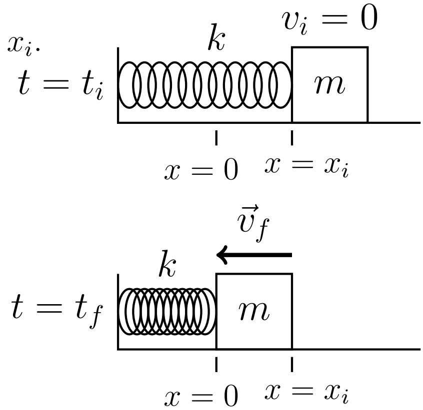
Lecture 19: Energy Conservation

Warm-Up Activity

When can we say that energy is conserved?

L19-1: Block on a Spring – Forces

- A block of mass m on a level, frictionless surface is attached to an ideal, massless spring of constant k that is initially stretched.
- At time t_i, the block is **released from rest** at $x = x_i$.
- At time t_f, the block reaches $x = 0$ moving to the left with speed v_f.
- System B consists of the block alone.
- System SB consists of the spring and the block.
- For the interval from t_i to t_f (for each system):



  (1) List all external forces acting on the system.

  (2) Identify the point of contact associated with each force.

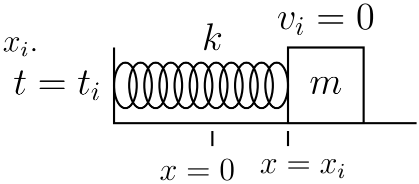
  (3) Draw a vector to indicate the **displacement** associated with each force.

  (4) Determine if the work done by **each force** is positive, negative, or zero.

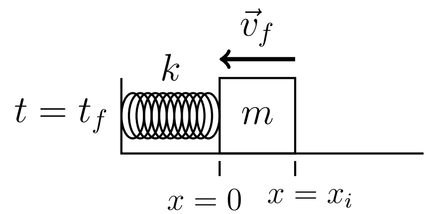
- What do you want to remember about this situation for future problems?

L19-2: Block on a Spring – Energy

- A block of mass m on a level, frictionless surface is attached to an ideal, massless spring of constant k that is initially stretched.
- At time t_i, the block is **released from rest** at $x = x_i$.



- At time t_f, the block reaches $x = 0$ moving to the left with speed v_f.
- System B consists of the block alone.
- System SB consists of the spring and the block.



- For the interval from t_i to t_f (for each system):
  (1) Determine if the **net external work** is positive, negative, or zero (based on L19-1).
  (2) Determine if the **change in total energy** is positive, negative, or zero.
  (3) Determine if the **change in kinetic energy** is positive, negative, or zero.
  (4) Determine if the **change in potential energy** is positive, negative, or zero.
- What is different about the two systems?

L19-3: Undulant Track

Consider the ball that can roll on the track in the center of the room. Ignore friction and air resistance. The ball starts from rest at the top of the track. Use the apparatus to see how the ball moves.

(1) At what point will the ball be moving the fastest? How do you know?

(2) At what point will the ball be moving the slowest? How do you know?

(3) Are there any stable equilibrium points? If so, then where are they located?

(4) Are there any unstable equilibrium points? If so, then where are they located?

(5) Make a graph of the gravitational potential energy of the ball vs. the horizontal position. Remember to define the origin.

(6) On the same set of axes, make a graph of the total mechanical energy of the ball vs. horizontal position. Assume that the ball starts from rest.

(7) Where are the points determined previously for questions 1 through 4 above located on the graph?

(8) How can stable and unstable equilibrium points be defined in terms of the graph of potential energy vs. horizontal position?