Physics 218 – Exam II

Spring 2018 (all UP sections)   March 19^{th}, 2018

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 3 short (A, B and C) and 4 long problems (1–4) on 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**. 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 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 in the problem, all of the questions require you show your work and reasoning.
9. Have your TAMU ID ready when submitting your exam to the proctor.
10. For **any** numerical questions involving the acceleration due to gravity, instead of 9.8 m/s^2 take $\boldsymbol{g = 10}$ **m/s^2**.

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

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

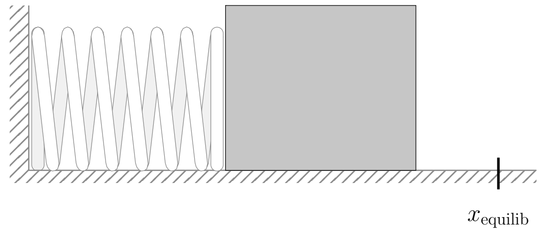
Signature: ______________________________ Section Number: ____________________

Instructor: (circle one)

Akimov	Dierker	Ko	Kocharovsky	Lyuksyutov
Mahapatra	Mioduszewski	Ross	Royston	Wu

Short Problems:

A) A block, of mass 1 kg, is placed on a rough horizontal surface and pressed up against a massless spring with spring constant $k = 20$ N/m as shown in the figure to the right. The coefficients of static and kinetic friction are $\mu_s = 0.5$ and $\mu_k = 0.4$. The block compresses the spring a distance $x = 0.05$ m from its equilibrium position and is released with zero kinetic energy.



(a) Turn the drawing into a free-body diagram of the block just after it is released.

(b) What is the magnitude of the force of friction between block and the surface just after it is released?

LO	S	U
23.1		
25.1		
26.1		
29.1		
21.1		
25.2		
29.2		

B) A small parcel at the Post Office is on a frictionless horizontal table in front of a rough, uneven incline where friction is not negligible. A postal worker compresses the box against a spring and, after it is released, it rises to a vertical height h above its starting point where another postal worker is waiting to collect it.

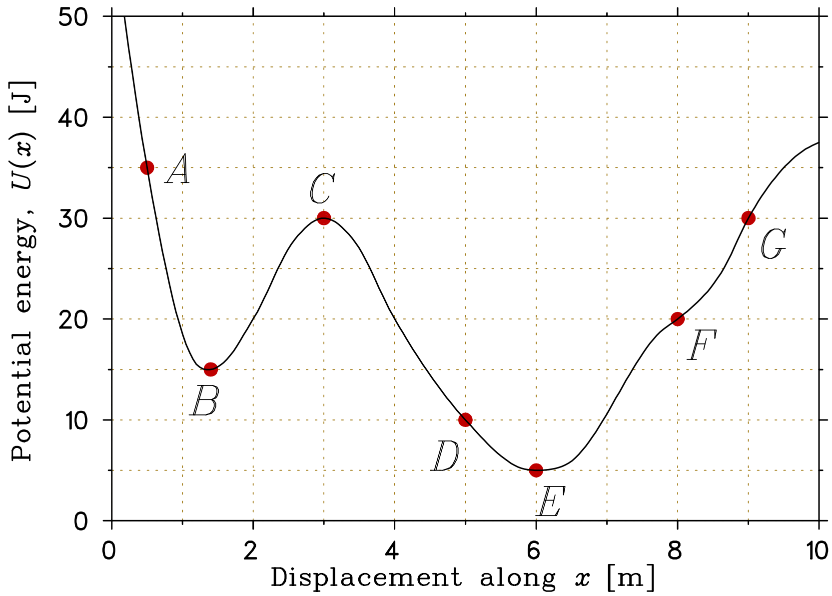
(a) Identify which forces acting on the block do positive work, which do negative work, and/or which do no work during it's motion up to the 2^{nd} postal worker.

(b) For each of the forces which do work (positive or negative) on the box, state whether it is a conservative or non-conservative force.

