

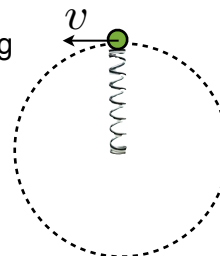
Exam #1 Physics 1501Q, Fall 2012 **BOX AND LABEL YOUR ANSWERS!**

1. A 200,000 kg locomotive pulls three train cars with mass 50,000 kg each. The train leaves Hartford train station, headed due north, exactly as the clock strikes noon. The coefficient of friction between the train and the track is $\mu_k=0.01$.
 - (a) Draw the free body diagram for the entire train, including friction and the pulling force F_0 supplied by the locomotive. Set up a coordinate system.
 - (b) What is the normal force preventing the train from falling through the earth?
 - (c) What is the frictional force on the train?
 - (d) The acceleration of the train is 0.2 m/s^2 . What is the magnitude of the pulling force?
 - (e) After a period of constant acceleration, the train stops accelerating and maintains its constant speed of 25 m/s . For how long was the constant acceleration maintained?
 - (f) A passenger quickly runs from the 1st car to the bathroom in the second car at a speed of 0.5 m/s . What is the speed of the passenger with respect to the ground?

2. In a game of table shuffleboard, a 1 kg puck is sent sliding across a table, with the goal of reaching a particular point along the table as closely as possible. It was determined that a 1 m/s initial speed has the puck stopping exactly 5 m down the table with constant (negative) acceleration all the while.
 - (a) Draw the free body diagram and coordinate system including gravity and friction.
 - (b) What is the normal force supporting the puck?
 - (c) What is the acceleration of the puck down the table?
 - (d) What frictional force would provide this acceleration?
 - (e) What is the coefficient of friction μ_k between the puck and the table?

3. A mass on a spring hangs from a hook. The equilibrium length of the spring is 10 cm, and a 3 kg mass stretches it an additional 5 cm.

- (a) What is the spring constant k ?
- (b) Another 5 kg is added to the load. What is the new displacement?
- (c) A 1 kg mass on the same spring is laid out on a frictionless surface and made to swing in a uniform circular trajectory on the ground as shown. The displacement of the spring from equilibrium is constant and found to be 6 cm. Find the speed v of the mass.
- (d) The spring suddenly breaks at a point where the mass connects to the spring. Briefly describe the horizontal components of the trajectory.



4. A 20 g mass on a spring with a constant $k=30 \text{ N/m}$ is used to launch a block across a frictionless table and up a frictionless ramp as shown. Initially, the spring is compressed by 2 cm and let go. (*Hint: use the work-energy theorem.*)
 - (a) Integrate Hooke's law $F_s=-kx$ and obtain the work done to compress the decompress the spring by an distance d .
 - (b) When let go, the work done to compress the spring is now undone and used to accelerate the mass. Find the speed v as the mass passes the spring's equilibrium and loses contact with the spring.
 - (c) The ramp has an incline of 10 degrees and there is no friction. Find the distance D that the mass travels up the ramp.

