



Physics 101

Fall Semester  
First Midterm Exam  
Saturday, October 21, 2017  
12:00 pm - 01:30 pm

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

Student's Number: ..... Section: .....

Choose your Instructor's Name:

- Dr. Ahmed Al-Jassar  
Dr. Hala Al-Jassar  
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Dr. Nasser Demir
- Dr. Abdul Mohsen  
Dr. Tareq Al Refai  
Dr. Abdul Khaleq  
Dr. Belal Salameh

For Instructors use only

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
		1	1	1	2	2	2	2	2	3	3	20
P1												

Important:

1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
  - i) 4 Questions
  - ii) 5 Short Problems
  - iii) 2 Long Problems.
3. No solution = no points.
4. Use SI units.
5. Check the correct answer for each question.
6. Assume  $g = 10 \text{ m/s}^2$ .
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. The figure shows the trajectories of three projectiles. Which trajectory has the greatest initial vertical component of velocity ( $V_{yi}$ ).

\* 1

\* 2

\* 3

☒ All the same

Q2. The velocity of a particle moving along the x axis as a function of time is shown in the figure. The **speed** of this particle is:

\* Always increasing.

\* Always decreasing.

☒ Decreasing then increasing.

\* Increasing then decreasing.

Q3. If  $\vec{A}$  and  $\vec{B}$  are nonzero vectors and  $\vec{A} \cdot \vec{B} = 0$ , then which of the following is always true.

\*  $|\vec{A} \times \vec{B}| = 0$

\*  $\vec{A}$  is parallel to  $\vec{B}$

☒  $|\vec{A} \times \vec{B}| = AB$

\*  $|\vec{A} \times \vec{B}| = 1$

Q4. A pilot drops a package from a plane **flying horizontally at a constant speed**. Neglecting air resistance, when the package hits the ground the horizontal location of the plane will be

\* behind the package.

☒ directly above the package.

\* in front of the package.

\* undetermined.

Part II: Short Problems (2 points each)

SP1. You walk 53 m to the north, then 45 m in a direction  $60^\circ$  east of north as shown in the figure. **Determine the magnitude and direction of your resultant displacement relative to the positive x-axis.**

$$\vec{A} = 53\hat{j} \text{ m}, \vec{B} = 45 \cos(30)\hat{i} + 45 \sin(30)\hat{j} = (39\hat{i} + 22.5\hat{j}) \text{ m}$$
$$\vec{R} = \vec{A} + \vec{B} = (39\hat{i} + 75.5\hat{j}) \text{ m}$$
$$|\vec{R}| = \sqrt{39^2 + 75.5^2} = 85 \text{ m}$$
$$\theta = \tan^{-1}\left(\frac{75.5}{39}\right) = 62.7^\circ$$

Answer:  $|\vec{R}| = 85 \text{ m}, \theta = 62.7^\circ$

1

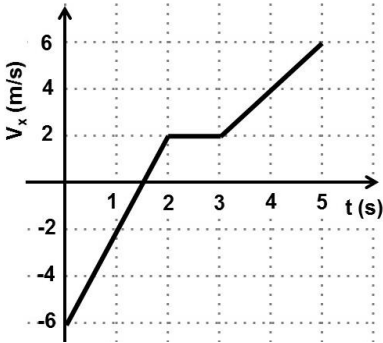
**SP2.** A car is moving along the positive x axis. If it starts from point A with a speed of 10 m/s and accelerates at a rate of 3 m/s<sup>2</sup> to reach point B at a speed of 20 m/s. **What is the distance (in m) between point A and point B?**

$$V_{xf}^2 = V_{xi}^2 + 2a_x\Delta x$$
$$(20)^2 = (10)^2 + 2(3)\Delta x$$
$$\Delta x = 50 \text{ m}$$

Answer:  $\Delta x = 50 \text{ m}$

**SP3.** The figure shows the velocity of a particle moving along the x axis as a function of time. **Find the average acceleration (in m/s<sup>2</sup>) of the particle in the time interval from t=1 s to t=5 s.**

$$a_{av-x} = \frac{V_{xf} - V_{xi}}{t_f - t_i} =$$
$$= \frac{6 - (-2)}{5 - 1}$$
$$= +2 \text{ m/s}^2$$



