Center for Academic Resources in Engineering (CARE)
Peer Exam Review Session

Phys 211 – University Physics: Mechanics

Midterm 1 Worksheet

The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.

Tutors are available to answer questions, review problems, and help you feel prepared for your exam during these times:

Session 1: Feb 27, 4-5:30pm, Amanda and Aditya Session 2: Feb 28, 3-4:30pm, Isabel and Jason

Can't make it to a session? Here's our schedule by course:

https://care.engineering.illinois.edu/tutoring-resources/tutoring-schedule-by-course/

Solutions will be available on our website after the last review session that we host, as well as posted in the zoom chat 30 minutes prior to the end of the session

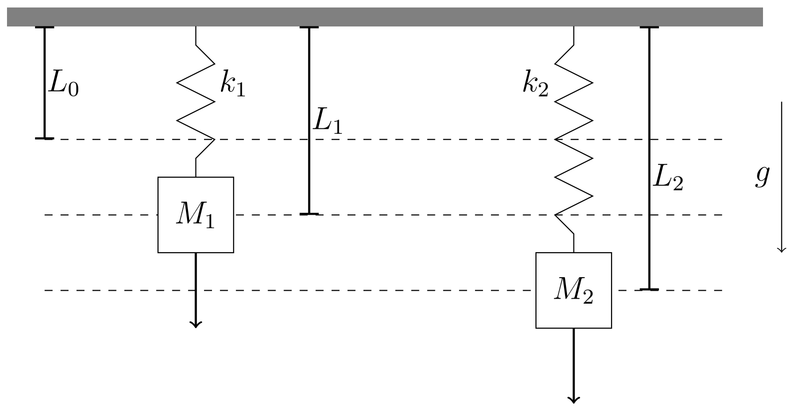
Step-by-step login for exam review session:

1. Log into Queue @ Illinois
2. Click "New Question"
3. Add your NetID and Name
4. Press "Add to Queue"
5. Join the zoom link in the staff message

Please do not log into the zoom call without adding yourself to the queue

Good luck with your exam!

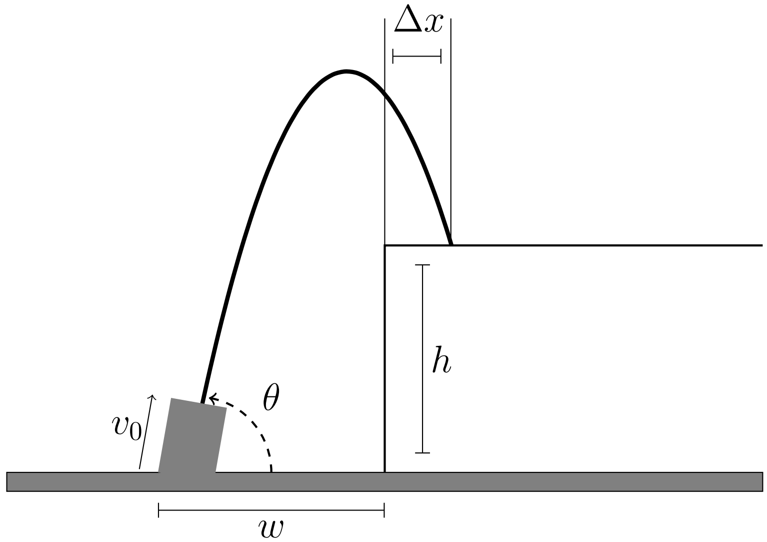
1. Two massless springs have the same natural length (the length when there is no elongation or compression), L_0. The spring constant of each spring is k_1 and k_2, respectively. Mass M_1 hangs from spring 1 and it reaches equilibrium at length L_1. Mass M_2 hangs from spring 2 and it reaches equilibrium at length L_2.



(a) If $k_2 = \frac{1}{2}k_1$ and $M_2 = 3M_1$, what is the relationship between L_1 and L_2?

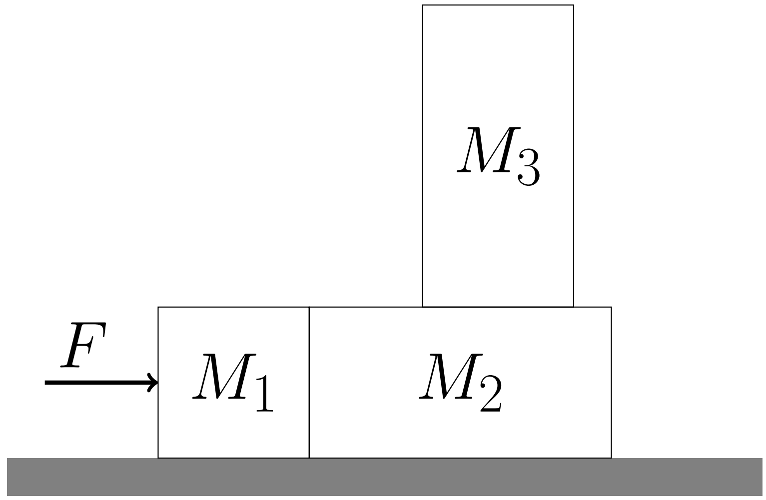
(b) Suppose we displace spring 1 by some additional $\Delta x = 0.5$, how much potential energy was added to the spring? Assume $L_0 = 0.5$, $L_1 = 1$, and $k_1 = 5$.

2. A fountain has several water jets with the geometry shown in the figure. The distance from the jet to the cliff is $w = 2$ m and the height of the cliff is $h = 1.5$ m. If the initial speed of the water coming out of the jet is $v_0 = 7$ m/s and the jets are firing at an angle $\theta = 45°$ does the water reach the top of the cliff? If so, what is the value of Δx?



A) 0.81 m
B) 0 m
C) Doesn't make it
D) 1.62 m
E) 2 m

3. Three blocks are placed in contact on a horizontal frictionless surface. A constant force of magnitude $F = 30$ N is applied to the box of mass $M_1 = 8$kg. There is friction between the surfaces of blocks $M_2 = 2M_1$ and $M_3 = 3M_1$ ($\mu_s = 0.5$, $\mu_k = 0.3$) so the three blocks accelerated together to the right.

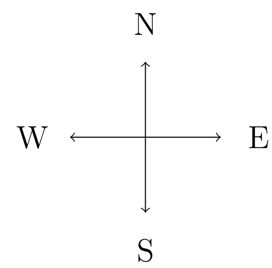


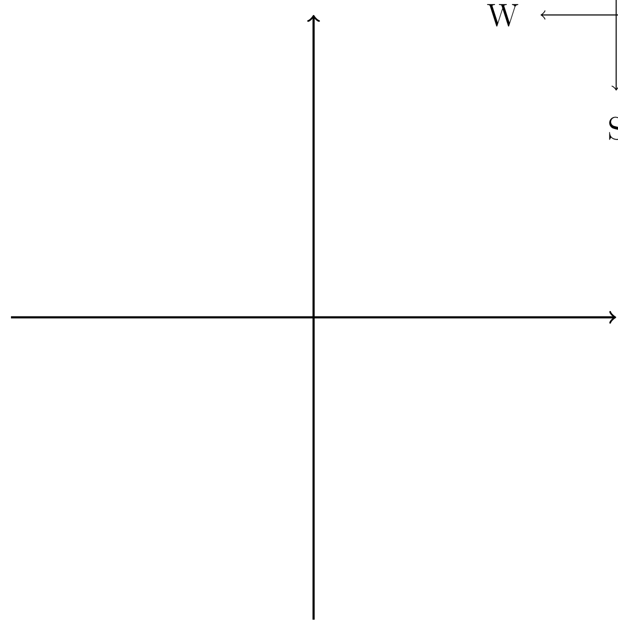
(a) Which block has the smallest magnitude of net force acting on it?

(b) What is the acceleration of the blocks? (You may assume block M_3 does not slide or fall off block M_2)

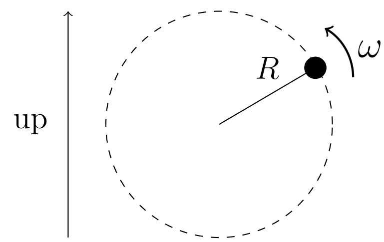
(c) What is the maximum force F that can be applied, before the M_3 block slides off?

4. An airplane travels with a velocity of 115 m/s due east with respect to the air. The air is moving at a speed of 25 m/s with respect to the ground at an angle of 40° north of west. What is the speed of the plane with respect to the ground?





5. A mass, $m = 2.3$ kg, is tied to a string of length $R = 0.9$ m and set in uniform circular motion in the vertical plane, as shown in the lower figure. The angular velocity of the rotating mass is $\omega = 26$ rad/s.



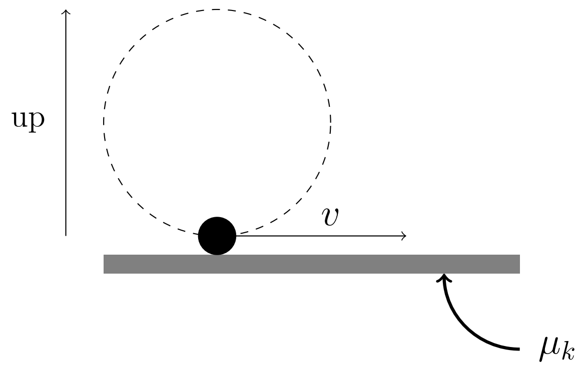
The string tension is largest at:

A) The top of the circle

B) The bottom of the circle

C) It is the same at all points on the circle

6. When the same mass as Problem 5 is at the bottom of the circle, the string suddenly breaks so that the mass slides (without rolling) on a rough, horizontal surface with $\mu_k = 0.82$, as shown. What is the magnitude of the work done by friction as it comes to rest?



