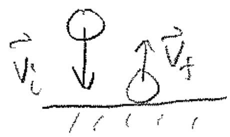
Physics 1200 Name: Key

Quiz 2, Spring 2012, Form: A Date: ______________

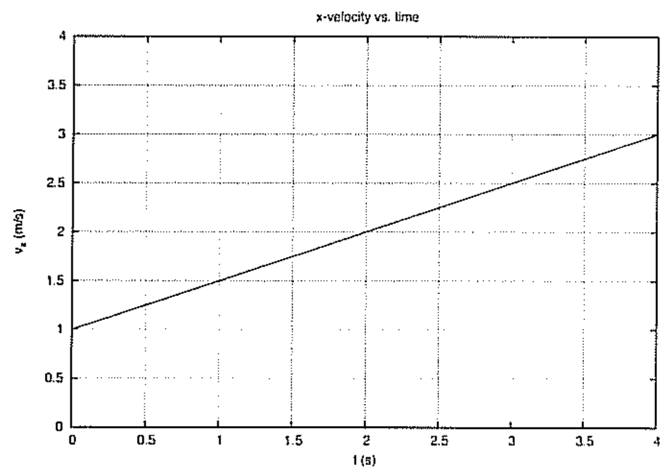
You must include units with all quantities (that have units). You must explain reasoning or show work for all questions.

1. [5] A golf ball is dropped vertically onto a table top and bounces. Just before it hits the table, its velocity is $(0, -4, 0)$ m/s. After hitting the table, its velocity is $(0, 3, 0)$ m/s. What is the coefficient of restitution of the golf ball?



$$C_R = \left|\frac{v_{f\perp}}{v_{i\perp}}\right| = \frac{3}{4} = 0.75$$

2. You analyze a video of a fancart on a track, and the x-velocity of the fancart as a function of time looks like the graph below.



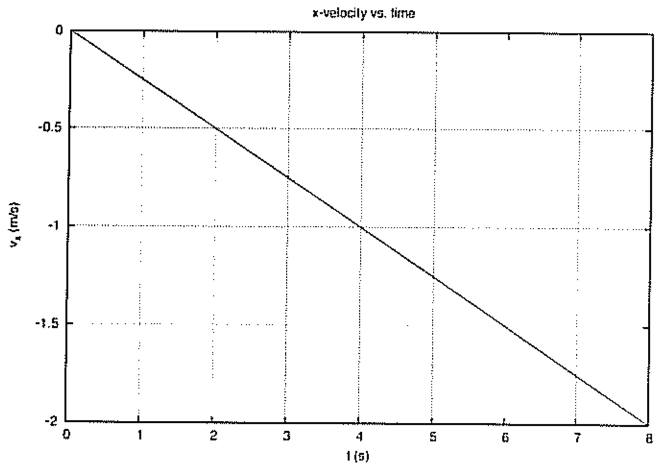
[5](a) What is the x-acceleration of the fancart? Be sure to show your calculation or explain how you determined your answer.

$$a_x = \text{slope} = \frac{3-1\ \frac{m}{s}}{4-0\ s} = \frac{2}{4}\ \frac{m}{s^2} = 0.5\ \frac{m}{s^2}$$

[5](b) Is the cart speeding up or slowing down? Explain you reasoning.

v_x is + and a_x is +, so the cart is speeding up.

3. You analyze a video of a fancart on a track, and the x-velocity of the fancart as a function of time looks like the graph below.



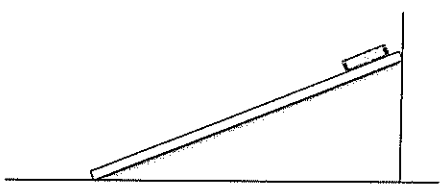
[5](a) What is the x-acceleration of the fancart? Be sure to show your calculation or explain how you determined your answer.

$a_x = \text{slope} = \frac{(-2 - 0 \frac{m}{s})}{8 - 0\,s} = -\frac{1}{4}\frac{m}{s^2} = -0.25 \frac{m}{s^2}$

[5](b) Is the cart speeding up or slowing down? Explain your reasoning.

V_x is $-$ and a_x is $-$, so the cart is speeding up.

4. Suppose that you set up an inclined track and a cart as shown below. (This is exactly like the apparatus for the Newton's Second Law experiment that you did in class.)



