Physics 1210 Exam #1 Spring 2011 **NAME** Answer Key

Please write directly on the exam and attach other sheets of work if necessary. Calculators are allowed. No notes or books may be used. For worked problems 12-14, be complete and show all work, beginning with diagrams and fundamental, general equations used. For multiple choice answers, circle one or more answers. Multiple choice problems have only one correct answer. You may choose to circle two answers on multiple choice and, if one of them is correct, receive half credit. Circle three and if one is correct, 1/3 credit, etc.

1. (7 pts) The position of an object moving along the *x*-axis is given by $x = -2\text{m} + (12.0\text{ m/s})t - (3.0\text{ m/s}^2)t^2$. How many times does this object pass through the point $x = 0$?

A. twice, first moving in the positive *x*-direction, then moving in the negative *x*-direction
B. twice, first moving in the negative *x*-direction, then moving in the positive *x*-direction
C. only once, moving in the positive *x*-direction
D. only once, moving in the negative *x*-direction
E. never

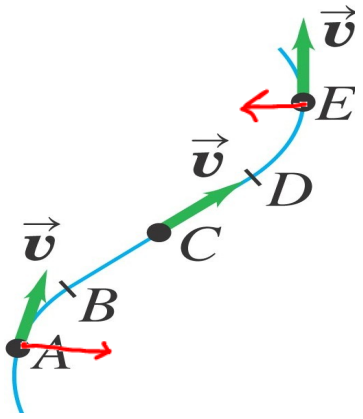
2. (7 pts) When you drop an object from rest from a certain height, it takes time *T* to reach the ground with no air resistance. If you dropped it from three times the height, how long (in terms of *T*) would it take to reach the ground, again with no air resistance?

A. Less than *T*/9. B. *T*/9. C. Between *T*/9 and T/3.
D. *T*/3. E. Between *T*/3 and *T*. F. *T*.
G. Between *T* and 3*T*. H. 3*T*. I. Between 3*T* and 9*T*.
J. 9*T*. K. More than 9*T*.

3. (7 pts) A baseball is launched at a 30° angle above the horizontal. Ignore air resistance. The acceleration due to gravity changes

A. the magnitude of the ball's velocity in the *x*-direction
B. the sign of the ball's velocity in the *x*-direction
C. the magnitude of the ball's velocity in the *y*-direction
D. the sign of the ball's velocity in the *y*-direction
E. Both A and B
F. Both C and D

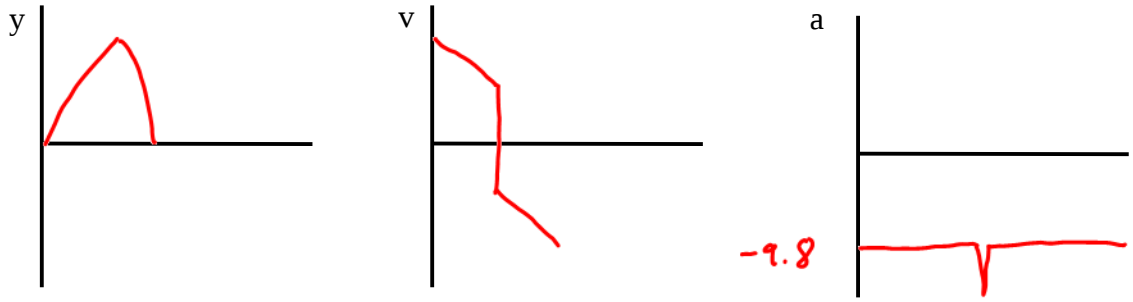
4. (7 pts) A particle moves at a constant speed along a path as shown in the diagram. Between points B and D, the path is a straight line. The velocity vectors of the particle are indicated at positions A, C, and E. Sketch the particle's *acceleration* vectors at points A, C, and E.

