Class Notes for Physics
Kinetic Energy
Western International High School
2020-2021

Kinetic Energy (KE): The energy related to motion.
Any moving object has a kinetic energy.

$$KE = 1/2\ m\ V^2$$

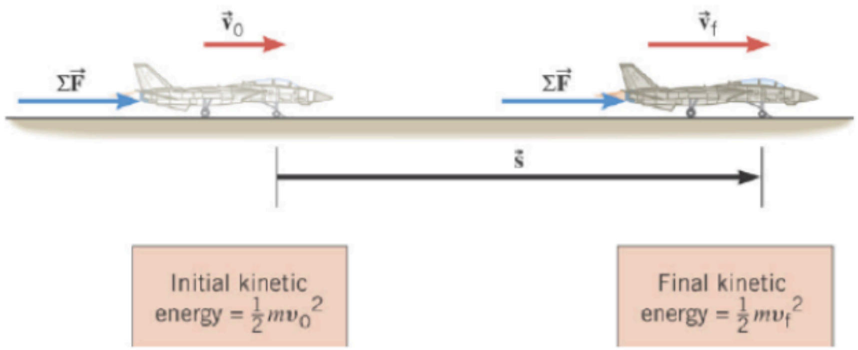
m = mass
V = Velocity, Speed

KE is a state function. It depends on the state.

Example: What is the kinetic energy of a curling stone of mass m = 6.0 kg sliding at a speed V = 4.0 m/s?
Curling stone sliding is a moving object, so it has kinetic energy.

$$KE = 1/2\ m\ V^2$$
$$= 1/2 \times 6 \times 4^2$$
$$= 48 \text{ Joule}$$

Energy (E) is the ability to do work. Work (W) is the transfer of energy.



Initial State Final State

Difference in kinetic energy = Final kinetic energy - Initial kinetic energy.

$$\Delta E = KE_{final} - KE_{initial}$$

$$\Delta E = KE_f - KE_o$$

$$\Delta E = KE_f - KE_o = \text{Work}$$

The work done equals the change in kinetic energy

There are two ways to calculate work:
There are two formula for work

1) Work = Force x displacement = F x S

2) Work = $\Delta E = KE_f - KE_o$

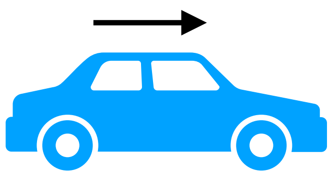
$$Work = 1/2\ m\ V^2{}_f - 1/2\ m\ V^2{}_o$$

1) + 2) Work = $F \times S = 1/2\ m\ V^2{}_f - 1/2\ m\ V^2{}_o$

$$F \times S = 1/2\ m\ V^2{}_f - 1/2\ m\ V^2{}_o$$

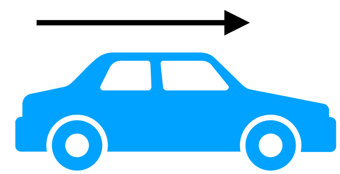
Example 2: Passing a Car;

To pass another car, a compact car of mass 875-kg speeds up from an initial speed of Vo = 22.0 m/s to a final speed of Vf = 44 m/s . Use its initial and final energies and calculate how much **work** was done on the car to increase its speed? The car is a moving object, so it has a kinetic energy:



$m = 875$ kg, $V_o = 22$ m/s

$KE_o = 1/2\ m\ V^2_o$



$m = 875$ kg, $V_f = 44$ m/s

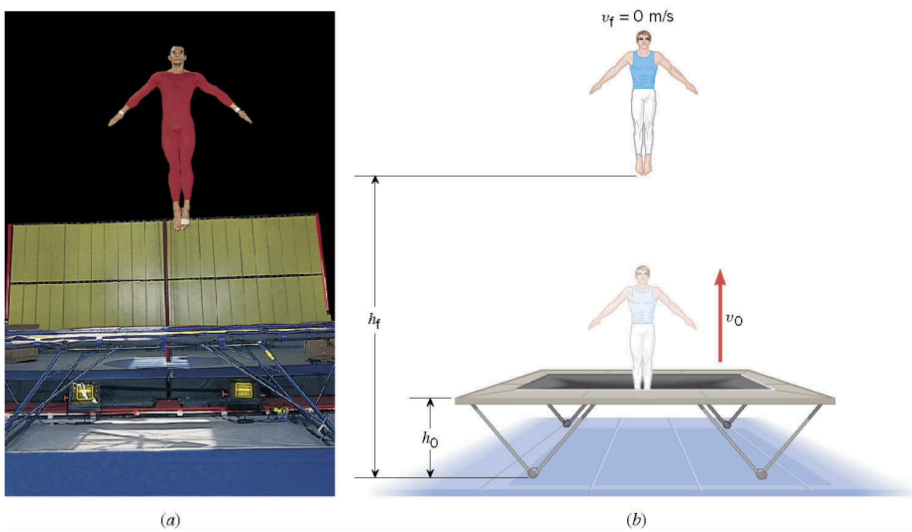
$KE_f = 1/2\ m\ V^2_f$

$$W = \Delta E = KE_f - KE_o$$

$$W = \Delta E = 1/2\ m\ V^2_f - 1/2\ m\ V^2_o$$

$$W = 1/2\ (875)(44)^2 - 1/2\ (875)(22)^2 = 635000 \text{ Joules}$$

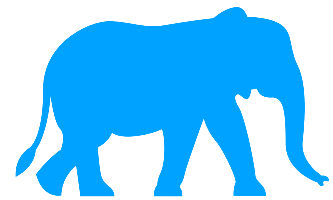
Example 3: A Gymnast on a Trampoline.
The gymnast of mass m leaves the trampoline at an initial speed Vo and reaches a final speed Vf of zero before falling back down. What is the formula for work?



