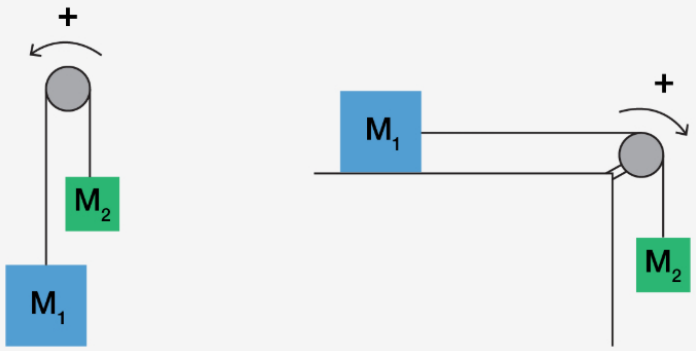
FlinnPREP™ for Practice Exam 1
Untimed Free Response

1. Suppose an Atwood machine and modified Atwood machine are constructed with masses M_1 and M_2 as shown in the following figure. M_1 is triple the magnitude of M_2 for both machines. Assume a frictionless surface for the modified Atwood machine shown and a pulley system with frictionless and massless string unless otherwise specified. Use the frame of reference provided.



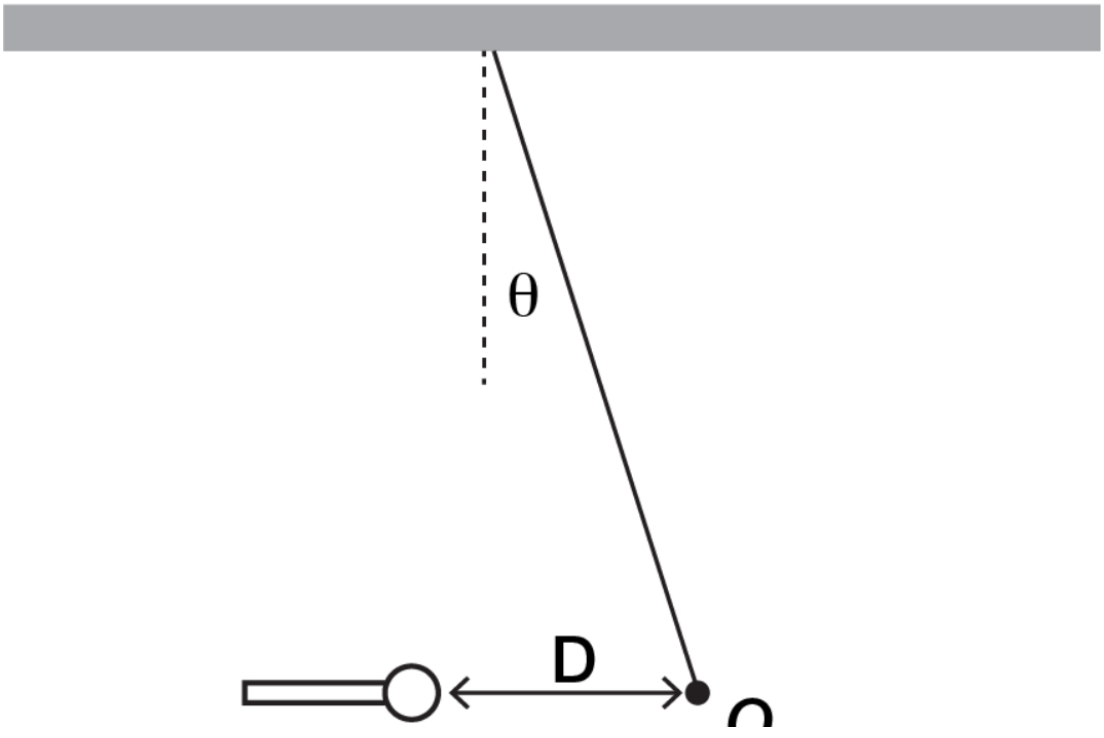
a. Determine the net force producing system's acceleration for both machines using M_1, M_2 and g (acceleration due to gravity). (2)

b. Using the solution from part a, determine which net force is greater and by how much. (2)

c. Justify why the net force of the Atwood machine is twice that of the modified Atwood Machine. In your reasoning, include Newton's 2nd law as a focal point, with particular emphasis on net force and acceleration. (2)

d. Suppose the surface for the modified Atwood machine is replaced with a different surface, such that the coefficient of static friction is 0.2. Determine the new acceleration of the system and compare it to the system's initial acceleration. (6)

