Kuwait University **Physics Department**

Physics 101

Spring Semester
First Midterm Exam
Saturday, March 3, 2018
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. Abdul Mohsen
Dr. Hala Al-Jassar	Dr. Tareq Al Refai
Dr. Fatema Al Do[illegible]ri	Dr. Abdul Khaleq
Dr. Nass[illegible]emir	Dr. Belal Salameh

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	SP1	[illegible]	SP3	SP4	SP5	LP1	LP2	Total
Pts	1	1	1	1	2	2	[illegible]	2	2	3	3	20

Important:

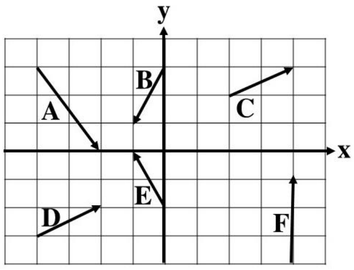
1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i) 4 **Q**uestions
   ii) 5 **S**hort **P**roblems
   iii) 2 **L**ong **P**roblems.
3. No solution = no points.
4. **Use correct units.**
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.
7. Mobiles are **strictly prohibited** during the exam.
8. Programmable calculators, which can store equations, are not allowed.
9. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

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

Q1. Which two vectors, when added, will have the **largest (positive) y component?**

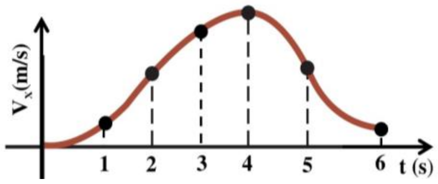
- * $\vec{C}$ and $\vec{D}$
- [✓ * $\vec{E}$ and $\vec{F}$]
- * $\vec{A}$ and $\vec{F}$
- * $\vec{A}$ and $\vec{B}$



Q2. The velocity versus time of an object moving along the x axis is shown in the figure. During which time interval is **the acceleration always positive**?

* $0 < t < 6$ * $4 < t < 6$

* $2 < t < 6$ [✓ * $0 < t < 4$]



Q3. A car is traveling along **the negative x-axis** begins to **slow down as** it approaches a traffic light. Then,

* Its acceleration and its velocity are positive. [✓ * Its acceleration is positive, but its velocity is negative.]

* Its acceleration and its velocity are negative. * Its acceleration is negative, but its velocity is positive

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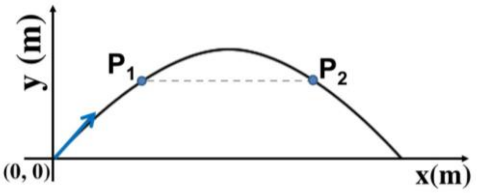
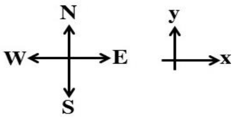
Q4. The trajectory of a ball which is projected from the ground level is shown in the figure. If the position and the velocity of the ball at point P_1 respectively, are: $\vec{r_1} = (2\hat{\imath} + 3\hat{\jmath})\text{m}$ and $\vec{V_1} = (4\hat{\imath} + 6\hat{\jmath})\text{m/s}$, **then the position and the velocity of the ball at point P_2 respectively, are:**

- * $\vec{r_2} = (2\hat{\imath} + 3\hat{\jmath})\text{m}$ and $\vec{V_2} = (4\hat{\imath} - 6\hat{\jmath})\text{m/s}$
- * $\vec{r_2} = (7\hat{\imath} + 3\hat{\jmath})\text{m}$ and $\vec{V_2} = (4\hat{\imath} + 6\hat{\jmath})\text{m/s}$
- [✓ * $\vec{r_2} = (7\hat{\imath} + 3\hat{\jmath})\text{m}$ and $\vec{V_2} = (4\hat{\imath} - 6\hat{\jmath})\text{m/s}$]
- * $\vec{r_2} = (7\hat{\imath} + 3\hat{\jmath})\text{m}$ and $\vec{V_2} = (-4\hat{\imath} - 6\hat{\jmath})\text{m/s}$



