Kuwait University Physics Department

جامعة الكويت
KUWAIT UNIVERSITY

Physics 101

Fall Semester

First Midterm Exam

Saturday, October 28, 2023

9:00 AM – 10:30 AM

Student's Name: …… Serial Number: ……

Model Answer

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

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

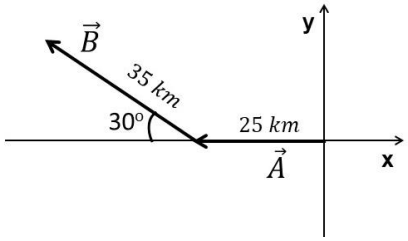
Important:

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. Two displacement vectors are shown. **Find $\vec{A} - 2\vec{B}$ in unit vector notation.**

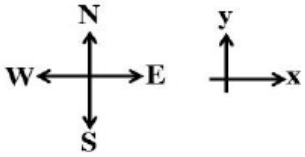


$\vec{A} = -25\,\hat{\imath}\ km$

$\vec{B} = (-35\cos 30^o\,\hat{\imath} + 35\sin 30^o\,\hat{\jmath})\ km = (-30.3\,\hat{\imath} + 17.5\,\hat{\jmath})km$

$\vec{A} - 2\vec{B} = -25\hat{\imath} - 2(-30.3\,\hat{\imath} + 17.5\,\hat{\jmath}) = (35.6\,\hat{\imath} - 35\,\hat{\jmath})\ km$

SP2. The scalar product of two vectors $\vec{A}$ and $\vec{B}$ is $-84\ m^2$. Vector $\vec{A}$ has magnitude $|\vec{A}| = 15\ m$ and direction 37° **north of east**. If vector $\vec{B}$ is in the west direction, **what is the magnitude of $\vec{B}$** ?



$\vec{A} \cdot \vec{B} = AB\cos\varphi$

$-84 = 15(B)\cos 143^o$

$B = 7$ m

SP3. A car traveling in a straight line **slows down** with constant acceleration. If the stopping distance is 80 m and the stopping time is 8 seconds, **find the car's initial speed (in km/h).**

$\Delta x = \left(\frac{v_{x_i} + v_{x_f}}{2}\right)\Delta t$

$v_{x_i} = 2\frac{\Delta x}{\Delta t} - v_{x_f} = 2\left(\frac{80}{8}\right) - 0 = 20$ m/s

$v_{x_i} = 20\left(\frac{3600}{1000}\right) = 72$ km/h

OR

$v_{x_f} = v_{x_i} + a_x t$

$0 = v_{x_i} + a_x(8) \Rightarrow a_x = \frac{-v_{x_i}}{8}$

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

$80 = v_{x_i}(8) + \frac{1}{2}\left(\frac{-v_{x_i}}{8}\right)(8)^2 \Rightarrow 4v_{x_i} = 80 \Rightarrow v_{x_i} = 20\ m/s$

$v_{x_i} = 20\left(\frac{3600}{1000}\right) = 72$ km/h

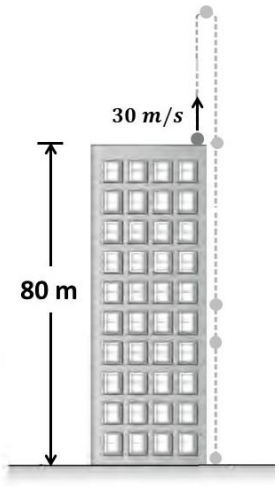
SP4. A particle is moving in the ***xy*-plane**. Its position vector as a function of time is given by $\vec{r}(t) = (2 + 25t - t^2)\hat{\imath} + (4t - t^4)\hat{\jmath}$, where $\vec{r}$ is measured in meters and t in seconds. **Find the <u>speed</u> of the particle at $t = 2$ seconds.**

$$\vec{v} = \frac{d\vec{r}}{dt} = (25 - 2t\,)\hat{\imath} + (4 - 4t^3)\hat{\jmath}$$

$$\vec{v}(2) = \big(25 - 2(2)\big)\hat{\imath} + (4 - 4(2)^3)\hat{\jmath} = (21\,\hat{\imath} - 28\,\hat{\imath})\ m/s$$

