arranged in the above table.
3. **Give your final answer in the correct units.**
4. Assume g = 10 m/s^2.
5. Mobiles are **strictly prohibited** during the exam.
6. Programmable calculators, which can store equations, are not allowed.
7. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

Part I: Short Problems (2 points each)

SP1. If $\vec{A} = 2\hat{\imath} - 4\hat{\jmath} + \hat{k}$, $\vec{B} = \hat{\imath} + 3\hat{\jmath} + 2\hat{k}$. **Find** $|\vec{A} \times \vec{B}|$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & -4 & 1 \\ 1 & 3 & 2 \end{vmatrix} = \hat{\imath}(-8-3) + \hat{\jmath}\,(1-4) + \hat{k}\,(6--4)$$

$$= -11\hat{\imath} - 3\hat{\jmath} + 10\hat{k}$$

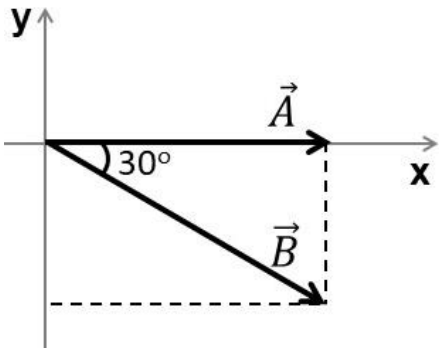
$$|\vec{A} \times \vec{B}| = \sqrt{11^2 + 3^2 + 10^2} = 15.2$$

SP2. Two displacement vectors are shown. If $B = 5\ cm$ and $A = B_x$, **find $\vec{A} - \vec{B}$ in unit vector notation**.

$$\overrightarrow{B} = 5\cos(30^o)\,\hat{\imath} - 5\sin(30^o)\hat{\jmath} = (4.3\hat{\imath} - 2.5\hat{\jmath})\ cm$$

$$\overrightarrow{A} = 4.3\hat{\imath}\ cm$$

$$\vec{A} - \vec{B} = +2.5\,\hat{\jmath}\ cm$$



SP3. A particle moves in the ***xy*-plane**. Its position vector is given by $\vec{r}(t) = (3 + t^3)\hat{\imath} + (4t^2 - 2t^3)\hat{\jmath}$, where $\boldsymbol{r}$ is in meters and $\boldsymbol{t}$ is in seconds. **Find the speed of the particle at $\boldsymbol{t = 2s}$.**

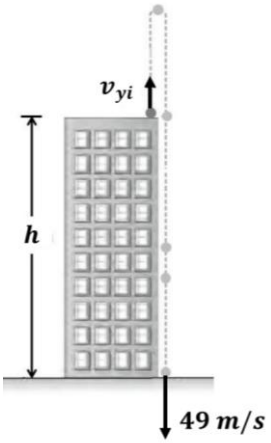
$$\vec{v}(t) = \frac{d\vec{r}}{dt} = [3t^2\hat{\imath} + \left(8t - 6t^2\right)\hat{\jmath}] \quad m/s$$

$$\vec{v}(2s) = (12\,\hat{\imath} - 8\,\hat{\jmath})\ m/s$$

$$|\vec{v}(2s)| = \sqrt{(12)^2 + (8)^2} = 14.4\ m/s$$

SP4. A stone is thrown vertically upward from the top of a building, as shown. The stone takes 6.9 seconds to reach the ground with final speed of $49\ m/s$. **Find the height of the building (h).**

$$v_{y_f} = v_{y_i} - gt$$
$$-49 = v_{y_i} - 10(6.9) \Longrightarrow v_{y_i} = 20\ m/s$$
$$\Delta y = v_{y_i}t - \frac{1}{2}gt^2$$
$$-\mathrm{h} = 20(6.9) - 5(6.9)^2 = -100\ m$$
$$h = 100\ m$$

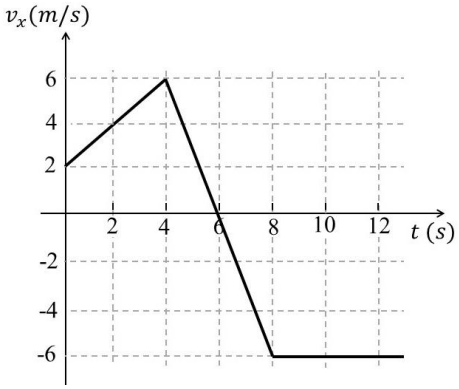


SP5. Starting from point A, you run a distance of $200\ m$ east (along the $+x$-direction) at an average speed of $5\ m/s$, and then you run a distance of $280\ m$ west (along the $-x$-direction) at an average speed of $4\ m/s$ to a reach point B. **Calculate your <u>average speed</u> between point A and point B.**

$$t_1 = \frac{d_1}{v_1} = \frac{200}{5} = 40s$$
$$t_2 = \frac{d_2}{v_2} = \frac{280}{4} = 70s$$
$$d_{total} = d_1 + d_2 = 480\ m$$
$$v = \frac{d_{total}}{t_{total}} = \frac{480}{110} = 4.4\ m/s$$

Part II: Long Problems (3 points each)

LP1. An object is moving along the x-axis. Its velocity changes with time as shown in the graph.



a) Find the velocity of the object at $t = 6\ s$.

