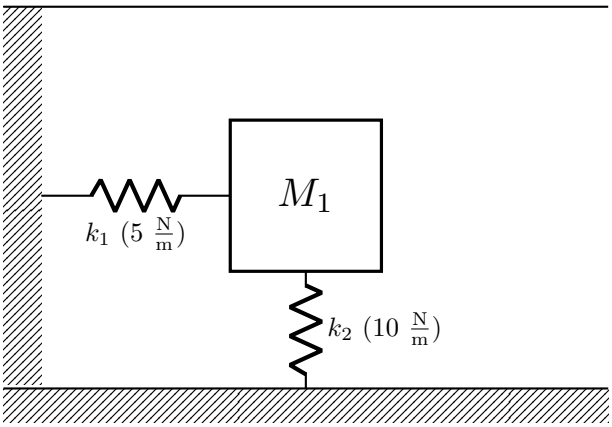
AP/Honors Quiz: Springs, Pulleys and Elevators

Full Name, Period, AP/Honors:

1 Bet you can't pick just one!

1. Two springs are connected to a 1.7 kg mass as shown. The whole system is in the back of a truck on Earth where the gravity is $-10\ \frac{\mathrm{m}}{\mathrm{s}^2}\hat{z}$. The spring with constant k_1 has been **extended** by a length Δx_1 and the spring with k_2 has been **compressed** by a length $\Delta x_2 = 2\Delta x_1$. The block is not moving relative to the truck. The truck's acceleration has no vertical component and the springs are exactly straight as shown.



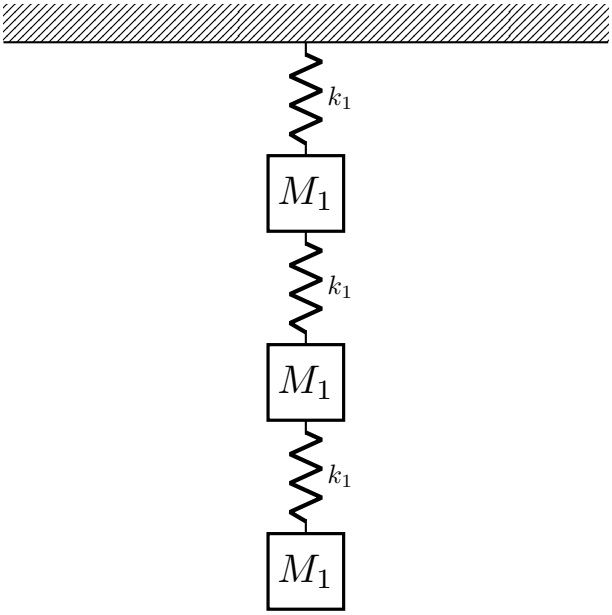
   (a) (3 pt, **All**) What is the magnitude of the acceleration of the truck?
   - A. 0 $\frac{\mathrm{m}}{\mathrm{s}^2}$
   - B. 2.5 $\frac{\mathrm{m}}{\mathrm{s}^2}$
   - C. 5 $\frac{\mathrm{m}}{\mathrm{s}^2}$
   - D. 20 $\frac{\mathrm{m}}{\mathrm{s}^2}$
   - E. 40 $\frac{\mathrm{m}}{\mathrm{s}^2}$

   (b) (2 pt, **All**) What is the direction of the acceleration of the truck?
   - A. Right
   - B. Left
   - C. Into the page
   - D. Out of the page
   - E. More than one of the above choices are possible.

   (c) (2 pt, **All**) Explain in two sentences or less why you chose the direction that you did.

2. (4 pt, **Honors**) A laptop is left on the (flat) roof of a car. Which of these would the driver need to do to ensure that the laptop doesn't fall off? Assume the surface of the road does not have bumps and air resistance is negligible.
   - A. Limit his maximum speed
   - B. Slam on the brakes at every opportunity.
   - C. Avoid backing up
   - D. Gently slow down before going around corners

3. (4 pt, **AP**) You create the following system consisting of three identical, massless, springs and 3 identical large masses and hang it from the ceiling. What will be the total extension of the springs? Total extension in this case means add all the extensions of the individual springs together.



A. $\frac{3M_1g}{k_1}$

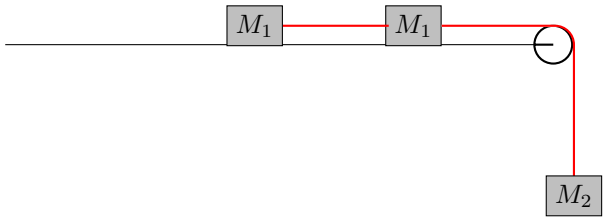
B. $\frac{6M_1g}{k_1}$

C. $\frac{9M_1g}{k_1}$

D. This arrangement is guaranteed to break the springs

2 Flashbacks to math class

(**All**) You have a large number of masses with mass m_1, a large number of masses with mass m_2, a string, and a pulley. You place N masses of m_1 on the table, and Q masses of m_2 hanging from the string one after another. All masses have a coefficient of kinetic friction of μ_k with the surface. Below is a diagram with $N = 2$ and $Q = 1$ to help you visualize.



1. (3 pt, **All**) The system is initially moving with a speed v to the right. You notice that the system slows down with time. Find the stopping time of the system. Your answer should include N and/or Q.

2. (3 pt, **All**) You remove hanging masses 1 at a time until the system moves with constant velocity once started. If the current number of masses on the table is $N_1 = 100$ and the current number hanging off is $Q_1 = 75$, what is the coefficient of kinetic friction?

3 Living the Dream!

(3 pt, **All**) Adrian is having a dream. In his dream, he inexplicably finds himself in a glass elevator (poor Adrian). He has a spring with a known spring constant k, and a block that has known friction coefficients with the floor of the elevator (μ_k, μ_s) and a known mass M. The block is far too heavy to lift, but he can slide it without too much trouble. He also has his lucky ruler. He can look through the glass and see the ground directly below, so he deduces that there is still gravity g downward. Help Adrian design an experiment to determine the acceleration of the elevator.