Kuwait University Physics Department

Physics 101

Summer Semester

First Midterm Exam

Saturday, July 5, 2025

9:00 AM – 10:30 AM

Student's Name: …… Serial Number: ……

Student Number: ……Section: ……

Choose your Instructor's Name:

Instructors: Drs. Al Dosari, Al Jassar, Al Qattan, Alsmadi, 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	20

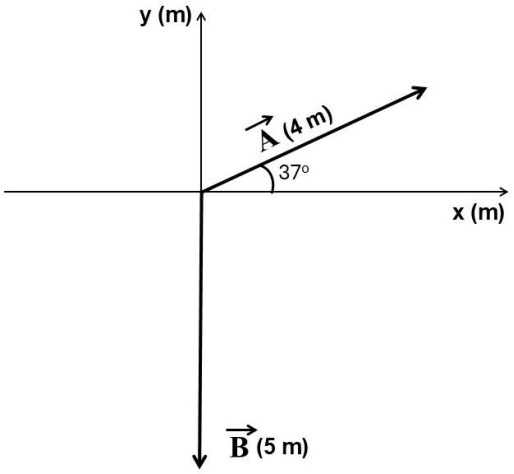
Important:

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. Two displacement vectors $|\vec{A}| = 4\ m$ and $|\vec{B}| = 5\ m$, are shown in the figure. **Find $\vec{A} + \vec{B}$ in unit vector notation**.



$\vec{A} = 4\cos(37^o)\,\hat{\imath} + 4\sin(37^o)\,\hat{\jmath} = (3.2\hat{\imath} + 2.4\hat{\jmath})\ m$

$\vec{B} = -5\hat{\jmath}\ m$

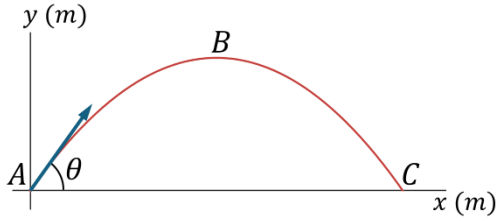
$\vec{A} + \vec{B} = (3.2\hat{\imath} - 2.6\hat{\jmath})\ m$

SP2. Given two vectors $\vec{A} = 2\hat{\imath} - 2\hat{\jmath}$ and $\vec{B} = \hat{\imath} + 3\hat{\jmath} + 2\hat{k}$. **Find $\vec{A} \times \vec{B}$**

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & -2 & 0 \\ 1 & 3 & 2 \end{vmatrix} = \hat{\imath}(-4) + \hat{\jmath}\,(-4) + \hat{k}\,(6 - -2)$$

$\vec{C} = -4\hat{\imath} - 4\hat{\jmath} + 8\hat{k}$

SP3. A stone is projected from the ground at point A with a speed of $20\ m/s$ at an angle $\theta = 37^{\circ}$, as shown. **Find the velocity of the stone at point C (just before it hits the ground) in unit vector notation**.



$v_{xi} = v_i\ cos\ 37^o = 16\ m/s$

$v_{yi} = v_i\ sin\ 37^o = 12\ m/s$

$v_x(C) = v_{xi} = 16\ m/s$

$v_y(C) = -v_{yi} = -12\ m/s$

$\vec{v}_c = (16\hat{\imath} - 12\hat{\jmath})\ m/s$

SP4. A particle moves along a **circular path** with a radius $R = 2m$. At an instant when its **speed** is $3\ m/s$ and increasing at a rate of $5\ m/s^2$, **what is the magnitude of its total acceleration?**

$$|\vec{a}| = \sqrt{(a_r)^2 + (a_T)^2}$$

$$|\vec{a}| = \sqrt{(\frac{v^2}{R})^2 + (5)^2}$$

$$|\vec{a}| = \sqrt{(\frac{3^2}{2})^2 + (5)^2} = 6.7 m/s^2$$

SP5. A stone is thrown **vertically upward** from the ground at point A with an **initial velocity** ($\vec{v}_0$). It takes $0.8\ seconds$ to travel from point A to point B. **How long will it take to travel from point A to point C?**

From A to B: $y = y_0 + v_0 t - \frac{1}{2} g t^2$

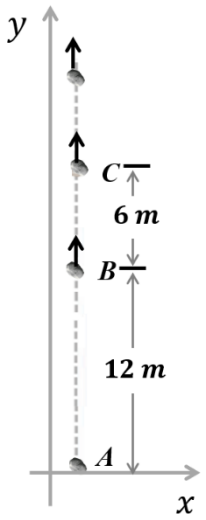
$$12 = 0 + v_0(0.8) - 5(0.8)^2$$

$$v_0 = 19\ m/s$$

From A to C: $y = y_0 + v_0 t - \frac{1}{2} g t^2$

$$18 = 0 + (19)(t) - 5(t)^2$$

$$t = 1.8\ s$$



Part II: Long Problems (3 points each)

LP1. A particle moves along the x-axis. Its position as a function of time is given by $x(t) = -12t + 1.5t^2$, where x is in $meters$ and t is in $seconds$.

a) Find the speed of the particle at $t = 0\ s$.

