Physics 218 – Exam II

Fall 2018 (all UP sections) **October 24$^{\text{th}}$, 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 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**. 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 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) Kocharovsky Melconian

Short Problems:

A) A 10 kg stone and a 100 kg stone are released from rest at the same height above the ground which we take to be $y = 0$. There is no appreciable air drag. Which of the following statement(s) is or are true? (You do not have to explain your reasoning for this problem.)

(a) Both stones will reach the ground at the same time.

(b) Both stones will have the same speed when they reach the ground.

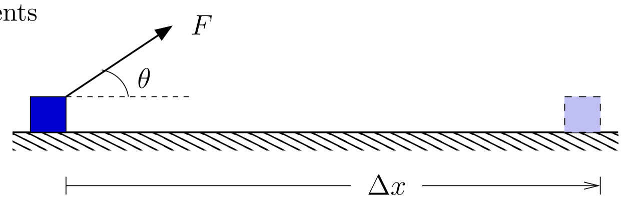
(c) Both stones will have the same acceleration as they fall.

(d) Both stones will have the same kinetic energy when they reach the ground.

(e) Both stones have the same initial gravitational potential energy.

LO	S	U
14.1		
14.2		
34.1		
38.1		
40.1		

B) A package is being pulled with a force $\vec{F}$ along a rough floor by a rope which makes an angle θ upwards from the horizontal. The coefficients of static and kinetic frictions are μ_s and μ_k, respectively.



(a) How much work is done by friction when the package is pulled a distance Δx?

Ans: ______________________________

(b) Can a potential be defined for friction? (Answer "yes" or "no" along with a *brief* explanation.)

LO	S	U
1.1		
21.1		
26.1		
27.1		
28.1		
32.1		
36.1		
37.1		

C) Draw a free-body diagram for each of the following objects:

(a) A projectile in motion in the presence of air resistance.

(b) A rocket leaving the launch pad with its engines operating (neglecting air resistance).

(c) A bird flying perfectly horizontally through the air (do not ignore the air).

LO	S	U
23.1		
30.1		
23.2		
30.2		
23.3		
30.3		
30.4		

D) A particle moving along the x-axis is acted upon by a conservative force, $F_x(x)$. At a certain point, the force is zero. For the following, you do not need to explain your reasoning.

(a) Which of the following statements about the value of the potential energy function, $U(x)$, at that point is correct?

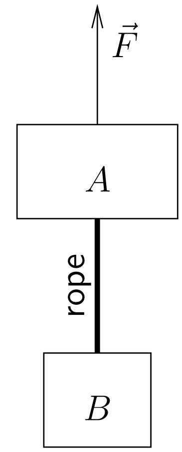
(i) $U(x) < 0$ (ii) $U(x) > 0$ (iii) $U(x) = 0$ (iv) Not enough information given to decide

(b) Which of the following statements about the value of the derivative of $U(x)$ at that point is correct?

(i) $\frac{dU(x)}{dx} < 0$ (ii) $\frac{U(x)}{dx} > 0$ (iii) $\frac{U(x)}{dx} = 0$ (iv) Not enough information given to decide

LO	S	U
37.2		
41.1		
42.1		
37.3		
41.2		
42.2		

Prob 1 The two blocks depicted to the right are connected by a heavy uniform rope with a mass of $m_{\text{rope}} = 4.00$ kg. The mass of block A is $m_A = 6.00$ kg and that of block B is $m_B = 5.00$ kg. An upward force of 300 N is applied as shown. Take $g = 10$ m/s^2 for this problem.



(a) Draw three free-body diagrams, one for block A, one for the rope, and another one for block B. Identify any action-reaction forces acting between the objects.

(b) What is the acceleration of the system?

Ans: ______________________________

(c) What is the tension at the top of the heavy rope?