A) 2.78 J

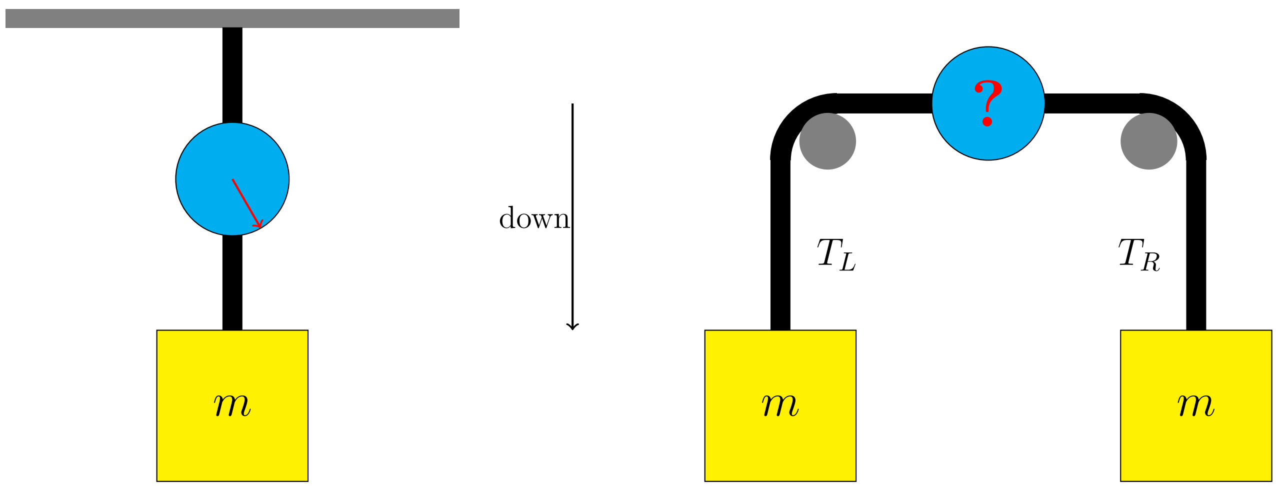
B) 6.29 J

C) 277.5 J

D) 629.0 J

E) 3.14 J

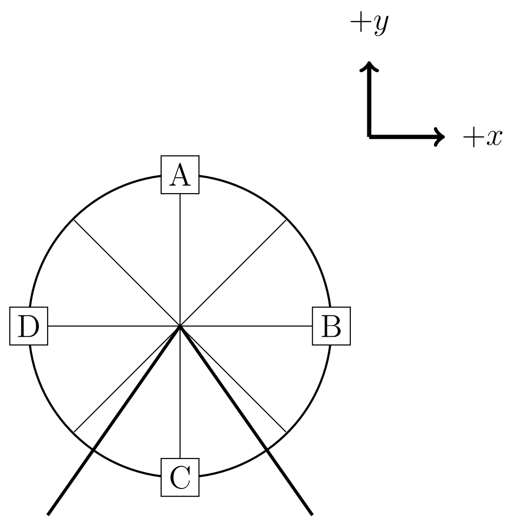
7. A box of mass m is hung from a spring scale as shown on the left side of the figure. The tension displayed on the spring scale is 30 N. A student now places the same spring scale between ropes that run over frictionless pulleys and support two identical boxes having the same mass m, as shown on the right side of the figure. Assume the spring-scale itself has no mass.



(a) What is the tension in the rightmost rope in the figure on the right side, T_R?

(b) What is the reading on the spring scale in the figure on the right side?

8. A Ferris wheel has a radius of 9 meters, and spins counterclockwise with a constant angular velocity $\omega = 0.4$ radians/second. (Cart B is going up at the instant shown.)



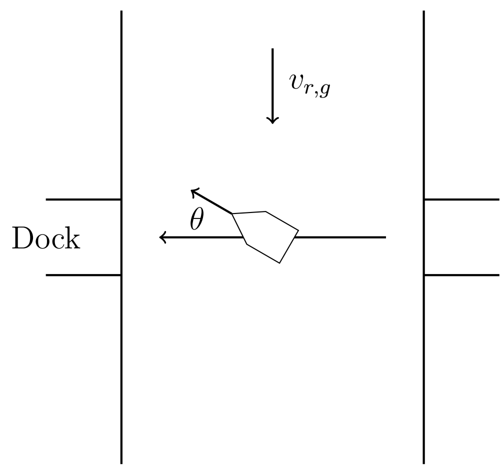
A) What is the speed of the cart A at the instant shown?

B) What is the x component of the acceleration of cart B at the instant shown?

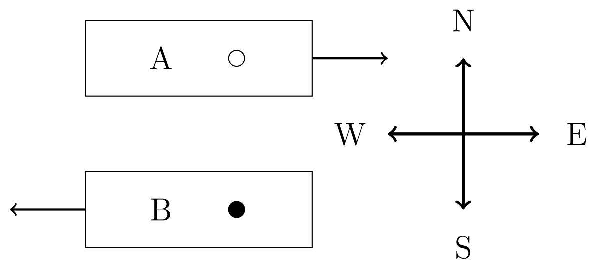
C) What is the y component of the acceleration of cart B at the instant shown?

D) What is the magnitude of the **maximum** force the Ferris wheel will exert on a 65kg person as they go around the ride?

9. A boat is traveling directly across a river (as seen by an observer standing on the shore) that flows at a uniform rate of $v_{r,g} = 10$ ft/s, as shown in the figure. To compensate for the flow of the river, the boat must head upstream as it travels. The speed of the boat is 18 ft/s with respect to the water. What is the angle between the direction the boat points and the direction it is traveling with respect to the shore?



10. You are sitting on train A, which is moving East at a speed of 30m/s with respect to the ground. You get up from your seat and move West at a speed of 2m/s relative to the train. The positive direction is defined as being to the East.
What is your velocity with respect to the ground?



A) 32m/s
B) -32m/s
C) 28m/s
D) -28m/s
E) 15m/s

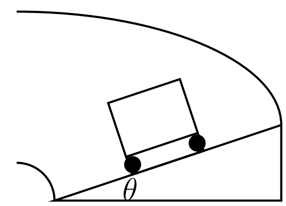
11. Train B begins moving West at a speed of 25m/s with respect to the ground. Your friend on train B begins to move East at a speed of 3m/s relative to the train.
What is your speed with respect to your friend?

A) 53m/s
B) -53m/s
C) 56m/s
D) -50m/s
E) 50m/s

12. A circular exit ramp is covered with ice (so it can be considered frictionless). If the curve is banked, is it possible for the car to not slip off? Why?

A) Yes

B) No



13. Using the previous situation, your car is traveling into the ramp at a speed of 45 m/s. If the ramp has a radius of 95 m, what is the necessary angle for the car to not slip off the ramp?

A) 65°

B) 45°

C) 72°

D) 43°

E) 20°