CONSERVATION OF ENERGY

1. Rationale
2. Conservative & Non-conservative Forces
3. Mechanical Energy & Potentials
4. Conservation of Energy Probs

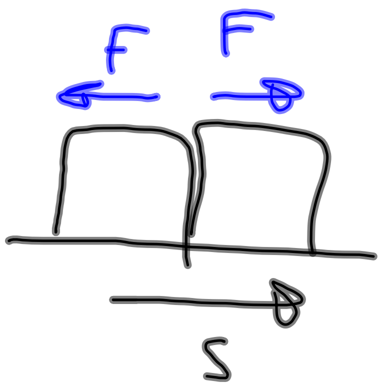
RATIONALE FOR CONSERVATION

Newton's 3rd Law

When one object pushes on a second, the second pushes back with the same force, but in the opposite direction.

Work

Work = Fs



(J)

in any interaction, once gets negative work, the other positive in the same amount.

What one loses, the other gains.

Conservative & Non-conservative Forces

Conservative Forces

When the object returns to the same position the force is identical in magnitude & direction, regardless of path.
e.g. springs & gravity

Non-conservative (Dissipative) Forces

Are dissipative because they are path or velocity dependent.
e.g. friction & drag

Mechanical Energy & Potentials

Conservative Forces give rise to potential energies

$Ue = 1/2\ ks^2$ $Ug = mgy$

Dissipative Forces give rise to thermal energy

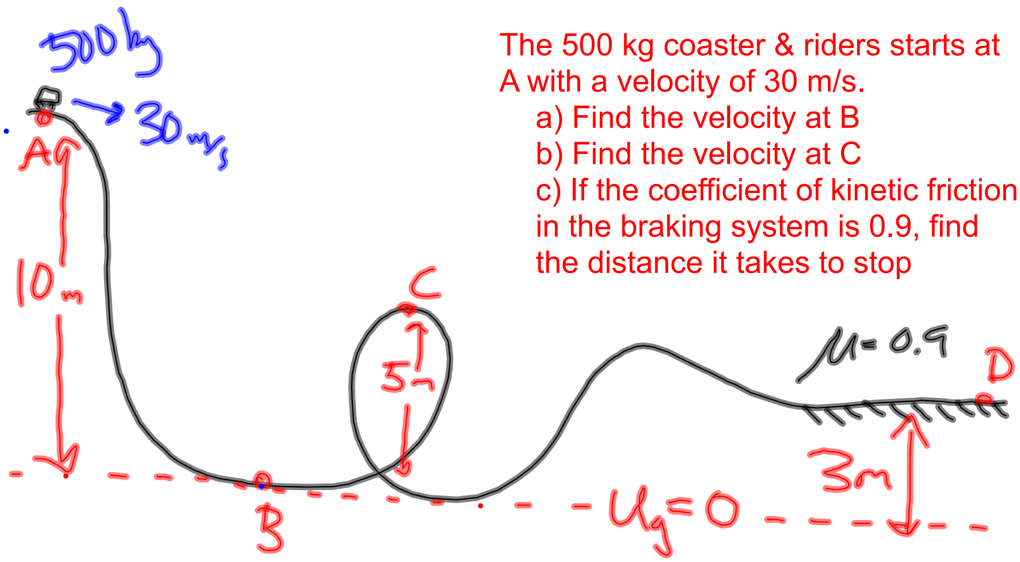
$Q_f = f\ d$ Q_D = complicated

Mechanical Energy = Potentials + Kinetic

Conservation of Energy Problems

1. Roller Coaster
2. Potential Energy graphs
   (forces & force graphs)
3. Spring on an incline
4. Drops

roller coaster



The 500 kg coaster & riders starts at A with a velocity of 30 m/s.

a) Find the velocity at B

b) Find the velocity at C

c) If the coefficient of kinetic friction in the braking system is 0.9, find the distance it takes to stop

a) $Ug_A + K_A = K_B$

$mgy_A + 1/2\ mv_A^2 = 1/2\ mv_B^2$

(m's cancel!)

