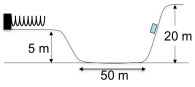
You will be graded on your *COMMUNICATION* of physics understanding

I provide some guiding questions and the *answer*. I don't do this because the answer is important. I want to stress that the answer is the least important part of this question, but if you got the answer right, it validates the route you took. What is important is the explanation you use. This is what I will be looking for in your exam.

#1 You and your friends are excited to be the first people to be on the new super drop ride. With you and your friends in a car, the total mass is 1000 kg. You drop down a very slippery track as shown at right (in a drawing that is way way too small to be used as a reasonable diagram). You start at the top at rest and compress the spring at the end by 2 meters as you come to a stop.



a) Without finding the answer, explain completely how you would go about finding the spring constant from the information given, right up to setting up the formulas. Did you make a good large drawing with labels identifying what is relevant? Did you pick a lens or several lenses? Did you make any of the following to : Free Body Diagram, Energy Flow, momentum flow, kinematics graph? $k = 75{,}000\ N/m$. That's a pretty stiff spring… That means that someone who is 100 kg (220 lbs) could stand on it with a force of 1000 N, producing only 1.3 cm of compression... is that correct?

b) Without finding the answer, explain completely how to find the maximum acceleration as we compress the spring, right up to setting up the formula. Did you make a good large drawing of the compressing spring with labels identifying what is relevant? Did you pick a lens or several lenses? Did you make any of the following to : Free Body Diagram, Energy Flow, momentum flow, kinematics graph? $a = 150\ m/s^2$. Or 15 times gravitational acceleration. This could kill you, but for short periods of time, you'd probably survive. See John Stapp and the table at the bottom of this Wikipedia Page.

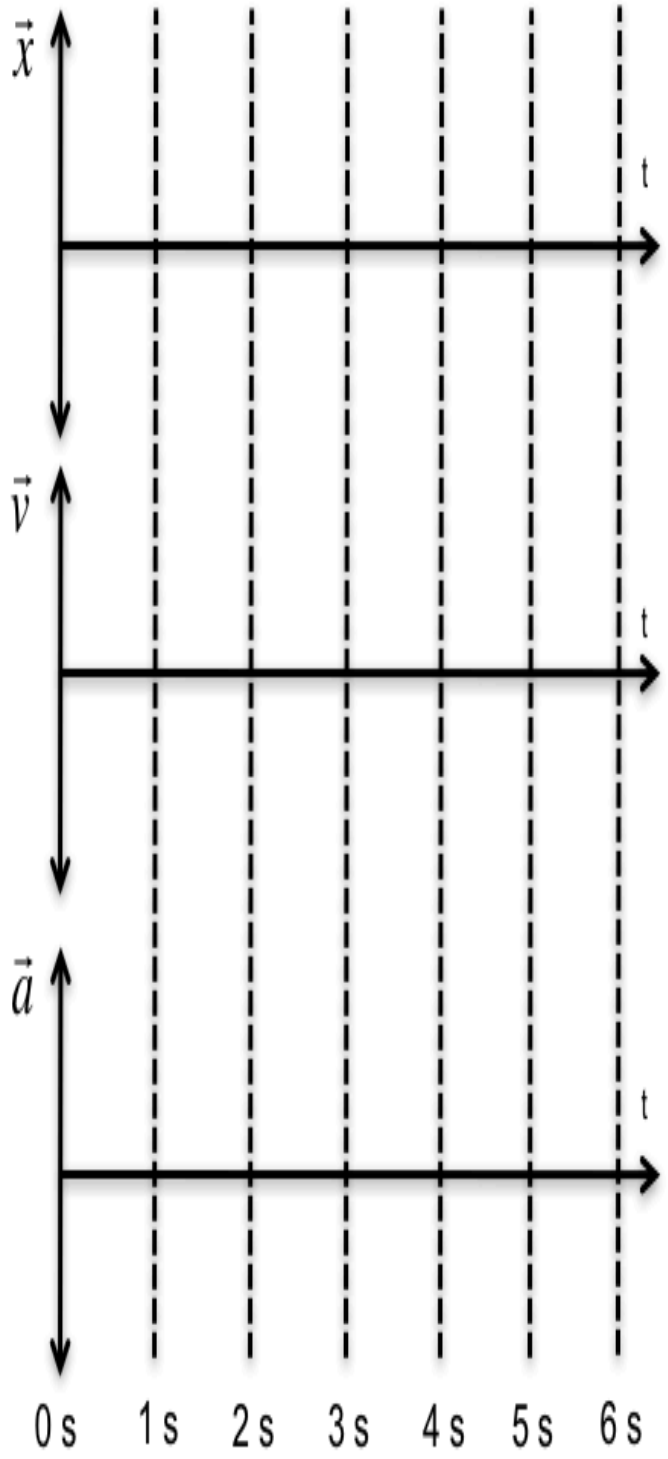
c) Let's say now that there is a coefficient of friction on the level part of the track of $\mu_d = 0.2$. Please describe how this would affect the way you solved (a) above for the spring constant. You should likely do a good FBD (free body diagram) and consider direction of force and what kind of affect it would have. I would use an energy lens and consider how this force would affect the energy. By using these considerations, you should be able to show that this significantly lowers the energy when the cart hits the spring… lowering the stored energy and calculated spring constant by a factor of 3.