[5](a) If you add metal bars to the car and double the mass, what must you do in order to keep the net force on the cart the same?

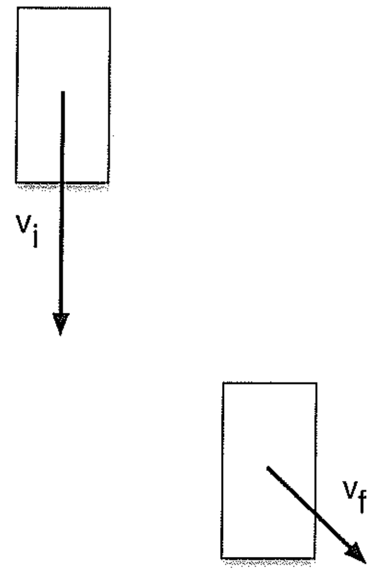
(a) increase the angle of inclination
((b)) decrease the angle of inclination
(c) nothing; adding mass will not change the net force on the cart

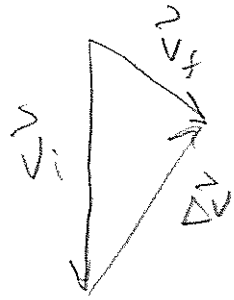
[5](b) Explain your reasoning to the question above.

$\vec{F}_{net} = m\vec{a}$ If $\vec{F}_{net}$ stays then doubling mass requires decreasing $\vec{a}$ by $\frac{1}{2}$. Thus, decrease the angle of the ramp.

5. In a Lunar Lander game, at some instant of time, the lunar module ~~as~~ has a velocity $\vec{v}_i$ shown below. At a later time, the module as the velocity $\vec{v}_f$.

[5](a) What is the direction of the net force on the lunar module? (Your answer should be an arrow that represents the net force vector. You must sketch a picture that correctly illustrates how to determine the direction of the net force?)



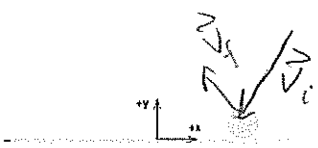


$\vec{a}$ and $\vec{F}_{net}$ are in same dir as $\Delta\vec{v}$, up and to the right.

[5](b) Did the lunar module speed up or slow down during this time interval? Explain your reasoning.

It slowed down because $|\vec{v}_f| < |\vec{v}_i|$ as indicated by the length of the arrows.

6. (BONUS) A basketball bounces on the floor. Just before hitting the floor, its velocity is $(-2, -3, 0)$ m/s. Just after hitting the floor, its velocity is $(-1.5, 1.5, 0)$ m/s.



$\vec{v}_i = (-2, -3, 0)\ \frac{m}{s}$

$\vec{v}_f = (-1.5, 1.5, 0)\ \frac{m}{s}$

[5](a) What is the coefficient of restitution of the basketball?

$$c_R = \left|\frac{v_{f\perp}}{v_{i\perp}}\right| = \left|\frac{1.5}{3}\right| = 0.5$$

[5](b) In what direction is the frictional force on the basketball? (to the right or to the left) You must explain your reasoning.

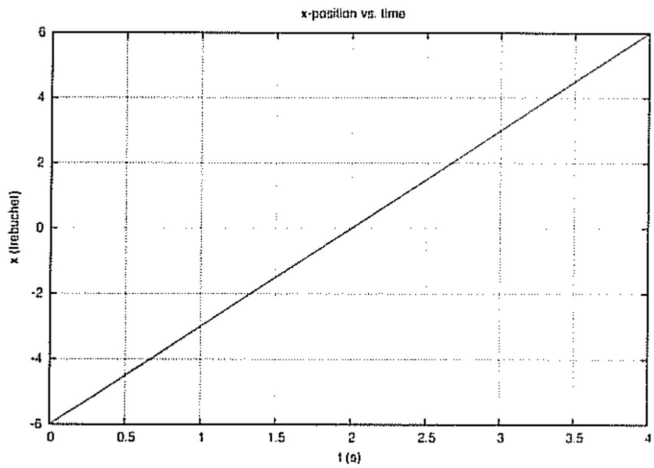
friction causes $v_{\parallel}$ to change. In this case, $v_{\parallel}$ is v_x and v_x decreases from $-2\ \frac{m}{s}$ to $-1.5\ \frac{m}{s}$. Thus friction acts to the right, causing v_x to slow down.

7. Suppose that there is a new game that is like angry birds except that you use a trebuchet to shoot angry water buffaloes. You capture a video of the motion of the water buffalo, and you use the the *trebuchet* as the standard unit of length. You find that the free-fall y-acceleration in the world of the game is -4 *trebuchets*/s^2.

[5](a) Using $\vec{g} \approx (0, -10, 0)$ m/s^2 for Earth, how many meters long is 1 trebuchet if we assume that the game's world is Earth?

$$\frac{-10 m/s^2}{-4 treb/s^2} = 2.5 \frac{m}{treb}$$ So 1 treb. is 2.5m long. ✓

[5](b) You use video analysis to determine the $x(t)$ graph for a water buffalo and obtain the graph below. Note that the unit for position is *trebuchet*.



What is the x-velocity of the water buffalo in *trebuchet*/s?

$$V_x = \text{slope} = \frac{6-(-6)\, treb}{4-0\ s} \ \frac{12\ treb}{4s} = 3\ \frac{treb}{s}$$

[5](c) Use your scaling factor from part (a) to determine the x-velocity in m/s.

$$V_x = \left(3 \frac{treb}{s}\right)\left(\frac{2.5m}{1 treb}\right) = 7.5 \frac{m}{s}$$

Section 2. Iterative Method of Applying Newton's Second Law

8. [20] A 0.045-kg golf ball is at the position $(-15, 0, 0)$ m on a level green when it is putted. Its velocity immediately after leaving the putter is $(8, 0, 0)$ m/s. There is a constant frictional force by the grass on the ball as it rolls that is $(-0.09, 0, 0)$ N. Use the iterative method to find the velocity and position of the golf ball at the following times: $t = 0.25$ s, $t = 0.5$ s, $t = 0.75$ s, $t = 1.0$ s. Show your work and neatly record your answer in a data table with three columns for t, *velocity*, and *position*. Write the positions and velocities as vectors.

$\vec{r}_i = (-15, 0, 0)$ m $\Delta t = 0.25$ s

$\vec{v}_i = (8, 0, 0)$ $\frac{m}{s}$

$\vec{F}_{net} = (-0.09, 0, 0)$ N

$m = 0.045$ kg

$t = 0.25$ s : $\vec{v} = (8,0,0) + \left(\frac{(-0.09,0,0)\,N}{0.045\,kg}\right)(0.25\,s) = (7.5, 0, 0)\ \frac{m}{s}$

$\vec{r} = (-15,0,0) + (7.5,0,0)(0.25\,s) = (-13.125, 0, 0)$ m

t	$\vec{r}$ (m)	$\vec{v}$ ($\frac{m}{s}$)
0	(−15, 0, 0)	(8, 0, 0)
0.25	(−13.125, 0, 0)	(7.5, 0, 0)
0.5	(−11.375, 0, 0)	(7, 0, 0)
0.75	(−9.75, 0, 0)	(6.5, 0, 0)
1.0	(−8.25, 0, 0)	(6, 0, 0)

Section 3. LAB

9. [20] Go to our course web site and download the video *toy-car.mov*. Use Tracker to analyze its motion.

   Sign: "I answered this question on my own without using any person or resource except my lab notebook and the Tracker software."

   Signature: ______________________________

   (a) When the car is speeding up and traveling to the right, what is (approximately) its acceleration? Give your answer and describe how you determined it.

slope of v_x vs. t is $\approx 0.31 \frac{m}{s}$

   For part (a), what is the direction of the net force on the car during this time interval? Explain your reasoning.

a_x is + so F_{net_x} is + and $\vec{F}_{net}$ is in +x dir.

$\vec{F}_{net}$ is prop. to $\vec{a}$ according to Newton's 2nd law ✓

   (b) At what time is the car at rest? Give your answer and describe how you determined it.

at rest is $v_x = 0$ which occurs at $t = 2.0$ s to $t = 2.33$ s

   (c) When the car is traveling to the right and slowing down, what is (approximately) its acceleration? Give your answer and describe how you determined it.

a_x = slope = $-0.77 \frac{m}{s^2}$

   For part (c), what is the direction of the net force on the car during this time interval? Explain your reasoning.

$\vec{F}_{net}$ is in −x dir. since a_x is negative.