$$W = \Delta E = KE_f - KE_o$$
$$= 1/2\ m\ V^2_f - 1/2\ m\ V^2_o$$
$$= 1/2\ m\ 0^2 - 1/2\ m\ V^2_o$$
$$= 0 - 1/2\ m\ V^2_o = \mathbf{- 1/2\ m\ V^2_o}$$

The gymnast is losing energy. Work is taken away energy.

A 6200 kg African elephant charges at a speed of $10\ \frac{m}{s}$.



What is the elephant's kinetic energy?

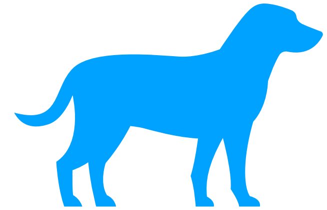
m = 6200 kg, V = 10 m/s KE?

$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for KE.

$$KE = 1/2\ m\ V^2$$
$$= 0.5 \times 6200 \times 10^2$$
$$= 3100 \times 100$$
$$= 310000 \text{ Joules}$$

A 30 kg dog runs at a speed of 15 $\frac{m}{s}$.



What is the dog's kinetic energy?

m = 30 kg, V = 15 m/s KE?

$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for KE.

$$KE = 1/2\ m\ V^2$$
$$= 1/2 \times 30 \times 15^2$$
$$= 0.5 \times 30 \times 225$$
$$= 15 \times 225$$
$$= 3375 \text{ Joules}$$

A $2.0\ \mathrm{kg}$ guinea pig runs at a speed of $1.0\ \frac{\mathrm{m}}{\mathrm{s}}$.

What is the guinea pig's kinetic energy?

m = 2.0 kg, V = 1.0 m/s KE?

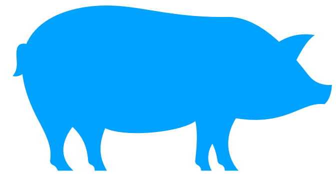
$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for KE

$$KE = 1/2\ m\ V^2$$
$$= 1/2 \times 2.0 \times 1^2$$
$$= 1 \times 1$$
$$= 1 \text{ joules.}$$

A 54 kg pig runs at a speed of $1.0 \frac{m}{s}$.

What is the pig's kinetic energy?



m = 54 kg, V = 1.0 m/s KE?

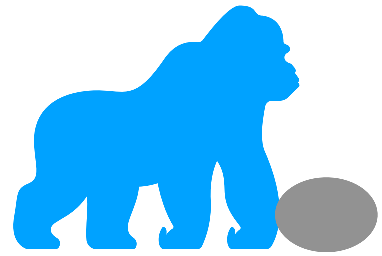
$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for KE.

$$KE = 1/2\ m\ V^2$$
$$= 1/2\ m\ V^2$$
$$= 0.5 \times 54 \times 1^2$$
$$= 27 \text{ Joules}$$

A baboon pushes a 3.1 kg stone with 150 J of kinetic energy.

What is the stone's speed?



m = 3.1 kg, KE = 150 Joules, V?

$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for V.

$$KE = 1/2\ m\ V^2$$

`$150 = 1/2 \times 3.1 \times V^2$

$$150 = 1.55 \times V^2$$

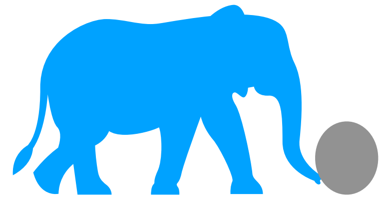
$$\frac{150}{1.55} = \frac{1.55}{1.55} \times V^2$$

$$96.77 = V^2$$

$$\sqrt{96.77} = \sqrt{V^2}$$

$$9.8 \text{ m/s} = V$$

A elephant kicks a 5.0 kg stone with 150 J of kinetic energy.



What is the stone's speed?

m = 5.0 kg, KE = 150 Joules, V?

$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for V.

$$KE = 1/2\ m\ V^2$$

$$150 = 1/2 \times 5.0 \times V^2$$
$$150 = 0.5 \times 5.0 \times V^2$$

$$150 = 2.5 \times V^2$$

$$\frac{150}{2.5} = \frac{2.5}{2.5} \times V^2$$

$$60 = V^2$$

$$\sqrt{60} = \sqrt{V^2}$$

$$7.745 \text{ m/s} = V$$

A cannon launches a $4.0\ \text{kg}$ bowling ball with $50\ \text{J}$ of kinetic energy.

What is the bowling ball's speed?

m = 4.0 kg, KE = 50 Joules, V?

$$KE = 1/2\ m\ V^2$$

Plug in the values and solve for V.

$$KE = 1/2\ m\ V^2$$

$$50 = 1/2 \times 4 \times V^2$$

$$50 = 2 \times V^2$$

$$\frac{50}{2} = \frac{2}{2} \times V^2$$

$$25 = V^2$$

$$\sqrt{25} = \sqrt{V^2}$$

$$5 \text{ m/s} = V$$