2. Students devise an experiment to explore the relationship between electrostatic force and distance. In this experiment, a small sphere, Q_1, is attached to an insulating rod and given negative charge. A second small insulating sphere, Q_2, is attached to insulting thread and also given a negative charge. Q_1 is brought near Q_2 so that Q_2 is repelled.



Q_1 Q_2

a. On the following figure, construct a free-body diagram of all the forces acting on Q_2. Do not place components of force on this diagram. (2)

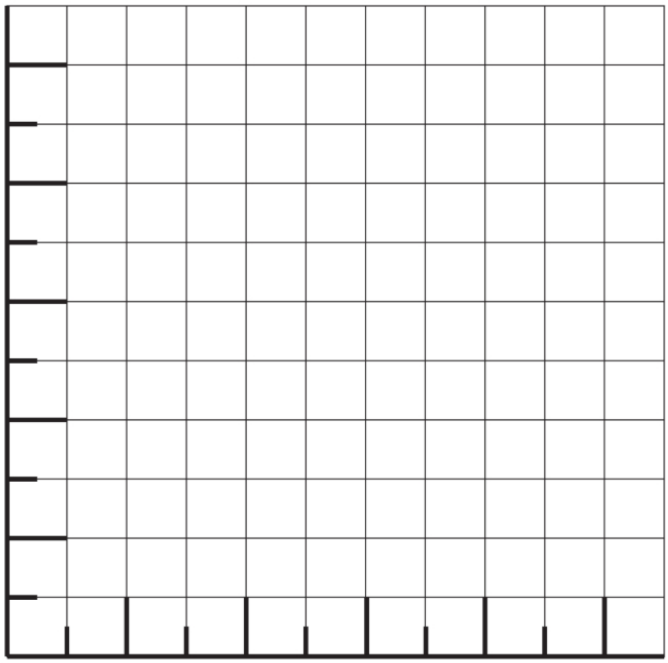
b. To which of the following is the electric force proportional? Justify your choice using words and symbols. (2)
_____ θ, ____ sin θ, or _____ cos θ?

c. Students then conduct the experiment moving Q_1 closer to Q_2. They use a digital camera to measure the distance *D* between spheres, and then they also measure the angle θ that the string makes with the vertical.

The students believe that Coulomb's Law applies to this situation and wish to present their data so they show a linear relationship. Using the two empty columns, manipulate one or both of the students' data columns so they can be plotted to show a linear relationship. At the top of the column, indicate how you manipulated the data along with correct units. (3)

	***D* (cm)**	**θ (degrees)**	
	4.5	5.7	
	3.2	11.5	
	2.6	17.4	
	2.23	23.6	
	2.0	30.0	

d. Using the following axes, plot the students' data, labeling each axis, and draw a best-fit line. (3)



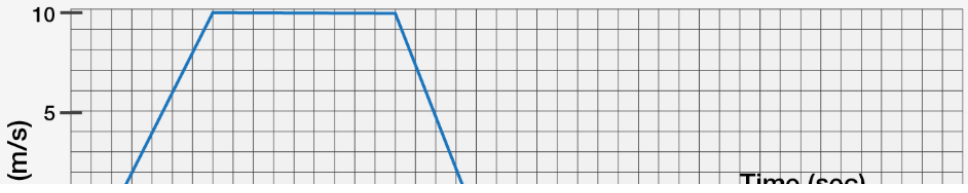
e. The two students each make a claim about the charges of Q_1 and Q_2. (2)

