Kuwait University Physics Department

Physics 101

Fall Semester
First Midterm Exam
Saturday, October 12, 2019
9:00 am – 10:30 am

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

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

Grades:

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
Pt	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.**

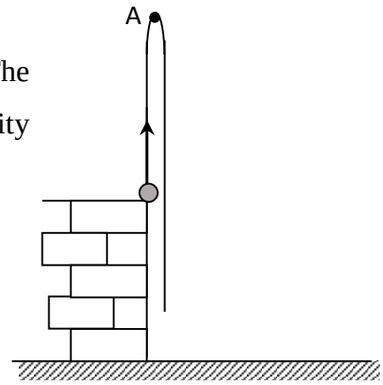
GOOD LUCK

Part I: Questions (one point each)

Q1. If $\vec{A}$ and $\vec{B}$ are **nonzero vectors** and $\vec{A} \cdot \vec{B} = 0$, then which of the following **is always true**.

* $\vec{A}$ is parallel to $\vec{B}$.
* (*) $|\vec{A} \times \vec{B}| = AB$
* $|\vec{A} \times \vec{B}| = 1$
* $|\vec{A} \times \vec{B}| = 0$

Q2. A ball is thrown **vertically upward form the top of a building** as shown. The signs of the ball's displacement (as measured from the initial position), velocity and acceleration, respectively **at the highest point in its path (point A) are:**

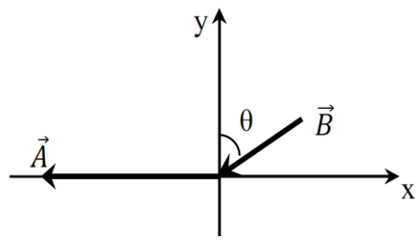


* (+, 0, +)
* (*) (+, 0, –)
* (+, 0, 0)
* (+, +, +)

Q3. A particle starts to move from the origin, its position vector at $t = 2\ s$ is $\vec{r}_1 = (4\hat{\imath} + 4\hat{\jmath})\ m$ and its position vector at $t = 4\ s$ is $\vec{r}_2 = (8\hat{\imath} + 6\hat{\jmath})\ m$ then **its average velocity (in m/s) during the time interval from 2 s to 4 s is:**

* $\hat{\imath}$
* $\hat{\imath} + \hat{\jmath}$
* (*) $2\hat{\imath} + \hat{\jmath}$
* $3\hat{\imath} + 2\hat{\jmath}$

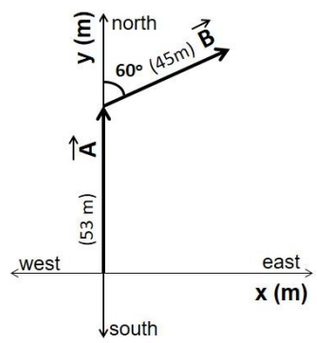
Q4. Vector $\vec{A}$ and vector $\vec{B}$ are shown in the figure. $\vec{A} \cdot \vec{B}$ equals:



* $AB\cos(\theta)$
* (*) $AB\sin(\theta)$
* $AB\cos(\pi/2 + \theta)$
* $AB\sin(\pi/2 + \theta)$

Part II: Short Problems (Two points each)

SP1. You walk 53 m to the north, then 45 m, 60° east of north as shown in the figure. Determine the magnitude and direction of **your displacement vector relative to east (x-axis).**



$\vec{A} = 53\hat{\jmath}$ m

$\vec{B} = 45\sin 60\,\hat{\imath} + 45\cos 60\ \hat{\jmath}$ m

$= 39\,\hat{\imath} + 22.5\ \hat{\jmath}$ m

$\vec{C} = \vec{A} + \vec{B}$

$\vec{C} = 39\,\hat{\imath} + 75.5\,\hat{\jmath}$

$C = \sqrt{(39)^2 + (75.5)^2} = \sqrt{7300} = 85\ m$

$\theta = tan^{-1}\ \frac{75.5}{39} = 62.7°$

Answer: $C = 85\ m\ ,\ \theta = 62.7°$

SP2. Two cars A and B start racing **from rest** at t = 0 s with constant accelerations of $\boldsymbol{a_A = a}$ and $\boldsymbol{a_B = \frac{1}{2}a}$, respectively. After 10 seconds the distance between the cars becomes 100 m. **Calculate the acceleration (in m/s^2) of car A ($\boldsymbol{a_A}$).**

$\Delta x_A = 0 + \frac{1}{2}at^2$

$\Delta x_B = 0 + \frac{1}{4}at^2$

$\Delta x_A - \Delta x_B = \frac{1}{4}at^2$

$100 = \frac{1}{4}a(10)^2 \quad \therefore a = 4\ m/s^2$

Answer: $a = 4\ m/s^2$

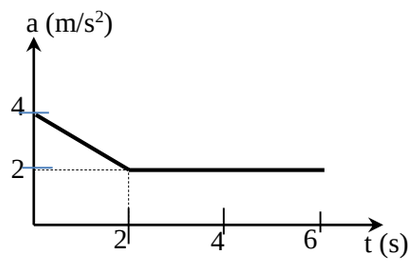
SP3. A particle starts moving at $t = 0\ s$ in a straight line with initial velocity of 2 m/s. Its acceleration as a function of time is shown in the figure. **Find the particle velocity (in m/s) at t = 4 s.**