$$speed = |\vec{v}| = \sqrt{21^2 + (-28)^2} = 35\ m/s$$

SP5. A stone is thrown vertically **upward** from the top of a building 80 m high, as shown. Its initial speed is 30 m/s. **If the total time it takes to reach the ground is 8 seconds, find the <u>average speed</u> of the stone from the initial to final point.**



$$av.speed = \frac{d}{t}$$

$$d = 2h + 80$$

from the initial point to the max. height

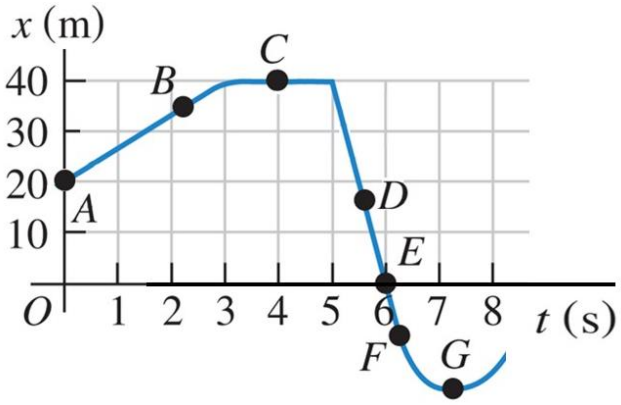
$$v_{y_f}^2 = v_{y_i}^2 - 2g\Delta y$$

$$h_{max} = \frac{v_{iy}^2}{2g} = \frac{30^2}{2(10)} = 45\ m$$

$$av.speed = \frac{d}{t} = \frac{2(45)+80}{8} = 21.25\ \text{m/s}$$

Part II: Long Problems (3 points each)

LP1. An object is moving along the x-axis. Its position as a function of time is shown in the graph.



a) Find the velocity of the object at instant C.

$v_x = 0\ m/s.$

b) Find the average velocity between $t = 0\ s$ and $t = 5\ s$.

$v_{av-x} = \frac{\Delta x}{\Delta t} = \frac{40-20}{5-0} = \frac{20}{5} = +4\ m/s$

c) Find the time when the object reaches the origin.

$x = 0 \quad at \quad t = 6s$ 0.5

d) At instant G, the acceleration of the object is

*** positive.**

*** negative.**

*** zero.**

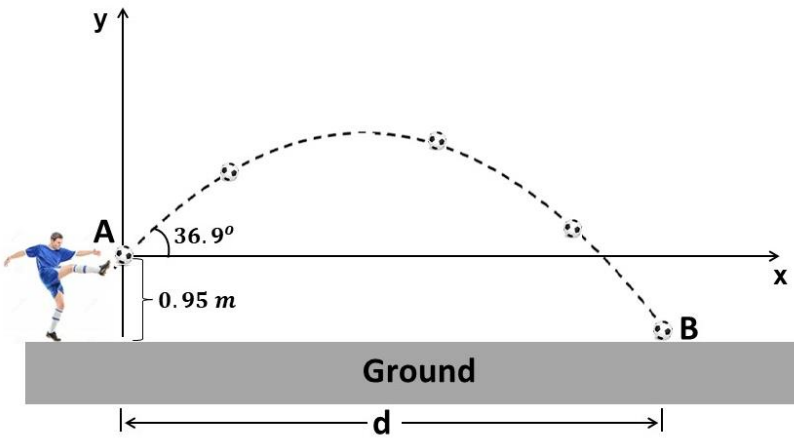
LP2. A ball is shot such that it leaves the player's foot at **point A** 0.95 m above ground level, as shown. The initial speed of the ball is 15 m/s at an angle of 36.9^o above the horizontal.

a) Find the time required for the ball to reach the ground.

$$\Delta y = v_{yi}t - \frac{1}{2}gt^2$$

$$-0.95 = 15\ sin\ 36.9\ t - \frac{1}{2}(10)t^2$$

$$t = 1.9\ s$$



b) Find the horizontal distance (d) between point A and point B.