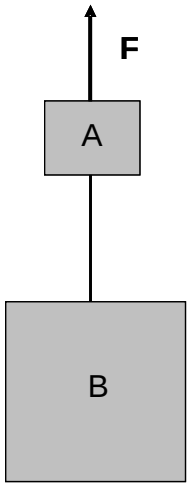


5. (7 pts) A cowgirl swings a rope, with a stone tied at one end, in a circle. The rope breaks. The stone flies straight up in the air. While the stone is still moving upward, how many forces act on the stone? ___1___ If more than zero, name each one. Gravity

6. (7 pts) A particle moves in a circular path of radius *R* with constant speed *v*. As it does this, its centripetal acceleration is *a*. If it instead moves in a circular path of radius 3*R*, what must its speed be for its centripetal acceleration to remain *a*?
A. *v*/9. B. *v*/3. C. 0.577 v. D. *v*. E. 1.73 *v* F. 3 *v*. G. 9 *v*.

7. (7 pts) You throw a bouncy racquet ball straight upwards in a racquetball court. It hits the hard ceiling while still moving quite quickly and bounces back toward you. Make a sketch of the Y vs. time, Y velocity vs. time, and Y acceleration vs. time plots for this scenario.





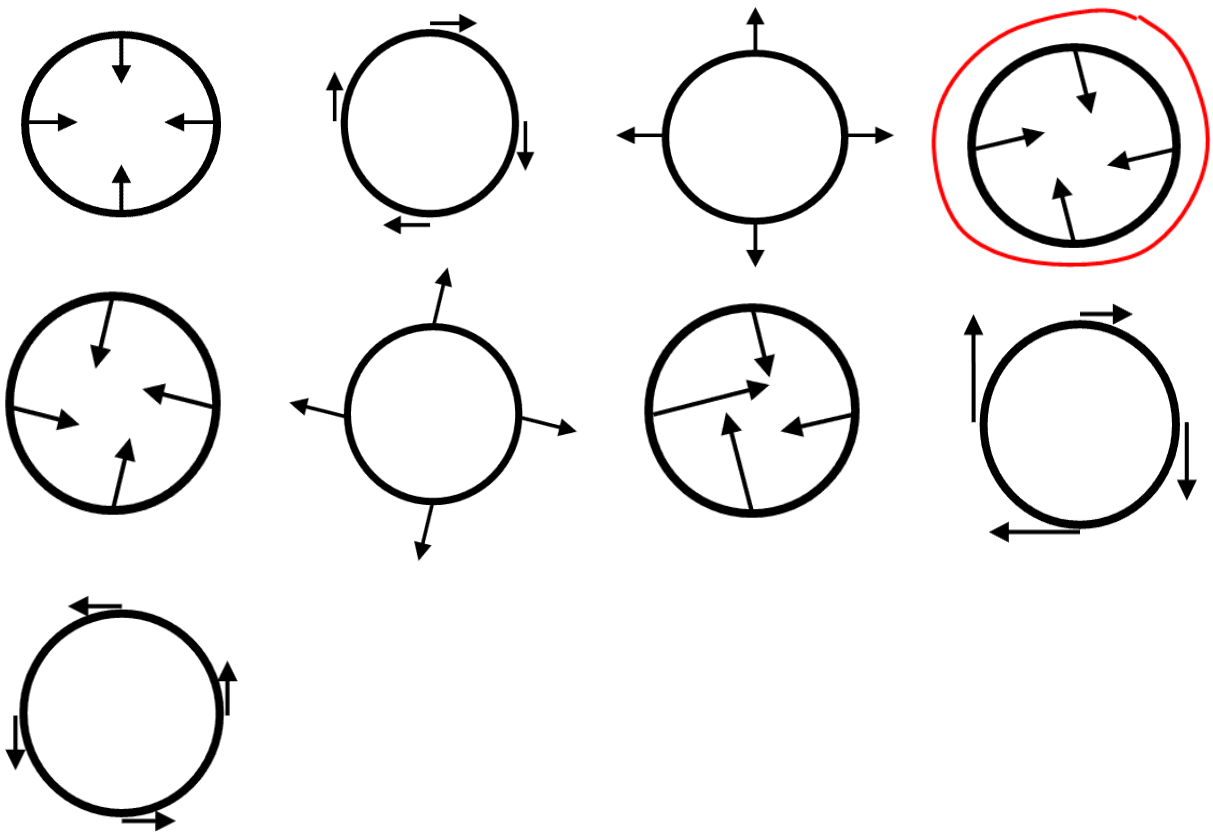
8. (7 pts) As the figure shows, two boxes are connected by a massless rope, and an upward force is applied to box A. If the two boxes are moving with a constant acceleration,

A. the force that box A exerts on box B is greater than the force that box B exerts on box A.
B. the force that box B exerts on box A is greater than the force that box A exerts on box B.
C. the force that box A exerts on box B is just as strong as the force that box B exerts on box A.
D. none of the above is correct

9. (7 pts) An object moves at constant speed in the -x direction.
A. There is an acceleration in the -x direction.
B. There are no forces acting on the object.
C. There are two forces acting, one toward +x and one toward -x but the -x one is larger.
D. There is a net force in the -x direction.
E. There is no net force acting on the object.

10. (7 pts) Three children throw identical stones off a bridge at the same time. #1 throws straight up, #2 throws horizontally, and #3 throws straight down.
A. #1 reaches the water first followed by #2, then #3.
B. #2 reaches the water first, followed by #1 & #3 together at the same time.
C. #2 reaches the water first, followed by #3 and then #1.
D. #3 reaches the water first followed by #1 & #2 together at the same time.
E. None of these.

11. (7 pts) A disk rotates in a clockwise direction about its center, and speeds up. Which diagram below correctly indicates the directions and relative magnitudes of acceleration vectors of four points on the rim of the disk? Circle the correct one.



12. (25 pts) The tortise leaves the Union headed on a straight line toward the Gym at the same time the hare leaves the Gym headed on a straight line toward the Union. The distance between the Gym and Union is 50 m. The tortise starts at a speed of 1 m/s and maintains a constant speed. The hare starts from rest and has a constant acceleration of 0.5 m/s^2 toward the Union. At what time do they cross? At what distance from the Union do they cross?

