1) Go over WS5 and 6
   1) Shape of incline doesn't affect how fast object is going at the bottom. But what about how **much time** it takes the object to get to the bottom of the incline?

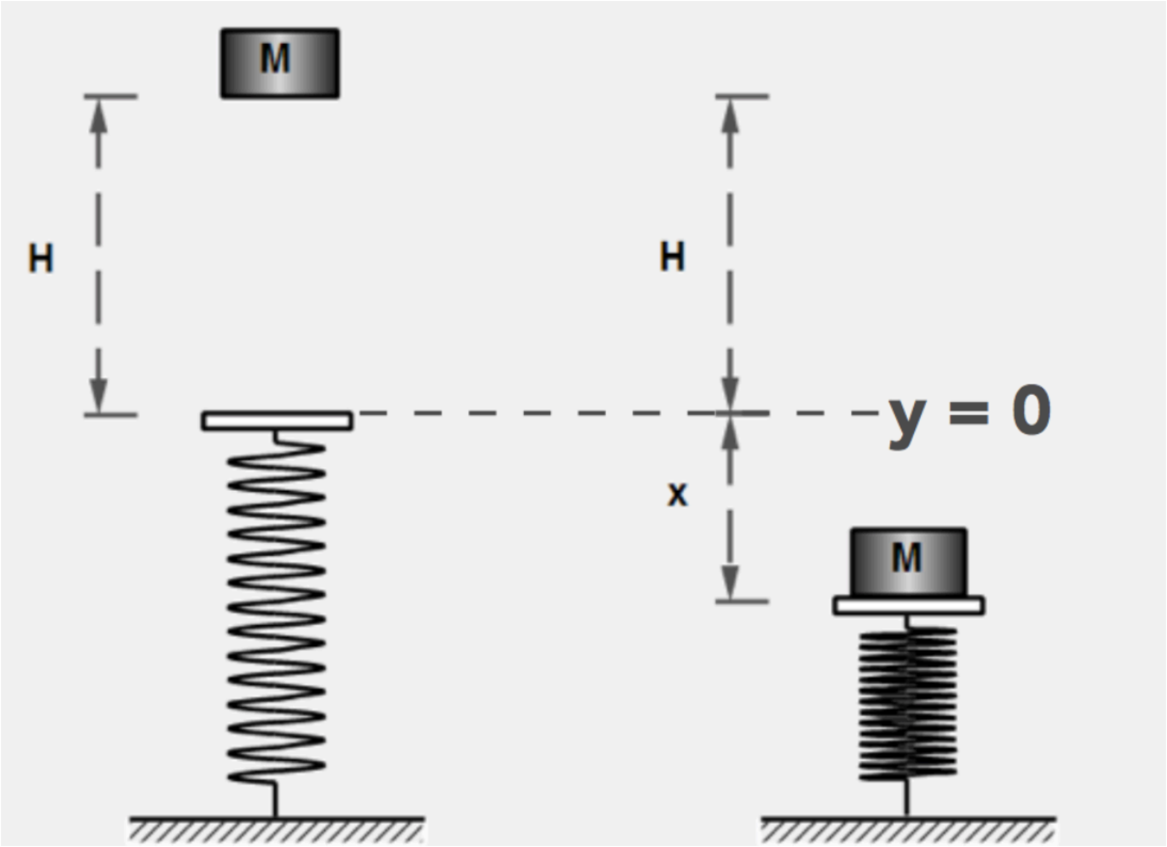
Everyone take a rubber band

I stretch a rubber band back. In physics terms, what am I doing to the rubber band? What kind of energy do I give the rubber band?

