Physics 218 – Exam I

Fall 2017 (all sections) **September 27th, 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. Calculators of any type are **not allowed**. Ensure that all your answers are in terms of the known variables given in the question.
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 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 (circle one): Akimov Dierker Melconian

Short Problems:

A) A car travels on a straight road in the $+\hat{\imath}$ direction for 40 km at a speed of 30 km/h. It then turns right and travels down a different straight road in the $-\hat{\jmath}$ direction for 20 km at 60 km/h.

(a) What is the vector displacement, in km, for the car at the end of the trip. Express you answer in terms of components.

(b) What is the average *speed*, in km/h, of the car during this trip? Give a numerical answer (e.g. $xx.x$ km/h)

LO	S	U
2.1		
3.1		
3.2		
3.3		
11.1		

B) Two vectors, $\vec{R}$ and $\vec{S}$, lie in the x-y plane. Their magnitudes are R and S, respectively, and the angles between them and the positive x-axis (measured counter-clockwise from the positive x-axis) are θ_R and θ_S, respectively. R's angle is bigger than S's, *i.e.* $\theta_R > \theta_S$.

(a) What is the value of the scalar product of $\vec{R}$ and $\vec{S}$?

(b) What is the vector product (magnitude and direction) of $\vec{R}$ and $\vec{S}$?

LO	S	U
2.2		
2.3		

C) An astronaut is rotated in a horizontal centrifuge at a radius of R meters with a centripetal acceleration of A m/s^2. In each of the following, express your answer in terms of R and A.

(a) What is the astronaut's speed?

(b) What is the period of motion?

(c) How many revolutions per minute are requred to produce this acceleration?

LO	S	U
3.4		
18.1		
3.5		
19.1		
19.2		

D) The velocity of a particle is given by $\vec{v}(t) = \left[-2 \text{ m/s} + (6 \text{ m/s}^6)t^5\right]\hat{\imath}$, and the position of the particle at $t = 1$ s is $\vec{r} = +1\hat{\imath}$ m.

(a) What is the acceleration of the particle as a function of time?

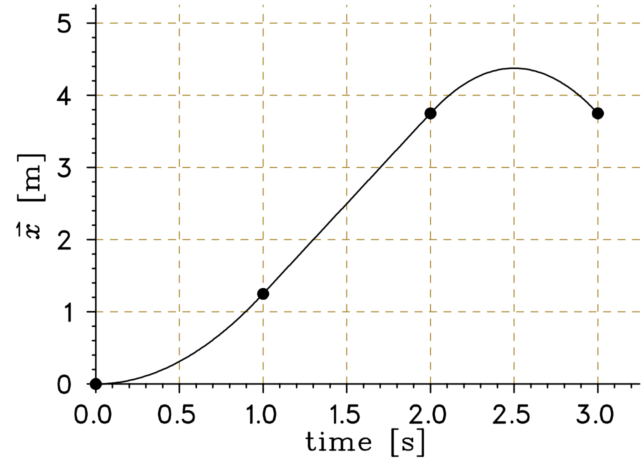
(b) What is the position of the particle as a function of time?

LO	S	U
8.1		
12.1		
8.2		
8.3		
12.2		

E) An object's displacement versus time is shown by the graph on the right below. Based on this graph, answer the following:

(a) Briefly (in 1–2 sentences) describe in words what this motion would look like, starting with

"A person starting from rest begins walking eastward, accelerating at a constant rate for the first second, at which point..."



(b) A second person starts at the same time and place as the first person, but has an initial velocity of $4\hat{\imath}$ m/s and an acceleration of $-2\hat{\imath}$ m/s^2. Write down the equation for this person's position as a function of time, and draw this motion on the graph. Be sure your curve is correct at $t = 0, 1, 2$ and 3 s.

