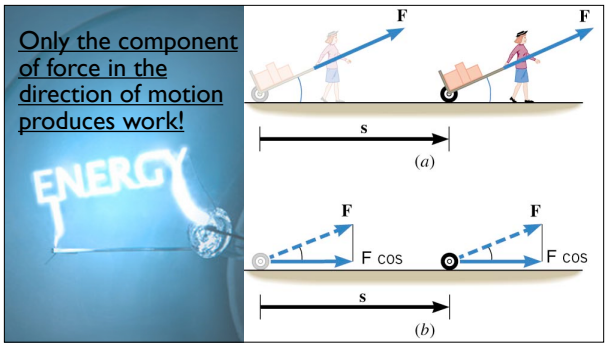
Work (a scalar)

- In physics, work is done when a force is applied through a distance.
- $W = F \cdot d$ =force · displacement
- The result of work is motion
- Unit of measure is the joule.
- If you pick up a 3N rock a distance of 2 meters, how much work have you done?
- If you push a wall with a force of 100N how much work have you done?

- Is there actually work being done on the left?
- Yes. But not by the 15N force used to hold it up. If you knew the coeff. of friction between the box and hands then you could calculate the force used to overcome friction that is in the direction of the motion.

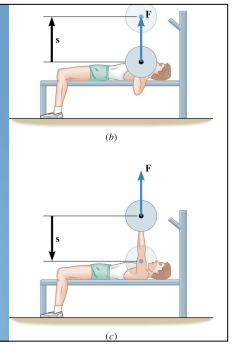
Only the component of force in the direction of motion produces work!



The meaning of + and -

While bench pressing, the work done pushing the bar up adds energy to the system and is considered positive. So work in is +

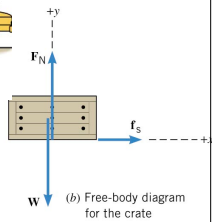
On the way down there is a decrease in energy and the work is said to be negative. So work out is -



(a)

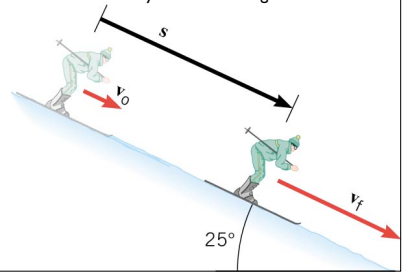
A 120 kg crate is on a flatbed truck that is moving with a=+1.5m/s^2. The crate does not slip as the truck covers a distance of d = 65m. What is the total work done by all forces acting on the crate?

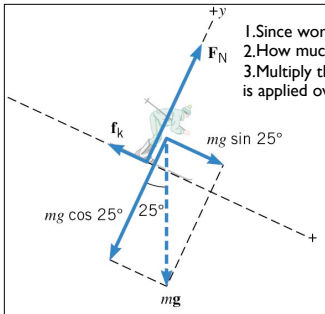
ANS: 11,700 J



(b) Free-body diagram for the crate

A 58 kg skier is coasting down a 25^0 slope. A kinetic frictional force F_k = 70N opposes her motion. If she travels a distance down the slope of 57 meters, determine the total work done by all forces acting on her.





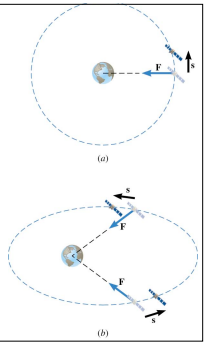
(b) Free-body diagram for the skier

1. Since work is force x distance find the ΣF
2. How much of it is in the direction of motion?
3. Multiply that part of the force by the distance it is applied over.

ANS: 9,980 J

How much work does gravity do on a satellite in orbit?

WORK IN PROGRESS



A Conservative Force

- A force is conservative when it does no net work on an object moving around a closed path.
- Work is independent of path

Conservative
Gravity
Spring Force
Electric Force

Nonconservative
Friction
Tension
Normal Force
Air resistance

Power

- Power is the rate at which work is done.
- P = W/t
- So the faster you do work, the more power is needed.
- SI unit of measure is the watt.

Power

- P = W/t
- So, if you pick up that same 3N rock a distance of 2 meters, and do it in 6 seconds how much power is needed?
- 3N·2m/6s = 1w

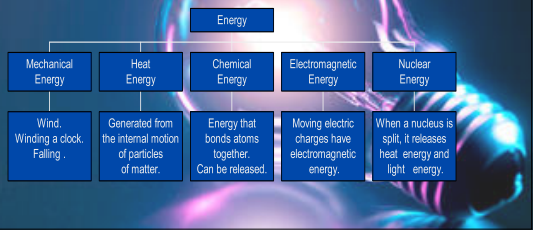
Calculate the Power

- A set of pulleys is used to lift a piano weighing 1000N. It is lifted 6 meters in 30 seconds. How much work was put into it and how much power was used?
- W=Fxd=1000Nx6m
- W=6000J
- P=W/t=6000J/30s
- P=200W

Work/Energy Therom:

- Everything has a quantity called energy associated with it.
- Defined as the ability to do work. "**WORK = ΔENERGY**"
- The SI unit of measurement for energy is the joule (J).

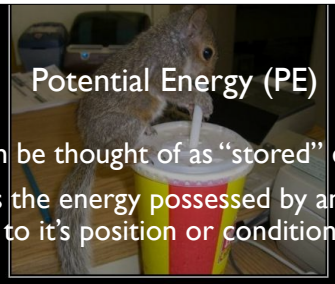
There are many types of Energy



Potential and Kinetic Energy

- In all these types of energies, energy can exist as either Potential Energy, Kinetic Energy, or both.

Potential Energy (PE)



- Can be thought of as "stored" energy.
- It is the energy possessed by an object due to it's position or condition.

Gravitational Potential Energy

- The potential energy "stored energy" in an object due to its height off the ground.
- Work was done against the force of gravity (weight), through a distance (height) to lift an object.
- The work done (W) is equivalent to the Gravitational Potential Energy (GPE) acquired by the object.

Gravitational Potential Energy

$W = F \cdot d$

$W = \Delta PE = F \cdot d$

$\Delta PE = F \cdot d$

$GPE = weight \cdot \Delta height$

$U = GPE = m \cdot g \cdot h$

Weight is the force due to gravity w=m·g

ΔPE due to gravity

Distance is just the height off the ground

Kinetic Energy (KE)

- Is the energy due to motion.
- A moving object has the ability to do work on another object.
- It is a scalar quantity

Kinetic Energy (K)

Using W=F·d and Newton's 2nd Law, F=m·a

The work done by a force to accelerate a mass is equivalent to the KE gain.

$$W = Fd$$

a=v/t assuming v_i =0

$$KE = mad$$

d=avg.velocity multiplied by time

$$KE = m\left(\frac{v}{t}\right)v_{avg}t$$

Avg. velocity=$v_{/2}$

Assuming v_i =0

$$KE = m\left(\frac{v}{t}\right)\left(\frac{v}{2}\right)t$$

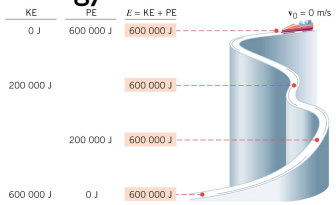
$$KE = \frac{1}{2}mv^2$$

Conservation of Mechanical Energy

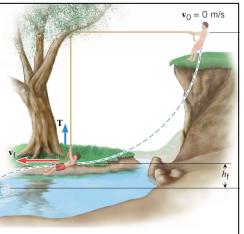
- The total mechanical energy (E=K+U) of an object remains constant as the object moves, provided the net work done by external nonconservative forces is ZERO.

Conservation of Mechanical Energy

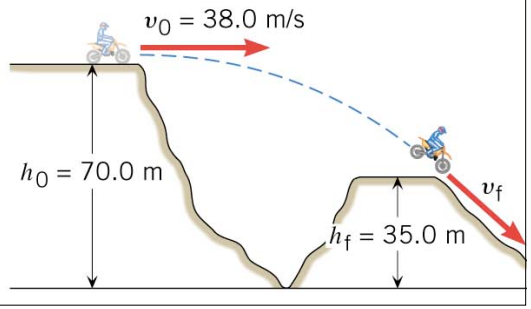
Energy can not be created or destroyed, it just changes forms.



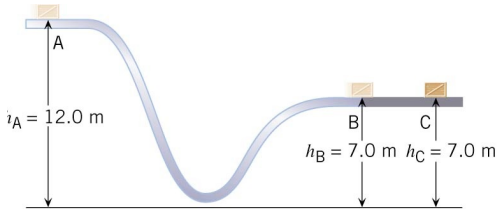
- If this person starts from rest, holding the rope horizontal, swings downward and lets the rope go at the bottom, can we use conservation of energy even though there is tension on him?
- Yes, because T is perpendicular to the direction of motion and does no work.
- If he is 4 m from the surface of the water when he jumps and 0.8 m when he lets go, find v_f.



- Find v_f
- 46.3m/s



A 0.5Kg block slides down a frictionless surface between A and B. Frictional forces begin at point B and bring it to rest at point C. If K_A=30J what is the kinetic energy at B? How much work does the frictional forces do between BC?



If the distance from B to C is 10m, find:

1. The force of friction
2. The acceleration
3. The time it takes friction to stop the box