Energy Stores

15th Oct

Energy Store	Description
Kinetic	Moving objects have energy in their kinetic store
Gravitational Potential	Objects gain gravitational potential energy when they are lifted above the ground
Elastic Potential	Objects gain elastic potential energy if they are stretched, squashed or twisted
Electrostatic	Charged objects such as protons and electrons have energy in their electrostatic store
Magnetic	Magnetic objects contain a store of energy
Chemical	Food, fuel and batteries all store chemical energy. They can transfer this energy in chemical reactions
Nuclear	Atomic nuclei release energy from their nuclear stores during nuclear reactions
Thermal	All objects have energy in their thermal store but the hotter the object the more thermal energy it contains

Energy Transfers

17th Oct

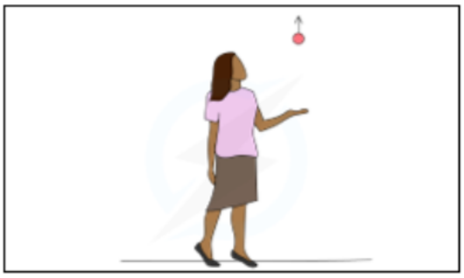
A SYSTEM in physics is an object or a small group of objects that interact.

In a CLOSED system the TOTAL ENERGY STORED remains CONSTANT (the energy is CONSERVED).

However, energy be can TRANSFERRED from one store to another.

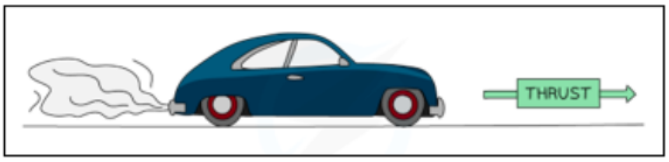
Transfer Pathway	Description
Mechanical working	When energy is transferred from one store to another by FORCES e.g. gravity, or friction
Electrical working	When energy is transferred by an electrical current
Heating	When energy is transferred from hot objects to colder objects
Radiation	When energy is transferred by sound or light waves.

An object thrown upwards



Kinetic store of the object DECREASES as the gravitational potential store INCREASES. This transfer is done mechanically (due to a force from the hand)

A car accelerated by a resultant force



The CHEMICAL STORE of the car DECREASES, the KINETIC STORE of the car INCREASES - this is a mechanical transfer

A car uses its brakes to slow down

Kinetic store of the car DECREASES. Friction causes the energy transfer. The thermal store of the brakes INCREASES.

Gravitational Potential Energy

30th Oct

The amount of G.P.E stored in an object depends on how much energy was transferred to the object when it was lifted from the ground.

This can depend on:
- the mass of the object
- the gravitational field strength
- the height it is lifted to

gravitational potential energy = mass x gravitational field strength x height

$$E_p = m \times g \times h$$

- E_p in joules, J
- m in kilograms, kg
- g in newtons per kilogram, N/kg
- h in metres, m

On Earth the gravitational field strength is 9.8 N/kg. This means that Earth's gravity exerts a force of 9.8 N on each kilogram of mass.

Note: exam questions will either ask you calculate 'g', or they will tell you to use 9.8 N/kg (or sometimes even 10 N/kg).

Kinetic Energy

30th Oct

The amount of kinetic energy stored in an object depends on how much energy was needed to get the object moving at its current speed.

We can also think of it as how much energy we would have to use to stop an object moving.

This can depend on:
- the mass of the object
- how quickly it is moving

Kinetic energy = 0.5 x mass x (speed)^2

$$E_k = \frac{1}{2}mv^2 \quad \text{or} \quad E_k = \frac{mv^2}{2}$$

E_k in joules, J

m in kilograms

v in metres per second, m/s

Worked example:

A remote controlled car has a mass of 0.5 kg and has 150 J of kinetic energy. How fast is it going?

$$150 = 0.5 \times 0.5 \times v^2 \quad ✓$$

$$v^2 = \frac{150}{0.5 \times 0.5}$$

$$v^2 = 600$$

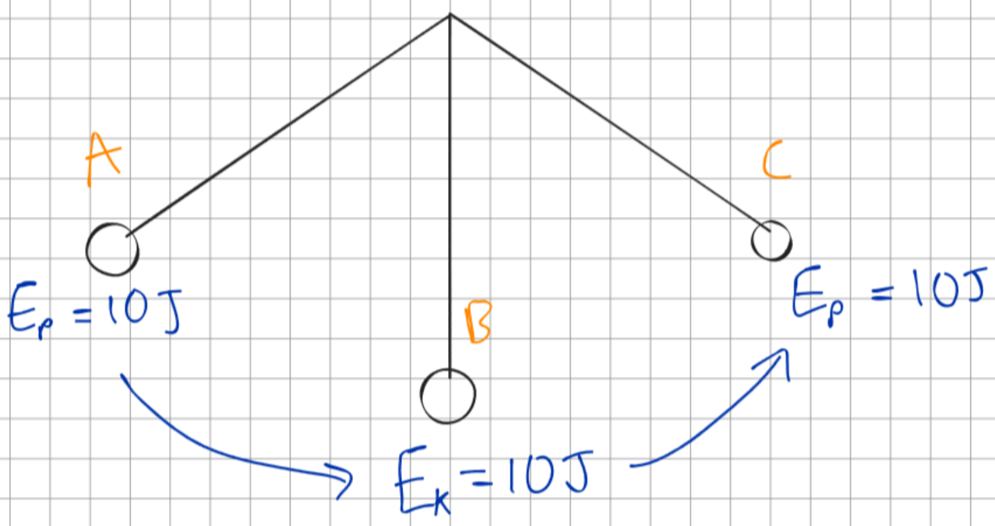
$$v = \sqrt{600} \quad ✓$$

$$= 24.5 \text{ m/s} \quad ✓$$

<u>Calculating Energy Transfers</u> <u>7th Nov</u>

Energy cannot be created or destroyed; it is merely transferred between stores.