$v_x(t) = \frac{dx}{dt} = -12 + 3t$

$v_x(t = 0) = -12 m/s$

$|v_x(t = 0)| = 12 m/s$

b) Find the average acceleration of the particle during the period from $t = 1s$ to $t = 3s$.

$$a_{av-x} = \frac{v_{x_f} - v_{x_i}}{\mathrm{t}} = \frac{v_x(3s) - v_x(1s)}{2} = \frac{-3-(-9)}{2} = 3\ \mathrm{m/s^2}$$

c) At what time will the particle change its direction of motion?

$v_x(t) = -12 + 3t = 0 \Rightarrow t = 4\ s$

LP2. A particle moving with **constant acceleration** in the ***xy*-plane** starts from the origin with an initial velocity $\vec{v}_0 = (4\hat{\imath} + 10\hat{\jmath})\ m/s$ and **comes to rest momentarily** at $t = 2.5s$.

a) **Find its acceleration in unit vector notation**.

$\vec{v}_f = \vec{v}_0 + \vec{a}t$
$0 = 4\hat{\imath} + 10\hat{\jmath} + \vec{a}(2.5)$
$\vec{a} = -1.6\hat{\imath} - 4\hat{\jmath}$

b) **Find its position at $t = 2.5s$ in unit vector notation**.

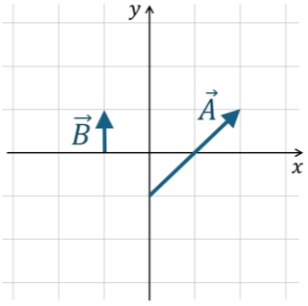
$\vec{r}_f = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$
$\vec{r}_f = 0 + (4\hat{\imath} + 10\hat{\jmath}) \times 2.5 + \frac{1}{2}(-1.6\hat{\imath} - 4\hat{\jmath})(2.5)^2 = 5\hat{\imath} + 12.5\hat{\jmath}$

c) **<u>After $t = 2.5s$,</u> the x-component of the particle's velocity would be:**

∗ Positive ⊛ Negative ∗ Zero

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

Q1. Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. If $\vec{C} = \vec{A} - \vec{B}$, then **which of the following statements is correct about the y-components of these vectors?**

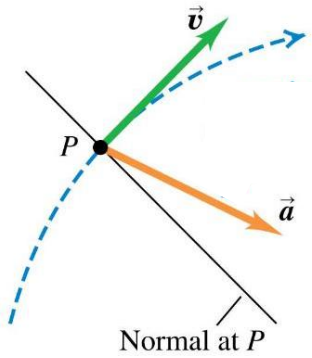


* $|C_y| > |A_y|$
* $|C_y| > |B_y|$
* $|C_y| < |B_y|$
* ⊛ $|C_y| = |B_y|$

Q2. A particle moves along the positive x-direction with **constant acceleration** ($\vec{a}$), the magnitude of its **velocity** ($|\vec{v}|$) is **increasing** with time. **Which one of the following statements must be correct?**

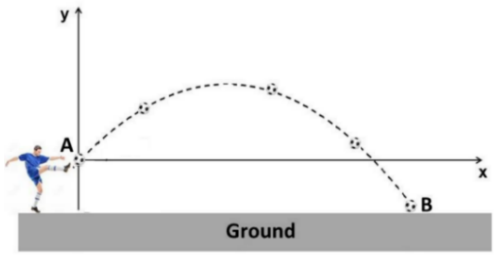
* $\vec{v} \cdot \vec{a} = 0$
* ⊛ $\vec{v} \cdot \vec{a} = |\vec{v}||\vec{a}|$
* $\vec{v} \times \vec{a} = |\vec{v}||\vec{a}|$
* $\vec{v} \cdot \vec{a} = -|\vec{v}||\vec{a}|$

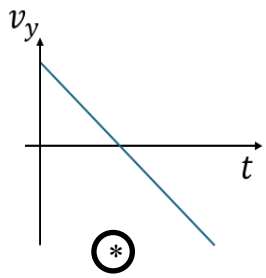
Q3. A particle is moving along **a curved path** and the direction of its **total acceleration $\vec{a}$ at point P** is shown in the figure. **At point P, the particle is:**



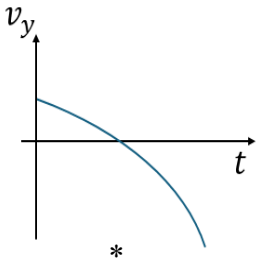
* moving with constant speed
* ⊛ speeding up
* slowing down
* having only centripetal acceleration

Q4. A ball is shot such that it leaves the player's foot at point A above ground level, as shown. During the ball's travel **from point A to point B**, which of the following graphs represents the y-component of the **ball's velocity (v_y) as a function of time?**





⊛



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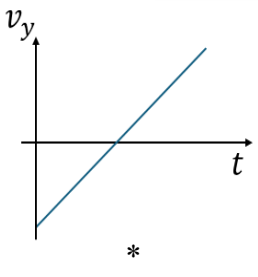

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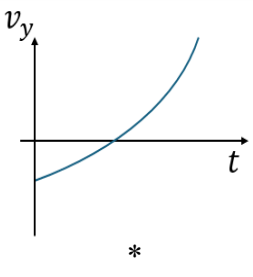

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