LO	S	U
7.1		
7.2		
7.3		
14.1		

F) Determine which of the following have constant acceleration versus those which have an acceleration that changes with time. Briefly explain your decision:

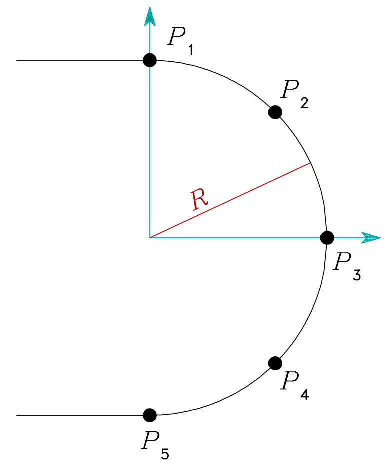
(a) $x(t) = 15\cos 25^\circ \text{ m} - (6.25 \text{ m/s}^2)(t - 25 \text{ s})^2$

(b) $v_x(t) = 10 \text{ m/s} + (0.2 \text{ m/s}^2)t - (5 \text{ m·s})t^{-2}$

(c) $x(t) = 2\cos 25^\circ \text{ m} + (0.25 \text{ m/s}^2)t^2$ and $y(t) = 2\sin 25^\circ \text{ m} - (0.25 \text{ m/s}^2)t^2$

LO	S	U
8.4		
15.1		
8.5		
15.2		
8.6		
15.3		

Prob 1 A train travelling along a horizontal track approaches and rounds a horizontal 180° turn. It slows down at a uniform rate from speed v_1 at point P_1 to speed v_3 just before point P_3 in a time t_{13}. At point P_3 there is no change in speed. Just after P_3 it speeds back up at a uniform rate to speed v_1 at point P_5. The radius of the curve is R, as shown in the figure below.



(a) Indicate the direction of the train's acceleration at points P_2, P_3, and P_4 directly on the figure.

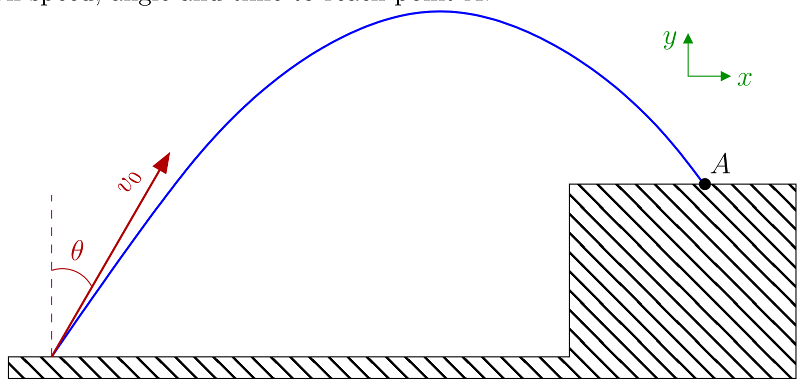
(b) What is the magnitude of the train's acceleration at point P_3?

(c) What is the magnitude of the train's acceleration at the moment the train reaches a speed v_2 at point P_2?

(d) A <u>different</u> train travels from P_1 to P_5 at a constant speed equal to v_1. How long, t_{15}, does it take for this train to go from P_1 to P_5?

LO	S	U
13.1		
13.2		
13.3		
18.2		
11.2		
12.3		
18.3		
19.3		

Prob 2 A stone is projected at a cliff with an initial speed v_0 directed at an angle θ relative to the vertical as shown. The stone strikes the cliff at point A in a time t after being launched. Express all answers to the following in terms of the the acceleration due to gravity, g, and the known speed, angle and time to reach point A.



(a) Write out the initial velocity of the stone in terms of components, *i.e.* v_{x0} and v_{y0}.

(b) What is the height, h, of the cliff?

(c) What is the velocity of the stone just before impact at A?

(d) What is the maximum height, H, that the stone reaches above the ground?

LO	S	U
1.1		
1.2		
14.2		
14.3		
14.4		
3.6		
14.5		

Prob 3 A helicopter is flying in a straight line over a level field at a constant speed of v_h in the $+\hat{\imath}$ direction and at a constant altitude of h. A package is ejected horizontally from the helicopter with an initial speed of v_p as seen by the helicopter, and in a direction opposite to the helicopter's motion.

(a) What is the initial velocity of the package relative to the ground?

(b) How much time, t_1, does it take for the package to strike the ground after being ejected from the helicopter?

(c) A truck is driving in the $+\hat{\imath}$ direction at a constant speed such that is covers a distance of D in a time, t_2. For this part of the problem, assume that as the package leaves the helicopter it is moving in the $+\hat{\imath}$ direction at a speed of v_2 relative to the ground. What is the velocity of the package when it leaves the helicopter as seen by the truck driver?

LO	S	U
1.3		
1.4		
20.1		
3.7		
14.6		
1.5		
11.3		
20.2		
20.3		

Extra Space: