Physics 206 – Exam II

Spring 2019 (all UP sections) **March 18th, 2019**

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 (4 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 two pages have 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 (and also on the extra sheets, which problem the work refers to) so the graders know to look at it!
5. Calculators of any type are **not allowed**. In the case of questions with numerical values, the math should be simple enough you will not need a calculator. For purely symbolic questions, 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 $\boxed{\text{final answer(s)}}$ and clearly indicate your work. Credit can be given **only** if your work is legible, clearly explained, and labelled.
8. Unless explicitly stated otherwise in the question, all of the free-response problems in this exam 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)

Allen Eusebi Kocharovsky Kubik

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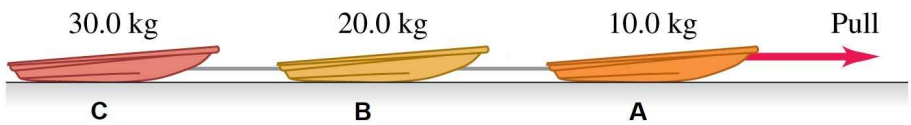
Problems:

Prob 1 A father, F, is pulling three sleds A, B, and C with his 3 children – Alice, Bob, and Cindy – (one per each sled, respectively) across frictionless horizontal surface of ice, using straight horizontal massless ropes as shown. Their masses are 10 kg for A, 20 kg for B, and 30 kg for C. They are lined up as shown and the father pulls on the rope attached to A with a force of 180 N.



(a) What is the acceleration of the system of 3 children?

Ans: _____

(b) Draw the free body diagram for the child A.

(c) What is the tension, T_{AB}, in the rope between A and B?

Ans: _____

(d) What is the tension, T_{BC}, in the rope between B and C?

Ans: _____

(e) Find the force, T_{AF}, that the rope exerts on the father.

Ans: _____

LO	S	U
21.1		
23.1		
24.1		
26.1		
21.2		
24.2		
21.3		
24.3		
22.1		

Prob 2 A froghopper has a mass of 10 milligrams and can jump straight up at 4.0 m/s, exerting a force on the ground for 1.0 millisecond. Take the acceleration of gravity to be 10 m/s^2.

(a) Draw the free body diagram for the froghopper when it is in contact with the ground.

(b) Find the magnitude and direction of the force that the froghopper exerts on the ground, assuming that it is constant during the 1 ms of his hop.

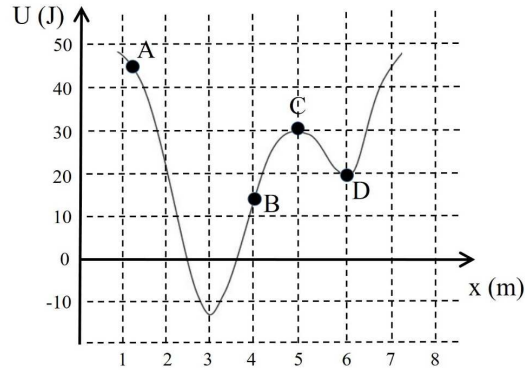
Ans: _____

(c) Use the principle of energy conservation to find the maximum height of flight.

Ans: _____

LO	S	U
23.2		
26.2		
3.1		
10.1		
10.2		
14.1		
21.4		
22.2		
3.2		
34.1		
38.1		
40.1		

Prob 3 A particle moves along the x-axis while acted on by a conservative force parallel to the x-axis. The potential energy function of this force is shown in the graph. The particle is released from rest at point A.



(a) At point A, what is the direction of the force on the particle?

Ans: _____

(b) At point B, what is the direction of the force on the particle?

Ans: _____

(c) At point C, what is the value of the force on the particle?

Ans: _____

(d) At what value of x is the kinetic energy of the particle the largest?

Ans: _____

(e) Find the value(s) of x where the particle is in stable equilibrium.

Ans: _____

(f) Find the value(s) of x where the particle is in unstable equilibrium.

Ans: _____

(g) What is the largest value of x the particle can reach if it starts from rest at point A? Also, determine the largest value of x the particle can reach if it starts from point B and point D.

Ans: _____

_____

_____

LO	S	U
44.1		
44.2		
44.3		
34.2		
40.2		
41.1		
41.2		
42.1		
41.3		
42.2		
42.3		
43.1		
43.2		
43.3		

Prob 4 As a respected engineer, you are called to be an expert witness in traffic court. A driver slammed on the brakes, locking the wheels so that they could not rotate and instead just slid. The vehicle came to a halt in 270 ft at constant acceleration. The coefficient of kinetic friction between tires and pavement was 0.50. The speed limit was 55 mi/hr, which is approximately 25 m/s. You can also approximate 3 ft as 1 m. Take the acceleration of gravity to be 10 m/s^2.

