Kuwait University Physics Department

جامعة الكويت
KUWAIT UNIVERSITY

Physics 101

Spring Semester

First Midterm Exam

Saturday, October 25, 2025

8:00 – 9:30 AM

Student's Name: …… Serial Number: ……

Student's Number: ……Section: ……

Choose your Instructor's Name:

Instructors: Drs. Al Dosari, Al Jassar, Al Qattan, Al Smadi, Askar, Demir, Salameh, Zaman

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	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.**

Model Answer

GOOD LUCK

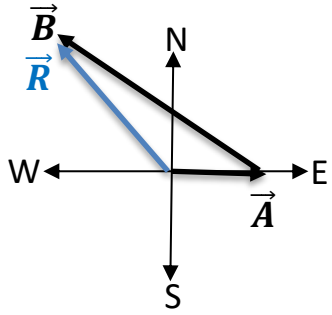
Part I: Short Problems (2 points each)

SP1. Find the angle between the vector $\vec{A} = 6\hat{\imath} - 3\hat{\jmath} + 2\hat{k}$ and the **+ x axis**.

$$\theta_x = \cos^{-1}\left(\frac{A_x}{A}\right)$$

$$\theta_x = \cos^{-1}\left(\frac{6}{\sqrt{6^2 + (-3)^2 + 2^2}}\right) \approx 31^\circ$$

SP2. A Kuwait University professor starts walking 5 m East, then 15 m at 37 degrees North of West. Find the **magnitude and direction of the resultant displacement**.



$\vec{A} = 5\,\hat{\imath}$ m

$\vec{B} = -15\cos 37\,\hat{\imath} + 15\sin 37\,\hat{\jmath}$ m

$\vec{R} = \vec{A} + \vec{B} \approx -7\hat{\imath} + 9\hat{\jmath}$ m

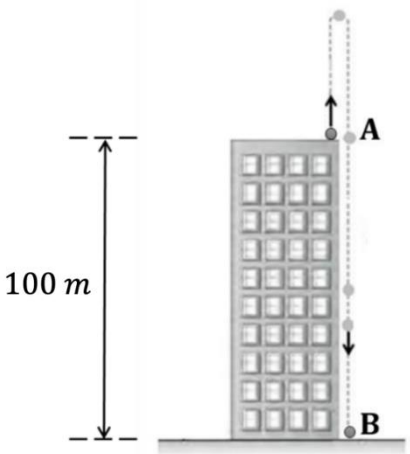
$|\vec{R}| = \sqrt{(-7)^2 + 9^2} \approx 11.4$ m

$\theta = \tan^{-1}\left(\frac{9}{7}\right) \approx 52$ degrees N of W (or 38 degrees W of N or 128 degrees CCW from E (+x direction)

SP3. A ball is thrown **vertically upward** from point A at the top of a building 100 m high, as shown. It reaches its **maximum height** after 2 *seconds*. **Find its velocity (in m/s) at point B, just before it touches the ground**.

$v_f = v_i - gt$
$0 = vi - 10(2)$
$v_i = 20\ m/s$

$v_f^2 = v_i^2 - 2g\Delta y$
$v_f^2 = 20^2 - 20(-100)$
$v_f = -49\ m/s$



SP4. An object moves in the ***xy plane*** with its position vector as a function of time given by: $\vec{r}(t) = (t^2)\,\hat{\imath} + (8t - t^2)\hat{\jmath}$, where $\vec{r}$ is measured in $meters$ and t is measured in $seconds$. **Find the time** when the velocity $\vec{v}(t)$ **is perpendicular to** the acceleration $\vec{a}(t)$.

