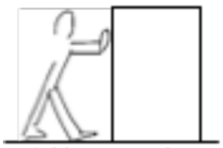


The person uses 40 N of force to push the box 8 m to the right. At the same time, the box experiences 6 N of friction.

a) How much work was done by the person?
b) How much energy must the person have used up to do the work?
c) What form of energy did the person use to do the work?
d) How much work was done by friction?
e) How much Heat was generated?
f) How much KE did the box gain?

a) $W = F \Delta x = (40)(8) = 320 \text{ J}$

b) 320 J

c) Chem PE

d) $W = Fd = (6\text{N})(8\text{m}) = 48 \text{ J}$

e) 48 J

f) $320\text{J} - 48\text{J} = 272\text{J}$

Energy **lost** by the doer of the work = **Work Done** = Energy **gained** by the one the work was done on.

Energy keeps moving around when work is done.

In an isolated system, the total energy stays constant.

$$E_{earlier} = E_{later}$$

Cutting out the middle man...

Using work, come up with specific equations for the three mechanical energies.

Gravitational PE (energy of height)

Kinetic E (energy of motion)

Elastic PE (energy of stretch/compression)

Gravitational PE (energy of height)

$$GPE = W_{lifting} = F\,\Delta y$$

equal to the weight lifted

height lifted to

$$GPE = \overbrace{mg}h$$

Kinetic E (energy of motion)

$$KE = W_{\text{speeding up}} = F\,\Delta x$$

Force that causes an acceleration

change in position

$a = \frac{F_{net}}{m}$

$$KE = ma\Delta x$$

But wait, we can reduce this a bit...

$$\text{remember: } v^2 = v_i^2 + 2a\Delta x \text{ ?}$$

assume it starts from rest

$$v^2 = 2a\Delta x$$

$$\frac{v^2}{2} = a\Delta x$$

$$KE = ma\Delta x$$

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

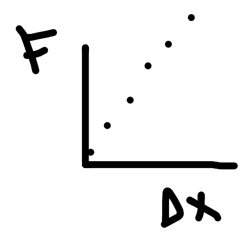
Elastic PE (energy of stretch/compression)

$$\mathbf{EPE = W_{stretching} = F\ \Delta x}$$

equal to the spring force

stretch

spring constant = slope = $k = \dfrac{F}{\Delta x}$



solve for F: $F = k(\Delta x)$

substitute back: $\mathbf{W = k(\Delta x)\Delta x}$

$$\mathbf{EPE = \frac{k(\Delta x)^2}{2}}$$

Gravitational PE (energy of height)

$$GPE = mgh$$

Kinetic E (energy of motion)

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

Elastic PE (energy of stretch/compression)

$$EPE = \frac{k(\Delta x)^2}{2}$$

The Heat Mob

Every time work is done, they'll extort some energy and convert it to heat.

Friction

Drag

Elastic Imperfections

Convert Mechanical Energy to Heat

Let's assume for now that no Mechanical Energy is lost to Heat.

You throw a 2 kg ball straight upward at 30 m/s.

a) How much kinetic energy did it have at the start?

b) How much kinetic energy will it have when it reaches the top?

b) How much gravitational PE will it have when it reaches the top?

c) How high did it go above the start?

a) $KE = \frac{mv^2}{2} = \frac{(2)(30^2)}{2} = 900\text{ J}$

b) $KE = 0$

c) $GPE = 900\text{ J}$

d) $GPE = mgh$

$900 = (2)(10)h$

$\frac{900}{20} = \frac{20h}{20}$

$45\text{ m} = h$

To load a spring loaded TPL you push a 0.1 kg dart in 0.2 m. The spring constant is 400 N/m

a) How much Elastic PE will be stored in the TPL with it loaded and ready to go?

b) How much Elastic PE will be stored in the TPL after you launch the dart?

c) How much Kinetic E will the dart have after you launch?

d) How fast does the dart launch?

a) $EPE = \frac{k(\Delta x^2)}{2} = \frac{(400)(0.2^2)}{2} = 8\,J$

b) $EPE = 0$

c) $KE = 8\,J$

d) $KE = \frac{mv^2}{2}$

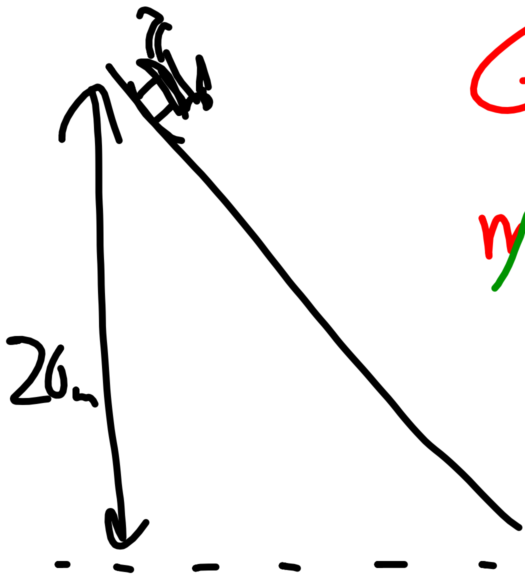
$2 \cdot 8 = \frac{(0.1)v^2}{2} \cdot 2$

$\frac{16}{0.1} = \frac{0.1\,v^2}{0.1}$

$160 = v^2$

$\sqrt{160} = v$

$12.6\,m = v$



$$E_i = E_F$$

$$GPE = KE$$

$$\cancel{m}gh = \frac{\cancel{m}v^2}{2}$$

$$gh = \frac{v^2}{2}$$

$$2gh = v^2$$

$$2(10)(20) = v^2$$

$$400 = v^2$$

$$\sqrt{400} = v$$

$$\boxed{20\,\text{m/s} = v}$$