Kuwait University Physics Department

Physics 101

Summer Semester
First Midterm Exam
Sunday, June 24, 2018
6:00 pm – 7:30 pm

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

Dr. Hala Al-Jassar Dr. Tareq Al Refai
Dr. Fatema Al Dosari Dr. Abdul Khaleq
Dr. Belal Salameh

Model Answer

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
	1		1	1	2	2	2	2	2	3	3	20

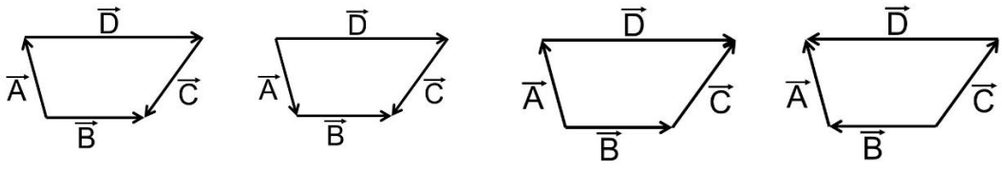
Important:

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 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

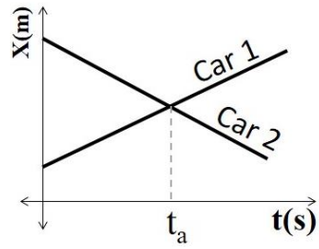
Part I: Questions (Choose the correct answer, one point each)

Q1. Which of the following figures satisfies the relation $\vec{A} = \vec{B} + \vec{C} - \vec{D}$



* * (*) *

Q2. The position versus time graph of two cars that are moving **along the-x axis** on two parallel lanes is shown in the figure. **At the time t_a, the two cars have:**



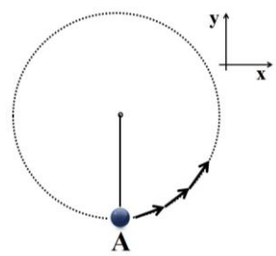
* same position, same velocity and different acceleration.

* same position, same velocity and same acceleration.

* same position, different velocity and different acceleration.

(*) same position, different velocity and same acceleration.

Q3. A particle is moving with **constant speed v** in a circle of radius **R** as shown in the figure. The velocity $\vec{\mathbf{v}}$ and the acceleration $\vec{\mathbf{a}}$ of the particle **at point A are**:



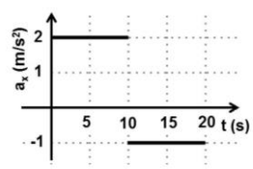
* $\vec{v} = v\hat{i}$ and $\vec{a} = -\frac{v^2}{R}\hat{i}$

(*) $\vec{v} = v\hat{i}$ and $\vec{a} = \frac{v^2}{R}\hat{j}$

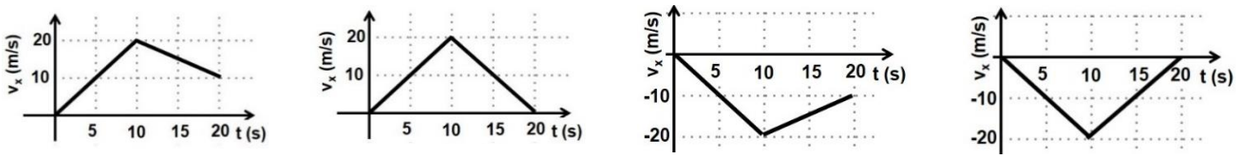
* $\vec{v} = -v\hat{i}$ and $\vec{a} = -\frac{v^2}{R}\hat{j}$

* $\vec{v} = v\hat{j}$ and $\vec{a} = \frac{v^2}{R}\hat{i}$

Q4. An object **starts from rest** and then moves along the x-axis, its **acceleration versus time** is shown in the figure.



Which of the following figures represents its velocity versus time?



