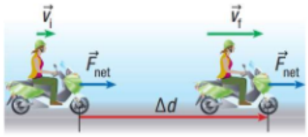
SPH3U 5.2 Energy

1. Kinetic energy

Energy:	The ability to do work.
kinetic energy	Energy possessed by moving objects.
equation	$E_k = \frac{1}{2}mv^2$ Units: $kg(\frac{m}{s})^2 = kg\,m^2/s^2 = \underline{J}.$

Where does this value come from? Consider the amount of work it takes to change speeds.

Imagine a motorcycle moving at a constant speed, which then accelerates to a new speed. To accelerate, it must have a force acting on it. What is the work done by this force? Assume that all you know is the mass of the motorcycle, its initial speed, and its final speed.



$W = F\Delta d \qquad F = ma \longrightarrow \underline{W = ma\Delta d}.$

$v_f^2 = v_i^2 + 2a\Delta d \qquad a = \frac{v_f^2 - v_i^2}{2\Delta d} \longrightarrow W = m\left(\frac{v_f^2 - v_i^2}{2\cancel{\Delta d}}\right)\cancel{\Delta d}$

$W = m\left(\frac{v_f^2 - v_i^2}{2}\right) = \boxed{\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2}$

$\underline{W = E_{kf} - E_{ki}}$

How much work is done to accelerate from rest to some final speed ($v_i = 0$)?

$W = \frac{1}{2}mv^2 = \underline{E_k}.$

Calculate the kinetic energy of a 150 g baseball that is traveling toward home plate at a constant speed of 35 m/s.

$E_k = \frac{1}{2}mv^2 = \frac{1}{2}(0.15)(35)^2$

$= \underline{92\,J.}$

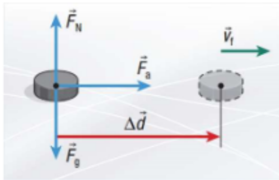
2. The relationship between mechanical work and kinetic energy

What is the work done to change from one speed to another?

$\boxed{W = \Delta E_k} = E_{kf} - E_{ki}$

This is called the work-energy principle.

A 165 g hockey puck initially at rest is pushed by a hockey stick on a slippery horizontal ice surface by a constant horizontal force of magnitude 5.0 N (assume that the ice is frictionless). What is the puck's speed after it has moved 0.50 m?



$W = F\Delta d = (5)(0.5) = \underline{2.5\text{ J}}$

$W = \Delta E_k = E_{kf} - \cancel{E_{ki}}$

$E_{kf} = W = \underline{2.5\text{ J.}} = \frac{1}{2}mv^2 \quad v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2(2.5)}{0.165}} = \underline{\underline{5.5\text{ m/s.}}}$

3. Gravitational potential energy: A stored type of energy

Potential energy:	A stored form of energy
gravitational potential energy	Energy due to gravitational force and object's height.
equation	$E_g = mgh$ Units: J.
reference level	The zero point that you measure height from.

Where does this value come from? Consider the amount of work it takes to lift something.

Imagine lifting a textbook off your desk at a constant speed (not accelerating). Remember, this means that forces are balanced ($F_{net} = 0$). How much work is done by the applied force?

h $F_a = F_g = mg$ F_g

$W = F\Delta d$

$\underline{W = mgh} = E_g$.

What is the gravitational potential energy of a 48 kg student at the top of a 110 m high drop tower ride relative to the ground?

$E_g = mgh$
$= 48(9.8)(110\text{ m})$
$= \underline{5.2 \times 10^4\text{ J.}}$

4. Mechanical energy

Mechanical energy:	Total kinetic and gravitational potential energy of an object. $E_m = E_k + E_g$.

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