(c) Use the work-energy theorem to find an expression for the maximum kinetic energy in terms of the spring constant, k, and initial compression of the spring, Δx.

LO	S	U
32.1		
32.2		
32.3		
32.4		
36.1		
36.2		
36.3		
38.1		
39.1		

C) Consider the graph shown below, illustrating the potential energy for motion of a particle in the $\hat{\imath}$ direction. The horizontal axis shows the displacement in meters along the x axis. All of the questions below do not require you to explain your reasoning.



(a) Of the labelled points A through G, at which position does the particle experience

i. the largest positive force?

ii. the largest negative force?

iii. the largest magnitude of force (either positive or negative)?

(b) Identify which of the labeled point(s) represent positions of stable equilibrium, and also identify any point(s) corresponding to unstable equilibrium.

(c) For each of the following starting points, the particle is released from rest. In each case, identify the minimum and maximum values of x the particle will reach. (Supply numerical answers, by reading from the graph.)

i. If it is released from rest at point D

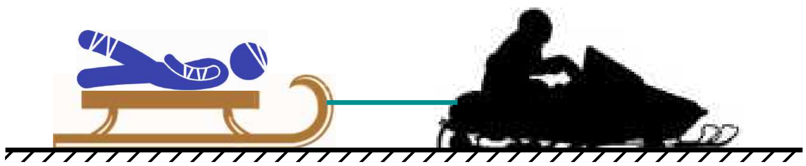
ii. If it is released from rest at point F

iii. If it is released from rest at point A

LO	S	U
44.1		
44.2		
44.3		
42.1		
42.2		
42.3		
43.1		
43.2		
43.3		

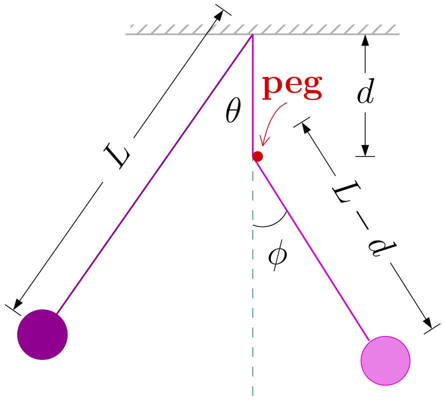
Prob 1 An injured bobsledder of mass $m = 50$ kg is laying on the horizontal bed of a toboggan which is being pulled to the hospital by a snowmobile via a strong, massless, horizontal rope. There is friction between the patient and the toboggan, but because of the icy conditions, there is no friction between the toboggan and the ground. For the following, take the snowmobile's acceleration to be 3.0 m/s^2 to the right.

(a) Draw free-body diagrams for the toboggan and person. Clearly identify any action-reaction pairs between the person and toboggan (for example by circling your labels for them and connecting them by a line with arrows).



(b) The coefficient of static friction of the person with the bed of the toboggan is 0.5. What is the magnitude of the static friction when the snowmobile's acceleration is 3 m/s^2?

LO	S	U
22.1		
22.2		
23.2		
23.3		
24.1		
26.2		
26.3		
26.4		
29.3		
29.4		
21.2		
29.5		



Prob 2 A small ball of mass M is attached to a massless rope of length L, initially making an angle $\theta = 60°$ with the vertical as shown (not to scale). It is released from rest and air resistance is negligible throughout its motion. A peg is placed in the wall behind the pendulum which is above the starting point of mass; the string of the pendulum will encounter it just after the mass reaches the lowest point of its motion.

(a) Find the speed of the ball at the lowest point of its motion.