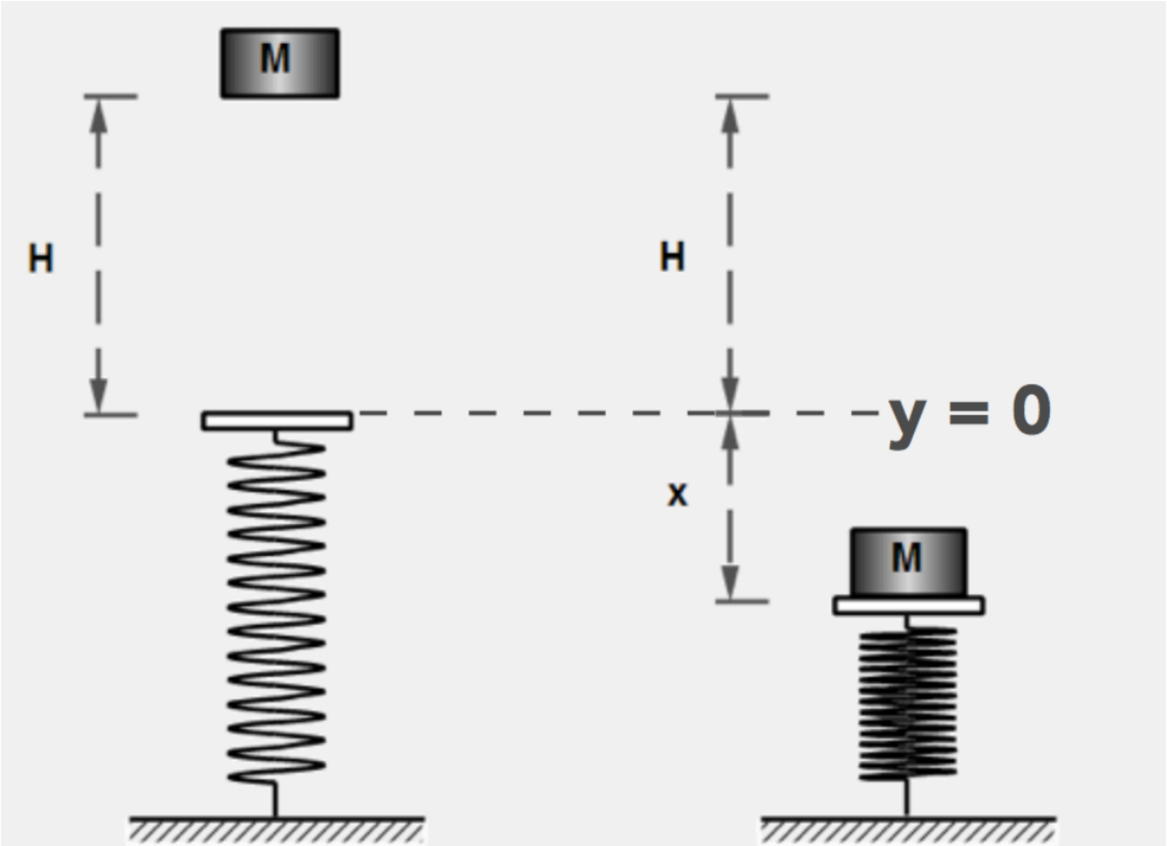
What energy does the rubber band have when I release it?

Ideally, the PE from pulling the rubber band back goes all into KE. What might slow the rubber band down?

A block of mass 2.60 kg, starting from rest, falls a vertical distance of 55.0 cm before striking a vertical coiled spring, which it compresses 15.0 cm. What energy transformations happen in this scenario?



A block of mass 2.60 kg, starting from rest, falls a vertical distance of 55.0 cm before striking a vertical coiled spring, which it compresses 15.0 cm. What is the spring constant of the spring, assuming it has negligible mass?



$mgh_i = -mgh_f + \frac{1}{2} kx_f^2$

K = 1580 N/m

DISSIPATIVE FORCES

We've been neglecting nonconservative forces (like friction) in conservation of energy problems

In natural processes, mechanical energy (KE + PE) doesn't remain constant – it **decreases.**

