EXAM II, PHYSICS 1403, July 23, 2014, Dr. Charles W. Myles
INSTRUCTIONS: Please read ALL of these before doing anything else!!
1. PLEASE put your name on every sheet of paper you use and write on one side of the paper only!!
   PLEASE DO NOT write on the exam sheets, there will not be room! This wastes paper, but it makes my grading easier!
2. PLEASE show all work, writing the essential steps in the solutions. Write formulas first, then put in numbers. Partial credit will be LIBERAL, provided that essential work is show n. Organized, logical, easy to follow work will receive more credit than disorganized work.
3. The setup (PHYSICS) of a problem will count more than the math of working it out.
4. PLEASE write neatly. Before handing in your solutions, PLEASE: a) number the pages & put the pages in numerical order, b) put the problem solutions in numerical order, & c) clearly mark your final answers. If I can’t read or find your answer, you can’t expect me to give it the credit it deserves.
5. NOTE! The words “EXPLAIN”, “DISCUSS” & “DEFINE” below mean to answer mostly in ENGLISH, NOT math symbols!

I HAVE 41 EXAMS TO GRADE!! PLEASE HELP ME GRADE THEM EFFICIENTLY BY FOLLOWING THESE SIMPLE INSTRUCTIONS!!

FAILURE TO FOLLOW THEM MAY RESULT IN A LOWER GRADE!! THANKS!

An 8.5” x 11” piece of paper with anything written on it & a calculator are allowed. NOTE: Question 1, Conceptual Questions IS REQUIRED! You may work any three (3) of the remaining 4 problems for four (4) problems total. (This means 4 complete problems, with all of their parts!). Each problem is equally weighted & worth 25 points, for 100 points on this exam.

1. MANDATORY CONCEPTUAL QUESTIONS!!! Answer briefly all parts in a few complete, grammatically correct English sentences. Give answers using mainly ENGLISH WORDS, NOT symbols or equations! If you insist on using symbols, DEFINE all symbols! NO credit will be given for answers with ONLY symbols! If a part contains more than one question, please be sure to answer each one!

   a. State Newton’s 1st Law. How many objects at a time does it apply to?
   b. State Newton’s 3rd Law. How many objects at a time does it apply to?
   c. See Fig. 1! Suppose that you are riding in a convertible with the top down. It is moving to the right (x-direction) at constant velocity \( v_x \). You throw a ball straight up (from your viewpoint) with initial velocity \( v_{oy} \) while the car moves forward at \( v_x \). Neglect air resistance. Will the ball land behind the car, in front of the car, or in the car? WHY? Explain (briefly) your answer. Use what you know about projectiles! Make a sketch of the situation to illustrate your explanation. NOTE! If you don’t make a sketch, you will lose points!

   d. See Fig. 2! A hockey puck slides (to the right) at constant velocity \( v \) across a flat, horizontal, frictionless ice surface. Which of the sketches in the figure is the correct free body diagram for this puck? WHY? Explain your answer using Newton’s Laws! [Hint: Is there a force in the direction of the puck’s motion?] To answer correctly, you need to think like Newton (300+ years ago) NOT like Aristotle (3,000+ years ago)].

   e. A box of mass \( m \) sits statically (not moving!) on a flat horizontal table. Fig. 3 is the box’s free body diagram when the only forces acting on it are the normal force \( F_N \) upward & it’s weight \( mg \) downward. Is the normal force \( F_N \) in this case equal in size & opposite in direction to the box’s weight \( mg \)? Which Newton’s Law of Motion did you use to answer this?

   f. Briefly (in a sentence or two) Define Static Equilibrium.
NOTE: WORK ANY THREE (3) OF PROBLEMS 2., 3., 4., or 5.!!!!!!

4. See Fig. 6. A cannon ball is shot from the ground with an initial velocity \( v_0 = 43 \text{ m/s} \) at an angle \( \theta_0 = 50^\circ \) with the horizontal. It lands on top of a nearby building of height \( h = 44 \text{ m} \) above the ground. Neglect air resistance. To solve this, take \( x_0 = y_0 = 0 \) where the cannon ball is shot. It is probably best to take the upward direction as positive! (Hint: That the building’s height is \( 44 \text{ m} \) above the ground is totally irrelevant to every question but that in part e!)

Calculate:

a. The horizontal & vertical components of the initial velocity.
b. The cannon ball’s maximum height above the ground.
c. The time it takes to reach its maximum height.
d. Its horizontal (x) distance from the starting point when it has reached its maximum height.
e. The horizontal & vertical components of the velocity, \( v_x \) & \( v_y \), after the cannon ball has been in the air for \( t = 5 \text{ s} \).
f. The cannon ball’s velocity (magnitude & direction) after it has been in the air for \( t = 5 \text{ s} \). (Hint: Use the results you found in part e).
g. 5 POINT BONUS! Calculate the time it takes the cannon ball to land on the top of the building. When it does so, calculate its horizontal distance \( d \) from its starting point. (Hint: You will need to use the quadratic equation to answer this!).

