Homework: http://math.mnrt.net/

Name KEY _____ raw _____ scaled _____ percent

Physics Trimester 2 Exam 1 (152 Points)

■ **This is a take home exam. Here are the rules:**

The exam is due at the start of class on Thursday, February 28.

You may
[1] use your book, your notes, and a calculator while doing the exam,
[2] use any other book while doing the exam,
[3] use the internet to learn more about these topics while doing the exam (not recommended).

You may not
[1] communicate with anyone about these questions until the exams have all been collected. This includes communicating in person, in writing, over the phone, on-line.

■ **Any questions about these rules, just ask me at any time. If you believe there is an error in a question, ask me about it.**

■ **Please work out your solutions as rough drafts on paper other than this exam paper. When you turn in this exam (on this paper) it should be your final draft of your best work. If you need another blank copy of this exam, just ask me or download one from my web site.**

■ **Suggestions**
Start on this exam right away. The longer you have to think about it, the better you will do. You might even do your best thinking while you are doing something other than sitting and trying hard to figure out the problems.

Make your final draft as clear and as well organized as possible. I want to give you credit for what you know, so make it easy for me to see what you know and can do.

■ **When questions are stated with units, correct units must be given in your answers. Unless an exact answer is requested, round all answers to the nearest hundredth. For example: write 23 as 23.00, 23.4 as 23.40, 19.146 as 19.45, 123.0578 as 123.06.**

■ **A. Answer the following. (30 points each)**

[1] Find the magnitude of vector $\vec{v} = \begin{bmatrix} 3 \\ 7 \end{bmatrix}$.

$$|\vec{v}| = \sqrt{9+49}$$
$$= \sqrt{58}$$
$$\approx 7.62$$

[2] If $\vec{a} = \begin{bmatrix} 3 \\ 4 \end{bmatrix}$ and $\vec{b} = \begin{bmatrix} 5 \\ 7 \end{bmatrix}$, find $\vec{v} = \vec{a} + 2\vec{b}$.

$$\begin{bmatrix} 3 \\ 4 \end{bmatrix} + 2\begin{bmatrix} 5 \\ 7 \end{bmatrix}$$
$$= \begin{bmatrix} 3 \\ 4 \end{bmatrix} + \begin{bmatrix} 10 \\ 14 \end{bmatrix}$$
$$= \begin{bmatrix} 13 \\ 18 \end{bmatrix}$$

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■ **B. Answer the following. (15 points each).**

[1] Points A, B, and C are collinear. If A is (−3, 7, 2) and B is (9, −3, 5), and the distance from Point A to Point C is 3 times the distance from Point A to Point B, find the coordinates of Point C.

$$\vec{OC} = \vec{OA} + 3\vec{AB}$$

$$= \begin{bmatrix} -3 \\ 7 \\ 2 \end{bmatrix} + 3\begin{bmatrix} 9+3 \\ -3-7 \\ 5-2 \end{bmatrix}$$

$$= \begin{bmatrix} -3 \\ 7 \\ 2 \end{bmatrix} + \begin{bmatrix} 36 \\ -30 \\ 9 \end{bmatrix}$$

$$= \begin{bmatrix} 33 \\ -23 \\ 11 \end{bmatrix}$$

$\therefore$ C (33, −23, 11)

For $\vec{OC} = 3\vec{AB}$, minus 10 pts

Kelsey used $3\vec{AB}$ And did it right! See hers for example

[2] Point C is the center of a circle with diameter AB. Find the coordinates of B, if A is (−3, 7) and C is (13, −5).

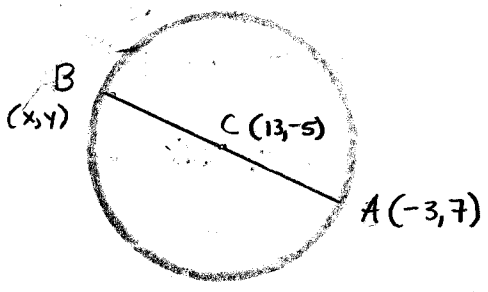
$$\vec{OB} = \vec{OA} + 2\vec{AC}$$

$$= \begin{bmatrix} -3 \\ 7 \end{bmatrix} + 2\begin{bmatrix} 13+3 \\ -5-7 \end{bmatrix}$$

$$= \begin{bmatrix} -3 \\ 7 \end{bmatrix} + \begin{bmatrix} 32 \\ -24 \end{bmatrix}$$

$$= \begin{bmatrix} 29 \\ -17 \end{bmatrix}$$

$\therefore$ B (29, −17)



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■ **C. Answer the following. (23 points each).**

[1] A marble is thrown straight up with an initial velocity of 30 $\frac{m}{s}$. What is the maximum height that it attains? (Use $\vec{g} = 10\ \frac{m}{s^2}$ and neglect the effects of air.)