$$\vec{v} = \frac{d\vec{r}}{dt} = (2t)\hat{\imath} + (8 - 2t)\hat{\jmath}$$

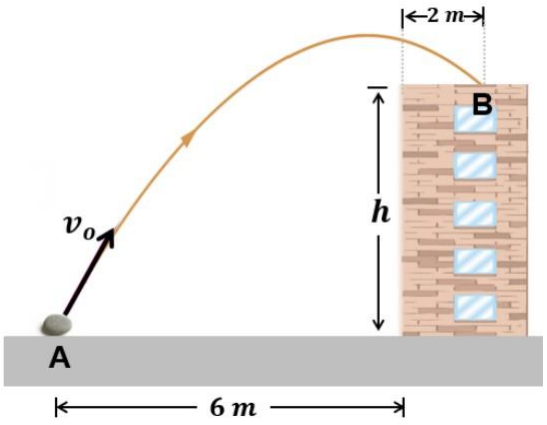
$$\vec{a} = \frac{d\vec{v}}{dt} = 2\hat{\imath} - 2\hat{\jmath}$$

$$\vec{a} \cdot \vec{v} = 0$$

$$2(2t) - 2(8 - 2t) = 0$$

$$t = 2\ sec$$

SP5. A stone is thrown from point A with an initial speed v_0. The stone strikes the roof of a building at point B. If the **time to travel from point A to point B is 2 *seconds***, and the height $h = 16\ m$, **find the initial velocity $\vec{v}_0$ in unit vector notation.**



$$\Delta x = v_{0x}t$$

$$v_{0x} = \frac{\Delta x}{t} = \frac{8}{2} = 4\ m/s$$

$$\Delta y = v_{0y}t + \frac{1}{2}a_y t^2$$

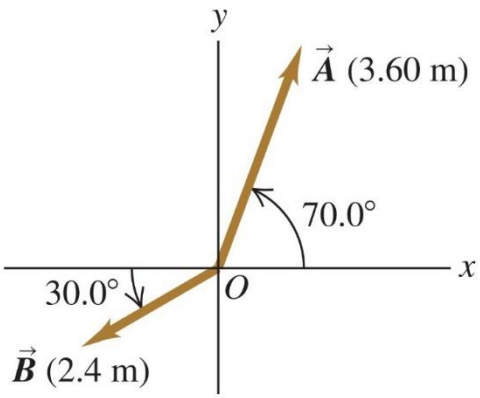
$$16 = v_{oy}(2) + \frac{1}{2}(-10)(2^2)$$

$$v_{0y} = 18\frac{m}{s}$$

$$\vec{v}_0 = 4\hat{\imath} + 18\hat{\jmath}$$

Part II: Long Problems (3 points each)

LP1. Given two vectors $\vec{A}$ and $\vec{B}$ with their magnitudes and directions shown in the figure.



(a) Find the vector $\vec{C} = 2\vec{A} - \vec{B}$, in unit vector notation.

$$\vec{A} = 3.6\cos 70\,\hat{\imath} + 3.6\sin 70\,\hat{\jmath} \approx 1.2\,\hat{\imath} + 3.4\hat{\jmath}\ m$$

$$\vec{B} = -2.4\cos 30\,\hat{\imath} - 2.4\sin 30\,\hat{\jmath} = -2.1\hat{\imath} - 1.2\hat{\jmath}\ m$$

$$\vec{C} = 2(1.2\,\hat{\imath} + 3.4\hat{\jmath}) - (-2.1\hat{\imath} - 1.2\hat{\jmath}) \approx 4.5\hat{\imath} + 8.0\,\hat{\jmath}\ m$$