(*) * * *

Part II: Short Problems (2 points each)

SP1. The position of a particle moving along the x-axis is given by $x(t) = t^3 - 4t$, where x is measured in **m** and t is measured in **s**. **Calculate the average acceleration (in m/s^2) of the particle in the time interval from t=2 s to t=4 s.**

$$v_x(t) = \frac{dx}{dt} = 3t^2 - 4$$

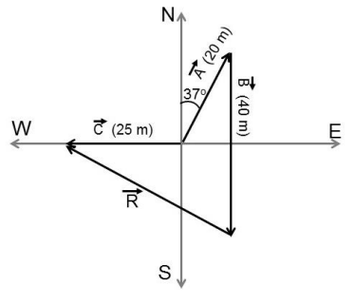
$$a_{av-x} = \frac{\Delta v_x}{\Delta t} = \frac{v_x(4s) - v_x(2s)}{2}$$

$$= \frac{44 - 8}{2} = 18\ m/s^2$$

Answer: $a_{av-x} = 18\ m/s^2$

SP2. A man starts moving from his house. He moves 20 m at 37° east of north then 40 m due south. **Find the distance (in m) between the man and his car which is 25 m to the west from his house.**

$\vec{A} = (20\sin(37^o)\,\hat{\imath} + 20\cos(37^o)\,\hat{\jmath})\text{m}$
$= (12\,\hat{\imath} + 16\,\hat{\jmath})\text{m}$
$\vec{B} = -40\,\hat{\jmath}\,\text{m}$
$\vec{C} = -25\,\hat{\imath}\,\text{m}$
$\vec{R} = \vec{C} - \vec{A} - \vec{B} = [(-25-12)\hat{\imath} + (40-16)\hat{\jmath}]\,m$
$= (-37\hat{\imath} + 24\hat{\jmath})\,m$
$|\vec{R}| = \sqrt{(-37)^2 + (24)^2} = 44.1\,m$



Answer: $|\vec{R}| = 44.1\,m$

SP3. Foure vectors $\vec{A} = 3\hat{\jmath} - 2\hat{k}, \vec{B} = -3\hat{\imath}\,, \vec{C} = 4\hat{\imath} + 2\hat{\jmath}$, and $\vec{D} = \vec{A} \times \vec{B}$. **Find the angle between $\vec{C}$ and $\vec{D}$.**

$$\vec{D} = \vec{A} \times \vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 0 & 3 & -2 \\ -3 & 0 & 0 \end{vmatrix}$$

$= 6\hat{\jmath} + 9\hat{k}$

$$\theta = \cos^{-1}\left(\frac{\vec{C}\cdot\vec{D}}{|\vec{C}||\vec{D}|}\right)$$

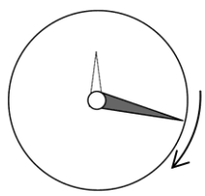
$$= \cos^{-1}\left(\frac{2(6)}{\sqrt{16+4}\sqrt{36+81}}\right) = 75.6^o$$

Answer: $\theta = 75.6^o$

SP4. The minute arm of a clock is 30 cm in length. **Find the centripetal acceleration (in m/s^2) of the tip of the arm.**

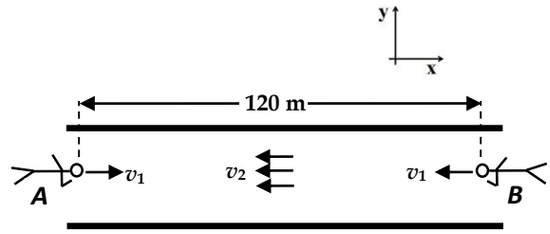
$$v = \frac{2\pi R}{T} = \frac{2(3.14)(0.3)}{60} = 0.0314\ \text{m/s}$$

$$a_c = \frac{v^2}{R} = \frac{(0.0314)^2}{0.3} = 3.29\times10^{-3}\text{m/s}^2$$



Answer: $a_c = 3.29\times10^{-3}\text{m/s}^2$

SP5. Two swimmers **A** and **B** start at two opposite points that are **120 m apart**, as shown in figure. **A** swims due east, while **B** swims due west. Both swimmers swim at **a constant velocity v_1 = 3 m/s relative to the river**. The river has a constant velocity v_2 = 1 m/s due west relative to the ground. **Find the distance (in m) swum by A when he meets B in the river.**