d) *Save for the end only if you have extra time*. Can you tell me if the consideration of friction would have a large or small effect on your answer for (a), *supporting your answer.* Done above.

#2 The mass of your friend is 50 kg and she is in a 450 kg elevator for a total mass of 500 kg. She is moving downward and her speed is decreasing as she stops on the ground floor. The table at right indicates the speed as a function of time.

a) Please make the graphs describing her motion. Make sure they have the right shape, and if you have time, please fill in the correct numbers.

Time (s)	Speed (m/s)
0	8
1	8
2	6
3	4
4	2
5	0
6	0



#3 Imagine your friend is 50 kg and is standing on a scale in the previous page.

a) What does the scale under her read at t = ½ s?

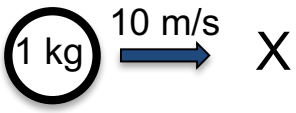
b) What does the scale under her read at t = 3 s?

For both of these, we pick a lens of dynamics… please follow the protocol very carefully and pay particular attention to the two questions about acceleration. The answers should come out to be:

a) 500 N

b) 600 N

#4 A 1.0 kg ball moving at 10 m/s *to the right,* has a totally *elastic* collision with *stationary* "Ball X" of unknown mass, and *bounces off to the left* at 8 m/s. We want to find the mass of Ball X, and its final velocity. Is it a good idea to draw a picture? In the actual exam, the direction of the 1 kg ball doesn't change, so these answers are different from that on your exam. But do this one anyway, OK?



a. Without doing any math, can you tell me if the mass of Ball "X" is more or less than 1 kg? That is: fill in the space with < , >, or = : m_X___1 kg
please give a reason A physicist simplifies things. What must happen to the 1 kg ball in an elastic collision if "X" is infinitely large? Is infinitesimally small? Is exactly the same as 1 kg? What do you see happen here? Which is it more like.

b. What must be the momentum of Ball X after the collision? Please use your momentum lens and make a momentum flow diagram, or consider the change in momentum of the ball you know. Can you find the impulse (change in momentum) of the other ball?

c. What must be the kinetic energy of Ball X after the collision?
Can you do the same as b above but for energy?

d. Find the mass of ball X and the final velocity of ball X.
This is just simultaneous equations… the math lens. There are two unknowns: mass and velocity. But there are two equations: momentum and kinetic energy. Can you solve them? I get 9 kg and 2 m/s. Now, can you visualize this happening? For the example in your exam where the 1 kg ball doesn't change direction, I get a mass of 1/9 kg and a speed of 18 m/s

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