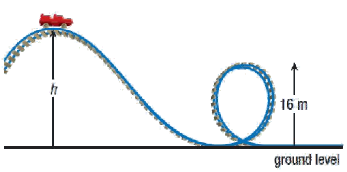
SPH4U UNIVERSITY PHYSICS

ENERGY & MOMENTUM

☞ Springs & Conservation of Energy (P.201-208)

Springs & Conservation of Energy

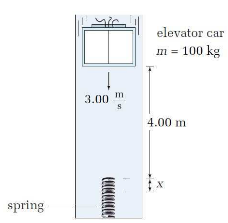
As was stated earlier, the law of conservation of energy is one of the most useful tools in physics. Since work and energy are scalar quantities, directions are not involved. As a result, vector diagrams are not needed, and angles do not have to be calculated. In any given event, the problem is usually to identify the types of energy involved and to ensure that the total energy in all its different forms at the end of the event equals the total energy at the beginning.



Springs & Conservation of Energy

NOTE!

The analysis is often easiest when the motion occurs in a horizontal plane. However, the analysis becomes a bit more complicated when the motion is vertical, since there are now changes in gravitational potential energy along with elastic potential energy and kinetic energy.

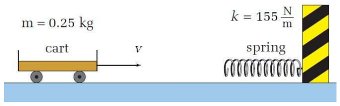


Springs & Conservation of Energy

PRACTICE

1. A low-friction cart with a mass of 0.25 kg travels along a horizontal track and collides head on with a spring that has a spring constant of 155 N/m. If the spring was compressed by 6.0 cm, how fast was the cart initially travelling? (Hint: $E_T = E_T'$)

   v = 1.5 m/s



Springs & Conservation of Energy

PRACTICE

2. A 70.0 kg person steps through the window of a burning building and drops to a rescue net held 8.00 m below. If the surface of the net is 1.40 m above the ground, what must be the value of the spring constant for the net so that the person just touches the ground when the net stretches downward?

   k = 6580 N/m

Springs & Conservation of Energy

PRACTICE

3. A 0.20 kg block is dropped on a vertical spring that has a spring constant of 180 N/m. The block attached to the spring compresses it by 15 cm before momentarily stopping. Determine the height from which the block was dropped.

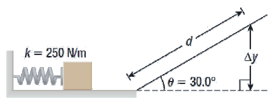
   Δh = 0.88 m

Springs & Conservation of Energy

PRACTICE

4. A block with a mass of 2.0 kg is held against a spring with a spring constant of 250 N/m. The block compresses the spring 22 cm from its equilibrium position. After the block is released, it travels along a frictionless surface and then up a frictionless ramp, as shown.
   (a) Determine the elastic potential energy stored in the spring before the mass is released.

(a) E_e = 6.1 J

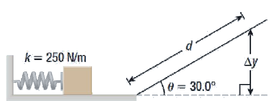


Springs & Conservation of Energy

PRACTICE

4. A block with a mss of 2.0 kg is held against a spring with a spring constant of 250 N/m. The block compresses the spring 22 cm from its equilibrium position. After the block is released, it travels along a frictionless surface and then up a frictionless ramp, as shown.
   (b) Calculate the speed of the block as it travels along the horizontal surface.

(b) v = 2.5 m/s

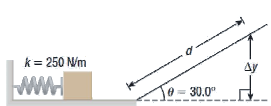


Springs & Conservation of Energy

PRACTICE

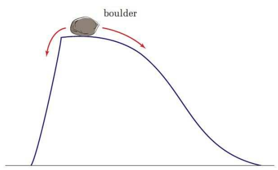
4. A block with a mss of 2.0 kg is held against a spring with a spring constant of 250 N/m. The block compresses the spring 22 cm from its equilibrium position. After the block is released, it travels along a frictionless surface and then up a frictionless ramp, as shown.
   (c) Determine how far along the ramp the block will travel before it stops.

(c) d = 0.62 m (Δy = 0.31 m)



Conservative & Non-Conservative Forces

*The forces we have been dealing with are referred to as **conservative forces**. This means that the amount of work they do on a moving object does not depend on the path taken by that object. For example, in the absence of friction, the boulder in the diagram below will reach the bottom of the hill with the same kinetic energy and speed whether it is dropped off the cliff on the left or slid down the slope on the right.*



Conservative & Non-Conservative Forces

*However, friction is a **non-conservative force**. The amount of work done by a non-conservative force depends on the path taken by the force and the object. For example, the amount of energy transferred to the snow in the diagram below depends on the path taken by the skier. The skier going straight down the slope should reach the bottom with a greater speed than the skier who is tracking back and forth across the slope.*

Conservative & Non-Conservative Forces

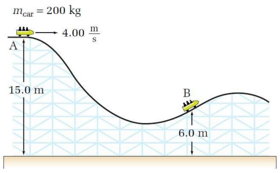
NOTE!

When dealing with non-conservative forces, the law of conservation of energy still applies. However, you must account for the energy exchanged between the moving object and its environment.

Conservative & Non-Conservative Forces

PRACTICE

5. A roller-coaster car is moving as shown. If 3400 J of thermal energy are produced through friction between points A and B, determine the speed of the car at point B. Express your answer to 3 significant digits.



$E_{TA} = E_{TB}$

$E_{kA} + E_{gA} = E_{kB} + E_{gB} + E_{thermal}$

$v_B = 12.6$ m/s

✔ Check Your Learning

TEXTBOOK

P.208 Q.2,5,7,9

WIKI (ENERGY & MOMENTUM)

✎.... 4U2 - LAB#2 (Fizzix Spring Launch Analysis)

✎.... 4U2 - QUIZ#1 (Work & Energy)

NOTE!

You will not be able to do Q.10 (Part A) nor Q.2 and 3 (Part D) just yet.