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

Name ______________________________ ____ raw ____ scaled ____ percent

Physics Trimester 1 Exam 1 - Take Home Part (90 Points)

One Dimensional Motion

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

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.

The exam is due at the start of class on Friday, November 16. The second part of this exam will be given in class on Friday, November 16.

- **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.**

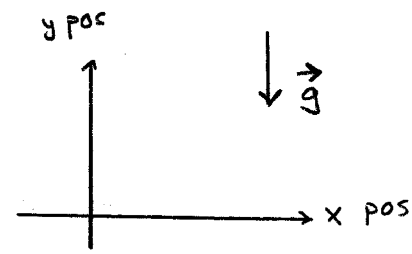
- **Suggestions**
Start on this exam right away. The longer you have to think about it, the better you will do. You might even do your best thinking while you are doing something other than sitting and trying hard to figure out the problems.

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.

- **There are 9 lettered questions {a,b,c}. Each such question counts for 10 points. On all questions, you are to neglect air resistance, and friction - just as you did on homework. Round all answers to 4 decimal places.**

[1] A ball is dropped from a height of 3 m and rebounds from the floor to a height of 2 m. (Use $g = 9.81\ \frac{m}{s^2}$ for the acceleration of gravity.)

[a] What is the velocity of the ball just as it reaches the floor?
[b] What is its velocity just as it leaves the floor?
[c] If it is in contact with the floor for 0.02 s, what are the magnitude and direction of its average acceleration during this time interval?



[a] $v^2 = v_0^2 + 2a\Delta x$

$= 2(-9.81\ m/s)(-3\ m)$

$= 58.86\ \frac{m^2}{s^2}$

$\therefore\ \vec{v} = 7.6720\ \frac{m}{s}$, down.

[b] $v^2 = v_0^2 + 2a\Delta x$

$\Rightarrow\ v_0^2 = v^2 - 2a\Delta x$

$= -(2)(-9.81\ \frac{m}{s})(2\ m)$

$= 39.24$

$\therefore\ \vec{v}_0 = 6.2642$, UP

[c] $a_{avg} = \frac{\Delta v}{\Delta t} = \frac{6.2642 - (-7.6720)\ \frac{m}{s}}{.02\ s}$

$= \frac{13.9362\ m/s}{.02\ s}$

$\therefore\ a_{avg} = 696.81\ \frac{m}{s^2}$, UP

[2] A car is traveling 80 $\frac{\text{km}}{h}$ in a school zone. A police car starts from rest just as the speeder passes it. The police car accelerates at a constant rate of 8 $\frac{\text{km}}{h \cdot s}$.

[a] When does the police car catch the speeding car?
[b] How fast is the police car traveling when it catches the speeder?

[a] Police catch speeder when both police and speeder same distance from reference point (place where speeder passes police car).

$$d_{car} = 80 \frac{km}{h} t$$

$$d_{police} = \frac{1}{2}\left(8 \frac{km}{h \cdot s}\right) t^2$$

$$80 \frac{km}{h} t = \frac{1}{2}\left(8 \frac{km}{h \cdot s}\right) t^2$$

$$\Rightarrow \quad 8 \frac{km}{h \cdot s} t^2 - 160 \frac{km}{h} t = 0$$

$$\Rightarrow \quad t\left(t\left(\tfrac{1}{s}\right) - 20\right) \frac{km}{h} = 0$$

$$t = 0, \quad t = 20 \text{ s}$$

∴ Police catch speeder 20 s after speeder passes police.

[b] $$V = 8 \frac{km}{h \cdot s} t$$

$$= 8 \frac{km}{h \cdot s} (20 \text{ s})$$

$$= 160 \frac{km}{h}$$

$$\therefore V_{police} = 160 \frac{km}{h}$$

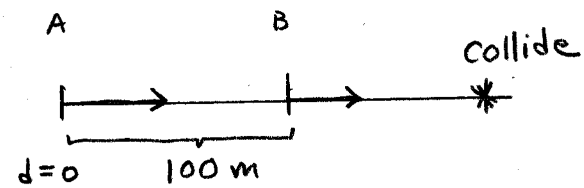
[3] Car A is traveling at 190 $\frac{km}{h}$ and is 100 m behind car B. Car B is traveling at 125 $\frac{km}{h}$. The driver of Car A and the driver of Car B both slam on the brakes at exactly the same instant. Each car slows down at the rate of 6 $\frac{m}{s^2}$.

[a] At what time after the brakes are applied do they collide?

$$d_A = V_{A0}\, t + \frac{1}{2} a t^2$$

$$d_B = X_0 + V_{B0}\, t + \frac{1}{2} a t^2$$

Collide $\equiv d_A = d_B$



$$190\ \frac{km}{h}\left(\frac{h}{3600\,s}\right)\left(\frac{1000\,m}{km}\right) = 52.\bar{7}\ \frac{m}{s}$$

$$125\ \frac{km}{h} = 34.7\bar{2}\ m/s$$

$$(52.\bar{7}\ \tfrac{m}{s})\,t - (\tfrac{1}{2})(6\ \tfrac{m}{s^2})t^2 = 100\,m + (34.7\bar{2}\ \tfrac{m}{s})\,t - \tfrac{1}{2}(6\ \tfrac{m}{s^2})t^2$$

$$\Rightarrow\quad (52.\bar{7}\ \tfrac{m}{s})\,t = 100\ m + (34.7\bar{2}\ \tfrac{m}{s})\,t$$

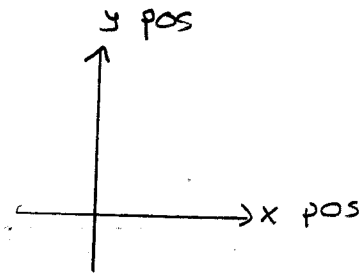
$$\Rightarrow\quad (18.0\bar{5}\ \tfrac{m}{s})\,t = 100\ m$$

$$\Rightarrow\quad t = \frac{100\ m}{18.05\ m/s}$$

$$\therefore\ t = 5.5385\ s$$

[4] A load of bricks is being lifted by a crane at a steady velocity of 5 $\frac{m}{s}$ when one brick falls off 6 m above the ground.

[a] What is the greatest height the brick reaches above the ground?
[b] How long does it take to reach the ground?
[c] What is its speed just as it hits the ground?



[a] $y = 6\,m + (5\,\frac{m}{s})t - \frac{1}{2}(9.81\,\frac{m}{s^2})t^2$

Y_{max} : $v(t) = 0 = (5\,\frac{m}{s}) - (9.81\,\frac{m}{s^2})t$

$\Rightarrow$ $\boxed{Y_{max} \text{ at } t = 0.5096\ s}$

$Y_{max} = 6\,m + (5\,\frac{m}{s})(.5096\,s) - \frac{1}{2}(9.81\,\frac{m}{s^2})(.5096\,s)^2$

$\therefore\ Y_{max} = 7.2742\ m$

[b] $7.2742\ m = \frac{1}{2}(9.81\,\frac{m}{s^2})t$

$\Rightarrow t = 1.2178\,s$

$\therefore$ Time to reach ground is $.5096\,s + 1.2178\,s = 1.7274\,s$

[c] $v = v_0 + at$

$= (9.81\,\frac{m}{s^2})(1.7274\,s)$

$\therefore\ v = 16.9457\ \frac{m}{s}$