$gy_A + 1/2\ v_A^2 = 1/2\ v_B^2$

$\sqrt{2gy_A + v_A^2} = v_B$

$v_B = 33$ m/s

b) $K_B = K_C + Ug_C$

$1/2\ mv_B^2 = 1/2\ mv_C^2 + mgy_C$

(m's cancel!)

$v_B^2 - 2gy_C = v_C^2$

$\sqrt{v_B^2 - 2gy_C} = v_C$

$v_C = 31.6$ m/s

c) $K_B = Q_D$

$1/2\ mv_B^2 = fd$

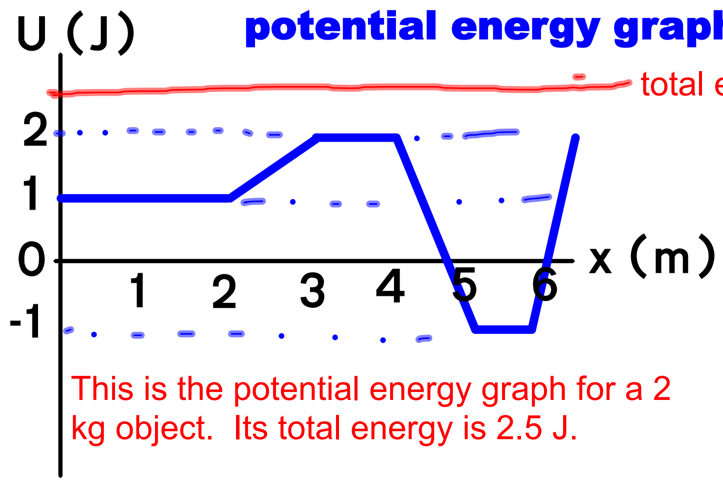
d = 57 m

$gy_A + 1/2\ v_A^2 = 1/2\ v_B^2$

$2gy_A + v_A^2 = v_B$

$v_B = 33$ m/s

potential energy graphs & forces



This is the potential energy graph for a 2 kg object. Its total energy is 2.5 J.

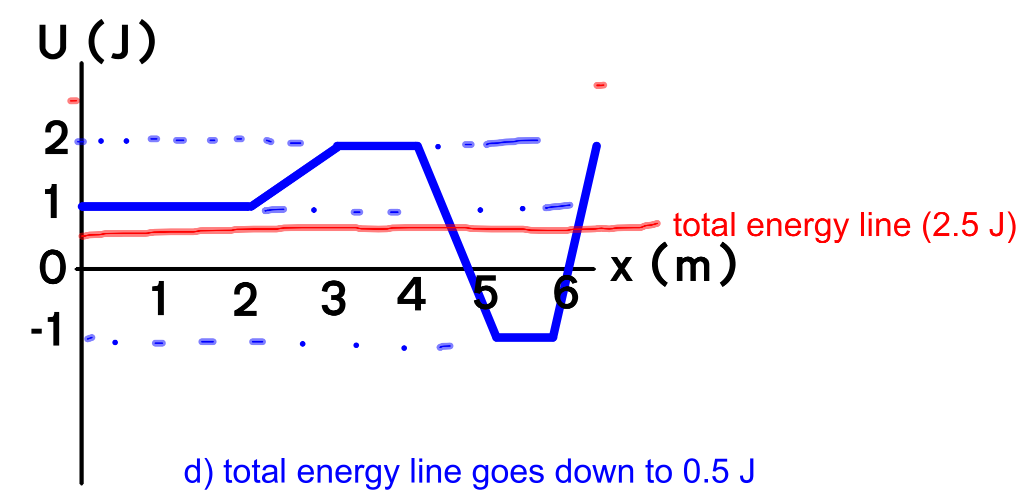
a) Find the kinetic energy at x = 1 m
b) Find the kinetic energy at x = 5.5 m
c) Find the force on the object at x = 2.5 m
d) If the object's total energy were 0.5 J, describe the motion it would have.