(a) Draw the free body diagram for the car.

(b) Use Newton's second law to calculate the acceleration of the car, both the magnitude and direction, taking the initial velocity to be in the positive direction.

Ans: _____

(c) Calculate the vehicle's initial speed, at the moment the driver hit the brakes:

i) first, by means of a kinematic equation, and

Ans: _____

ii) second, by means of the work-energy theorem.

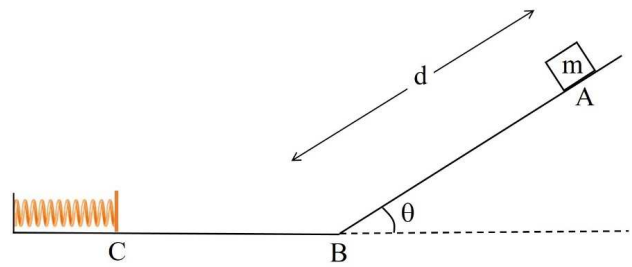
Ans: _____

(d) Check that both methods in the previous question give the same result for the initial speed. Was the driver travelling within the speed limit before hitting the brakes?

Ans: _____

LO	S	U
23.3		
26.3		
28.1		
3.3		
13.1		
21.5		
28.2		
3.4		
10.3		
14.2		
32.1		
34.3		
39.1		
6.1		

Prob 5 A box of mass m is initially held at rest (at point A) on an incline forming an angle θ with the horizontal. When released, it slides a distance d down the incline which has a rough surface with a coefficient of kinetic friction μ_k. After it reaches the bottom of the incline (point B), it continues to slide on a horizontal icy, frictionless surface. At point C, the box sticks to the end of a spring which has a negligible mass and spring constant k. The box compresses the spring as it slows down until the spring reaches its maximum compression. Express your answers to this problem in terms of the acceleration due to gravity g and the quantities defined above: m, θ, d, μ_k and k.



(a) Draw the free body diagram for the box while it is sliding down the incline.

(b) What is the work done by the force of gravity during this motion?

Ans: _____

(c) What is the work done by the force of friction during this motion?

Ans: _____

(d) Use the work-energy theorem to calculate the speed of the box at point B, the bottom of the incline.

Ans: _____

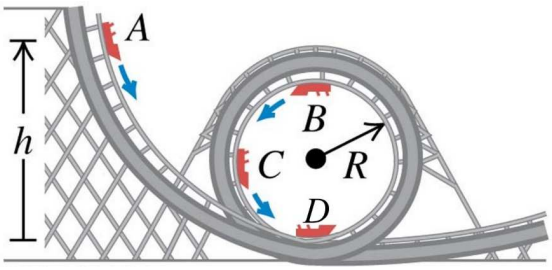
(e) Find the work done by the spring on the box when the spring reaches its maximum compression, and calculate how far the box has compressed the spring at this point.

Ans: _____

_____

LO	S	U
23.4		
26.4		
28.3		
32.2		
38.2		
28.4		
32.3		
3.5		
34.4		
39.2		
3.6		
32.4		
38.3		
40.3		

Prob 6 At an amusement park, a car of mass m rolls without friction around a track as shown. The car starts from rest at point A, a height $h = 3R$ above the bottom of the loop (R is the radius of the loop). Treat the car as a point-like particle.



(a) Draw the free body diagram for the car and find the car's kinetic energy and normal force acting on the car at the top of the loop (point B).

Ans: _____

(b) Draw the free body diagram for the car and find the car's kinetic energy and normal force acting on the car at the bottom of the loop (point D).

Ans: _____

(c) Draw the free body diagram for the car and find the car's kinetic energy and normal force acting on the car at the point C, which is at the end of a horizontal diameter.

Ans: _____

(d) Find the force that the car exerts on the loop at point C.

Ans: _____

(e) Compute the tangential and radial (centripetal) components of the car's acceleration at point C.

Ans: _____

(f) What is the minimum value of h (in terms of R) such that the car moves around the loop without falling off at the top (point B)?

Ans: _____

LO	S	U
18.1		
23.5		
26.5		
34.5		
38.4		
40.4		
18.2		
23.6		
26.6		
34.6		
38.5		
40.5		
18.3		
23.7		
26.7		
34.7		
38.6		
40.6		
22.3		
13.2		
17.1		
18.4		
21.6		
6.2		
18.5		
21.7		
38.7		
40.7		

Extra space: