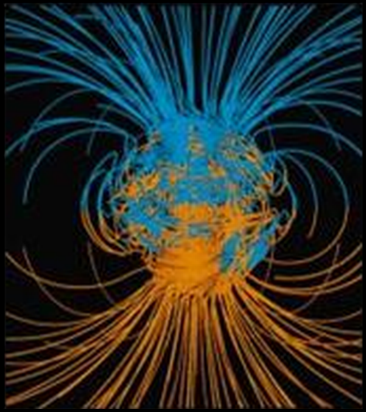


Phy2005
Applied Physics II
Spring 2018

Announcements: BW office hours T10th, R10th
Start working on HW problems!

Last time: Mechanics review I

- eqns. of motion for const. acceleration
- Newton’s laws
- Momentum conservation

Today: Mechanics review II

Top Hat Quiz Time

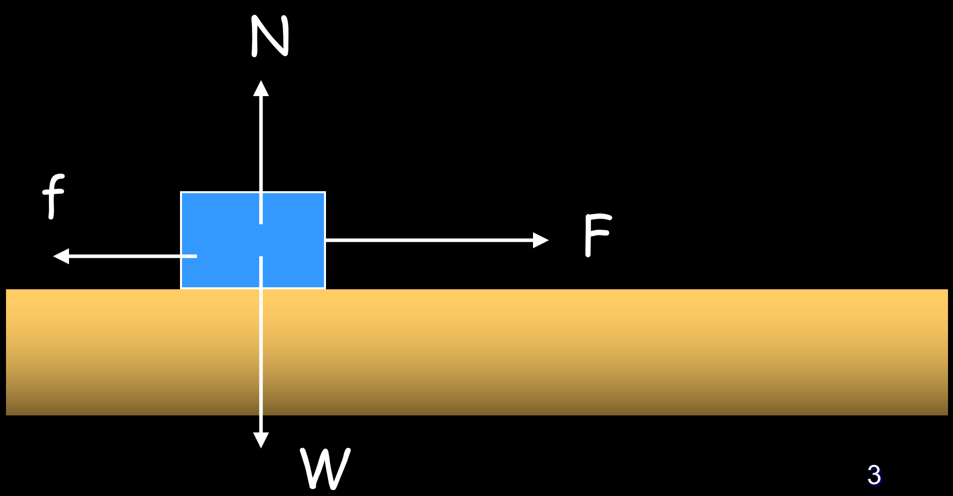
ACADEMIC HONESTY

Each student is expected to hold himself/herself to a high standard of academic honesty. Under the UF academic honesty policy. Violations of this policy will be dealt with severely. There will be no warnings or exceptions.

Have your phone ready!

Q1 A person pulls a block on a rough surface at a constant speed by a force F. The arrows in the figure correctly indicate the directions of F, friction (f), normal force (N), and weight (W). Which of the following relations among the force magnitudes must be true?

(1) We have to know the speed of the block.
(2) $F > f$ and $N = W$
(3) $F = f$ and $N > W$
(4) $F > f$ and $W > N$
(5) $F = f$ and $W = N$