On a potential energy graph, from the potential line to the total energy line gives you the Kinetic Energy.

a) 1.5 J
b) 3.5 J

On a potential energy graph, Force is the negative of the slope.

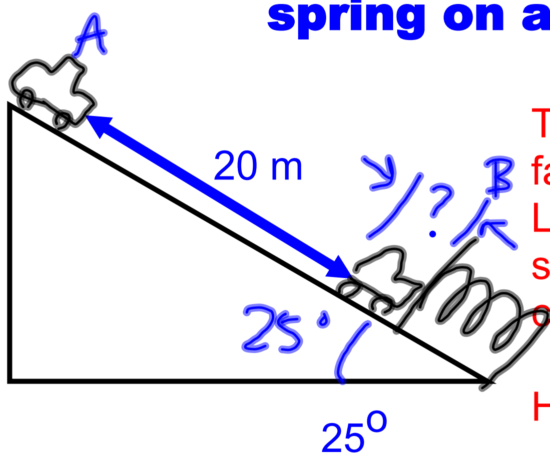
c) -1 N



d) total energy line goes down to 0.5 J

The object is now trapped between about 4.5 m and 6.5 m

spring on an incline

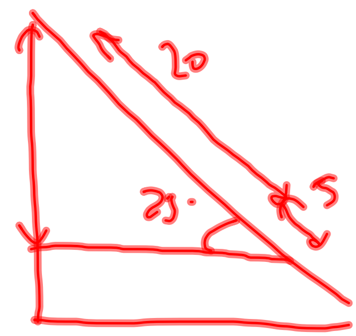


The 1000 kg car's emergency brake fails and it slides down the icy hill. Luckily someone has placed a giant spring at the bottom of the hill (spring constant 20,000 N/m)

How far does it compress the spring?

$$U_{G_A} = U_{e_B}$$

$$mg(y_A) = \frac{1}{2}ks^2$$



$$mg(20+s)\sin 25 = \frac{1}{2}ks^2 \qquad (20+s)\sin 25$$

$$(1000)(10)(20+s)\sin 25 = \frac{1}{2}(20,000)s^2$$

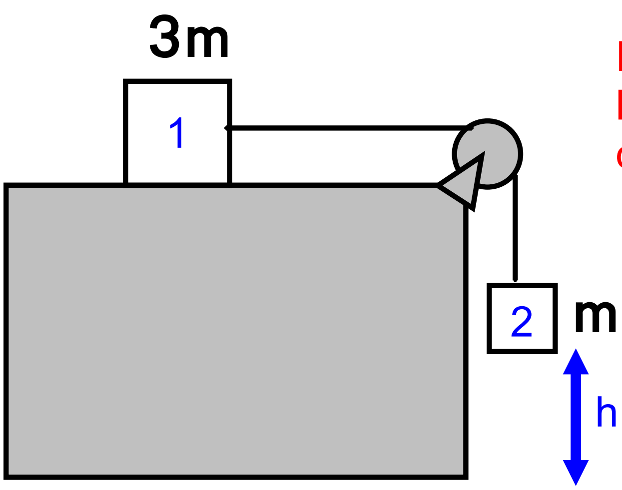
$$(200000 + 10,000s)(0.42) = 10,000s^2$$

$$0 = 10,000s^2 - 4200s - 84,000$$

3.12 and −2.70

s = 3.12 m

spring on an incline



Find the velocity of Block 2 when it has descended a distance h, in terms of M, g, and h.

$U_g = K$

(note: only block 2 has Ug, but both will have K)

$mgh = 1/2\ (4m)\ v^2$

(m's cancel!)

$gh = 2\ v^2$

$\sqrt{gh/2} = v$