## Physics 141 06/14/2010 Exam 1 (105 pts)

## Multiple Choice (3 pts each, 15 pts total)

- 1. An object has a velocity directed to the right, and an acceleration directed to the left. Which of the following are true?
  - a. The position of the object is not changing in time.
  - b. The position of the object is increasing to the left with time, and its speed is increasing.
  - c. The position of the object is increasing to the right with time, and its speed is increasing.

d. The position of the object is increasing to the right with time, and its speed is decreasing.

2. Two identical stones are dropped from a tall building, one after the other. While both stones are falling, what will happen to the vertical distance between the them? Assume air resistance is negligible.

- a.) It will increase.
  - b. It will remain the same.
  - c. It will decrease.
  - d. It will first increase and then decrease.
- 3. A battle ship simultaneously fires two shells at enemy ships. If the shells follow the trajectories shown below, which ship will be hit first?
  - a. A b. B c. Both at the same time. d. Need more information. battleship
- 4. An object is held in place by friction on an inclined surface. The angle of inclination is increased until the object begins to slide. If the surface is kept at this angle, the object
  - a. Slows down.
  - b. Speeds up.
  - c. Moves at uniform speed.
  - d. None of the above.

- 5. If you jump out a plane, you will initially speed up as you fall downward. Eventually, Eventually, due to air resistance, your velocity will become constant in time. After this occurs, the magnitude of the force of wind resistance is
  - a. Much smaller than the force of gravity acting on you.
  - b. Slightly smaller than the force of gravity acting on you.
  - c. Equal to the force of gravity acting on you.
  - d. Greater than the force of gravity acting on you.

Multiple Choice (5 pts each, 30 pts total)

6. The graph below shows position as a function of time for two trains running on parallel tracks. Which is true?



- a. At time  $t_B$ , both trains have the same velocity.
- b. Both trains speed up the whole time.
- c. Both trains have the same velocity at some time before  $t_{\rm B}$
- d. Somewhere on the graph, both trains have the same acceleration.
- 7. A car accelerates from 4 m/s to 15 m/s at a rate of  $3.0 \text{ m/s}^2$ . How far does it travel while accelerating?
- Use  $V_{f}^{2} V_{i}^{2} = 2a \Delta x$   $\Rightarrow \Delta x = \frac{V_{f}^{2} V_{i}^{2}}{2} = \frac{(15m/s)^{2} (4m/s)^{2}}{2(3.0m/s^{2})} \approx$ a. 35 m b. 21 m c. 60 m d. 105 m 8. You walk 46 m to the north, then you turn 60 degrees to your right and walk another 45 m. How far are you from where you originally started?

Use either law of Costrues or components  $R^2 = (45)ml^2 + (46m)^2 - 2(46m)$  R = 78.8m R = 78.8ma. 45 m b. 86 m c. 41 m (d.) 79 m  $x = 45 \sin 60$ 

- 9. A ball is thrown straight upward from the ground with a velocity of 40 m/s. How much time passes before the ball strikes the ground?
- $V_{f} = V_{i} + cit \qquad 0 = ciom(s qt)$   $\Rightarrow t = 40m(s) = 4.08$   $\Rightarrow t = 40m(s) = 4.08$ a planet. The orbital radius is 22 here to the constraint of the const a. 4.1 s b. 2.5 s c 8.2 s d. 1.3 s 10. A satellite is in orbit around a planet. The orbital radius is 22 km and the 88 m/s gravitational acceleration at this height is 3.5 m/s<sup>2</sup>. What is the satellite's orbital speed? a. 88 m/s for certainet acceleration is the certain equal to certain equal to certainet acceleration b. 8.8 m/s **3**.  $a_{c} = \frac{v^{2}}{p} V = \sqrt{a_{c} g R} = \sqrt{(3.5 m/s^{2})(22 m \delta^{2} m)}$ C. 280 m/s d. 28 m/s = 277. 5 m/c = 280 m/1 11. A 55 kg mass is connected to a nail on a frictionless table by a (massless) string of length 1.3 m. If the tension in the string is 51 N while the mass moves in uniform circular motion on the table, how long does it take for the mass to make one 51 N is the centripetal force, Also, T=20K 51 N = MU<sup>2</sup> =) V = JOIN/R/m complete revolution? a. 7.4 s b. 5.9 s c. 8.1 s d. 6.9 s  $= \frac{1}{1.1} \frac{m/s}{s} = \frac{2\pi (1.3m)}{1.1m(s)} = 7.44s = 7.45$ Problems Show all work clearly and justify all answers logically/mathematica
  - 1. (20 pts) A physics student attempts to push a 50 kg crate across the floor by exerting 300 N of force parallel to the floor.
    - a. (2.5 pts) If the crate remains stationary, what is the magnitude of the static frictional force that is being exerted on the crate?



b. (2.5 pts) The student then begins to push harder, with a force of 400 N, and the crate still does not move. What is the magnitude of the static frictional force being exerted on the crate?