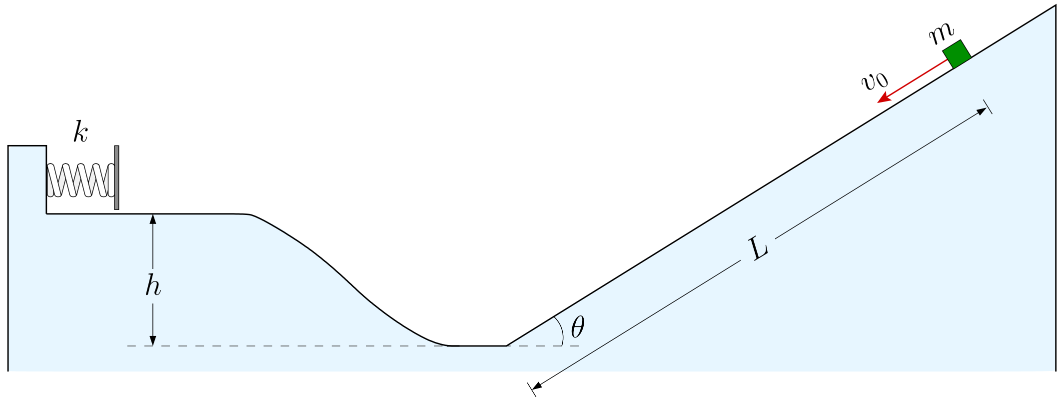
(b) Find the tension of the rope at the low point of the motion, just before the rope contacts the peg.

(c) After striking the peg, which is a distance d below the ceiling, what is the maximum final angle of the rope, ϕ? Express your answer in terms of L, d and θ.

(d) What work is done by the tension force during this process? Why?

LO	S	U
1.1		
3.1		
34.1		
38.2		
40.1		
3.2		
18.1		
21.3		
23.4		
24.2		
3.3		
38.3		
40.2		
24.3		
32.5		

Prob 3 A small mass m is sliding down a frictionless incline which makes an angle θ with the horizontal as shown. The mass is distance L along the ramp when it has an initial speed v_0. It then climbs a curved frictionless ramp, rising a vertical distance h from ground level, after which the mass encounters a spring, of spring constant k.



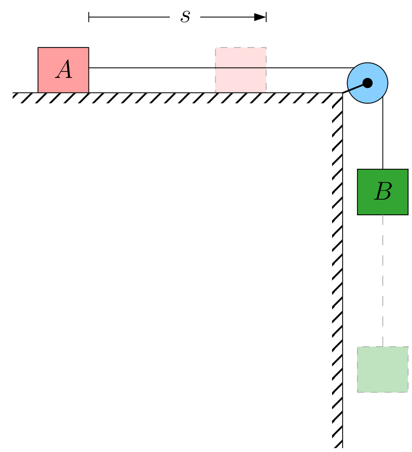
(a) Find the maximum distance D by which the spring is compressed from its equilibrium length.

(b) Find the magnitude of the maximum acceleration of the mass while it is in contact with the spring.

(c) While the mass is contacting the spring, sand is spread in the lower region of the ramp. Thereafter, the mass leaves the spring and climbs a maximum distance $L/2$ up the incline. Find the work done by friction during the return trip, including sign.

LO	S	U
1.2		
3.4		
34.2		
38.4		
38.5		
40.3		
21.4		
25.3		
28.1		
38.6		
39.2		

Prob 4 Two blocks are connected over a frictionless, massless pulley by a thin massless wire as shown. The coefficient of kinetic friction between block A and the table is $\mu_k = 0.1$. The system is released from rest. Block B descends and block A moves $s = 1.0$ m to the right. Both blocks have a mass $m_A = m_B = 1.0$ kg and, as noted on page 1, take $g = 10$ m/s^2.



(a) Draw a free body diagram for each mass, and find the work done by friction force when block A has moved $s = 1.0$ m to the right.

(b) How much work does gravity do on the system when the blocks have moved 1 m?

(c) Use the work-energy theorem to find the total kinetic energy of the system when the blocks have moved 1 m.

(d) Find the speed of the blocks when the blocks have moved 1 m.

LO	S	U
23.5		
23.6		
24.4		
26.5		
28.2		
28.3		
32.6		
32.7		
38.7		
39.3		
3.5		
34.3		