Kuwait University Physics Department

Physics 101

Spring Semester
First Midterm Exam
Saturday, March 2, 2019
9:00 am – 10:30 am

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

Prof. Yacoub Makdisi	Tareq Al Refai
Dr. Ahmed Al-Jassar	Dr. Belal Salameh
Dr. Hala Al-Jassar	Dr. Abdel Khaleq
Dr. Nasser Demir	

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
Pts	1	1	1	1	2	2	2	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 SI 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. **Please write down your final answer in the box shown in each problem.**
10. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

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

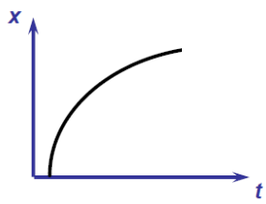
Q1. If $|\vec{A}+\vec{B}| = |\vec{C}|$ and $|\vec{A}| + |\vec{B}| = |\vec{C}|$, then

* $\vec{A}$ is perpendicular to $\vec{B}$
* (*) $\vec{A}$ is parallel to $\vec{B}$
* $\vec{A}$ is anti parallel to $\vec{B}$
* The angle between $\vec{A}$ and $\vec{B}$ is 45°

Q2. Ball A is dropped from the top of a building. **One second later**, ball B is dropped from the **same building**. As time progresses, **the difference in their speeds**. (assume no air resistance)

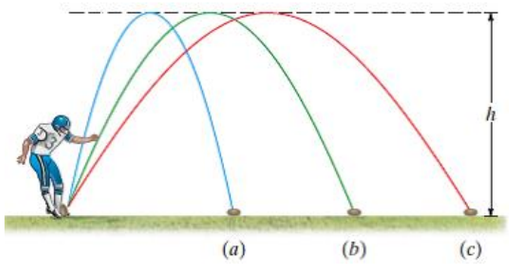
* increases
* (*) remains constant
* decreases
* cannot be determined from the information given

Q3. The graph of position versus time for a car is given below. **What can you say about the velocity of the car** over the shown period of time?



* it speeds up all the time
* (*) it slows down all the time
* it moves at constant velocity
* sometimes it speeds up and sometimes it slows down

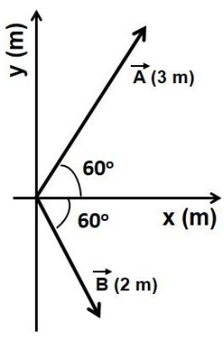
Q4. The three trajectories in the shown figure reach **the same maximum height** (h). Ignore the air resistance, **which trajectory has the longest time in air?**



* a
* b
* c
* (*) all have the same time.

Part II: Short Problems (2 points each)

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



$\vec{A} = 3\cos 60\,\hat{\imath} + 3\ \sin 60\ \hat{\jmath}$

$= (1.5\,\hat{\imath} + 2.6\,\hat{\jmath})\ m$

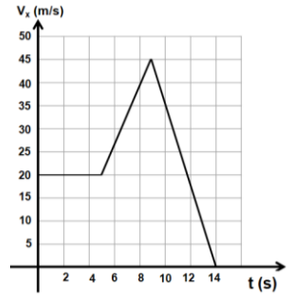
$\vec{B} = 2\cos 60\,\hat{\imath} - 2\ \sin 60\ \hat{\jmath}$

$= (1\,\hat{\imath} - 1.73\,\hat{\jmath})\ m$

$\vec{A} - \vec{B} = (0.5\,\hat{\imath} + 4.33\,\hat{\jmath})m$

Answer: $\vec{A} - \vec{B} = (0.5\,\hat{\imath} + 4.33\ \hat{\jmath}\ )$ m

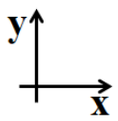
SP2. The figure shows the velocity of an object moving along the x-axis as a function of time. **Find the average acceleration (in m/s^2) of the object during the interval from $t = 0s$ to $t = 14s$.**



$$a_{av-x} = \frac{V_{xf} - V_{xi}}{t_f - t_i}$$
$$= \frac{0-20}{14-0}$$
$$= -1.43 \ \ m/s^2$$

Answer: $a_{av-x} = -1.43 \ \ m/s^2$

SP3. A particle **on a planet** is moving with constant acceleration. It is given an **initial velocity** of 19 m/s (**upward).** After 10 s, its velocity is 19 m/s (**downward**). **Find the acceleration due to gravity of this planet (magnitude and direction).**



$V_f = V_i + at$

$-19 = 19 + a(10)$

$a = -3.8 \ m/s^2$

$|a| = 3.8 \, m/s^2$

Direction = downward

Answer: $|a| = 3.8$ m/s^2 downward

SP4. A particle is moving along the positive x-axis. Its speed **decreases** uniformly from 0.4 m/s to 0.2 m/s in 5 s **and then it moves with a constant acceleration** of 0.2 m/s^2 during the next 4 s. **What is the average speed (in m/s) of the particle over the whole time interval?**