Dissipative forces like friction reduce total mechanical energy

DISSIPATIVE FORCES

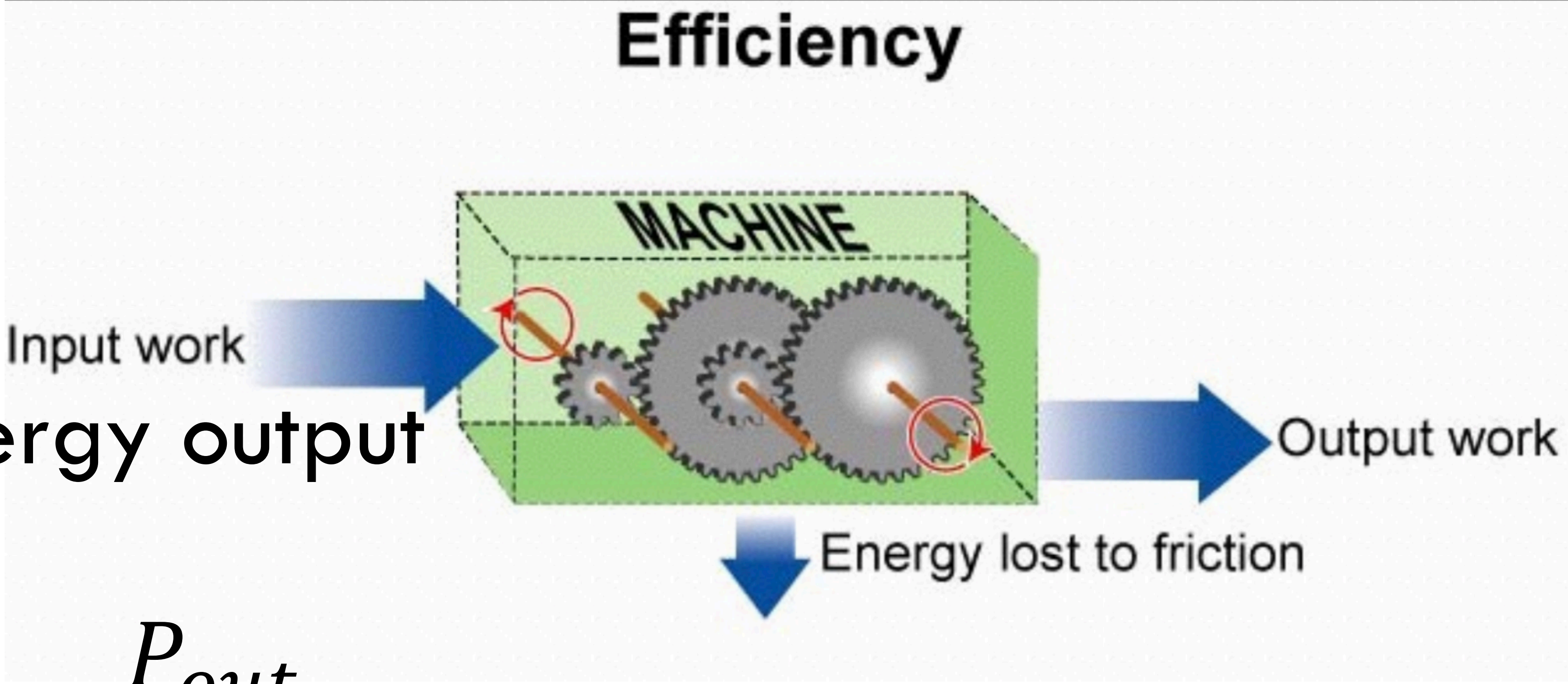
Include dissipative forces: total energy is conserved

$W_{NC} = \Delta KE + \Delta PE$

Conservation of energy with gravity and friction:

$$\frac{1}{2}m{v_i}^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f + F_{fr}d$$

EFFICIENCY



Ratio of useful energy output to energy input

$$Eff = \frac{W_{out}}{W_{in}} \left(= \frac{P_{out}}{P_{in}}\right) x\ 100\%$$

A power plant burns 75 kg of coal every second. Each kg of coal contains 27 MJ (Mega Watts) of chemical energy. What is the power of the power station in Watts?

- (75 kg x 27 MJ per kg)/1 sec
- 2.03 GW (Giga watts)

It’s input power is 2.03×10^9 W.

The electrical power output of the plant is 800 MW. What’s the efficiency of the plant?

$= {}^{800,000,000\ \text{W}}/_{2,300,000,000\ \text{W}}$

$= 0.39 \times 100\%$ to create a percentage

$= 39\%$

Where does the rest of the energy go?