Film: The Mechanical Universe

15. Conservation of Momentum

Remark: ignore the brief discussion of calculus   d ~ Δ

Momentum p=mv

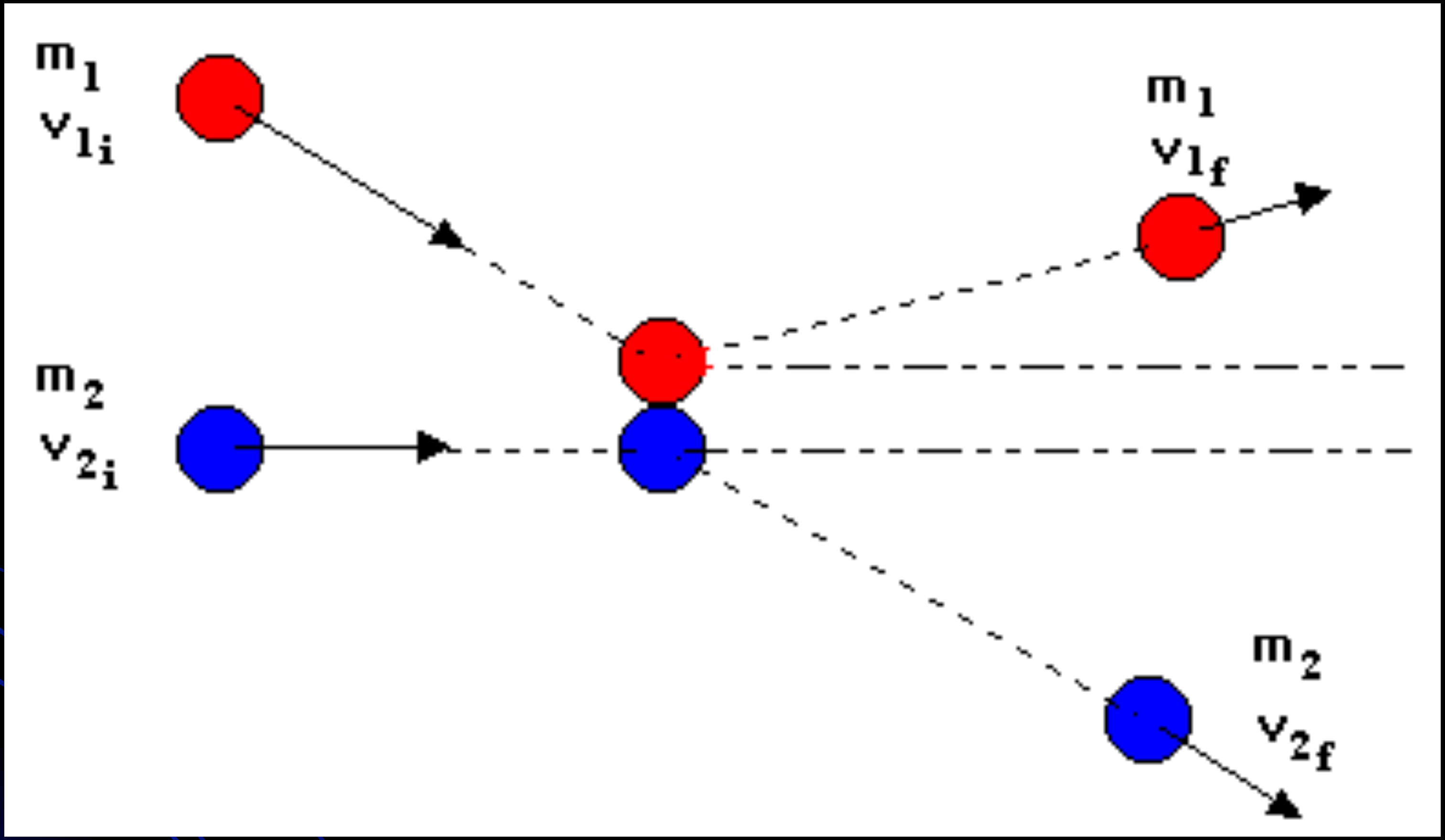
Newton's 2nd law: $F = \Delta p/\Delta t$

An external force causes a change in total momentum

So if there is no external force, total momentum is conserved

NB Films available for free at Caltech youtube site

Momentum conservation



Since no external force acts on the two balls, momentum is conserved:

$$p_{1i} + p_{2i} = p_{1f} + p_{2f}$$

Momentum Conservation in one dimension

Ex. 4-1. A car waiting at the traffic light at 34th St. and University Avenue masses 1000 kg. A 4000 kg truck going west loses its brakes and plows into the car from behind going 10 m/s. The truck and car stick together and continue through the intersection. What is their combined velocity immediately after the collision?

Momentum before the collision: (4000 kg)(10 m/s) + (1000 kg)(0) = 40,000 kg-m/s
" " after " " (4000 kg + 1000 kg) v

Momentum conservation $\Rightarrow$ 40,000 kg-m/s = 5000 kg • v $\Rightarrow$ v = 8 m/s to the west.

Energy, Work, & Conservation

Energy
||
Ability to do Work

For work to be done,

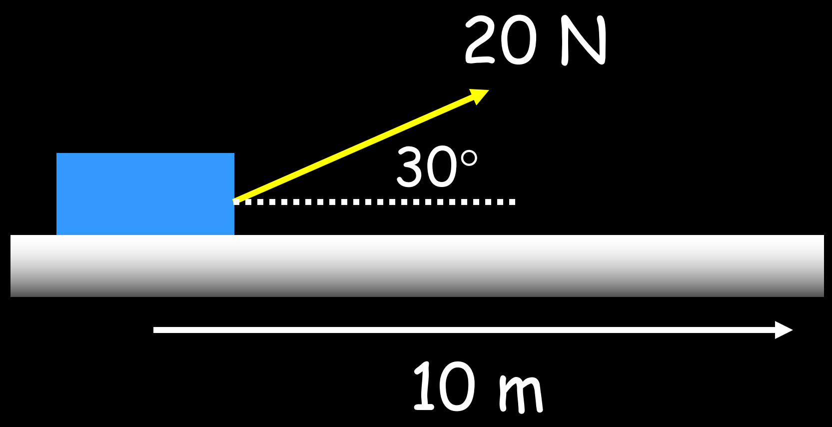
(1) there must be an applied force
(2) the force must act through a distance (displacement)
(3) the force must have a component along the displacement.

Work = (force component) x (displacement)

Unit of work: Nm = J (Joule)

Ex 4-1 How much work is done by a 20 N force in pulling the block as shown in the figure a distance 10 m?

W = 173 Nm = 173 J



$W = (F\cos\theta) \cdot S$

force component along the displacement

θ: angle made by F and S

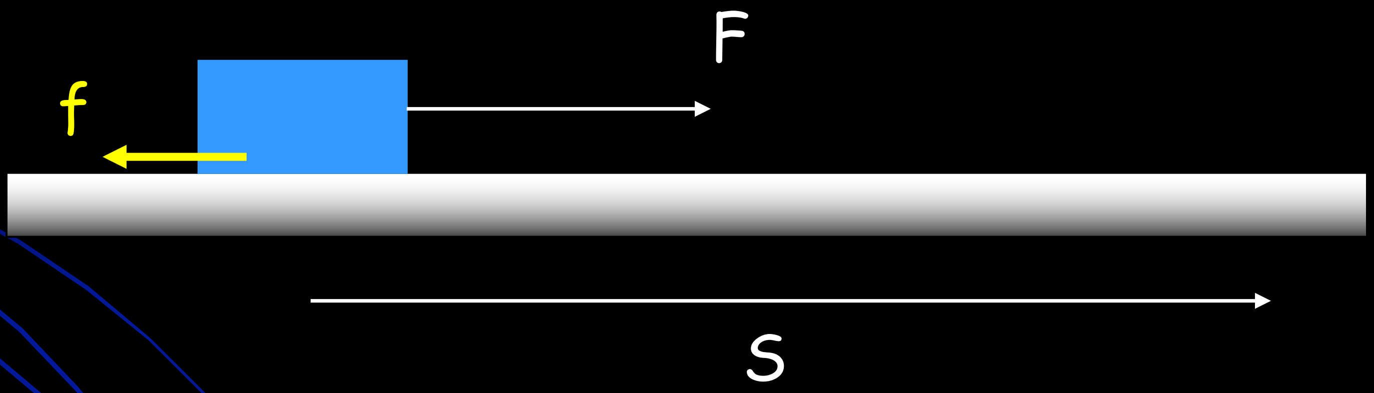
Ex 4-2 Who did the most work?

John pushed a 20 lb box horizontally with a 200 N force for 20 m.
Julia pulled a 40 lb box horizontally with 200 N force for 20 m.
Eddie lifted up a 100 lb box and walked horizontally for 20 m.
Kathy pushed a 10 lb box horizontally with 150 N for 30 m.

(1) John
(2) Julia
(3) Eddie
(4) Kathy
(5) I have to know how large the frictional force is.

Energy
||
Ability to do Work

Conversely, if a force did work on an object, it added to the object an amount of energy equal to the work done!!



F did positive work on the block → increased energy
f did negative work on the block → decreased energy (dissipation)

Potential Energy

Position or Condition

MECHANICAL ENERGY

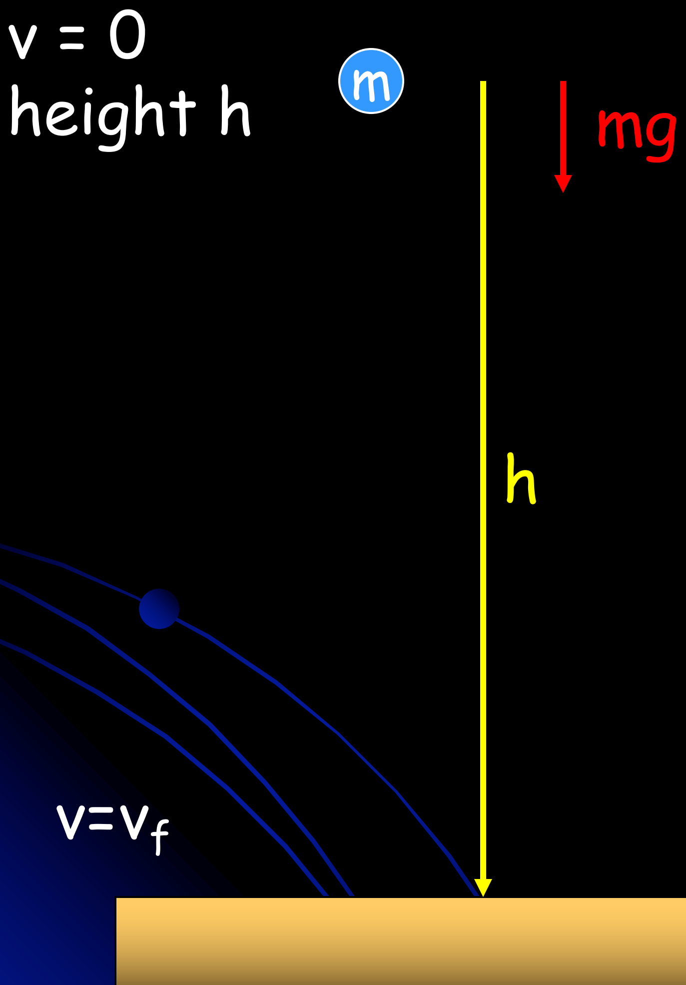
Kinetic Energy

Motion ($mv^2/2$)

Work-Energy Theorem

The work of a *net* external force on an object is equal to the change in kinetic energy of that object

$$W = \Delta KE$$



Work done by mg

$= (mg) \times h = mgh$

Change in kinetic energy

$= mgh$

$= (K.E.)_f - (K.E.)_i$

$= (1/2)mv_f^2 - 0$

$$v_f = (2gh)^{1/2}$$

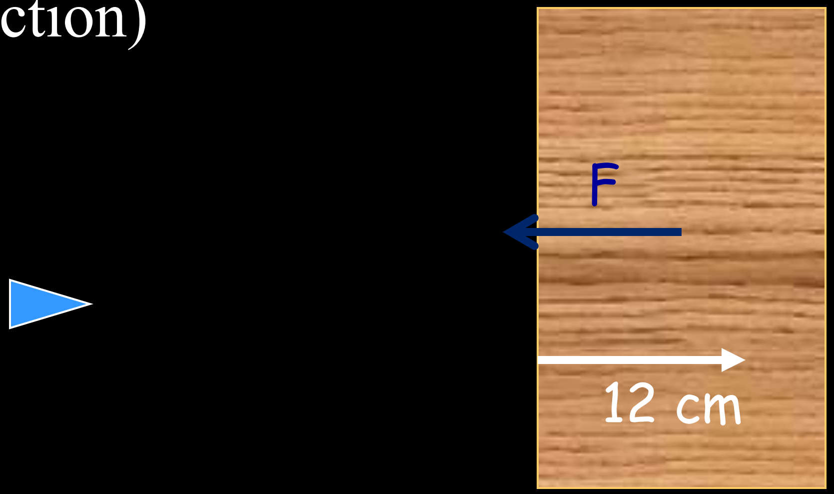
Q: Wait! Doing work changes potential energy too, right? when I lift a barbell from my chest above my head, I've done work, and increased its *potential* energy. What's going on?

A: Consider the usual lift, when one starts at one height, barbell at rest, and lifts to a new height, with barbell again at rest. Change in K is 0! Why: because *total force,* hence *total work,* is zero! Your force taken alone, did work to increase potential energy.

Work-kinetic energy theorem relates to *total force*!

Ex 4-3 What average force F is necessary to stop a 16-g bullet traveling at 260 m/s as it penetrates into a wood block for a distance of 12 cm?

F = 4510 N (see fig. for direction)



Top Hat Quiz Time

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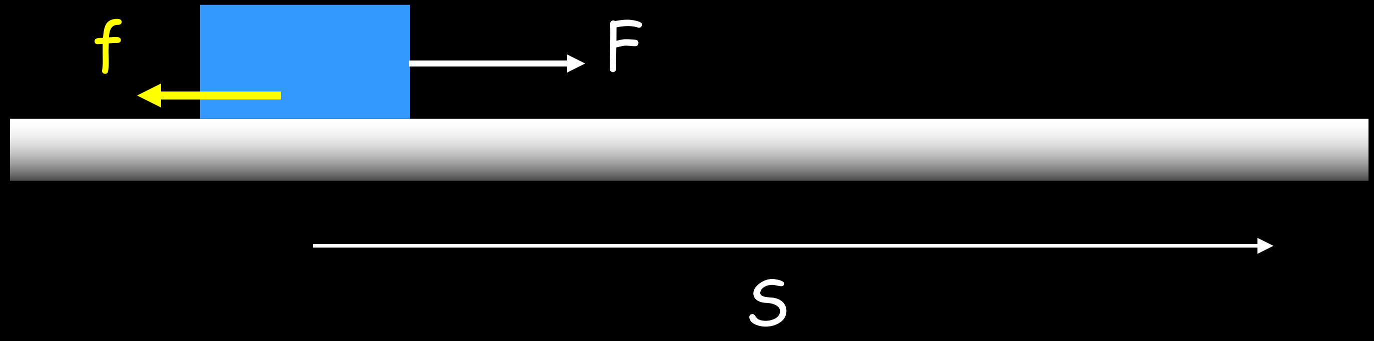
Q2 A block was pulled by applying a force F on a rough surface for a certain distance S. During this process the block was moving with a constant speed. Choose the *wrong* statement:



(1) f = F
(2) F did positive work on the block.
(3) f did negative work on the block.
(4) As a result, the mechanical energy of the block has increased.
(5) There is no change in kinetic energy.

Film: The Mechanical Universe

13. Conservation of Energy

Remark: ignore the brief discussion of calculus
apologies for the geeky humor

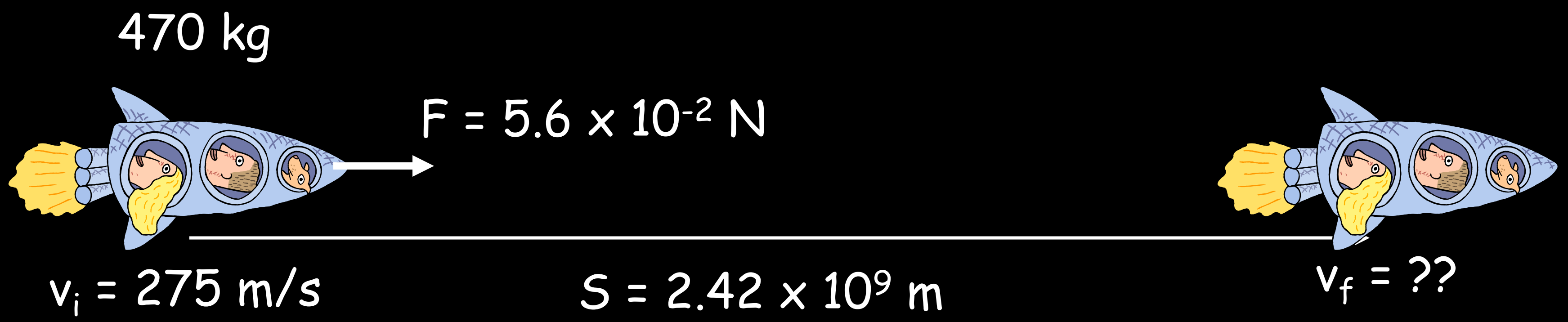
$$E = K + U$$

- If there are no dissipative forces, mechanical energy is conserved

If there is dissipation, heat is created mech. en. *not* conserved

NB Films available for free at Caltech website

Ex 4-4 Space probe Deep Space I was launched on Oct 24, 1998. It uses a type of engine called an IPD (Ion Propulsion Drive) which can put out a thrust force 5.6×10^{-2} N. The probe (470 kg) started the engine when the speed was 275 m/s and has been propelled for 2.42×10^{6} km so far. What is the speed of the probe now?



$v_f = 804$ m/s