Kuwait University Physics Department

Physics 101

Spring Semester

First Midterm Exam

Saturday, April 2, 2022

11:00 AM – 12:30 PM

Student's Name: …….……. Serial Number: ……

Student's Number: ……. Section: ……

Choose your Instructor's Name:

Dr. Ahmed Al-Jassar	Dr. Belal Salameh
Dr. Hala Al-Jassar	Dr. Nasser Demir
Dr. Tareq Al Refai	Dr. Ruqayyah Askar
Dr. Abdul Khaleq	Dr. Bedoor Alkurtass

For Instructor's 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

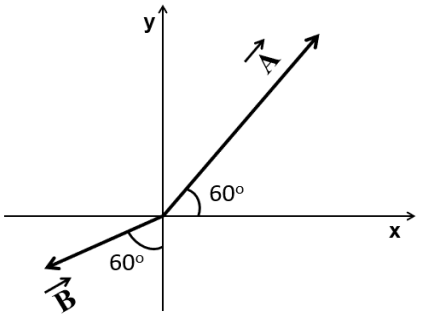
Important:

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. $\vec{A}$ and $\vec{B}$ are two vectors as shown. The magnitudes of $\vec{A}$ and $\vec{B}$ are $|\vec{A}| = 7\ m$ and $|\vec{B}| = 3\ m$. **Find the magnitude of $\vec{A} + \vec{B}$.**



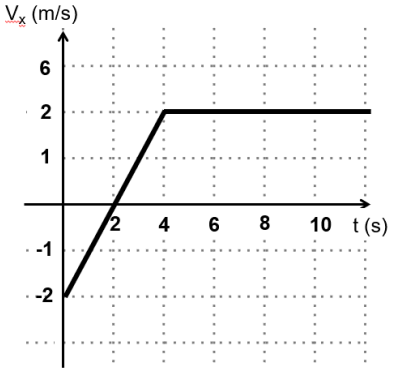
$$\vec{A} = (7\cos(60^o)\,\hat{\imath} + 7\sin(60^o)\,\hat{\jmath})\ m = (3.5\,\hat{\imath} + 6.1\,\hat{\jmath})\ m$$

$$\vec{B} = (-3\sin(60^o)\,\hat{\imath} - 3\cos(60^o)\,\hat{\jmath})\ m = (-2.6\,\hat{\imath} - 1.5\,\hat{\jmath})\ m$$

$$\vec{A} + \vec{B} = \left((3.5 - 2.6)\,\hat{\imath} + (6.1 - 1.5)\,\hat{\jmath}\right) m = (0.9\,\hat{\imath} + 4.6\,\hat{\jmath})\ m$$

$$|\vec{A} + \vec{B}| = \sqrt{0.9^2 + 4.6^2} = 4.7\ m$$

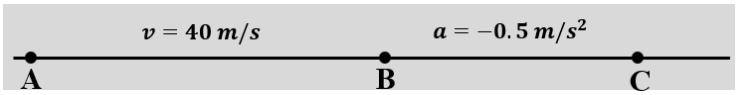
SP2. A particle moves along the x-axis, its velocity as a function of time is shown. **Find the <u>average speed</u> for the first 10 seconds.**



$$d = |Area| = \tfrac{1}{2}(2)(2) + \tfrac{1}{2}(2)(2) + (2)(6) = 16\ m$$

$$Av.speed = \frac{d}{t} = \frac{16}{10} = 1.6\ m/s$$

SP3. A particle moves from point A to point B in 20 $seconds$ with **a constant velocity** of 40 m/s. As the particle reaches point B it starts to reduce its velocity with **a constant acceleration** of $a = -0.5\ m/s^2$. The particle stopped finally at point C. **Find the distance covered by the particle from point <u>A to point C.</u>**



$$d_{AB} = vt = 40(20) = 800\ m$$

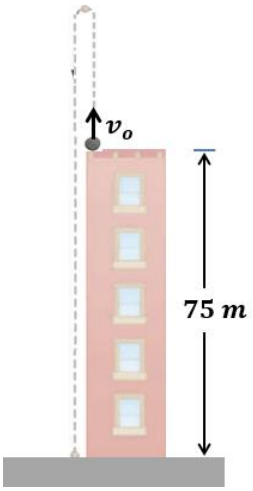
$$v_c^2 = v_B^2 + 2\,a\,d_{BC}$$

$$0 = 40^2 + 2\,(-0.5)\,d_{BC} \Longrightarrow d_{BC} = 1600\ m$$

$$d = d_{AB} + d_{BC}$$

$$d = 800 + 1600 = 2400\ m$$

SP4. A ball is thrown vertically upward from the roof of a building 75 m high. After 5 $seconds$ the ball hits the ground. **With what initial velocity was the ball thrown?**

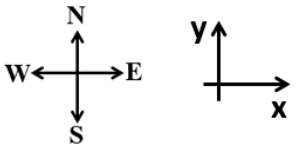


$$\Delta y = v_o t - \frac{1}{2} g t^2$$

$$-75 = v_o(5) - 5(5^2)$$

$$v_o = \frac{5(5^2) - 75}{5} = 10\ m/s$$

SP5. A car moves 40 km in the direction 36.9^o north of east then 48 km due south and finally 32 km due east. **Find the average velocity in unit vector notation (in km/hr) of the car if the whole trip takes 2 hours**.



