95.141 Exam 2a, November 2, 2009

Section Number ______________

Section Instructor_____________

Name ___________________________,____________________

Last Name First Name

Last 3 Digits of Student ID number: ____ ____ ____

Answer all questions, beginning each new question in the space provided. Show all work. Show all formulas used for each problem prior to substitution of numbers. Label diagrams and include appropriate units for your answers! Write your name and section number at the top of each page in the space provided and write the name of your section instructor in the place provided on this cover sheet. **You may use an alphanumeric calculator (one which exhibits physical formulas) during the exam, as long as you do not program any numbers to memory. By using an alphanumeric calculator you agree to allow us to check its memory during the exam. Simple scientific calculators are always OK.**

Score on each problem:

1. _______

2. _______

3. _______

4. _______

Total Score (based on 100 pts) ________

Be prepared to show your student ID Card

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Problem 1 (25 points – 5 points each, no partial credit on this problem only, don't forget units if a fill-in answer)

1-1. A 70 kg skydiver experiences a drag force as a function of velocity (in m/s), opposite the direction of motion, whose magnitude is given

$$F_D(v) = 0.19v^2$$

What is the skydiver's terminal velocity?

A) 3610m/s B) 60m/s C) 19.2 m/s D) 9.8m/s

1-2. Venus completes one orbit of the sun every 225 days. If the distance between Earth and the sun is $149.6 \times 10^6 km$, how far is Venus from the sun?

A) $72 \times 10^6 km$ B) $206 \times 10^6 km$ C) $92.5 \times 10^6 km$ D) $108.2 \times 10^6 km$

1-3. What is the angle between the two vectors $\vec{A} = 3\hat{i} - 2\hat{j} + 4\hat{k}$ and $\vec{B} = -5\hat{i} + 6\hat{k}$?

A) 65^o B) 130^o C) 77.6^o D) 12.4^o

1-4. What is the angular velocity of a hard drive disc spinning at 7200 rpm (rotations per minute)

A) 754 rad/s B) 120 rad/s C) 377 rad/s D) 377 m/s

1-5. What is the Force of gravity on a 5kg object at the surface of the moon? (assume only the moon exerts this force). R_{moon}=1.74x10^3km, M_{moon}=7.35x10^{22}kg.

A) $1.42 \times 10^7 N$ B) $7.5N$ C) $8.15N$ D) 49 N

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Problem 2 (25 points): A car travels around a curve of radius R=200m at a constant speed of 40m/s :

(a) (5 pts) What is the centripetal acceleration of the car?

(b) (5 pts) If the curve is flat, and we can assume friction, draw the free body diagram for the car (show the coordinate system you choose).

(c) (5 pts) Determine the coefficient of friction required to keep the car from slipping. Is this a kinetic or static coefficient?

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Problem 2, continued

d) (5pts) Now assume the road is covered in a thin sheet of ice, and is effectively frictionless. The curve is now banked. Draw the free body diagram for the car (show the coordinate system you choose).

e) (5pts) At what angle must the road be banked to prevent the car from slipping?

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Problem 3 (25 points): A skier of mass m=70kg starts from rest and skis down a hill that is 100m high, and has a constant slope.

a) (10pts) If there was no friction on the slope, what would the final speed of the skier be?

b) (5 pts) If the final speed of the skier is actually 30m/s, what is total work done by Friction on the skier?

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Problem 3 Cont.

c) (10pts). If the coefficient of friction for skis on snow is μ_k=0.25, what is the slope of the hill (θ)? Hint: first calculate the frictional Force on the skier and the length of the hill as a function of θ.

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Problem 4 (25 points): Two masses (combined m=8kg) are placed on a vertical spring, compressed by a distance of Δy=0.2m. The spring is released, and the masses are launched upwards, reaching a maximum height of 12m above the equilibrium position of the spring. (In this problem, equilibrium of the spring refers to equilibrium with the masses on the spring)

a) (5 pts) What is the spring constant (k) of the spring?

b) (5pts) What is the velocity of the masses as they leave the spring?

c) (5 pts) Using the work-energy principle and your answer for (b), calculate the work done on the masses by the spring.

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Problem 4 cont.

d) (5pts) Calculate the work done by gravity on the masses from the time they leave the spring to the time they reach the peak of their trajectory.

e) (5pts) Suppose I catch one of the masses (which weighs 2kg) at the top of its trajectory. The other mass falls back onto the spring. How much is the spring compressed by the remaining mass?