Goal: Find when $x_{f_H} = x_{f_T}$

U

$x = 0$

Tortise

$x_{o_T} = 0$

$v_{o_T} = 1 \frac{m}{s}$

$a_T = 0$

$x_{f_T} = x_{o_T} + v_{o_T} t + \frac{1}{2} a_T t^2$

$v_{f_T} = 0 + 1 \frac{m}{s} t + 0$

G

$x = 50$

Hare

$x_{o_H} = 50$

$v_{o_H} = 0$

$a_H = -0.5 \frac{m}{s^2}$

$x_{f_H} = x_{o_H} + v_{o_H} t + \frac{1}{2} a_H t^2$

$x_{f_H} = 50 + 0 + \frac{1}{2}(0.5) t^2$

set $x_{f_T} = x_{f_H}$ and solve for t

$1t = 50 - \frac{1}{2}(0.5) t^2$

$0 = -\frac{1}{2}(0.5) t^2 - 1t + 50$

a b c

quadratic solution

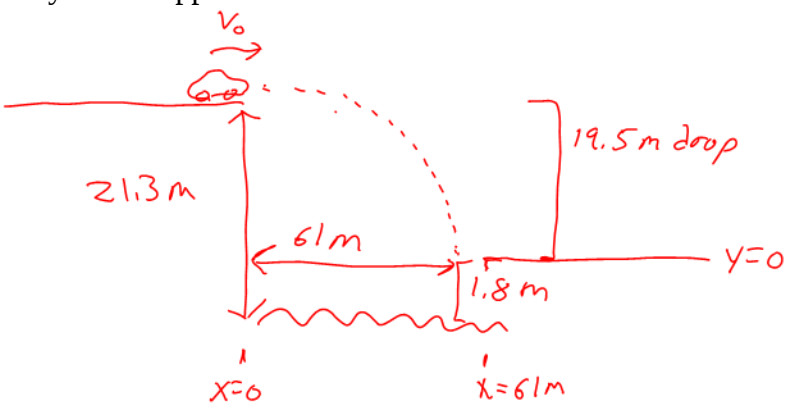
$t = 12.3$ sec

use this to find T position

$x_{f_T} = 1 \frac{m}{s} (12.3\ s)$

$= 12.3$ m from union

13. (25 pts) A car comes to a bridge during a storm and finds the bridge washed out. The driver must get to the other side, so he decides to try leaping it with his car. The side of the road the car is on is 21.3 m above the river, and the road before the washed-out bridge is perfectly horizontal. The road on the opposite side is a mere 1.8 m above the river. The river itself is a raging torrent through the 61.0-m gap. How fast should the car be traveling at the time it leaves the road in order just to clear the river and land safely on the opposite side?



Find V_0 so that car travels 61m before falling 19.5m.

several possible approaches.

Find time to fall 19.5m

$$y_f = y_0 + \cancel{V_{0y}}^{0} t + \frac{1}{2} a_y t^2$$

$$0 = 19.5 + \frac{1}{2}(-9.8)t^2$$

$$t = \sqrt{\frac{2(19.5)}{-9.8}} = 2.0\,s$$

must travel 61m in 2 sec

Car

x_0	x_f	v_{0x}	v_{fx}	a_x	y_0	y_f	v_{0y}	v_{fy}	a_y
0	61	?	v_{0x}	0	19.5	0	0	?	-9.8

$$x_f = \cancel{x_0}^{0} + v_{0x} t + \frac{1}{2}\cancel{a_x}^{0} t^2$$

$$x_f = v_{0x} t$$

$$v_{0x} = \frac{x_f}{t} = \frac{61m}{2s} = 30.5\,\frac{m}{s}$$

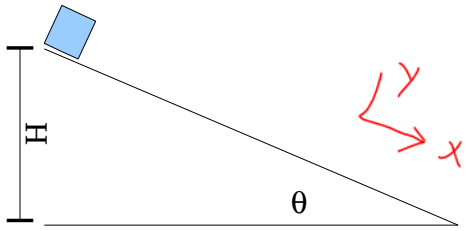
14. (30 pts) A box with a mass of M kg is placed on the top of a frictionless, inclined hill with a slope angle of θ. The height of the hill is H meters, and the initial velocity of the box is zero.

(1) Draw a free-body diagram of the box.

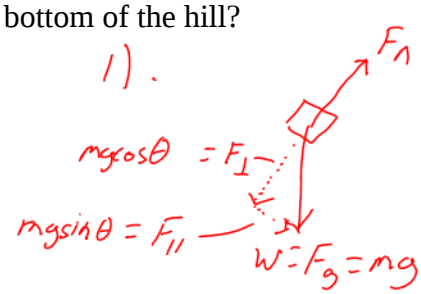
(2) Find an expression for the acceleration of the box in terms of the given quantities and g?

(3) Give an expression for the speed of the box when it reaches the bottom of the hill?

(4) How long does it take for the box to reach the bottom of the hill?



1).



2) $\Sigma F = ma$

$F_\parallel = ma$

$mg\sin\theta = ma$

$a = g\sin\theta$

3) $v_f = v_0 + at$ or $v_f^2 = v_0^2 + 2a(x_f - x_0)$

let $x_0 = 0$

$v_0 = 0$, $x_0 = 0$, x_f = length of ramp

$x_f = \frac{H}{\sin\theta}$

so

$v_f^2 = 0 + 2(g\sin\theta)\left(\frac{H}{\sin\theta}\right)$

$v_f = \sqrt{2gH}$

4) time to slide is

$x_f = x_0 + v_0 t + \frac{1}{2}at^2$

$x_f = \frac{1}{2}at^2 \rightarrow t = \sqrt{\frac{2x_f}{a}} = \sqrt{\frac{2\frac{H}{\sin\theta}}{g\sin\theta}} = \sqrt{\frac{2H}{g}}\frac{1}{\sin\theta} = t$