Wasted as heat (thermal energy) – up the chimney of the power station, in the cooling towers, and because of friction in machinery

Do WS 3 and 4, and WS1 Power problems

Do WS 3, 4, rest of WS 1

MASS ENERGY

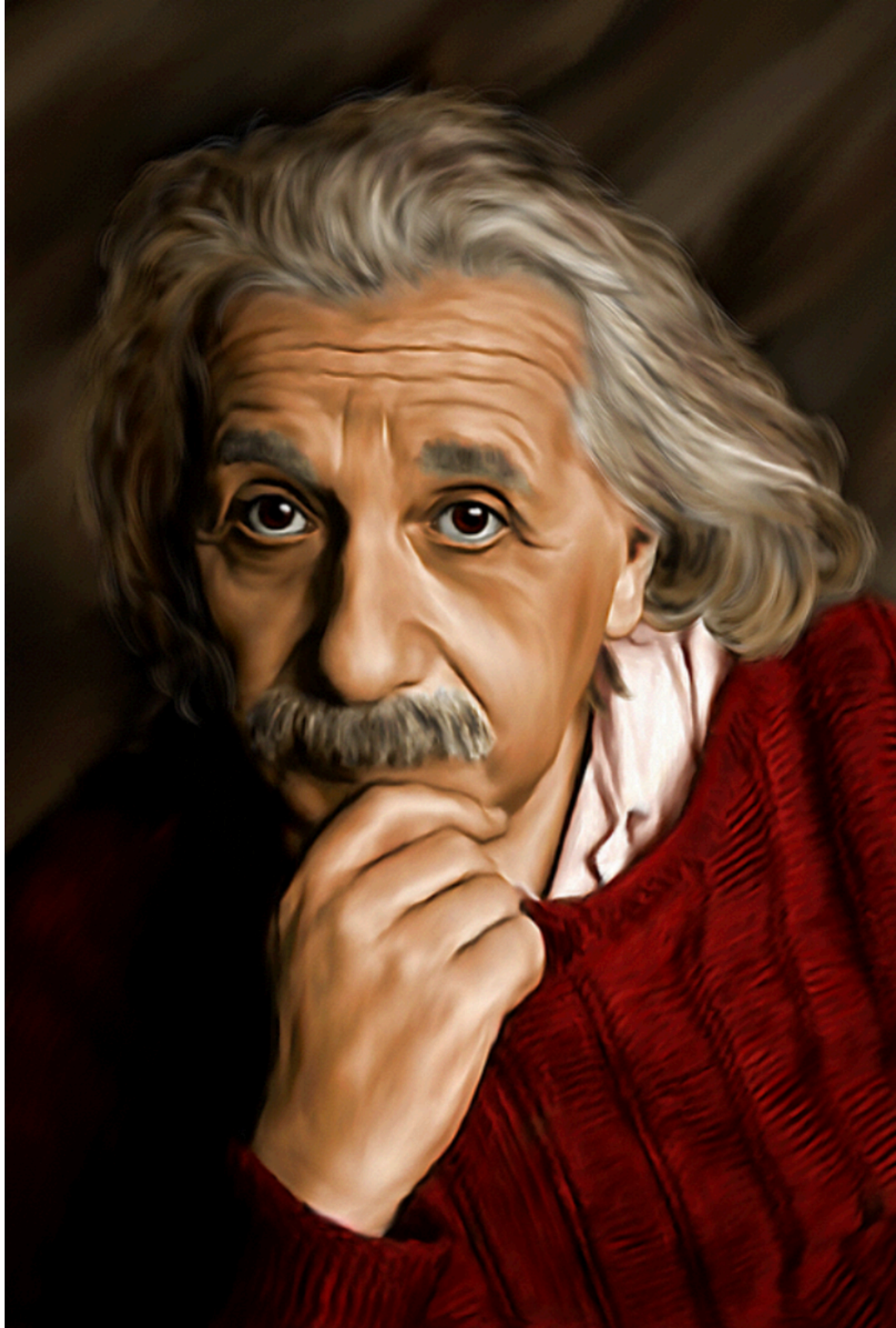
In 1905, Albert Einstein was the first to propose equivalence between mass and energy