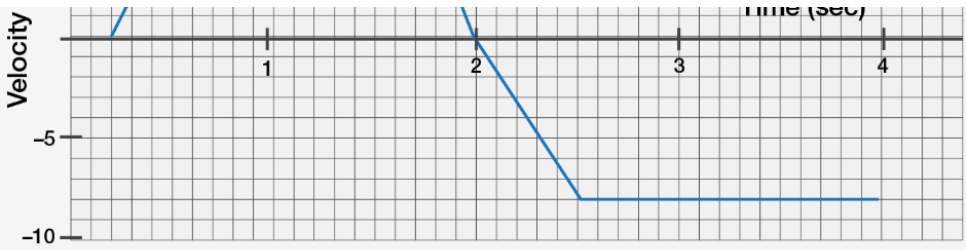
Student A: The charge of Q_1 was greater than the charge of Q_2 because Q_2 moved away from Q_1.

Student B: Each charge experienced an equal force, but we can't determine which charge is bigger.
With which student do you agree? Justify your answer.

3. Some dogs compete in a sport called Fly-ball, a timed race that begins when a human handler releases a dog that runs down a lane with four hurdles. After the fourth hurdle, the dog slows down to jump on a box, which releases a ball. The dog catches the ball and returns it to the handler along the lane of hurdles.

During one such race, a researcher used high-speed video and computer analysis to record the velocity of the dog. These data are shown on the following graph.





a. Indicate every time interval or instant of time when the dog is at rest. (1)

b. Based on the information in the graph, determine the distance the dog ran to reach the box. Explain how you used the graph to arrive at the answer. (2)

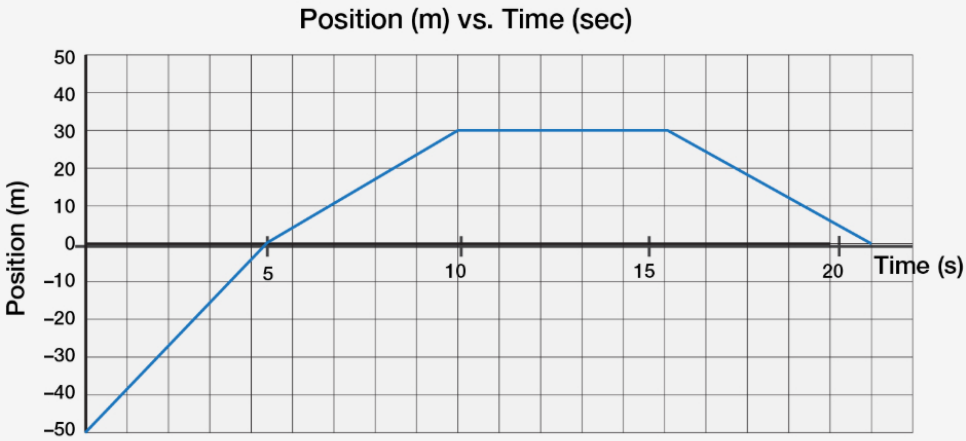
c. During what time interval(s) is the dog reducing its speed? (1)

d. The researcher is curious about how the dog is able to stop. The coefficient of friction between the dog's feet and the lane is 0.8. Based on the information in the graph, is a frictional force enough to slow down the dog? Justify your answer with calculations and a written explanation. (3)

4. In the following figure, two tubes sit with open ends facing a variable frequency–generating speaker. The tubes are identical with exception to their length. The speaker produces a very low frequency note initially, then the frequency is slowly increased until the tubes begin to resonate. It is observed that only one tube resonates at a time until a very high frequency is reached and both tubes then resonate.

Use a well-defined and reasoned argument, along with any necessary images or equations, to describe why the tubes resonate individually at low frequencies and together at select high frequencies. (7)

5. A toy car beginning at rest has a force applied such that its position changes over time as shown in the graph provided.



a. Construct a corresponding velocity vs. time graph for the toy car based on this position vs. time graph. (2)

b. Based on the graph created in part a, construct a graph depicting the net force of the toy car as a function of time. Assume the toy car has a mass of 1 kg. (2)

c. Based on the graph developed in part b, determine the impulse delivered to the toy car for the duration of motion. (1)

d. From your result in part c, use the impulse from 0 to 5 seconds to demonstrate via the Impulse-Momentum Theorem that the velocity remains the same. (2)

Finished

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