Same logic as above  $\Rightarrow \left| f_5 = 400 N \right|$ 

c. (5 pts) The crate finally begins to move when the student exerts 450 N of force on the crate. What is the coefficient of static friction between the crate When see crute is just about to and the floor? more the state frictional force has reached Ac maximum and is equal to MSN. fs III von N=mg 450 N = fs - us N = us mg ) us = 450 N/my = 0.9 d. (5 pts) What is the acceleration of the crate if the coefficient of kinetic friction is 0.2? Once Y4 Crate begins moving, Y4 Crational Corre opposing notion drops to Y4 kmetic value, No which is equal to us N. In As above N=mg. e. (5 pts) After 5 seconds of pushing the crate with a force of 450 N, the student  $27.0 \text{ M/s^{-1}}$ tires and allows the crate to slide to rest. How far is the crate from its starting position? Hers must be broken outs two parts. First find the distance traveled while neceleuting DX = 1/2 (7.04/1/52) (55)<sup>2</sup> = 88 m Hun find distance traveled outter the student lets go. Howeve there is now a new acceleration equal to:  $-f_{k} = -\mu_{w} mg = ma \Rightarrow \alpha = -\mu g = -1.96 m/s^{2} \qquad V_{p}^{2} - V_{i}^{2} = 2a_{2}\Delta x_{2}$   $\Rightarrow \Delta x_{2} cm be found using T + colso need 1$ talso need vi! 2. (10 pts) A 10 kg hangs from a system of massless pulleys as shown. With what force V= at sme must you pull to lift the mass with constant velocity? How does this compare with the " cruta steet weight of the mass? from rust. Notice that T, Tz, Tz are all the sume rope. This means Vi = (7.01m/2) 235m/s  $T_1 = T_2 = T_3$ . =) (35m/3)2 = 6)X2 Since M is moving with constant valocity TS-mg=0 => TS=mg 2 (1.96 4/22) F Now pulley 2 gives = 312.5  $2T - T_5 = 2T - my = 2$  $\frac{\partial X_{tot}}{\partial t} = \frac{\partial X_1 + \partial X_2}{\partial t}$ =) T = my which is this force is equal to that required. m = yorm

3. (15 pts) The figure below shows a *conical pendulum*. Its bob, whose mass m is 1.5 kg, whirls around a horizontal circle at a constant speed v at the center of the cord whose length L, measured to the center of the bob is 1.7 m. The cord makes an angle of 37 degrees with the vertical. As the bob swings around the circle, the cord sweeps out the surface of a cone.



a. (5 pts) Draw a free body diagram for the pendulum bob.

in a stuble "orbit.

To find T, we hed V. From Newton's 2nd law Trace - my = 2 Trine = may = mv2/R , where Hy divide the second eyer. by the first the part hole the second V = Jtent gR  $tent = \frac{V^2}{gR} \Rightarrow V = Jtent gR$   $T = \frac{2\pi R}{\sqrt{g}tent} = 2\pi \sqrt{\frac{R}{g}tent}$  but  $R = L \le in \frac{R}{\sqrt{g}tent}$ Sytu bob. c. (5 pts extra credit) Describe how you might use a conical pendulum to measure the local acceleration due to gravity. = 2.34 s Fint the pudvious votates For a given mart perdel. Thin mensive

practice Since T=20, Lioso, me an ute find

- 4. (10 pts) A quarterback throws a football to a wide receiver with a velocity of 20 m/s at an angle of 45 degrees with respect to the horizontal.
  - a. (5 pts) How fast does a wide receiver have to run to catch the football if he begins running the moment the ball is thrown and catches the ball at the same height from which it was thrown?

This is the speed the wor must travel to stay b. (5 pts) How far does the wide receiver run before catching the ball? He Range is Vix t = R. so we need be time of flight. find time of flight to top of trajectory (Vy==) and multiply by two. vy = vi-gt => 0 = viy-gt t = viy = 1.44. Total distance Vix (at) 5. (10 pts) Two blocks are connected over a pulley as shown below. The mass of block 2 is 10 kg and the coefficient of kinetic friction is 0.20 and the angle of inclination is = 19.1 M/s30 degrees. Block 2 slides down the incline at constant speed. What is the mass of block 1? x 2.895 Newtone 2nd  $F_{y} = T - m_{ig} = 0$ Marchent V!  $m_1$ MARSE  $\mathcal{L}F_{Y} = N - mycor \theta = 0$  $f_{E} + mq sin \theta = ma$ 2Fx == mining at constant V N=mgcore MILN TM LOSO+ Sino) -ukingwist + M  $T = m_1 G$ =) - mig - ung coro + mysno