Name:_____ ID:_____ Lab (day/time)_____

Physics 201
Midterm Exam 1
7/1/2014

Collaboration is not allowed. Allowed on your desk are: up to ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating/graphing scientific calculator, 1 page of scratch paper, writing utensils, and the exam. You will have 55 minutes to complete this exam.

1. (4 points) A simple car consists of a gas pedal to increase your speed, a brake to slow you down, and a steering wheel to change your direction. Describe the ways you can (a) change your velocity and (b) change your acceleration while driving a car.

a.) $\Delta \vec{v}$? change speed or direction

So: gas, brake, or turn wheel

b.) $\Delta \vec{a}$? change $|\vec{a}|$ or direction

So: if moving, more/less gas or brake

if turning, more/less turning

if at rest, gas

2. (4 points) While driving in an exotic foreign land, you see a speed limit sign on a highway that reads 180,000 furlongs per fortnight. (a) How many miles per hour is this? (One furlong is 1/8 mile and a fortnight is 14 days. (b) How many cubic meters are in a cubic furlong? (One inch is 2.54 cm and there are 5280 feet in a mile)

a.) $\dfrac{180,000 \text{ furlongs}}{\text{fortnight}} \bigg| \dfrac{\text{fortnight}}{14 \text{ days}} \bigg| \dfrac{1 \text{ day}}{24 \text{ hr}} \bigg| \dfrac{1/8 \text{ mile}}{\text{furlong}} = \boxed{67.0 \text{ mph}}$

b.) $1 \text{ furlong}^3 \left[\dfrac{1/8 \text{ mile}}{\text{furlong}}\right]^3 \left[\dfrac{5280 \text{ ft}}{\text{mile}}\right]^3 \left[\dfrac{12 \text{ inches}}{1 \text{ ft}}\right]^3 \left[\dfrac{2.54 \text{ cm}}{1 \text{ inch}}\right]^3 \left[\dfrac{m}{100 \text{ cm}}\right]^3 = \boxed{8.14 \times 10^6 \, m^3}$

For questions 3 through 4 circle all correct answers, a given problem may have more than one correct answer. Each correctly circled answer will receive two points. There are **7** correct answers in this section and only the first **7** circled answers will be graded. There is no partial credit.
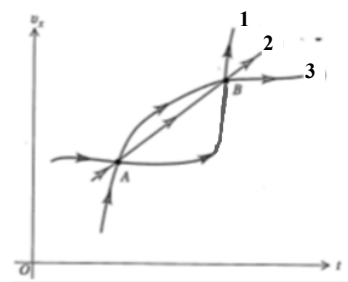
3. The velocity as a function of time for three different objects moving in a straight line are plotted to the right. Which of the following statements about their motion are *necessarily* (must be) true?

    [F] (a) At point A, the velocity of object 3 is greater than object 1 or 2.
    [T] (b) At point A, the acceleration of object 3 is greater than object 1 or 2.
    [?] (c) At point A, the position of object 3 is the same as object 1 or 2.

    [F] (d) At point B, the velocity of object 2 is greater than object 3.
    [T] (e) At point B, the acceleration of object 2 is greater than object 3.
    [?] (f) At point B, the position of object 2 is greater than object 3.

    [F] (g) Object 2 travels the same distance as object 1 between points A and B.
    [T] (h) Object 2 travels a greater distance than object 1 between points A and B.
    [T] (i) Object 2 has the same average acceleration as object 3 between points A and B.
    [F] (j) Object 2 has a greater average acceleration than object 3 between points A and B.

4. Two car's positions as a function of time are plotted to the right. Which of the following statements are false regarding this situation?
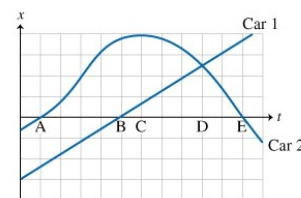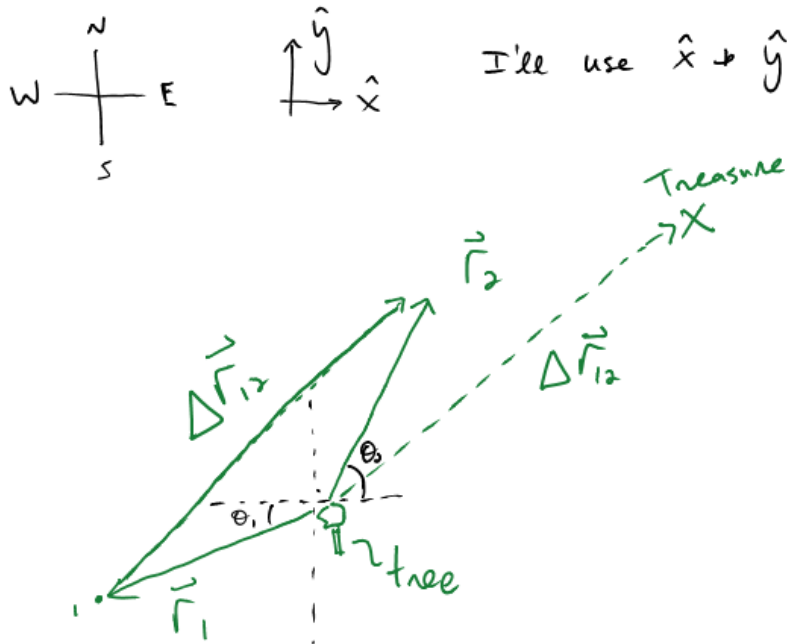
    [T] (a) Car 1 has the greatest average velocity between points A and D.
    [F] (b) Car 2 has the greatest average velocity between points A and D.
    [F] (c) Car 2 has the same acceleration at point B as car 1 does at point E.
    [T] (d) Car 2 has a greater acceleration than car 1 at point C.
    [F] (e) Car 1 is momentarily at rest at point B.
    [T] (f) Car 2 is momentarily at rest at point C.

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5. (2 points) Einstein's famous equation $E = mc^2$, relates energy (E), to mass (m) and the speed of light (c). What are (a) the dimensions, and (b) S.I. fundamental units of energy?

$$E = Mc^2 \quad , \quad M = mass \quad , \quad C = speed$$

(a) $$[D]_{Energy} = [M]\frac{[L]^2}{[T]^2}$$

(b)   units in S.I. $Kg \cdot \frac{m^2}{s^2}$

6. (10 points) Deserted on a deserted Island you spot a slightly exposed tin can under a tree. Upon opening it you find instructions to a buried treasure. It reads: "*Ten paces from this very tree in a direction twenty degrees south of west lies the first location. Ten paces from this very tree in a direction sixty degrees north of east lies the second location. Walk from this tree exactly the distance and direction you would walk from the first location to the second location and you will find ye treasure. Yar*" What are the coordinates of treasure?
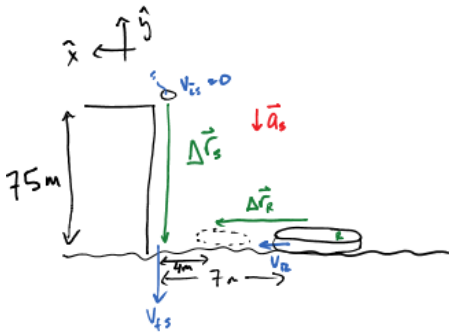

$$\vec{r}_1 + \Delta\vec{r}_{12} = \vec{r}_2 \quad , \quad So \quad \Delta\vec{r}_{12} = \vec{r}_2 - \vec{r}_1$$

$$\Delta\vec{r}_{12} = \left\langle |\vec{r}_2|\cos\theta_2 - \left(-|\vec{r}_1|\cos\theta_1\right) , |\vec{r}_2|\sin\theta_2 - \left(-|\vec{r}_1|\sin\theta_1\right) \right\rangle$$

$$\Delta\vec{r}_{12} = \left\langle 14.4 , 12.1 \right\rangle \text{ paces}$$

or 14.4 paces East & 12.1 paces North

7. (15 points) While on a 75.0-m-high bridge you see a raft floating at a constant speed on the river below. Trying to hit the raft, you drop a rock from rest when the raft has 7.00 m more to travel before passing under the bridge. The rock hits the water 4.00 m in front of the raft. (a) How long did it take for the rock to reach the water? (b) What is the speed of the raft. (c) What speed would you have needed to throw the rock straight upward if it is to hit the raft?

$\hat{x} \leftarrow \uparrow \hat{y}$

a.) stone

k
$a_{y_s} = -9.8 \text{ m/s}^2$
$V_{is} = 0 \text{ m/s}$
$\Delta y_s = -75 \text{ m}$

uk
a_{y_s}
V_{fs}
Δt_s

eqs:
(i) $\Delta x = V_i \Delta t + \frac{1}{2} a \Delta t^2$
(ii) $V_f = V_i + a \Delta t$
(iii) $V_f^2 = V_i^2 + 2a \Delta x$

eq (i) $\quad \Delta y_s = \cancel{V_{is} \Delta t_s} + \frac{1}{2} a_{y_s} \Delta t_s^2 \implies \Delta t_s = \sqrt{\dfrac{2 \Delta y_s}{a_{y_s}}} = \boxed{3.912 \text{ s}}$

b) Raft

k
$a_{x_R} = 0 \text{ m/s}^2$
$\Delta X_R = 3 \text{ m}$
$\Delta t_R = \Delta t_s = 3.912 \text{ s}$

uk
$V_{iR} = V_{fR} = V_R$

eq (i) $\quad \Delta X_R = V_R \Delta t_R + \frac{1}{2} \cancel{a_R} \Delta t_R^2$

$V_R = \dfrac{\Delta X_R}{\Delta t_R} = \boxed{0.767 \text{ m/s}}$

c.) find time it takes raft to travel the $7 \text{ m} = \Delta X_R$

eq (i) $\quad \Delta X_R = V_R \Delta t \implies \Delta t = \dfrac{\Delta X_R}{V_R} = 9.128 \text{ s}$

Now free-fall from 75-m-high to last Δt

k
$a_{y_s} = -9.8 \text{ m/s}^2$
$\Delta t = 9.128 \text{ s}$
$\Delta y_s = -75 \text{ m}$

uk
V_{is}
V_{fs}

eq (i) $\quad \Delta y_s = V_{iy_s} \Delta t + \frac{1}{2} a_{y_s} \Delta t^2$

$V_{iy_s} = \dfrac{1}{\Delta t} \left(\Delta y_s - \frac{1}{2} a_{y_s} \Delta t^2 \right)$

$\boxed{V_{iy_s} = 36.5 \text{ m/s}}$

Scores:
Problems

1	2	3-4	5	6	7

Exam Total