Energy Conservation 1

Conservative and Nonconservative Forces

Conservative force: the work it does is stored in the form of energy that can be released at a later time

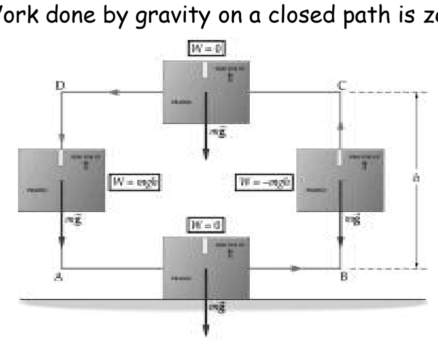
Example of a conservative force: gravity

Example of a nonconservative force: friction

Also: the work done by a conservative force in moving an object around a closed path is zero; this is *not* true for a nonconservative force.

Conservative Force: Gravity

Work done by gravity on a closed path is zero



Nonconservative Force: Friction

Work done by friction on a closed path is *not* zero

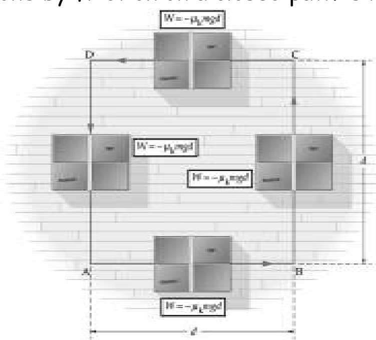


Table 8-1
Conservative and Nonconservative Forces

Force	Section
Conservative forces	
Gravity	5-6
Spring force	6-2
Nonconservative forces	
Friction	6-1
Tension in a rope, cable, etc.	6-2
Forces exerted by a motor	7-4
Forces exerted by muscles	5-3

Gravitational Potential Energy

- If we pick up an apple and put it on the table, we have done work on the apple. We can get that energy back if the apple falls back off the table; in the meantime, we say the energy is stored as potential energy.

The work done by a conservative force is equal to the negative of the change in potential energy.

When we lift the apple, gravity does negative work on the apple. When the apple falls, gravity does positive work.

$U = mgh$

Units: Joules (J)
h is measured above an arbitrary 0 --- usually the lowest point in the problem

Elastic Potential Energy

- If we compress a ball bearing against a spring in a projectile gun, we have done work on the ball bearing and spring. We can get that energy back if the spring is released; in the meantime, we say the energy is stored as potential energy.

$$U = \frac{1}{2}kx^2$$

Units: Joules (J)
x is the amount of stretch or compression beyond equilibrium length

Conservative Forces and Potential Energy

A potential energy can be associated with *any conservative force.*

$$\boxed{\Delta U = U_f - U_i = -W_c(i \to f)}$$

Gravitation: $\Delta U_g = U_f - U_i = -W_{\text{grav}}(i \to f) = mgy_f - mgy_i$

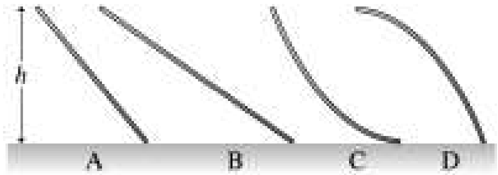
Spring: $\Delta U_s = U_f - U_i = -W_{\text{sp}}(i \to f) = -(\frac{1}{2}kx_f^2 - \frac{1}{2}kx_i^2)$

Both are *location-dependent* and *reversible* potential energies.

Note that friction is *not* a conservative force and is *irreversible.*

56. •• IP At the local playground a child on a swing has a speed of 2.12 m/s when the swing is at its lowest point. **(a)** To what maximum vertical height does the child rise, assuming he sits still and "coasts"? **(b)** How do your results change if the initial speed of the child is halved?

Slide ACT



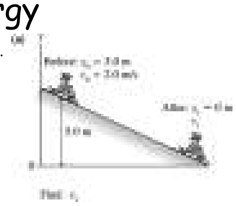
A small child slides down four frictionless sliding boards. Which relation below describes the relative magnitudes of her speeds at the bottom?

a) $v_C > v_A > v_B > v_D$ $\boxed{c)\ v_A = v_B = v_C = v_D}$ *e)* $v_C < v_A < v_B < v_D$

b) $v_A > v_B = v_C > v_D$ *d)* $v_A < v_B = v_C < v_D$

Sled Energy

Christine runs forward with her sled at 2.0 m/s.
She hops onto the sled at the top of a 5.0 m high, very slippery slope.
What is her speed at the bottom?



$K_1 + U_{g1} = K_0 + U_{g0}$

$\frac{1}{2}\cancel{m}v_1^2 + \cancelto{0}{mgy_1} = \frac{1}{2}\cancel{m}v_0^2 + \cancel{m}gy_0$

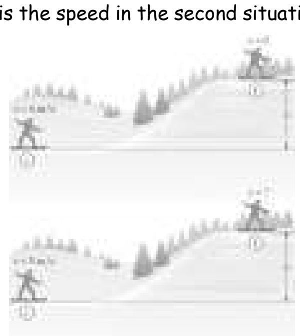
$v_1 = [v_0^2 + 2gy_1]^{1/2}$

$= [(2.0\ m/s)^2 + 2(9.80\ m/s^2)(5.0\ m)]^{1/2}$

$= 10.1\ m/s$

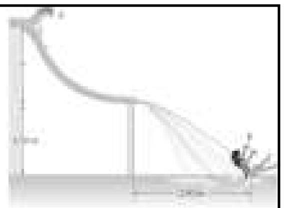
Energy Cons. ACT

What is the speed in the second situation?



v = 3 m/s

57.•• The water slide shown in **Figure 8–23** ends at a height of 1.50 m above the pool. If the person starts from rest at point A and lands in the water at point B, what is the height *h* of the water slide? (Assume the water slide is frictionless.)



58.•• If the height of the water slide in Figure 8–23 is h=3.2 m and the person's initial speed at point *A* is 0.54 m/s, at what location does the swimmer splash down in the pool?