$E = mc^2$

$m = E/c^2$

c is the speed of light

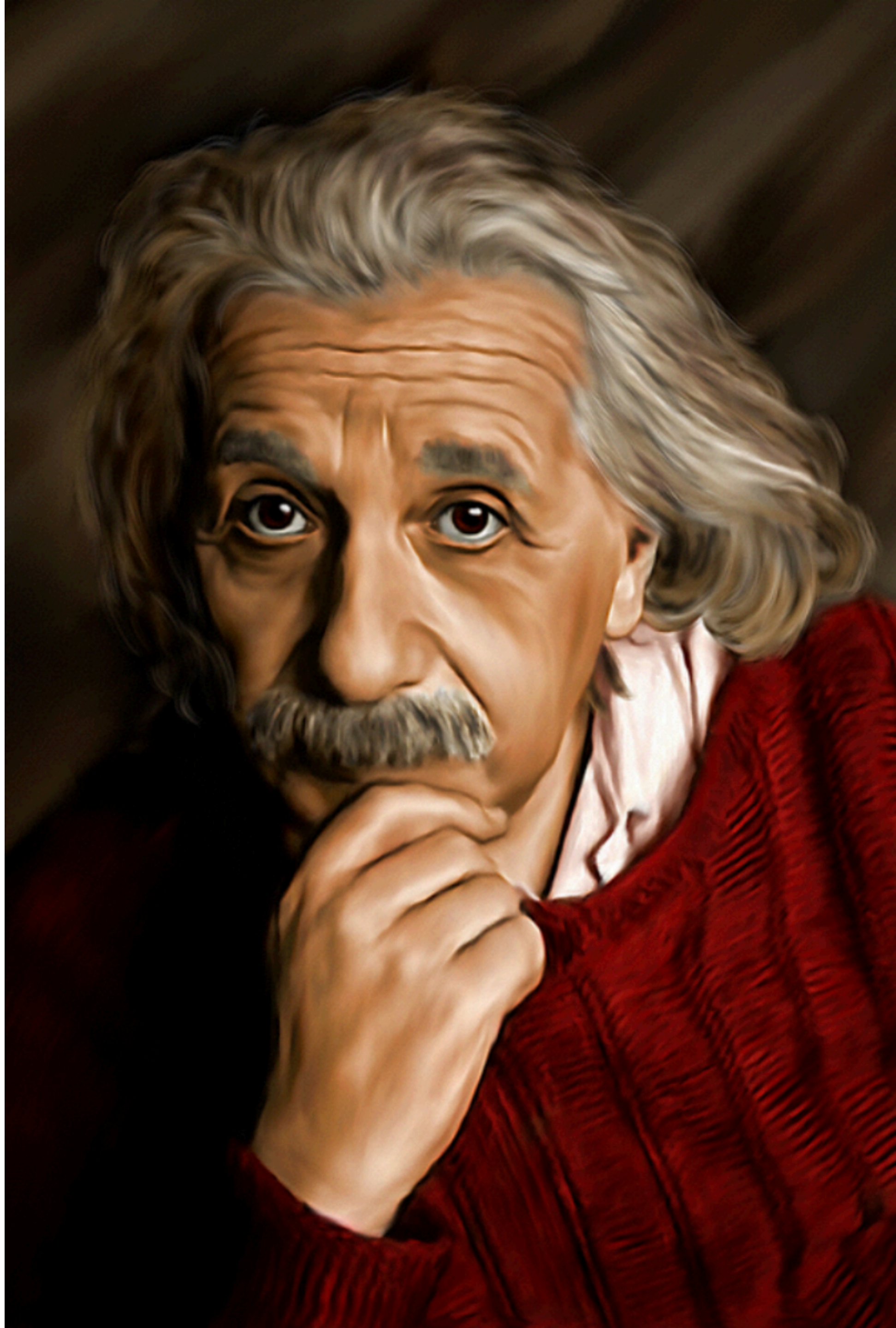
$c = 3.00 \times 10^8$ m/s



WHAT MASS ENERGY IS NOT

"Mass is a form of energy"

"Mass can be converted into energy"



