Physics 218 – Exam I

Spring 2017 (all sections) **February 13$^{\text{th}}$, 2017**

Please fill out the information and read the instructions below, but **do not open the exam** until told to do so.

Rules of the exam:

1. You have 90 minutes (1.5 hrs) to complete the exam.
2. Formulae are provided to you with the exam on a separate sheet. Make sure you have one before the exam starts. You may *not* use any other formula sheet.
3. Check to see that there are 8 numbered (four double-sided) pages in addition to the scantron-like cover page. **Do not remove any pages**.
4. If you run out of space for a given problem, the last page has been left blank and may be used for extra space. Be sure to indicate *at the problem under consideration* that the extra space is being utilized so the graders know to look at it!
5. You may use any type of handheld calculator. However, you **must** show your work. If you don't show *how* you integrated or *how* you took the derivative or *how* you solved a quadratic of system of equations, etc., you will **not** get credit.
6. Cell phone use during the exam is strictly prohibited. Please turn off all ringers as calls during an exam can be quite distracting.
7. Be sure to put a box around your $\boxed{\text{final answer(s)}}$ and clearly indicate your work. Credit can be given **only** if your work is legible, clearly explained, and labelled.
8. All of the questions require you show your work and reasoning.
9. Have your TAMU ID ready when submitting your exam to the proctor.

Fill out the information below and sign to indicate your understanding of the above rules

Name: ______________________ UIN: ______________________
(printed *legibly*)

Signature: ______________________ Section Number: ______________

Instructor: Akimov Eusebi Dierker Kocharovsky Mahapatra Teizer Rapp Ulmer
(**circle one**)

Short Problems:

A) Two vectors, $\vec{A}$ and $\vec{B}$, have magnitudes $A = 1$ and $B = 5$. Their vector product is $\vec{A} \times \vec{B} = 3\hat{\imath} - 4\hat{\jmath}$. What are:

(a) the angle α between vectors $\vec{A}$ and $\vec{B}$?

(b) their scalar product?

LO	S	U
2.1		
2.2		
3.1		

B) Consider the motion of a particle that experiences a variable acceleration given by $a_x(t) = a_{0,x} + bt$, where $a_{0,x}$ and b are constants and $x = x_0$ and $v_x = v_{0,x}$ at $t = 0$. Find the position of this particle as a function of time.

LO	S	U
8.1		
8.2		
14.1		
14.2		
15.1		

C) A boat makes a turn along circular trajectory in the horizontal xy plane, initially travelling in the $+\hat{\jmath}$ direction to finally heading in the $-\hat{\jmath}$ direction. Find the acceleration vector (magnitude and direction) in the middle of the turn, if the boat made the turn in 2.00 seconds and its speed was 5.00 m/s during whole turn.

LO	S	U
16.1		
18.1		
19.1		

D) Two piers, A and B are located on a river; B is a distance D meters downstream of A. Two friends must make round trips from A to B and return. One rows a boat at a constant speed of v_0 relative to the water, and the other walks along the shore at a constant speed of v_0. If the velocity of the water relative to the shore is v_w in the direction from A to B, how long does it take each of the friends to make their round trip?

LO	S	U
3.2		
3.3		
14.3		
20.1		
20.2		

Prob 1 A cowboy moved along a straight line on a horizontally-flat field from the position $\vec{r}_1 = 3\hat{\imath}$ km to the position $\vec{r}_2 = 4\hat{\jmath}$ km.

(a) Use an appropriate two-dimensional coordinate system to plot the vectors of the initial and final positions.

(b) Also on this coordinate system, plot the displacement vector.

(c) Calculate the $\hat{\imath}$ and $\hat{\jmath}$ components of the displacement vector.

(d) Calculate the magnitude of the displacement vector up to one significant figure.

(e) Find the angle between the displacement vector and the vector of average velocity for this movement.

LO	S	U
1.1		
1.2		
2.3		
2.4		
2.5		
9.1		

Prob 2 An amusement park ride is composed of a horizontal wheel of seats that can be raised or lowered during the ride. The seats are arrayed on a circle of radius R, and the wheel of seats makes one complete revolution in a time T about a vertical axis passing through the center of the ride. At the start of the ride the wheel is raised to the top of the ride, a distance of H above the starting height off the ground and is set into rotation about the vertical axis. The wheel of seats is then lowered with a constant vertical velocity of v_{drop} while the wheel continues to rotate about the vertical axis of the ride. Answer the following in terms of the constants given:

(a) What is the speed of a person sitting in one of the seats on the ride relative to an observer on the ground?

(b) Find the magnitude and direction (vertical and radial components) of the acceleration of this rider.

(c) What is the angle between the rider's velocity vector relative to the ground and the horizontal plane during rider's descent?

LO	S	U
1.3		
1.4		
12.1		
18.2		
19.2		
20.3		

Prob 3 A physics professor, equipped with a rocket backpack, steps out of a helicopter at an altitude of 600 m with zero initial velocity. For 5.00 s, she falls freely. At that time, she fires her rocket so that her acceleration becomes 15 m/s^2 upwards until her rate of descent reaches 4.0 m/s. At this point, she adjusts her rocket engine controls to maintain that rate of descent until she reaches the ground. Neglect any effects due to air resistance in this problem.

(a) On two graphs using the same time scales, sketch her acceleration and velocity as functions of time. (Take upward to be positive)

(b) What is her speed at the end of the first 5.0 s?

(c) What is the duration of her slowing-down period?

(d) What is the vertical distance from the helicopter at the moment she reaches a speed of 4.00 m/s.

LO	S	U
3.4		
9.2		
9.3		
12.2		
14.4		
15.2		

Prob 4 Student engineers decided to test a rocket they had built by launching it at an angle of $\phi = 45°$ with respect to the horizontal along a straight, flat segment of a highway. At the time of the launch another student was driving her truck toward where the rocket was launched. The rocket reached a maximum height of $h = 80$ m and landed in the back of this truck as it came back to earth. The truck was traveling with a constant speed of $v_t = 90$ km/h during the time of the rocket flight. Consider the rocket as the projectile with the engine turned off after it was launched and that the back of the truck and the launching point of the rocket were at exactly the same height. Neglect air resistance and take the acceleration due to gravity to be $g = 10$ m/s^2.

(a) What was the horizontal distance from the launch point where the rocket landed?

(b) Where was the truck, relative to the launch point of the rocket, when it was launched?

(c) An observer in the back of the truck measures the velocity and acceleration of the rocket while in flight. In the reference frame of the truck, what is the velocity and acceleration of the rocket when it is at its highest point on its trajectory?

LO	S	U
1.5		
3.5		
12.3		
14.5		
15.3		
20.4		
20.5		

Extra Space: