# Kuwait University Physics Department

جامعة الكويت
KUWAIT UNIVERSITY

# Physics 101

Fall Semester

First Midterm Exam

Saturday, October 26, 2024

8:00 AM – 9:30 AM

Student's Name: …… Serial Number: ……

Student's Number: ……Section: ……

Choose your Instructor's Name:

**Instructors: Drs.** Al Dosari, Al Jassar, Al kurtas, Al Qattan, Al Refai, 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.**

GOOD LUCK

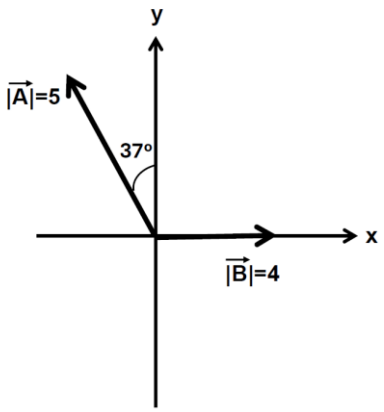
## Part I: Short Problems (2 points each)

**SP1**. The vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. **Find $\vec{B} - \vec{A}$ in unit vector notation**.

$$\vec{A} = -5\sin(37°)\,\hat{\imath} + 5\cos(37°)\,\hat{\jmath} = -3\hat{\imath} + 4\hat{\jmath}$$

$$\vec{B} = 4\hat{\imath}$$

$$\vec{B} - \vec{A} = 7\hat{\imath} - 4\hat{\jmath}$$

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**SP2**. Given three vectors: $\vec{A} = 2\hat{\imath} + 3\hat{k}$ ; $\vec{B} = 2\hat{\imath} + 4\hat{\jmath}$ ; $\vec{C} = 3\hat{\jmath} + \hat{k}$. **Find $\vec{A} \cdot (\vec{B} \times \vec{C})$**

$$\vec{B} \times \vec{C} = \begin{bmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & 4 & 0 \\ 0 & 3 & 1 \end{bmatrix} = 4\hat{\imath} - 2\hat{\jmath} + 6\hat{k}$$

$$\vec{A}.\left(\vec{B} \times \vec{C}\right) = 8 + 18 = 26$$

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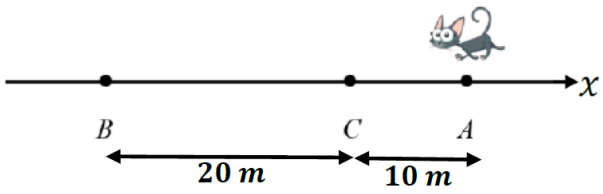
**SP3**. A cat runs along a straight line from point **A to point B and then turns back to point C**, as shown. The entire motion took 8 $s$. **Find the cat's average velocity for the entire trip**.




$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_C - x_A}{t_C - t_A}$$

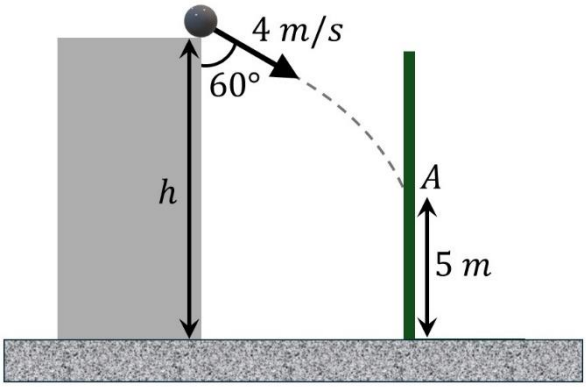
$$\bar{v} = \frac{-10 - 0}{8} = -1.25\ m/s$$

**SP4.** A ball is projected from the top of a building with $v_i = 4\ m/s$ at an angle of 60° and hits a wall at point **A**, as shown. **What is the height of the building ($h$) if the travel time is 2 seconds?**

$$\Delta y = v_{y_i} t - \frac{1}{2} g t^2$$

$$-(h - 5) = -2v_i sin30 - 5(2)^2$$

$$h = 29\ m$$

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**SP5.** A ball is thrown **vertically upward** from the ground. Its height after 2 seconds is 6 $m$ above the ground. **Find the maximum height of the ball ($h_{max}$).**

$$y_f = y_i + v_{y_i} t - \frac{1}{2} g t^2$$

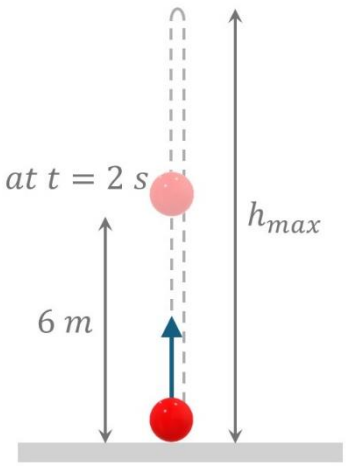
$$6 = 0 + 2v_{y_i} - 5(2)^2$$

$$v_{y_i} = 13\ m/s$$

$$v_f^2 = v_i^2 - 2g(y_f - y_i)$$

$$0 = 169 - 20(y_f - 0)$$

$$y_f = h = 8.45\ m$$



## Part II: Long Problems (3 points each)

**LP1.** A particle moves along **the y-axis**. Its position as a function of time is given by $y(t) = 6 + 12t - 5t^2$ where $y$ is in $m$ and $t$ is in $s$.

**a) What is the velocity of the particle at $t = 0\ s$ and at $t = 2\ s$.**

$$v_y(t) = \frac{dy}{dt} = 12 - 10t$$
$$v_y(0) = 12 - 10(0) = 12\ m/s$$
$$v_y(2) = 12 - 10(2) = -8\ m/s$$

**b) At what time does the particle change its direction?**

$$v_y(t) = 0 = 12 - 10t$$
$$t = 1.2\ s$$

**c) Find the distance that the particle covers from $t = 0\ s$ to $t = 2\ s$.**

$$\Delta y_1 = y(1.2) - y(0) = [6 + 12(1.2) - 5(1.2)^2] - [6 + 12(0) - 5(0)^2] = 7.2\ m$$
$$\Delta y_2 = y(2) - y(1.2) = [6 + 12(2) - 5(2)^2] - [6 + 12(1.2) - 5(1.2)^2] = -3.2\ m$$
$$d = |\Delta y_1| + |\Delta y_2| = 7.2 + 3.2 = 10.4\ m$$

**LP2.** At $t = 0$, a particle starts from the **origin** with an initial velocity of $\vec{v}_i = (9\,\hat{j})\ m/s$ and moves in the *x-y* plane with a constant acceleration of $\vec{a} = (2\hat{i} - 4\hat{j})\ m/s^2$.

**a) Find the time at which the particle reaches $x = 15\ m$.**

$$x_f = x_i + v_{x_i}t + \frac{1}{2}a_x t^2$$

$$15 = 0 + 0 + \frac{1}{2}(2)t^2$$

$$t = 3.87\ s$$

**b) Find the particle's speed at $t = 3\ s$.**

$$\vec{v}_f = \vec{v}_i + \vec{a}t = 9\,\hat{j} + (2\hat{i} - 4\hat{j})(3) = (6\hat{i} - 3\hat{j})$$

$$|v| = \sqrt{(6)^2 + (-3)^2} = 6.7\ m/s$$

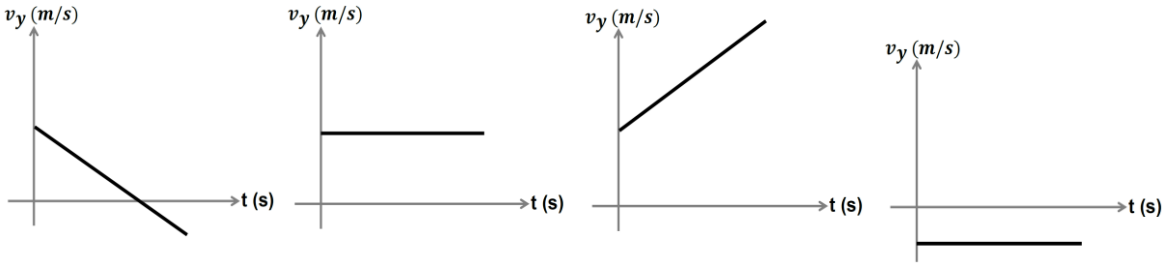
**OR**

$$v_x = v_{x_i}t + a_x t = 0 + 2(3) = 6\ m/s$$

$$v_y = v_{y_i}t + a_y t = 9 - 4(3) = -3\ m/s$$

$$|v| = \sqrt{(6)^2 + (-3)^2} = 6.7\ m/s$$

**c) Which of the following graphs best represents the particle's vertical velocity $v_y$ versus $t$?**

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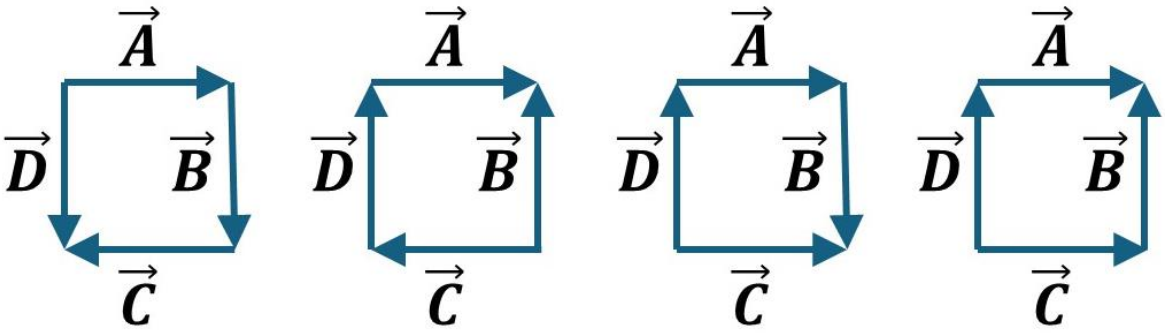
**Part III: Questions (Choose the correct answer, one point each)**

**Q1.** Which of the following figures satisfies the relation $\vec{B} = \vec{A} + \vec{D} - \vec{C}$ :




* * * (*)

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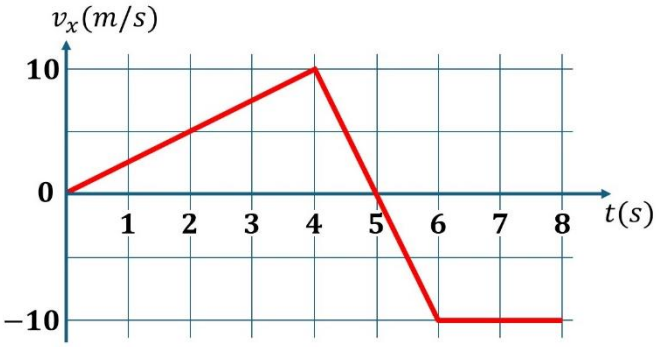
**Q2.** The figure shows the **velocity-time graph** for a particle moving along **the x-axis**. During which time intervals is the particle **speeding up?**




* $[0 - 4], [4 - 5]$

(*) $[0 - 4], [5 - 6]$

* $[4 - 5], [5 - 6]$

* $[0 - 4]$ only

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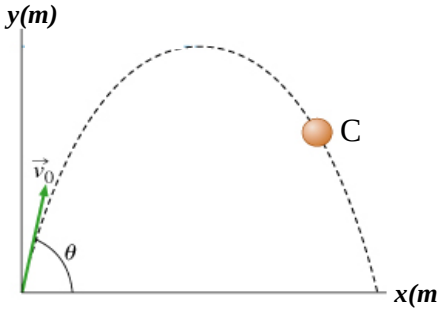
**Q3.** A projectile is fired from the ground with an initial velocity ($\vec{v}_0$) at an angle ($\theta$) with the horizontal, as shown. **At point C**, what are the **signs** of ($v_x$ and $v_y$), respectively?




* $(+, +)$

* $(-, +)$

(*) $(+, -)$

* $(-, -)$

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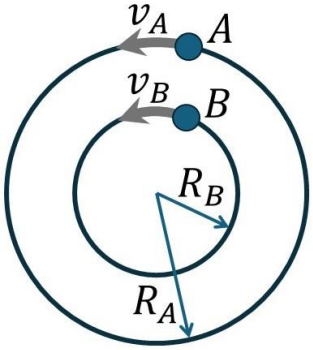
**Q4.** Two objects are moving with the **same constant speed** $(v_A = v_B)$ in two concentric circles, as shown. If the magnitude of acceleration for object A is $a_A$ and for object B is $a_B$, then which of the following statements is correct:




* $a_A = a_B = 0$

* $a_A = a_B \neq 0$

* $a_A > a_B$

(*) $a_A < a_B$