MASS ENERGY

Two objects made of the same parts will not, in general, have the same mass

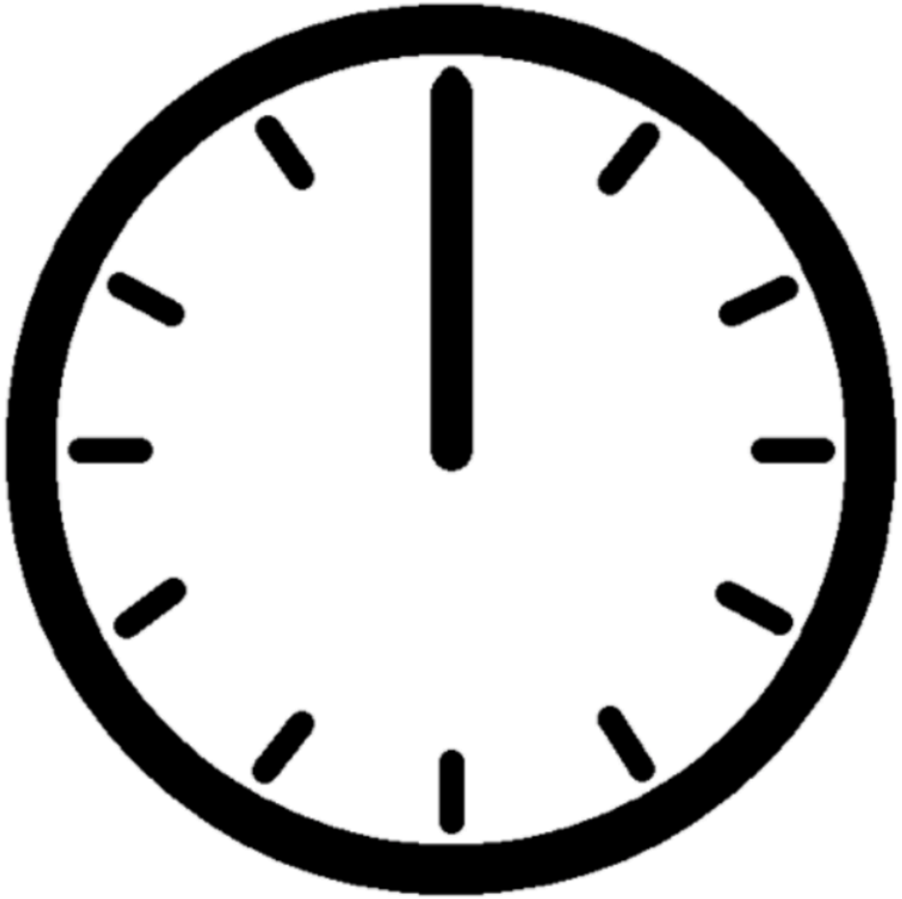
Mass depends on how the parts are arranged/move within the bigger object

$$m_1 \neq m_a + m_b + m_c$$

$$m_2 \neq m_a + m_b + m_c$$

Fully Wound Up & Running

Stopped



$$m > m$$

MASS ENERGY

$m_{watch} = m_{parts} + m_{extra}$

KE + PE + $E_{thermal}$

$$m_{extra} = \frac{KE + PE + E_{thermal}}{c^2}$$

m_{extra} =.0000000000000000001% m_{watch}

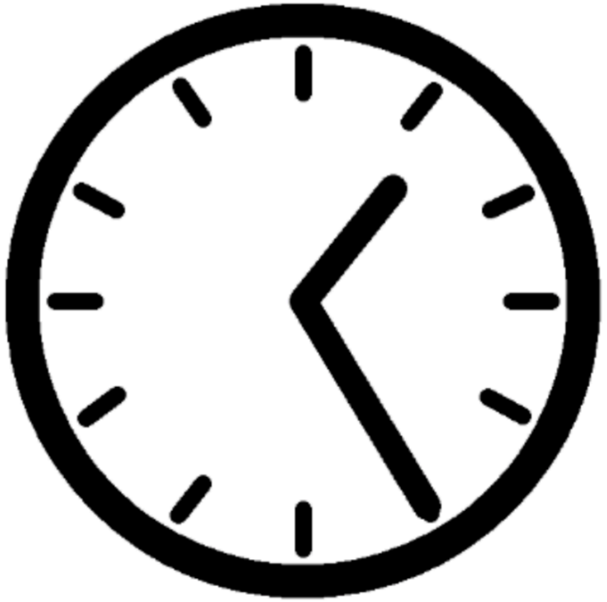
$m \neq$ amount of matter!

MASS ENERGY

Can think of mass as an indicator of how difficult an object is to accelerate, or how much gravitational force that object will feel

Either way, **a ticking watch has more mass than a stopped watch**

(If for some reason you put the watch in an oven, it would have even more mass!)