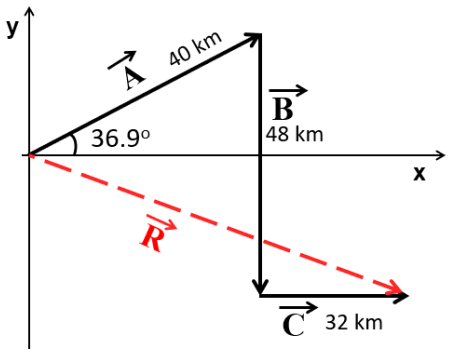
$$\vec{A} = (40\cos\ (36.9^o)\,\hat{\imath} + 40\sin(36.9^o)\,\hat{\jmath})\ km = (32\,\hat{\imath} + 24\,\hat{\jmath})\ km$$

$$\vec{B} = -48\,\hat{\jmath}\ km$$

$$\vec{C} = 32\,\hat{\imath}\ km$$

$$\vec{R} = \vec{A} + \vec{B} + \vec{C} = (64\,\hat{\imath} - 24\,\hat{\jmath})\ km$$

$$\vec{v}_{av} = \frac{\vec{R}}{t} = (32\,\hat{\imath} - 12\,\hat{\jmath})\ km/hr$$



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 $x(t) = 4 + 6t - t^2$ where $x\ is\ in\ \boldsymbol{m}\ and\ t\ is\ in\ \boldsymbol{s}$

a) Find the particle's initial velocity (at $\boldsymbol{t = 0\ s}$)

$$v_x(t) = \frac{dx}{dt} = 6 - 2t$$
$$v_x(0\ s) = 6 - 2(0) = 6\ m/s$$

b) At what position does the particle change its direction?

$$v_x(t) = 6 - 2t = 0 \Longrightarrow t = 3\ s$$
$$x(3s) = 4 + 6(3) - 3^2 = 13\ m$$

c) Find the distance covered by the particle during the first 6 $\boldsymbol{seconds}$.

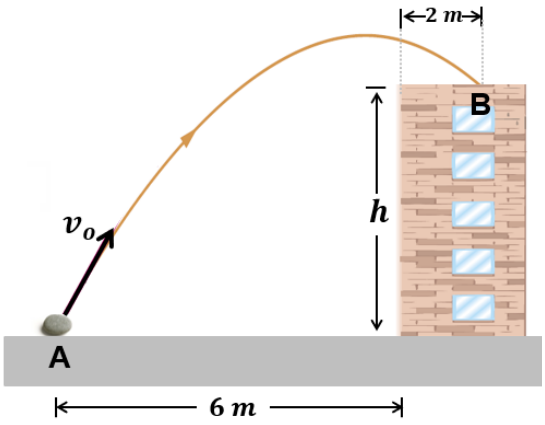
$$d = |\Delta x(0s - 3s)| + |\Delta x(3s - 6s)|$$
$$= |x(3s) - x(0s)| + |x(6s) - x(3s)|$$
$$= |13 - 4| + |4 - 13| = 18\ m$$

d) With what acceleration does the particle move?

$$a_x(t) = \frac{dv_x}{dt} = -2\ m/s^2$$

LP2. A stone is thrown from point A with an **initial** velocity $\vec{v}_o = (4\hat{\imath} + 12\hat{\jmath})\ m/s$. The stone strikes the roof of a building at point B.

a) With what initial speed was the stone thrown from point A?



$$v_o = \sqrt{4^2 + 12^2} = 12.6\ m/s$$

b) Find the total time of flight.

$$\Delta x = v_{x_o} t \Rightarrow t = \frac{\Delta x}{v_{x_o}} = \frac{8}{4} = 2\ s$$

c) Find the height (h) of the building.

$$h = \Delta y = v_{y_o} t - \frac{1}{2} g t^2 = (12)(2) - 5(2^2) = 4\ m$$

d) With what velocity in unit vector notation does the stone hit the roof at point B?

$$v_{x_B} = v_{x_o} = 4\ m/s$$

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

$$\vec{v}_B = (4\hat{\imath} - 8\hat{\jmath})\ m/s$$

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

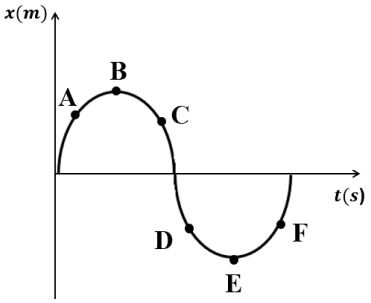
Q1. If $\vec{A} = 2\hat{\imath} - 2\hat{\jmath} + \hat{k}$, $\vec{B} = 2\hat{\jmath}$ and $\vec{C} = \vec{A} + \vec{B}$, then

* $|\vec{C}| > |\vec{A} + \vec{B}|$
* $|\vec{C}| < |\vec{A} + \vec{B}|$
* $|\vec{C}| > |\vec{A} - \vec{B}|$
* (*) $|\vec{C}| < |\vec{A} - \vec{B}|$

Q2. $\vec{A}$ and $\vec{B}$ are non-zero vectors. If $|\vec{A} \times \vec{B}| = 0$, then

* $\vec{A} \cdot \vec{B} = 0$
* $\vec{A} \cdot \vec{B} = -\vec{B} \cdot \vec{A}$
* (*) $\vec{A} \cdot \vec{B} = AB$
* $\vec{A}$ is perpendicular to $\vec{B}$

Q3. A man is moving along the x-axis. His position as a function of time is shown. **At which of the labeled points his velocity is <u>negative</u>?**



* (*) C and D
* D and F
* D, E, and F
* C and F

Q4. A ball is kicked from the ground with initial velocity $\vec{v} = (4\hat{\imath} + 3\,\hat{\jmath})\ m/s$. **Neglecting air resistance, the speed and acceleration of the ball at the highest point, respectively are:**

* $(4\ m/s, +10\ m/s^2)$
* (*) $(4\ m/s, -10\ m/s^2)$
* $(zero, -10\ m/s^2)$
* $(zero, +10\ m/s^2)$