95.141 Exam 2a, March 31, 2010

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. Mass A (100kg) and Mass B(500kg) are placed on a table, separated by 10cm. What is the Force of Gravity between the two masses?

A) 3.34×10^{-5} N B) 3.34×10^{-4} N C) 3.34×10^{-8} N D) 3.34×10^{-10} N

1-2. Mercury orbits the Sun at a distance of 57.9×10^{6} km and completes one orbit every 0.241 yrs. If Jupiter is 778.3×10^{6} km from the Sun, what is the Period of Jupiter's orbit?

A) 6.43 yrs B) 3.24yrs C) 141 yrs D) 11.9 yrs

1-3. What is the change in the gravitational potential energy of a 4kg block which falls off a 2m high table onto the ground?

$$\Delta U_g = \_\_\_\_\_$$

1-4. Calculate the scalar (dot) product of the vectors $\vec{A} = 8\hat{j} + 3\hat{k}$ and $\vec{B} = 3\hat{i} + 2\hat{j} - 4\hat{k}$.

$$\vec{A} \bullet \vec{B} = \_\_\_\_\_$$

1-5. A 1000kg car accelerates from 10m/s to 25m/s. What is the net work done on the car?

$$W = \_\_\_\_\_$$

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Problem 2 (25 points): A child (m=30kg) sits 5m from the axis of rotation on a flat turn-table which makes a full rotation every 8 seconds.

a) (6pts) Give the child's period (T) and frequency (f)

$T =$_____, $f =$_____

b) (6pts) What is the tangential velocity of the child?

$v_T =$_____

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c) (8pts) What is the centripetal acceleration of the child? What must the centripetal force acting on the child be?

a_c =_____ , F_c =_____

d) (8pts) If this is the fastest the child can go without slipping off the turntable, determine the coefficient of static friction between the child and the table surface.

μ_s =_____

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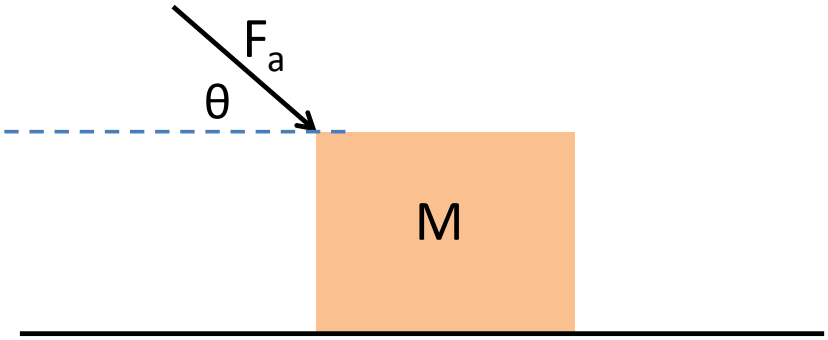
Problem 3 (25 points): A block of mass M=3kg sits on a surface with μ_s=0.3 and μ_k=0.2. A force is applied to the block as shown in the diagram, with θ=20°.



(a) (10 pts) Draw the free body diagram for this system, showing all Forces acting on the system and your coordinate system.

(b) (5 pts) If F_a=20N, calculate the Normal Force acting on the mass.

$\vec{F}_N$ =_____

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(c) (5 pts) If the applied force F_a=20N, calculate the acceleration of the mass.

a=_____

(d) (5 pts) If the mass moves 100m , what is the work done by the Normal Force over this distance?

W_{normal}=_____

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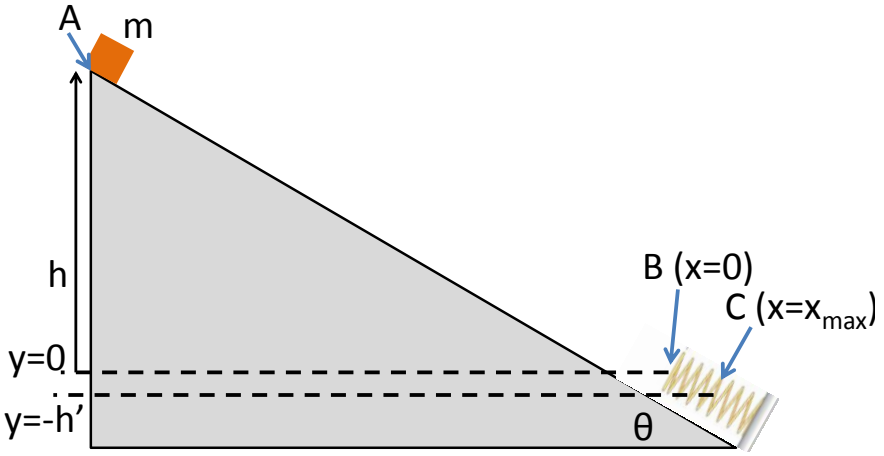
Problem 4 (25 points): A mass m (3kg) is released from rest at point A (at h=8m) on a frictionless inclined plane (θ=35°). It slides down the plane and hits a spring (spring constant k=200N-m) at point B. At point C, the spring is fully compressed, and the mass's speed is 0.



a) (6 pts) What is the speed of the block at point B, right before it touches the spring?

v_B =_____

b) (6 pts) There are 3 types of energy in this system. Give an expression for the energy of the system at i) point B (x=0) and ii) at point C ($x=x_{max}$). Give your answers in terms of m, v, k, g, θ and x_{max} (the maximum compression of the spring).

E_{total} AT POINT B **E_{total} AT POINT C**

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c) (8 pts) Use conservation of Energy to determine the maximum compression of the spring.

Δx_{max} =_____

d) (5pts) What is the work done by the spring from point B to C?

$W_{S,BC}$ =_____