(b) Find the scalar product $\vec{A} \cdot \vec{B}$

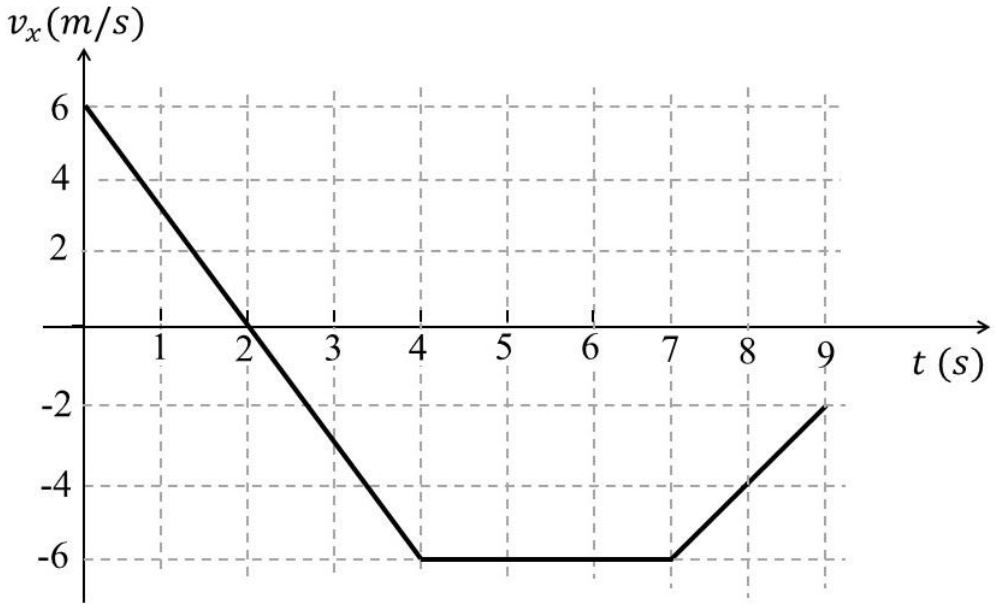
$$\vec{A} \cdot \vec{B} = AB\cos\emptyset = (3.6)(2.4)\cos 140 \approx -6.6\ m^2$$

(c) Find the vector product $\vec{A} \times \vec{B}$. Indicate the magnitude and direction.

$$|\vec{A} \times \vec{B}| = AB\sin\emptyset = (3.6)(2.4)\sin 140 \approx 5.6\ m^2$$

Direction = out of page (+z direction)

LP2. The velocity time graph of an object moving along the x-axis is shown in the figure.



(a) Find the object's **acceleration** at $\boldsymbol{t = 2\ seconds}$.

$$a(t = 2) = \frac{0 - 6}{2 - 0} = -3\ m/s^2$$

(b) **Find when** the object **stops momentarily**.

$$t = 2\ seconds$$

(c) **Find the total distance traveled** between $\boldsymbol{t = 0}$ **and** $\boldsymbol{t = 7s}$.

$$D = \frac{1}{2}(2)(6) + \left|\frac{1}{2}(2)(-6)\right| + |(3)(-6)| = 30\ m$$

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

Q1. A particle moves along the x-axis and has a position given by $x(t) = t^2 + 10$ where x is in $meters$ and t is in $seconds$. **Which of the following statements is true when $t > 0$?**

* The particle is at the origin at some time.
* The velocity of the particle doubles every second.
(*) The acceleration of the particle is constant.
* The particle changes its direction some time.

Q2. Given two vectors $\vec{A}$ and $\vec{B}$ such that $\left|\vec{A}\right| = 3$ and $\left|\vec{B}\right| = 4$. **Which of the following represents the allowed range for the magnitude of their cross product $\left|\vec{A} \times \vec{B}\right|$?**

* $\left|\vec{A} \times \vec{B}\right| > 12$
* $\left|\vec{A} \times \vec{B}\right| < -12$
(*) $0 \leq \left|\vec{A} \times \vec{B}\right| \leq 12$
* $-12 \leq \left|\vec{A} \times \vec{B}\right| \leq 0$

Q3. The value of $\hat{j} \cdot (\hat{k} \times \hat{\imath})$ is

* -1 (*) $+1$ * 0 * $\hat{\imath}$

Q4. A particle moves in **circular motion at constant speed**. **Which of the following is a possible set of velocity and acceleration vectors for the particle?**

* $\vec{v} = 2\hat{\imath}, \quad \vec{a} = 0$
* $\vec{v} = 2\hat{\imath}, \quad \vec{a} = -6\hat{\imath}$
* $\vec{v} = 2\hat{\imath}, \quad \vec{a} = -6\hat{\imath} + 6\hat{\jmath}$
(*) $\vec{v} = 2\hat{\imath}, \quad \vec{a} = 6\hat{\jmath}$