$v(t) = v_0 + g.t$

$= 30\ \frac{m}{s} - (10\ \frac{m}{s^2})t$

at h_{max}, $v(t) = 0$,

so $30\ \frac{m}{s} - (10\ \frac{m}{s^2})t = 0$

$\Rightarrow t = \frac{-30}{-10}\ s$

$\Rightarrow t = 3\ s$

when $h = max.$

Then $h(t) = 30\ \frac{m}{s}(3\ s) - \frac{1}{2}(10\ \frac{m}{s^2})(3s)^2$

$= (30)(3)\ m - 5(9)\ m$

$= 90\ m - 45\ m$

$= 45\ m$

$\therefore$ marble reaches a maximum hght of 45 m

[2] A projectile is launched from height zero meters with an initial velocity of $\vec{v} = \begin{bmatrix} 15\,m/s \\ 36\,m/s \end{bmatrix}$. Assuming that the projectile lands 1.50 seconds later, how far away from the launch point does it land? (Use $\vec{g} = 10\ \frac{m}{s^2}$, neglect the effects of air, and assume the ground is level.)

$x(t) = (15\ \frac{m}{s})(1.5\ s)$ } no acel in horiz direction

$= 22.5\ m$

$\therefore$ Projectile lands 22.5 m from launch point.

Also accept 108 m, since } !

$y(t) = 0 \Rightarrow t = 7.2\ s$

and $x(7.2\ s) = 108\ m$

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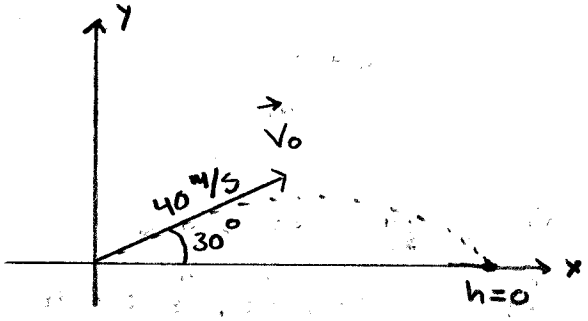
■ **D. Answer the following. (8 points each).**

[1] A projectile is launched from height zero meters with an initial speed of 40 $\frac{m}{s}$ at an angle of 30° with respect to the horizontal. How far away from the launch point does it land? (Use $\vec{g} = 10\ \frac{m}{s^2}$, neglect the effects of air, and assume the ground is level.)



$x(t) = V_{ox}\, t$

$y(t) = V_{oy}\, t - \frac{1}{2} g t^2$

$\cos 30° = \frac{V_{ox}}{40\ m/s}$

$V_{ox} = 40 \frac{m}{s} \cos 30°$

$\boxed{V_{ox} = 34.64\ m/s}$

$\sin 30° = \frac{V_{oy}}{40\ m/s}$

$V_{oy} = 40\ m/s\ (\frac{1}{2})$

$\boxed{V_{oy} = 20\ m/s}$

when $y(t) = 0$,

$20 \frac{m}{s} t - 5 \frac{m}{s^2} t^2 = 0$

$5t(4 - t) = 0$

$t = 4\ s$

$\boxed{y = 0 \Rightarrow t = 4\ s}$

then

$x(4\ s) = 34.64 \frac{m}{s} (4\ s)$

$=$

∴ Projectile lands 138.56 m from launch Pt.

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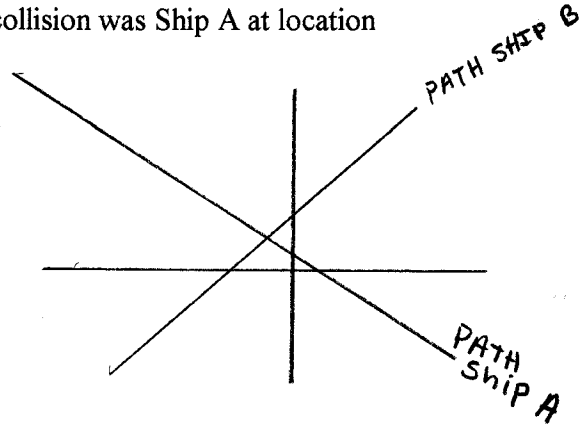
[2] Note that "mph" means $\frac{\text{mi}}{h}$.

The position of ship A is given by the vector equation $\vec{u} = \begin{bmatrix} -87\,\text{mi} \\ 100\,\text{mi} \end{bmatrix} + t\begin{bmatrix} 10\,\text{mph} \\ -10\,\text{mph} \end{bmatrix}$.

The position of ship B is given by the vector equation $\vec{v} = \begin{bmatrix} -20\,\text{mi} \\ 30\,\text{mi} \end{bmatrix} + s\begin{bmatrix} -14\,\text{mph} \\ -15\,\text{mph} \end{bmatrix}$.

Supposing that the ships collide, how many hours prior to the collision was Ship A at location (−87 mi, 100 mi)?



Position Ship

A: $\vec{u}(t) = \langle -87, 100\rangle + t\langle 10, -10\rangle$

B: $\vec{v}(s) = \langle -20, 30\rangle + s\langle -14, -15\rangle$

at Point of Collision,

$\vec{u}(t) = \vec{v}(s)$

$$\begin{bmatrix} -87 + 10t = -20 - 14s \\ 100 - 10t = 30 - 15s \end{bmatrix}$$ 2 EQNS 2 UNKS

$\Rightarrow s = \frac{-3}{29}\,h$

$\boxed{s = -0.103\,h}$

$\Rightarrow \boxed{t = 6.85\,h}$

Ship A reached collision point 6.85 h after passing Point (−87, 100).

Ship B reached collision Point .103 h <u>before</u> it would reach Point (−20, 30).

∴ Ship A was at Point (−87, 100) <u>6.85 h</u> before the Collision.