Conservation of Energy

Energy Transfer

We already know that energy cannot be created or destroyed, only transferred from one store (type) to another and transferred from one thing to another. Eg a speaker transfers electrical energy to sound energy with the energy itself is being transferred to the surroundings.

An isolated (or closed) system means an energy transfer is occurring where none of the energy is lost to the surroundings. In reality all transfers are not isolated, and all of them waste energy to the surroundings.

Kinetic Energy

Kinetic energy is the energy a moving object has. Let us consider a car that accelerates from being stationary (u=0) to travelling at a velocity v when a force, F, is applied.

The time it takes to reach this velocity is give by $v = u + at \rightarrow v = at \rightarrow t = \frac{v}{a}$

The distance moved in this time is given by $s = \frac{1}{2}(u+v)t \rightarrow s = \frac{1}{2}(v)t \rightarrow s = \frac{1}{2}(v)\frac{v}{a} \rightarrow s = \frac{1}{2}\frac{v^2}{a}$

Energy transferred = Work Done, Work Done = Force x distance moved and Force = mass x acceleration

$E = W \rightarrow E = Fs \rightarrow E = mas \rightarrow E = ma\frac{1}{2}\frac{v^2}{a}$

$$\boxed{E_K = \tfrac{1}{2}mv^2}$$

Velocity is measured in metres per second, m/s
Mass is measured in kilograms, kg
Kinetic Energy is measured in Joules, J

Gravitational Potential Energy

This type of potential energy is due to the position of an object. If an object of mass m is lifted at a constant speed by a height of h we can say that the acceleration is zero. Since *F=ma* we can also say that the overall force is zero, this means that the lifting force is equal to the weight of the object → $F=mg$

We can now calculate the work done in lifting the object through a height, h.

$WD = Fs \rightarrow WD = (mg)h \rightarrow WD = mgh$

Since work done = energy transferred

$$\boxed{\Delta E_P = mg\Delta h}$$

Height is a measure of distance which is measured in metres, m
Gravitational Potential Energy is measured in Joules, J

Everyday energy transfers

In many situations gravitational potential energy is converted into kinetic energy, or vice versa. Some everyday examples of this are:

Swings and pendulums If we pull a pendulum back we give it GPE, when it is released it falls, losing its GPE but speeding up and gaining KE. When it passes the lowest point of the swing it begins to rise (gaining GPE) and slow down (losing KE).

Bouncing or throwing a ball Holding a ball in the air gives it GPE, when we release this it transforms this into KE. As it rises it loses KE and gains GPE.

Slides and ramps A ball at the top of a slide will have GPE. When it reaches the bottom of the slide it has lost all its GPE, but gained KE.

Work done against resistive forces

In each of these cases it appears as though we have lost energy. The pendulum doesn't swing back to its original height and the ball never bounces to the height it was released from. This is because work is being done against resistive forces.

The swing has to overcome air resistance whilst moving and the friction from the top support.

The ball transforms some energy into sound and overcoming the air resistance.

Travelling down a slide transforms energy into heat due to friction and air resistance

The *total* energy before a transformation = The *total* energy after a transformation