$\Delta x_1 = V_{av}\Delta t = \left(\frac{0.2 + 0.4}{2}\right)(5) = 1.5 \, m$

$\Delta x_2 = V_i \, t + \frac{1}{2}at^2 = (0.2)(4) + \frac{1}{2}(0.2)(4)^2 = 2.4 \, m$

$V_{av} = \frac{d}{t} = \frac{1.5+2.4}{9} = 0.43 \, m/s$

Answer: $V_{av} = 0.43 \, m/s$

SP5. An object starts from **the origin** at $t = 0 \, s$, with initial velocity of $\vec{V_o} = (6\hat{\imath} + 8\hat{\jmath}) \, m/s$ and moves in the xy plane with constant acceleration of $\vec{a} = (2\hat{\imath} - 4\hat{\jmath}) \, m/s^2$. **How far is the object from the origin at $t = 2s$?**

$\vec{r}_f = \vec{r}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2$

$= (6\,\hat{\imath} + 8\,\hat{\jmath})\,(2) + \frac{1}{2}(2\hat{\imath} - 4\hat{\jmath})\,(2)^2$

$= (16\,\hat{\imath} + 8\,\hat{\jmath})m$

$d = |\vec{r}_f| = \sqrt{16^2 + 8^2} = 17.9 \, m$

Answer: $d = 17.9 \, m$

Part III: Long Problems (3 points each)

LP1. A boy runs across the playground. The coordinates of his position as a function of time are given by:

$$x(t) = -3t^2 + 4t$$
$$y(t) = 2t^2 - 3$$

where x and y are in meters, and t is in seconds.

a) What is the position vector ($\vec{r}$) of the boy at $t = 2\ s$ in unit vector notation?

$$\vec{r}(2s) = \left(-3(2)^2 + 4(2)\right)\hat{\imath} + (2(2)^2 - 3)\,\hat{\jmath}$$
$$= (-4\,\hat{\imath} + 5\,\hat{\jmath})\ \text{m}$$

Answer: $\vec{r}(2s) = (-4\,\hat{\imath} + 5\,\hat{\jmath})$ m

b) What is the velocity vector ($\vec{V}$) at $t = 2\ s$ in unit vector notation?

$$\vec{V} = \frac{d\vec{r}}{dt} = [(-6t + 4)\,\hat{\imath} + 4\,t\,\hat{\jmath}]\ m/s^2$$
$$\vec{V}(2s) = (-8\,\hat{\imath} + 8\,\hat{\jmath})\ m/s$$

Answer: $\vec{V}(2s) = (-8\,\hat{\imath} + 8\,\hat{\jmath})\ m/s$

c) What is the average velocity vector ($\vec{V}_{av}$) from $t = 0\ s$ to $t = 2\ s$ in unit vector notation?

$$\vec{V}_{av} = \frac{\Delta\vec{r}}{\Delta t} = \frac{\vec{r}(2) - \vec{r}(0)}{2 - 0} = \frac{-4\,\hat{\imath} + 5\,\hat{\jmath} + 3\hat{\jmath}}{2}$$
$$= (-2\,\hat{\imath} + 4\,\hat{\jmath})\ m/s$$

Answer: $\vec{V}_{av} = (-2\,\hat{\imath} + 4\,\hat{\jmath})\ m/s$

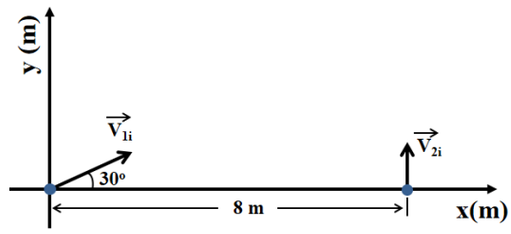
LP2. A projectile is shot from the origin with initial speed $V_{1i} = 24\ m/s$ at $\theta = 30°$. **At the same time**, a second object is thrown **upward** with $V_{2i} = 12\ m/s$, as shown in the figure.

a) Write the position vector ($\vec{r}\ (t)$) as a function of time for the first projectile.

$$\vec{r}(t) = x(t)\,\hat{\imath} + y(t)\,\hat{\jmath}$$

$$= 24\cos 30\ \ t\,\hat{\imath} + (24\sin 30\,t - 5\,t^2)\,\hat{\jmath}$$

$$= (20.78\,t\,\hat{\imath} + (12t - 5\,t^2)\,\hat{\jmath})m$$



Answer: $\vec{r}(t) = (20.78\,t\,\hat{\imath} + (12t - 5\,t^2)\,\hat{\jmath})m$

b) At what time do the two objects hit each other?

$$\Delta x_1 = (V_{1i}\cos\theta)\,t = 8\,m$$

$$t = \frac{8}{24\cos 30} = 0.385\ s$$

Answer: $t = 0.385\ s$

c) At what height (h) from the ground do the two objects hit each other?

$$\Delta y = h = V_{2i}t - \frac{1}{2}\,g\,t^2$$

$$= 12(0.385) - 5(0.385)^2$$

$$= 3.88\,m$$

Answer: $h = 3.88\,m$