Energy Whiteboard Problems

1. (a) Consider an object that is thrown vertically up into the air. Draw a graph of gravitational *force* vs. height for that object.

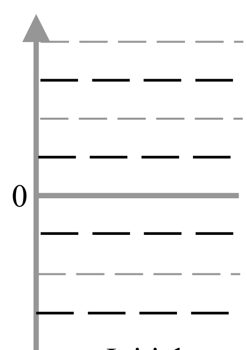
(b) Based on your experience with the formula for elastic energy, how do you think the gravitational *energy* shows up on the graph?

(c) What is the formula for gravitational force?

Based on your graph, what is the formula for gravitational energy?

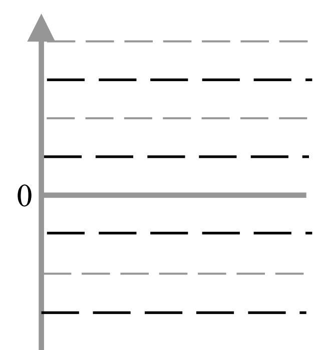
2. A 2kg ball is dropped from a height of 1.8m above the ground. (a) Draw a system schema, choose your system, and add energy flow arrows. (b) Draw a set of at least five pie charts for this situation. The first pie should show how the energy is stored when the ball is help motionless before being dropped. Your last pie chart should show how the energy is stored *just before* the ball hits the ground. (c) Draw an initial and final energy bar graph for this situation. The bar graphs should show the same information as your first and last pie charts. (d) What is the block's velocity *just* before it hits the ground? Show your work and use units.

Pie Charts



Initial

Schema



Final

3. For comparison, use previous models of physics to determine the velocity of the ball just before it hits the ground. *To solve this problem, you must pretend that you do not know the velocity, but only have the original given information, 2kg and 1.8m.*

(a) Which previous models of physics apply to this problem? Explain.

(b) Draw at least four diagrams and/or graphs. Choose the ones you find the most helpful.

(c) Determine equations from those diagrams and graphs and use them to solve for the velocity of the ball just before it hits the ground. Show your work and use units.

(d) Do you get the same answer using this model?

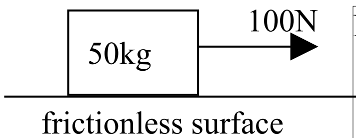
4. For each of the following situations, draw a graph of force vs. distance and indicate how the energy stored or transferred would show up on the graph.

(a) A person pushes an object across a horizontal surface with a constant force.

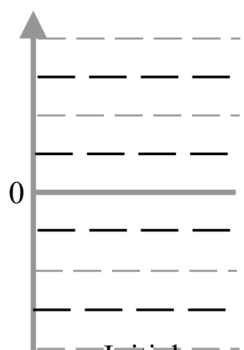
(b) The person stops pushing and a frictional force causes the object to slow down.

(c) (Review) A stretched spring pulls an object until it reaches it's relaxed length.

5. The 50kg box pictured below is initially at rest on the frictionless surface. A person pulls the box for a distance of 10.0m by exerting a constant force of 100N. (a) Draw a system schema, choose your system, and add energy flow arrows. (b) Draw a set of at least five pie charts for this situation. The first pie should show how the energy is stored before the person starts pulling, and the last one should show how the energy is stored when the person has pulled it for 10.0m. (c) Draw an initial and final energy bar graph for this situation, using block bars (and block arrows on the system schema) to illustrate that energy is conserved. (d) What is the block's velocity if it starts from rest and is pulled a distance of 10.m across the frictionless surface? Show your work and use units.

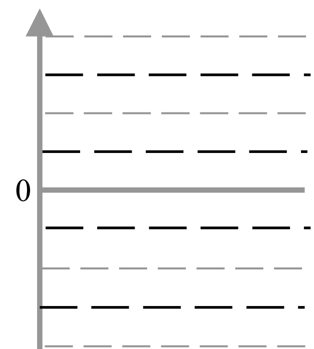


Pie Charts



Initial

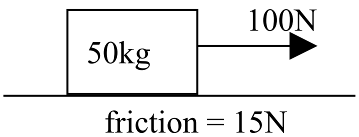
Schema



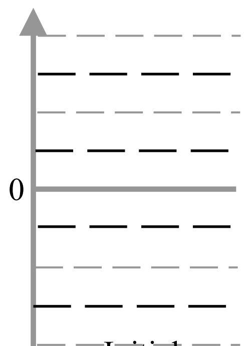
Final

(e) For comparison, use previous models of physics to determine the velocity of the cart. *To work this problem, you will have to pretend that you don't know the velocity and only know the given information, 50kg, 100N and 10.0m.*

6. A person pulls a 50 kg box pictured below with a force of 100 N for a distance of 10.0m as in problem 5, however this time the surface is not frictionless, but instead exerts a force of 15N on the box. (a) Draw a system schema, choose your system, and add energy flow arrows. (b) Draw a set of at least five pie charts for this situation. The first pie should show how the energy is stored before the person starts pulling, and the last one should show how the energy is stored when the person has pulled it for 10.0m. (c) Draw an initial and final energy bar graph for this situation, using block bars (and block arrows on the system schema) to illustrate that energy is conserved. (d) What is the block's velocity if it starts from rest and is pulled a distance of 10.m? Show your work and use units.

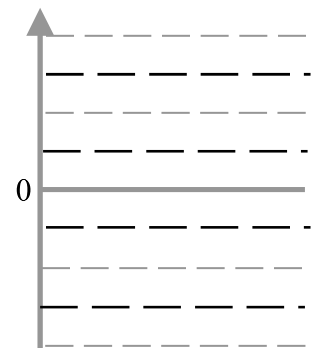


Pie Charts



Initial

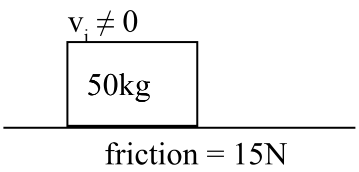
Schema



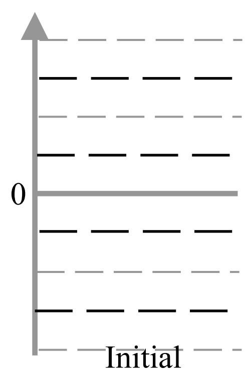
Final

(e) For comparison, use previous models of physics to determine the velocity of the cart after the person has pulled it 10.0m.

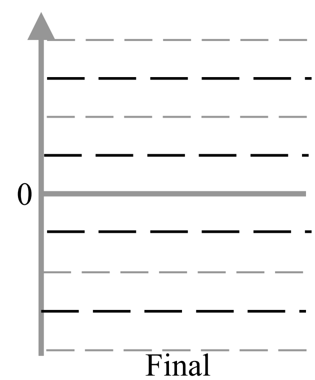
7. After the person in problem 6 has pulled the box for 10m, she lets go and stops pulling. The floor still exerts a frictional force 15N on the box. (a) Draw a system schema, choose your system, and add energy flow arrows. (b) Draw a set of at least five pie charts for this situation. The first pie should show how the energy is stored the instant the person lets go, and the last one should show how the energy is stored when the box comes to rest. (c) Draw an initial and final energy bar graph for this situation, using block bars (and block arrows on the system schema) to illustrate that energy is conserved. (d) How far does the box travel before coming to rest? Show your work and use units.



Pie Charts

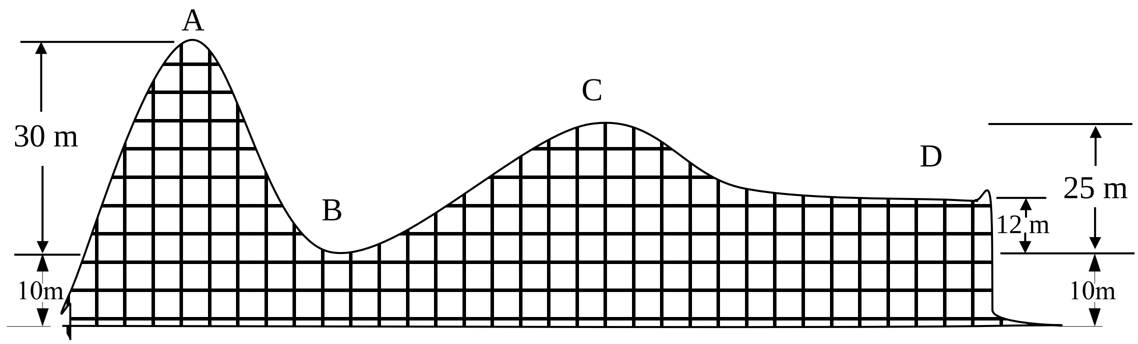


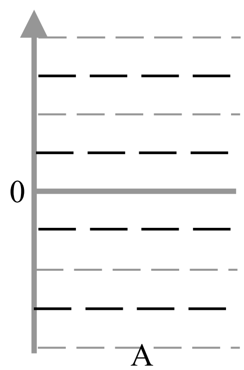
Schema

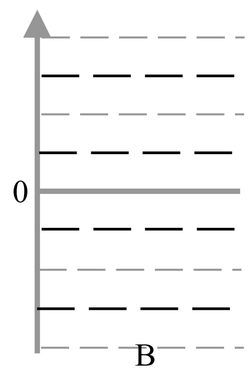


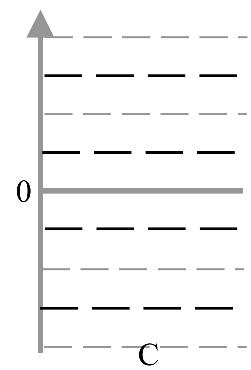
(e) For comparison, use previous models of physics to determine the distance the box travels.

8. A roller coaster of mass 500kg is pulled up a hill where it passes point A with a velocity of 1.70m/s. Then it and its screaming occupants (also mass 500kg) go careening down the frictionless track. You may also neglect air resistance. (a) Draw a system schema between points A and B, choose your system, and add energy flow arrows. Copy your system schema between points B and C and points C and D. Choose the same system in all three schemas, and add appropriate energy flow arrows for each time interval. (b) Draw energy bar graphs showing how the energy is stored at points A, B, C and D. *Make certain they show that energy is conserved.* (c) Determine the speed of the car at points B, C and D. Show your work and use units.



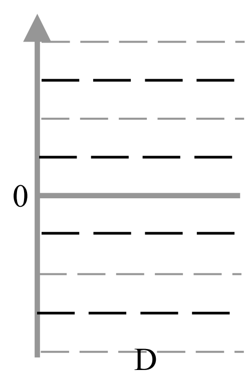






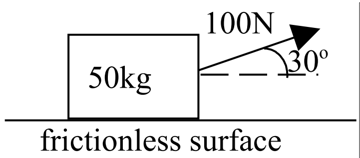
Schema A $^{23}_{11}$ B

Schema B $^{23}_{11}$ C

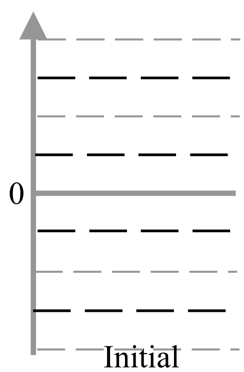


Schema C $^{23}_{11}$ D

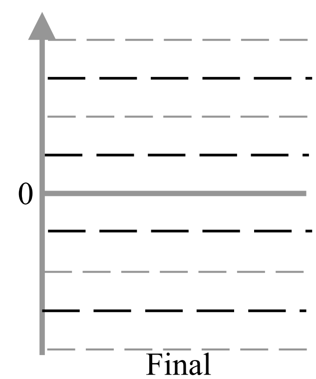
9. The person in problem 1 now pulls the box upward at a 30º angle from the horizontal. The block once again starts from rest and is pulled a distance of 10.m across the frictionless surface. (a) Draw a system schema, choose your system, and add energy flow arrows. (b) Draw a set of at least five pie charts for this situation. The first pie should show how the energy is stored before the person starts pulling, and the last one should show how the energy is stored when the person has pulled it for 10.0m. (c) Draw an initial and final energy bar graph for this situation, using block bars (and block arrows on the system schema) to illustrate that energy is conserved. (d) What is the block's velocity if it starts from rest and is pulled a distance of 10.m across the frictionless surface? Show your work and use units.



Pie Charts



Schema



(e) For comparison, use previous models of physics to determine the velocity of the cart after the person has pulled it 10.0m.