Ans: ______________________________

LO	S	U
22.1		
22.2		
23.4		
24.1		
30.5		
3.1		
17.1		
21.2		
4.1		
21.3		
22.3		
24.2		
24.3		

Prob 2 A proton with mass m is a distance D away from a uranium nucleus and approaching it with an initial speed v_D. The proton is repelled by the uranium nucleus by a conservative force with a magnitude $F(x) = \alpha x^{-2}$, where x is the separation between the two objects and α is a positive constant with units of $\mathrm{N\,m^2}$. Assume that the uranium nucleus remains at rest at $x = 0$ throughout this 1D problem.

(a) Can a potential be defined for this force? If "yes", find the potential as a function of x, assuming it goes to zero as $x \to \infty$; if "no", briefly explain why not.

(b) What is the speed of the proton when it is a distance d from the uranium nucleus, where $d < D$?

Ans: ______________________________

(c) As the proton approaches the uranium nucleus, the repulsive force slows down the proton until it comes momentarily to rest, after which the proton moves away from the uranium nucleus. How close to the uranium nucleus does the proton get?

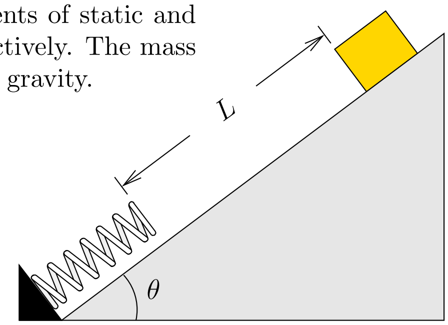
Ans: ______________________________

(d) What is the speed of the proton when it is again a distance D away from the uranium nucleus?

Ans: ______________________________

LO	S	U
8.1		
36.2		
37.4		
3.2		
34.2		
37.5		
39.1		
3.3		
37.6		
39.2		
34.3		
36.3		
39.3		

Prob 3 A 5-kg package is released on a $\theta = 53.1°$ incline, $L = 4.5$ m from a long spring that is attached to the bottom of the incline as shown to the right. The coefficients of static and kinetic friction between the package and the incline are 5/6 and 4/6 respectively. The mass of the spring is negligible and take $g = 10$ m/s^2 for the acceleration due to gravity.



(a) What is the speed of the package just before it reaches the spring?

Ans: ______________________________

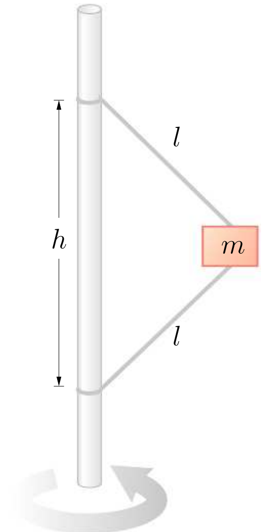
(b) If the spring is observed to have a maximum compression of 0.5 m, what is the spring constant, in N/cm?

Ans: ______________________________

LO	S	U
4.2		
9.1		
21.4		
26.2		
27.2		
28.2		
32.2		
34.4		
38.2		
40.2		

4.3		
9.2		
10.1		
21.5		
26.3		
27.3		
28.3		
32.3		
38.3		
40.3		

Prob 4 The $m = 4$ kg block in the figure is attached to a vertical rod by means of two strings. When the system rotates about the axis of the rod, the block moves in constant circular motion with strings extended as shown, where $l = 50$ cm and $h = 80$ cm. The tension in the upper string is 325 N and take the acceleration due to gravity to be 10 m/s^2.



(a) Turn the figure into a free-body diagram (or draw your own), labelling all forces acting on the mass and breaking them up into components.

(b) What is the tension in the lower cord?

Ans: ______________________________

(c) What is the speed of the block, in m/s? Express your answer numerically as the square root of an integer without attempting to evaluate the value of the square root.

Ans: ______________________________

LO	S	U
1.2		
9.3		
23.5		
24.4		
24.5		
1.3		
3.4		
21.6		
1.4		
3.5		
18.1		
19.1		
21.7		

Extra space: