Ep, Ek, and the Law of Conservation of Energy

Tuesday, December 06, 2011 1:40 PM

potential, kinetic Energy

Energy is the ability to make a change in some physical function in the universe

There are many types of energy. The ones we do this year are:

Gravitational potential energy (Ep)[two types]
kinetic energy of a moving mass (Ek)
Elastic energy (Ep)
Electrical potential energy (Ep)
Heat energy (Eh / Q)
Energy in waves (E)

Potential energies are WAITING to be used; stored up for future use.
Kinetic energies are energies being USED RIGHT NOW.
↳ motion/movement

Gravitational Ep NEAR EARTH'S SURFACE
(new way coming next chapter)
Depends on mass, depends on height above the surface, depends on gravitational field (acceleration due to gravity)

$\Delta Ep = m\,g\,\Delta h$

Find the Ep of the cat at right relative to the Earth surface

$E_p = 5(9.8)(-10)$
$= 490$ J

scalar
vector

Mechanical Kinetic Energy

$Ek = 1/2\ m\ v^2$

Find the kinetic energy of a cat of mass 3.0 kg running at 10 m/s.

$E_k = mv^2 - 3(10)^2 - 150$ J

Find the kinetic energy of a cat of mass 3.0 kg running at 10 m/s.

$$E_k = \frac{mv^2}{2} = \frac{3(10)^2}{2} = 150\ J$$

If you double the velocity of the cat what happens to its Ek?

$$E_k = \frac{mv^2}{2}$$

$$E_{k_2} = \frac{m(2v)^2}{2} = \frac{m\,4v^2}{2} = 2mv^2$$

$$\frac{E_{k_2}}{E_k} = \frac{2mv^2}{\left(\frac{mv^2}{2}\right)} = 4$$

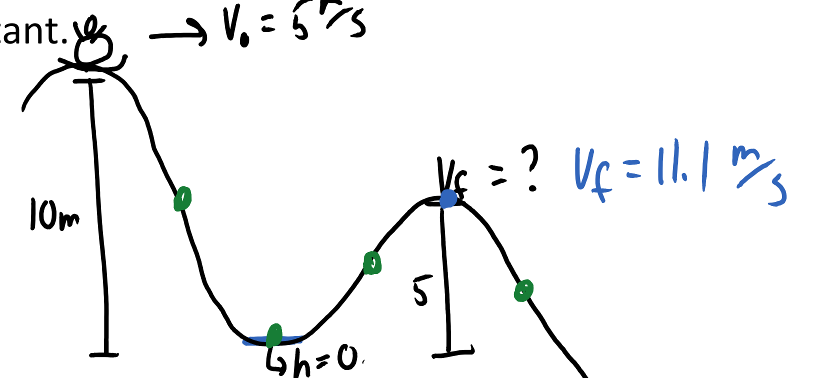
Elastic potential energy Ep= 1/2 k x [2] $F = k\Delta x$

k = spring constant (relates to the stiffness of a spring)

x = the stretched or compressed length in a spring.

ENERGY IS A SCALAR! IT IS INDEPENDENT OF DIRECTION!!

The Law of Conservation of Energy: total energy of the universe before and after an event Happens must remain constant.



$E_{po} + E_{ko} = E_{pf} + E_{kf} + Q$

$mgh_o + \frac{mv_o^2}{2} = mgh_f + \frac{mv_f^2}{2}$

$(-9.8)(-10) + \frac{5^2}{2} = (-9.8)(-5) + \frac{v_f^2}{2}$

Always choose the low point in an experiment to be the zero point for height.   0 $h \to \Delta h$

A rock is dropped from height 15 m what speed has it at height 5.0 m if there is no Air resistance?

$E_{po} + E_{ko} = E_{pf} + E_{kf}$ ~~$+Q$~~

$$mgh_o + \frac{mv_o^2}{2} = mgh_f + \frac{mv_f^2}{2}$$

$$(-9.8)(-15) = (-9.8)(-5)\,2 + \frac{v_f^2}{2}$$

$$v_f = \sqrt{196} = 14 \text{ m/s}$$

A cat is thrown at 20 m/s straight up from the surface of the Earth, to what maximum height does it rise (no air resistance)?

$$E_{po} + E_{ko} = E_{pf} + E_{kf}$$

$$mgh_o + \frac{mv_o^2}{2} = mgh_f + \frac{mv_f^2}{2}$$

$$gh_o + \frac{v_o^2}{2} = gh_f + \frac{v_f^2}{2}$$

$$\frac{v_o^2}{2} - \frac{v_f^2}{2} = gh_f - gh_o$$

$$v_o^2 - v_f^2 = 2g(h_f - h_o)$$

$$-v_f^2 = -v_o^2 + 2\underbrace{g}_{a}\underbrace{(h_f - h_o)}_{d}$$

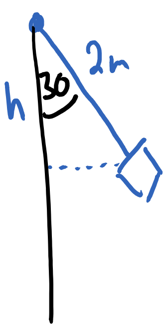
$$\rightarrow v_f^2 = v_o^2 + 2ad$$

$$0 = 20^2 + 2(-9.8)d$$

$$\frac{-20^2}{2(-9.8)} = d$$

$$20.4\text{ m} =$$

A pendulum of length 2.0 m is pulled from the equilibrium position
To 30^o and released. If the bob has mass 1.0 kg with what speed will
It pass through equilibrium? Ignore air resistance and frictional forces.



$$h = 2\cos(30) = 1.73$$

$\therefore$ The bob is $2 - 1.73 = .27$ m

$$gh_o + \frac{v_o^2}{2} = gh_f + \frac{v_f^2}{2}$$

$$(-9.8)(-.27) + \frac{0^2}{2} = (-9.8)(0) + \frac{v_f^2}{2}$$

$$v_f = \sqrt{2(9.8)(.27)} = 2.30 \text{ m/s}$$

As it works out, the bob reaches the equilibrium point at only 2.1m/s!

need to take Q into account.

What type of energy was created to make up for the missing Ek?

Q = heat

How much heat energy is produced?

$$(-9.8)(-.27) = \frac{(2.1)^2}{2} + Q$$

$$Q = .441\ J$$

Confirmed!