$$d = v_{x_i}t_{total} = 15\cos 36.9^{\circ}\ (1.9) = 22.8\ m$$

c) Find the velocity of the ball just before it strikes the ground (at point B) in unit vector notation.

$$v_{xf} = 15\ cos\ 36.9^{\circ} = 12\text{m/s}$$

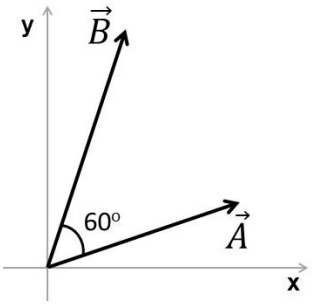
$$v_{yf} = v_{yi} - gt = 15\sin 36.9^{\circ} - 10(1.9) = -10\text{ m/s}$$

$$\vec{v}_f = (12\hat{\imath} - 10\hat{\jmath})\text{ m/s}$$

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

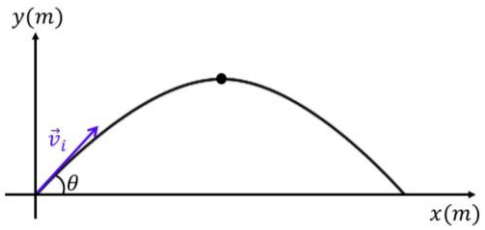
Q1. Two vectors $\vec{A}$ and $\vec{B}$ in the xy plane as shown. The magnitudes of the vectors are $|\vec{A}| = 3$ and $|\vec{B}| = 4$.

The result of the cross product $\vec{A} \times \vec{B}$ is:



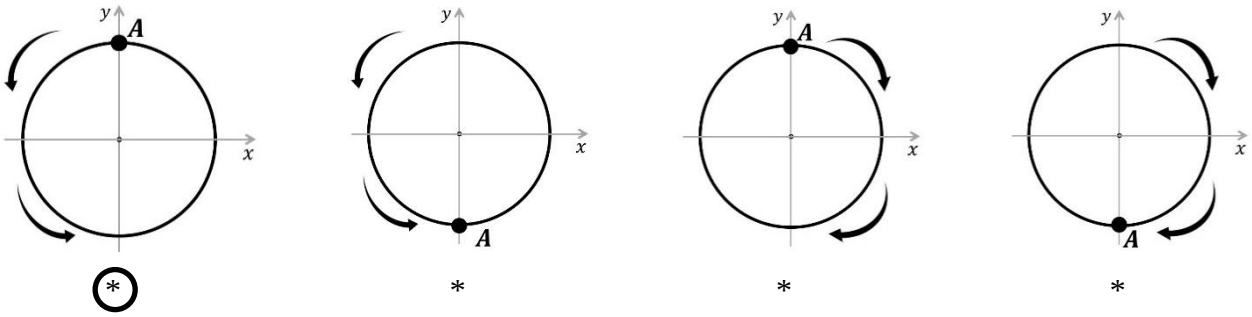
* $3\,\hat{k}$
* $6\sqrt{3}\,\hat{k}$
* $-6\sqrt{3}\,\hat{k}$
* $-3\,\hat{k}$

Q2. A projectile is launched from ground level. **When it reaches its maximum height**, which of the following **is true about its acceleration and velocity vectors**?



* $\vec{v} = 0$ *and* $\vec{a} = 0$.
* $\vec{v}$ *and* $\vec{a}$ **are parallel to each other.**
* $\vec{v}$ *and* $\vec{a}$ **are perpendicular to each other.**
* $\vec{v} = 0$ *and* $\vec{a} = -g\hat{j}$

Q3. A particle is moving in a horizontal circular path at a **constant speed**, as shown. If the velocity and acceleration of the particle at point A are $\vec{v}_A = -4\hat{\imath}$ m/s and $\vec{a}_A = -2\hat{\jmath}$ m/s^2, respectively, **the figure which satisfy these conditions is**



* * *

Q4. An object is moving along the x-axis. If the velocity is **positive** but the acceleration is **negative**, which of the following is true?

* The object is speeding up.
* The object is slowing down.
* The object is at rest.
* The object is moving at constant speed.