MASS ENERGY

As soon as you turn on a flashlight, its mass begins to drop immediately

MASS ENERGY

Sun's mass also drops simply because it shines ~4,000,000,000 kg/s

Sun is **not** converting mass to energy

(Don't worry, the sun will keep shining another 5 billion years, and only then it'll have lost 0.034% of its mass!)

MASS ENERGY

What is the mass energy of a 1.0 g peanut?

$E = mc^2$

$E = 0.001\text{kg} \times (3.0 \times 10^8)^2 = 9\times10^{13}\text{J} = 90\text{ TJ}$

What is the mass energy of a 60 kg person?

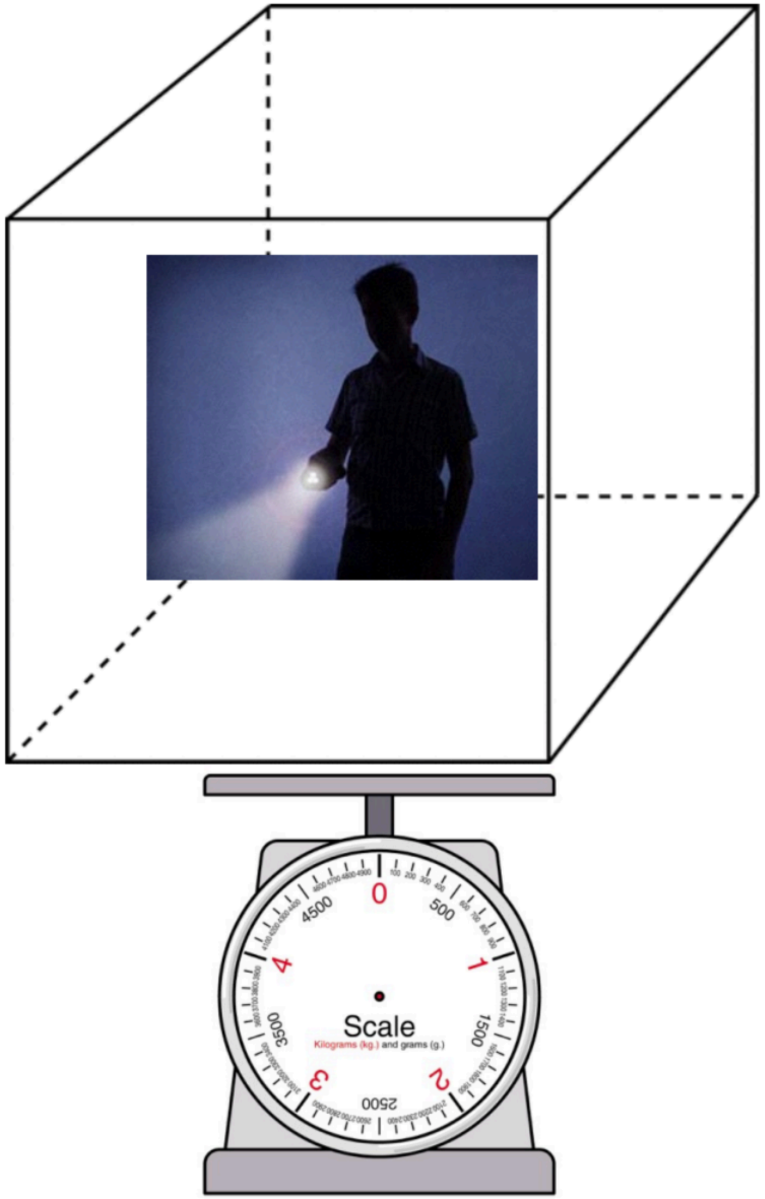
$E = 60\text{ kg} \times (3.0 \times 10^8)^2 = 5.4 \times 10^{18}\text{J}$

MASS ENERGY

Suppose I stand with a flashlight in a closed box that has mirrored walls and is resting on a scale.

Will the reading on the scale change if I turn on the flashlight?