Part II: Short Problems (2 points each)

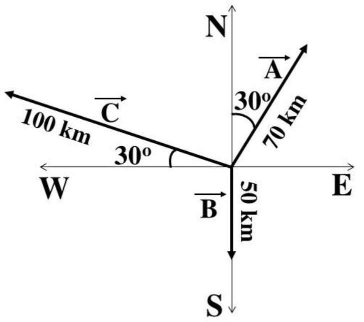
SP1. A car undergoes the following displacements: First, 70 **km in a direction 30° east of north**, then **50 km due south** and finally **100 km 30° north of west**. If the trip took **2 hours**, **find the average velocity (in km/h) of the car during the trip**. Use unit vector notation.



$\vec{A} = 70\sin(30^o)\,\hat{\imath} + 70\cos(30^o)\hat{\jmath} = (35\,\hat{\imath} + 60.6\,\hat{\jmath})\ km$

$\vec{B} == -50\,\hat{\jmath}\ \ km$

$\vec{C} = -100\ \cos(30^o)\,\hat{\imath} + 100\,sin(30^o)\hat{\jmath} = (-86.6\,\hat{\imath} + 50\ \ \hat{\jmath})\ km$

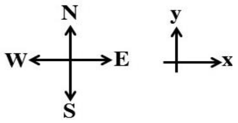


$\vec{R} = \vec{A} + \vec{B} + \vec{C} = (-51.6\,\hat{\imath} + 60.6\,\hat{\jmath})\ km$

$\overrightarrow{V_{av}} = \frac{\vec{R}}{t} = (-25.8\,\hat{\imath} + 30.3\,\hat{\jmath})\ km/hr$

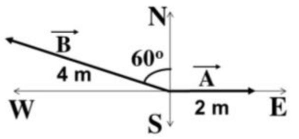
Answer: $\overrightarrow{V_{av}} = (-25.8\,\hat{\imath} + 30.3\,\hat{\jmath})\ km/hr$

SP2. Vector $\vec{A}$ of magnitude 2 m and pointing east and vector $\vec{B}$ of magnitude 4 m and pointing 60° west of north. **Find the magnitude of $\vec{A} \times \vec{B}$.**



$$|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}| \sin(\theta) = (2)(4)\sin(150^o)$$

$$= 4 \text{ m}^2$$



Answer: $|\vec{A} \times \vec{B}| = 4 \text{ m}^2$

SP3. A box slides across a floor with an acceleration of magnitude 0.5 m/s^2 in a direction opposite to its velocity. If the speed of the box is 4 m/s after sliding 9 m, **what was its initial speed (in m/s)?**

V_{xf}=4 m/s a_x=-0.5 m/s^2 $\Delta x = 9\ m$

$$V_{xf}^2 = V_{xi}^2 + 2a_x\Delta x$$

$$4^2 = V_{xi}^2 + 2(-0.5)(9)$$

V_{xi} = 5 m/s

Answer: V_{xi} = 5 m/s

SP4. A package is released from a helicopter which is moving upward at constant speed of 15 m/s. The package takes 8 s to reach the ground. **What was the height (in m) of the package above the ground when it was released? Neglect air resistance.**

V_{yi}= +15 m/s t=8 s

$$\Delta y = V_{yi}t - \frac{1}{2}gt^2 = 15(8) - 5(8)^2$$

= -200 m

h = 200 m

Answer: h = 200 m

SP5. If $\vec{A} + \vec{B} = 6\hat{\imath}$ and $\vec{A} - \vec{B} = 8\hat{\jmath}$, **find** $\boldsymbol{\vec{A} \cdot \vec{B}}$**.**