$v_x(t = 6s) = 0\ m/s$

b) Find the acceleration of the object at $t = 10\ s$.

$a_x(t = 10s) = 0\ m/s^2$

c) Find the **average <u>velocity</u>** of the object in the interval from $t = 4\ s$ to $t = 8\ s$.

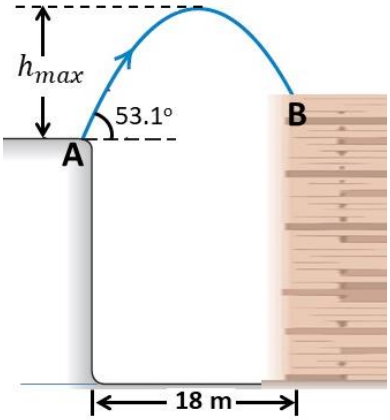
$$v_{av-x} = \frac{\Delta x}{t} = \frac{\frac{1}{2}(2)(6) - \frac{1}{2}(2)(6)}{4} = 0\ m/s$$

d) Find the **average <u>speed</u>** of the object in the interval from $t = 4\ s$ to $t = 8\ s$.

$$v_{av} = \frac{\mathrm{d}}{t} = \frac{\frac{1}{2}(2)(6) + \frac{1}{2}(2)(6)}{4} = 3\ m/s$$

LP2. A stone is thrown from the edge of a cliff (point A) with a speed of 15 m/s, at an angle of 53.1° above the horizontal, as shown. The stone strikes the ground at point B. Find

a) the time of flight from point A to point B.



$$v_{xi} = 15\cos(53.1^o) = 9\ m/s \qquad v_{yi} = 15\sin(53.1^o) = 12\ m/s$$

$$\Delta x = v_{xi}t \quad \Longrightarrow t = \frac{\Delta x}{v_{xi}} = \frac{18}{9} = 2\ s$$

b) the maximum height of the stone measured from the top of the cliff (h_{max}).

$$v_{y_f}^2 = v_{y_i}^2 - 2g\Delta y$$

$$0 = 12^2 - 20h_{max} \implies h_{max} = \frac{12^2}{20} = 7.2\ m$$

c) the velocity of the stone just before it hits the ground in unit vector notation.

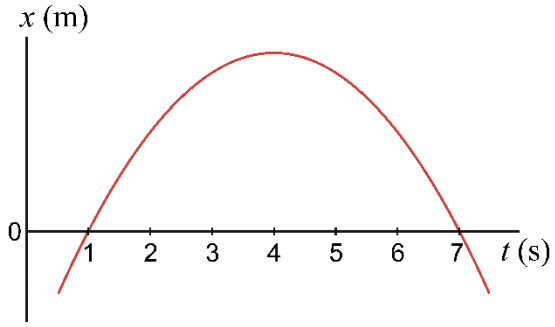
$$v_{x_f} = v_{x_i} = 9\ m/s$$

$$v_{y_f} = v_{y_i} - gt = 12 - (10)(2) = -8\ m/s$$

$$\vec{v}_f = (9\hat{\imath} - 8\hat{\jmath})\ m/s$$

Part III: Questions (Choose the correct answer, one point each)

Q1. The figure describes the position of an object moving along ***x*-axis** as a function of time. **Which of the following is correct at $t = 4\ s$?**



- $v_x > 0$ and $a_x < 0$
- $v_x = 0$ and $a_x > 0$
- $v_x = 0$ and $a_x = 0$
- ⊙ $v_x = 0$ and $a_x < 0$

Q2. If $\vec{A}$ and $\vec{B}$ are nonzero vectors and $\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}|$, then **which of the following is always true.**

(*) $|\vec{A} \times \vec{B}| = 0$

* $\vec{A}$ is perpendicular to $\vec{B}$

* $|\vec{A} \times \vec{B}| = \vec{A} \cdot \vec{B}$

* $|\vec{A} \times \vec{B}| = 1$

Q3. An object is moving along **the negative x-axis** and **speeding** up. Then,

* Its velocity and acceleration are positive.
* Its velocity is negative, and its acceleration is positive.
(*) Its velocity and acceleration are negative.
* Its velocity is positive, and its acceleration is negative.

Q4. A stone is projected from the ground with initial velocity $\vec{v} = (6\hat{\imath} + 7\,\hat{\jmath})\ m/s$. **Neglecting air resistance, the speed and acceleration of the stone at the maximum height, respectively are:**

* $(6\ m/s, +10\ m/s^2)$
(*) $(6\ m/s, -10\ m/s^2)$
* $(zero, -10\ m/s^2)$
* $(zero, +10\ m/s^2)$