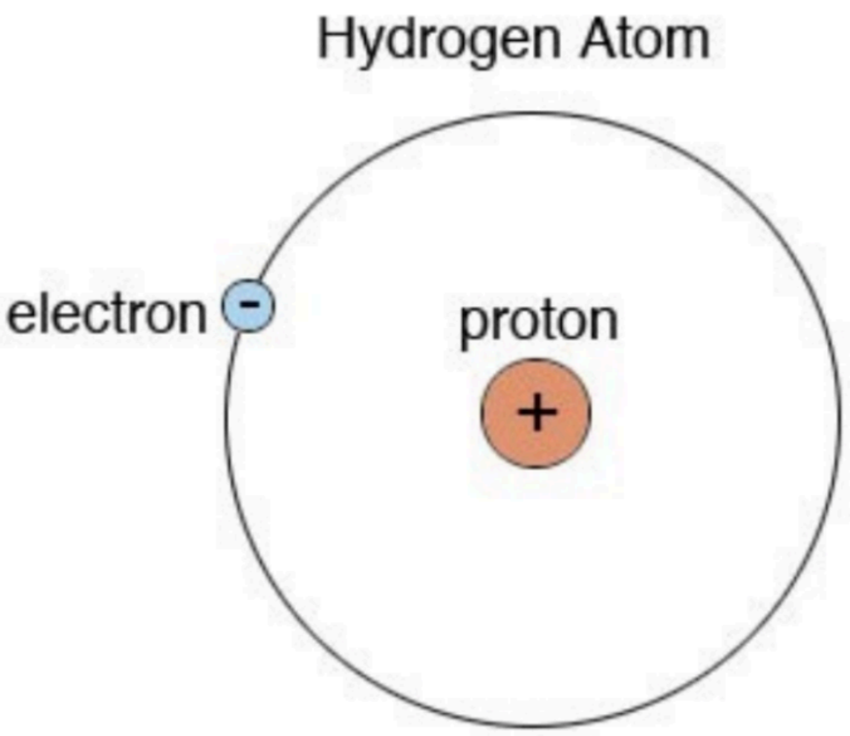
Nope! Energy stays inside the box



MASS ENERGY

Mass of hydrogen atom is less than combined masses of electron and proton

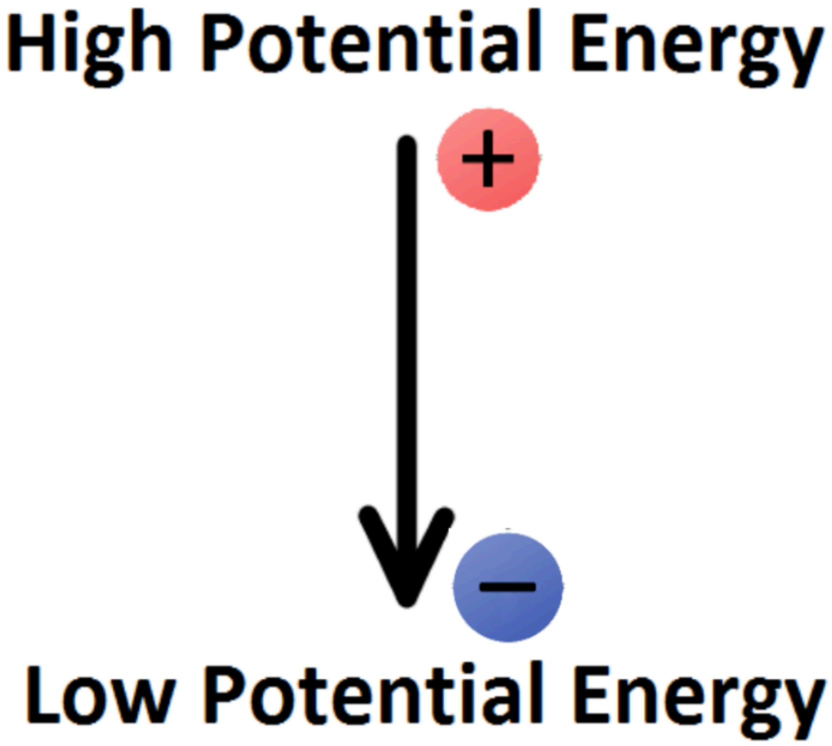
Potential energy can be negative



MASS ENERGY

If left to their own devices, all objects will go from high PE to low PE

PE between proton and electron drop as they get closer



MASS ENERGY

Barring weird circumstances, all atoms have less mass then their combined parts

Same goes for molecules

Mass of O_2 < 2x mass of oxygen atom