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

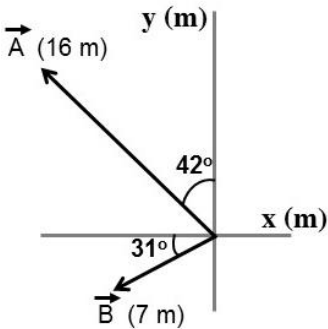
**SP4.** The vectors  $\vec{A}$  and  $\vec{B}$  are shown in the figure. **Find  $\vec{A} \times \vec{B}$ .**

$$|\vec{A} \times \vec{B}| = |\vec{A}| |\vec{B}| \sin \theta = (16)(7) \sin(79^\circ) = 110 \text{ m}^2$$
$$\vec{A} \times \vec{B} = +110 \text{ m}^2 \hat{k}$$

**OR**

$$\vec{A} = -16 \sin(42^\circ) \hat{i} + 16 \cos(42^\circ) \hat{j} = (-10.7\hat{i} + 11.9\hat{j}) \text{ m}$$
$$\vec{B} = -7 \cos(31^\circ) \hat{i} - 7 \sin(31^\circ) \hat{j} = (-6\hat{i} - 3.6\hat{j}) \text{ m}$$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -10.7 & 11.9 & 0 \\ -6 & -3.6 & 0 \end{vmatrix} = 0\hat{i} + 0\hat{j} + 110\hat{k} = +110 \text{ m}^2 \hat{k}$$



Answer:  $+110 \text{ m}^2 \hat{k}$

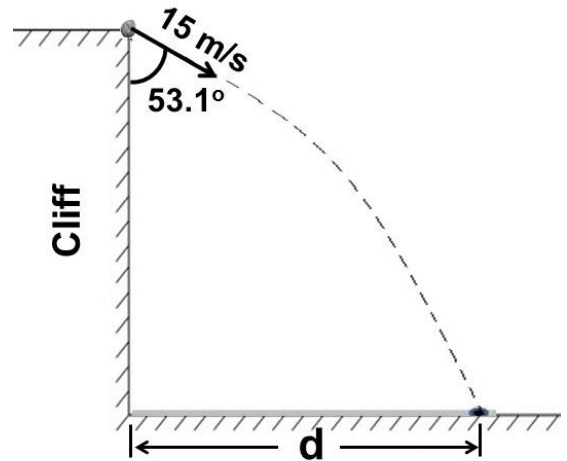
**SP5.** An object has a position given by  $\vec{r} = [(2 + 3t)\hat{i} + (3 - 2t^2)\hat{j}] \text{ m}$ , where t is measured in seconds. **What is the magnitude of the acceleration (in m/s<sup>2</sup>) of the object at time t = 2 s?**

$$\vec{a} = \frac{d^2\vec{r}}{dt^2} =$$
$$a_x = 0 \text{ m/s}^2$$
$$a_y = -4 \text{ m/s}^2$$
$$\vec{a} = -4 \text{ m/s}^2 \hat{j} \quad \text{Then} \quad a = 4 \text{ m/s}^2$$

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

**Part III: Long Problems (3 points each)**

**LP1.** A stone is thrown from the upper edge of a vertical cliff. The stone's initial velocity is 15 m/s directed at  $53.1^\circ$  with respect to the vertical, as shown in the figure. The stone hits the ground 2 s after being thrown and feels no air resistance.



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

$$V_{xi} = V_i \sin(53.1^\circ) = 12 \text{ m/s}$$

$$V_{yi} = -V_i \cos(53.1^\circ) = -9 \text{ m/s}$$

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

$$= -9(2) - 5(2)^2$$

$$\Delta y = -38 \text{ m}$$

$$h = 38 \text{ m}$$

Answer:  $h = 38 \text{ m}$

b) Find the horizontal distance (d) (in m) between the edge of the cliff and the point where the stone strikes the ground.

$$\Delta x = V_{xi}t = 12(2)$$

$$\Delta x = 24 \text{ m}$$

Answer:  $\Delta x = 24 \text{ m}$

**LP2.** A duck swims with a constant speed of 2 m/s toward a bridge. The bridge is 45 m above the water. A stone is **released from rest** from the bridge and hits the duck.

a) **How far was the duck when the stone was released?**

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

$$-45 = 0 - 5t^2$$

$$\Rightarrow t = 3 \text{ s}$$

$$\Delta x = V_{xi}t = 2(3) = 6 \text{ m}$$



Answer:  $\Delta x = 6 \text{ m}$

b) **Calculate the speed of the stone just before it touches the duck.**

$$V_{yf} = V_{yi} - gt = 0 - 10(3) = -30 \frac{\text{m}}{\text{s}}$$

$$\text{final speed} = 30 \text{ m/s}$$

Answer:  $\text{final speed} = 30 \text{ m/s}$