$\vec{v}_{A/G} = 2\hat{i}\ m/s \quad \vec{v}_{B/G} = -4\hat{i}\ m/s$

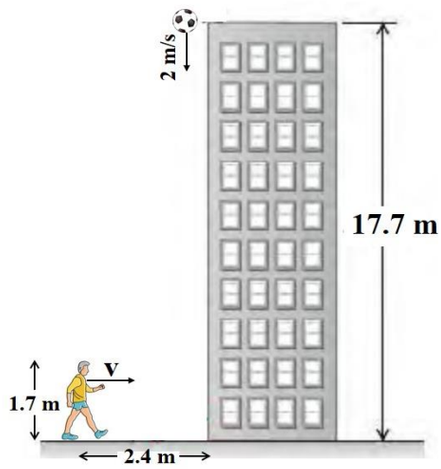
$$t = \frac{d}{|\vec{v}_{A/G}| + |\vec{v}_{B/G}|} = \frac{120}{6} = 20s$$

$$d_A = |\vec{v}_{A/G}|t = 2(20) = 40\ m$$

Answer: $d_A = 40$ m

Part III: Long Problems (3 points each)

LP1. A ball is **thrown downward** with a speed of 2 m/s from the roof of a 17.7 m tall building. A man who is 1.7 m tall was 2.4 m away from the building when the ball is thrown. If the man is walking alongside the building at **a constant speed v** as shown in the figure.



a) What must be the speed of the man (v) (in m/s) so that the ball will be dropped on his head?

For the ball

$\Delta y = -16\ m$

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

$$-16 = -2t - 5t^2$$

$\Rightarrow t = 1.6\ s$

For the man

$$v = \frac{d}{t} = \frac{2.4}{1.6} = 1.5\ m/s$$

Answer: $v = 1.5$ m/s

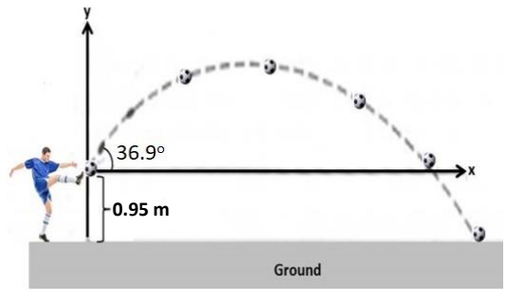
b) What is the velocity (in m/s) of the ball just before it touches the man's head?

$$v_{yf} = v_{yi} - gt$$

$$v_{yf} = -2 - 10(1.6) = -18\ m/s$$

Answer: $v_{yf} = -18$ m/s

LP2. A ball is shot such that it leaves the player's foot at a distance of **0.95 m above ground level** as shown in the figure. The initial speed of the ball is 15 m/s at an angle of 36.9° above the horizontal.



a) Find the time (in s) which is required for the ball to reach the ground.

$$v_{xi} = v_i \cos(36.9^o) = 12 \text{ m/s}$$

$$v_{yi} = v_i \sin(36.9^o) = 9 \text{ m/s}$$

$$\Delta y = -0.95 \text{ m}$$

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

$$-0.95 = 9t - 5t^2 \Rightarrow t = 1.9 \text{ s}$$

Answer: $t = 1.9\ s$

b) Find the velocity (in m/s) in unit vector notation of the ball just before it strikes the ground.

$$v_{xf} = v_{xi} = 12 \text{ m/s}$$

$$v_{yf} = v_{yi} - gt = 9 - 10(1.9) = -10 \text{ m/s}$$

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

Answer: $\vec{v}_f = (12\hat{i} - 10\hat{j})$ m/s

c) If the initial velocity of the ball is $\vec{v_i} = (v_{xi}\hat{i} + v_{yi}\hat{j})$ m/s, then its velocity and acceleration at the maximum height are:

* $\vec{v} = (v_{xi}\hat{i} + v_{yi}\hat{j})\text{m/s}$ and $\vec{a} = (-10\hat{i} - 10\hat{j})\text{m/s}^2$

(*) $\vec{v} = (v_{xi}\hat{i} + 0\hat{j})\text{m/s}$ and $\vec{a} = (0\hat{i} - 10\hat{j})\text{m/s}^2$

* $\vec{v} = (v_{xi}\hat{i} + 0\hat{j})\text{m/s}$ and $\vec{a} = (-10\hat{i} - 10\hat{j})\text{m/s}^2$