$\because\ \Delta v = Area$ under a vs t curve

$\therefore \Delta v = 4 + 2 + 4 = 10$

$\because v - v_o = 10$

$\therefore v = 2 + 10 = 12\ m/s$



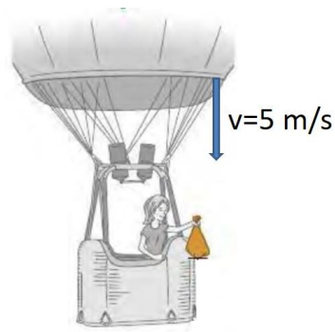
Answer: $v = 12\ m/s$

SP4. A hot-air balloon is moving downward at constant speed of 5 m/s. A package is released from rest from the balloon when it is 80 m above the ground as shown in the figure. **How long (in s) does the package take to reach the ground?**

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

$-80 = -5t - 5t^2$

$t = 3.5\ s$



Answer: t = 3.5 s

SP5. The velocity vector of a particle is given by

$\vec{v} = (4 - 2t)\,\hat{\imath} + 4\hat{\jmath}$ $\vec{v}$ is in m/s and t is in s.

Find the time (in s) at which the velocity $\vec{v}$ and acceleration $\vec{a}$ are perpendicular.

$\vec{a} = -2\,\hat{\imath}$

$\because \vec{v} \cdot \vec{a} = 0$

$\therefore [(4 - 2t)\,\hat{\imath} + 4\hat{\jmath}] \cdot (-2\,\hat{\imath}) \Longrightarrow -8 + 4t = 0$

$\therefore t = 2\ s$

Answer: $t = 2\ s$

Part III: Long Problems (Three points each)

LP1. An object moves along a straight line (x-axis). The equation of the object's position as a function of time is:

$$x(t) = 40 + 6\,t - 0.2\,t^2$$

where x in meter and t in second

a) Find the average velocity (in m/s) of the object during the first 20 s.

$\mathrm{x}(0) = 40\ m \qquad x(20) = 40 + 120 - 80 = 80\ m$

$$V_{av} = \frac{\mathrm{x}(20) - \mathrm{x}(0)}{20} = \frac{80 - 40}{20} = 2\ m/s$$

Answer: $2\ m/s$

b) Find the time (in s) at which the object reverse its direction of motion.

$$V = \frac{\mathrm{dx}}{\mathrm{dt}} = 6 - 0.4\,\mathrm{t} = 0 \Rightarrow \mathrm{t} = 15\ \mathrm{s}$$

c) Find the position (in m) of the object when its velocity is 4 m/s.

$\mathrm{v} = 6 - 0.4\,\mathrm{t}$

$4 = 6 - 0.4\,t$

$0.4\,t = 2$

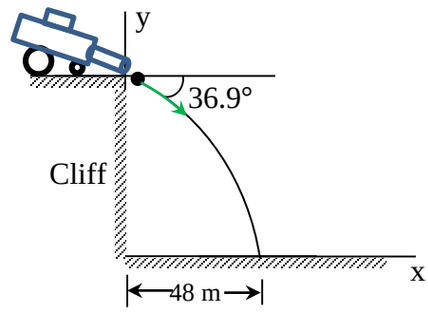
$t = 5\ s$

$x(5) = 40 + 30 - 5$

$= 65\ m$

Answer: $65\ m$

LP2. A cannon on the top of a cliff, fires a ball 36.9° below the horizontal direction as shown. The ball hits the ground after 2 s at a horizontal distance 48 m from the cliff.



a) With what initial speed (in m/s) does the cannon fire the ball?

$$v_{ox} = \frac{\Delta x}{\Delta t} = \frac{48}{2} = 24\ m/s$$

$$\because v_{ox} = v_o \cos 36.9$$

$$\therefore v_o = \frac{v_{ox}}{\cos 36.9} = \frac{24}{.8} = 30\ m/s$$

Answer: $30\ m/s$

b) With what velocity (in m/s) does the ball hit the ground in unit vector notation?

$$v_y = v_{oy} - gt$$

$$= -30 \sin 36.9 - 20$$

$$= -18 - 20 = -38\ \ m/s$$

$$\vec{v} = (24\,\hat{\imath} - 38\hat{\jmath})\ \ m/s$$

Answer: $(24\,\hat{\imath} - 38\hat{\jmath})\ m/s$

c) What is the height (in m) of the cliff?

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

$$= (-18)(2) - 5\,(2)^2$$

$$= -36 - 20 = -56\ m$$

$$\therefore h = 56\ m$$

Answer: $56\ m$