NOTE: WORK ANY THREE (3) OF PROBLEMS 2., 3., 4., or 5.!!!!!!

5. See Fig. 7. A person going for a walk follows the path shown in the figure. The total trip consists of four straight line paths. The displacement vector for the first leg is \( \text{A} = 100 \text{ m due East} \). For the second leg, the displacement is \( \text{B} = 300 \text{ m due South} \). The third leg is \( \text{C} = 150 \text{ m at 30° South of West} \). The fourth leg is \( \text{D} = 200 \text{ m at 60° North of West} \).

Calculate:

a. The vector components of the displacement vectors \( \text{A}, \text{B}, \text{C}, \text{& D} \)
   along the East-West (x) axis & along the North-South (y) axis.
   (That is, calculate the x & y components of the four displacement vectors.)
b. The x & y components of the resultant displacement vector \( \text{R} = \text{A} + \text{B} + \text{C} + \text{D} \).
c. Use the results of part b to calculate the magnitude & direction (with respect to the x-axis) of the resultant displacement vector, \( \text{R} \).

For parts d & e, assume that the person walks at constant speed for entire trip. The complete trip takes a time \( t = 30 \text{ minutes} = 1800 \text{ s} \). (Hints: Moving at constant speed means that there is NO ACCELERATION! The acceleration due to gravity \( g \) is TOTALLY IRRELEVANT to this problem!! If you think about parts d & e & use definitions, you may find that they are the easiest questions on this exam!!)

d. Calculate the average SPEED of the mail carrier for the entire trip.
e. Calculate the average VELOCITY of the mail carrier for the entire trip.
NOTE: WORK ANY THREE (3) OF PROBLEMS 2., 3., 4., or 5.!!!!!

2. See Fig. 4. A box of mass \( m = 38 \) kg is accelerated by being pushed across a flat table, using a force \( F = 48 \) N, which makes an angle \( \theta = 30^\circ \) BELOW the horizontal, as shown. The coefficient of kinetic friction between the box & the surface is \( \mu_k = 0.16 \). There is no vertical acceleration.

a. Sketch the free body diagram for the box, properly labeling all forces. NOTE! If you don't make a sketch, you will lose points!

Calculate:

b. The horizontal & vertical components of the force \( F \).

c. The the weight of the box. Use Newton's 2nd Law in the vertical direction to calculate the normal force \( F_N \) between the box & the surface. (Note: Answering that \( F_N \) is equal & oppositely directed to the weight will get ZERO credit! Such answers show a lack of understanding of vector forces & Newton's 2nd Law!!!!)

d. Using the results of part b, Calculate the friction force \( F_r \) on the box as it moves to the right.

e. Use Newton's 2nd Law to Calculate the box's acceleration \( a \). What forces cause this acceleration?

NOTE: WORK ANY THREE (3) OF PROBLEMS 2., 3., 4., or 5.!!!!!

3. See Fig. 5 Two masses \( (m_1 = 16 \) kg & \( m_2 = 24 \) kg) are connected by a massless cord over a massless, frictionless pulley as in the figure. \( m_1 \) sits on a frictionless table. The masses are released, \& \( m_1 \) moves to the right with acceleration \( a \) & \( m_2 \) moves down with the same acceleration. The tension in the cord is \( F_T \).

a. Sketch the free body diagrams for the 2 masses, properly labeling all forces. NOTE! If you don't make sketches, you will lose points!

Calculate:

b. The two unknowns are the acceleration \( a \) & the tension \( F_T \). By applying Newton's 2nd Law to the two masses, find the two equations needed to solve for \( a \) & \( F_T \). (Note: I don't mean to just write them abstractly as \( \Sigma F = ma \). I mean to write the explicit equations which result when Newton's 2nd Law is APPLIED to this problem! For each, I want to see which forces are on the left side of \( \Sigma F = ma \)! More credit will be given if you leave these equations in terms of symbols with no numbers substituted than if you substitute numbers into them.

c. Using the equations from part b, Calculate: \( a \) & \( F_T \) (in any order). (Note: To solve this you MUST solve two algebraic equations in two unknowns! Attempts to find the answers without doing this algebra will not be successful and will be given ZERO credit!)

If mass \( m_2 \) starts from rest \( (v_0 = 0) \), after time \( t = 3 \) s,

Calculate:

d. It's velocity.

e. The distance it has dropped.

(HINTS: Please THINK before answering parts d & e! Use kinematic equations from Ch. 2. But, obviously, \( m_2 \) is not in free fall, so the kinematic equations for free fall obviously do not apply to this question!)