$2\vec{A} = 6\hat{\imath} + 8\hat{\jmath} \quad \Rightarrow \vec{A} = 3\hat{\imath} + 4\hat{\jmath}$

$2\vec{B} = 6\hat{\imath} - 8\hat{\jmath} \quad \Rightarrow \vec{B} = 3\hat{\imath} - 4\hat{\jmath}$

$\vec{\mathrm{A}} \cdot \vec{\mathrm{B}} = (3)(3) + (4)(-4) = -7$

Answer: $\vec{\mathrm{A}} \cdot \vec{\mathrm{B}} = -7$

Part III: Long Problems (3 points each)

LP1. The position of a remote car is given by $x(t) = 6t + 3$ and $y(t) = 12t - 2t^2$, where x and y are in meters, and t is in seconds.

a. What is the magnitude of the car's velocity (in m/s) at t=2 s?

$V_x = \frac{dx}{dt} = 6 \ m/s \qquad V_y = \frac{dy}{dt} = (12 - 4t) \ m/s \qquad V_y(2s) = 4 \, m/s$

$\vec{V}(2s) = V_x(2s)\ \hat{\imath} + V_y(2s)\ \hat{\jmath} = (6\ \hat{\imath} + 4\ \hat{\jmath})$ m/s

$\left|\vec{V}(2s)\right| = \sqrt{6^2 + 4^2} = 7.2 \ m/s$

Answer: $\left|\vec{V}(2s)\right| = 7.2 \ m/s$

b. What is the position vector in unit vector notation of the car when its speed is 6 m/s.

Speed =6 m/s then $V_y = 0$ m/s

$V_y = 12 - 4t = 0 \quad \Longrightarrow \quad t = 3\ s$

$x(3\ s) = 6(3) + 3 = 21\ m$

$y\ (3\ s) = 12(3) - 2(3)^2 = 18\ m$

$\vec{r}(3s) = (21\ \hat{\imath} + 18\ \hat{\jmath})$ m

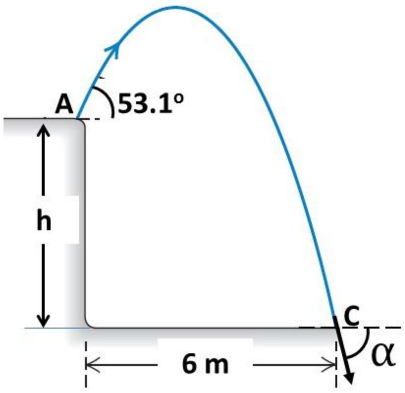
Answer: $\vec{r}(3s) = (21\ \hat{\imath} + 18\ \hat{\jmath})$ m

c. The car is moving with

* constant velocity
[✓ * constant acceleration]
* varying acceleration

LP2. A stone is thrown from the edge of a cliff (point A) with a speed of 5 m/s, at an angle of 53.1° above the horizontal as shown in the figure. The stone strikes the ground at point C, calculate,

a. The time of flight (in s) from point A to point C.



$$V_{xi} = 5\cos(53.1^o) = 3\ m/s \qquad V_{yi} = 5\sin(53.1^o) = 4\ m/s$$

$$\Delta x = V_{xi}t \quad \Longrightarrow t = \frac{\Delta x}{V_{xi}} = \frac{6}{3} = 2\ s$$

Answer: $t = \ 2\ s$

b. The height of the cliff (h) (in m).

$$\Delta y = V_{yi}t - \frac{1}{2}gt^2 = 4(2) - 5(2^2) = -12\ m$$

h = 12 m

Answer: h = 12 m

c. If the stone hits point C in the direction shown in the figure, find the angle α.

$$V_{xf} = V_{xi} = 3\ m/s$$

$$V_{yf} = V_{yi} - gt = 4 - (10)(2) = -16\ m/s$$

$$\alpha = tan^{-1}\left(\frac{16}{3}\right) = 79.4\ ^o$$

Answer: $\alpha = 79.4\ ^o$