This means that the total energy in a closed system stays constant.



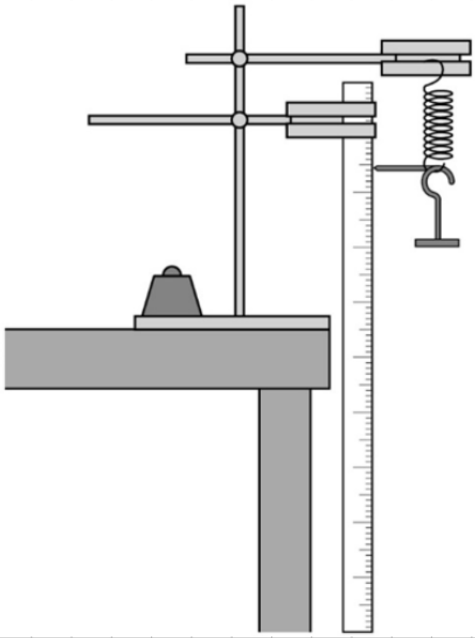
In this swing of a pendulum the gravitational potential energy is transferred to kinetic energy. As its height decreases, its speed increases. The total energy stored in the system stays constant.

Elastic Potential Energy

13th Nov

When we exert a force on an object like a spring, we can change its length.

When we stretch a spring we increase the elastic potential energy stored in it.



1. Set up the equipment as in the diagram opposite.
2. Measure the length of the spring before you add the mass hanger. Record this as 'Unstretched length in cm'.
3. Use a newtonmeter to measure the weight of the empty mass hanger. Record this as 'Force in N'
4. Hang the mass hanger from the spring.
5. Measure the length of the stretched spring'. Record this as 'Stretched length in cm'.
6. Remove the mass hanger and then repeat steps 1 to 5, adding 100g to the hanger each time.

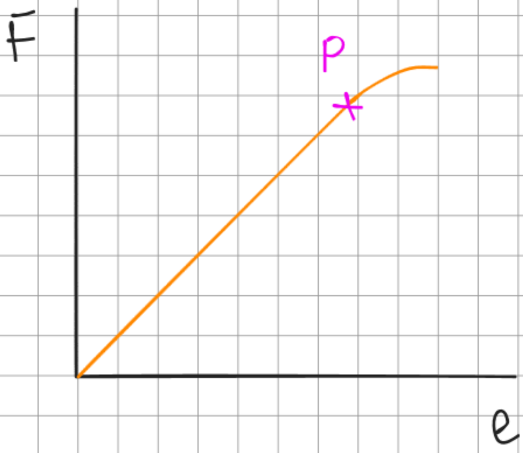
Force in N	Unstretched length in cm	Stretched length in cm

The extension of a spring tells us how much its length has changed (this can also be called compression, depending on how we apply the force).

Extension = stretched length - unstretched length

Extension should be stated in metres.

Force in N	Extension in m



'Up to point P (limit of proportionality) the EXTENSION is DIRECTLY PROPORTIONAL to the FORCE APPLIED.' – Hooke's Law

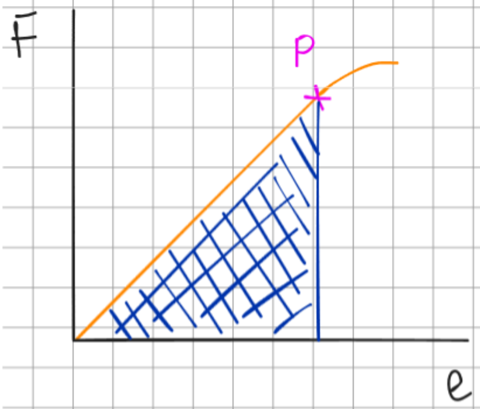
The GRADIENT of this straight (linear) section tells us the SPRING CONSTANT of the spring.

The SPRING CONSTANT, k, tells us how many newtons of force are needed to change the length of the spring by 1 metre.

Force = spring constant x extension

$$F = ke$$

- F: in newtons, N
- k: in newtons per metre, N/m
- e: in metres, m



The AREA between our line of best fit and the x-axis tells us the ELASTIC POTENTIAL ENERGY stored in the spring.

We can also calculate the elastic potential energy using the following equation:

Elastic Potential Energy = 0.5 x spring constant x (extension)^2

$$E_e = \frac{1}{2} k e^2$$

- E_e: in joules, J

Efficiency

27th Nov

The efficiency tells us the PROPORTION of the energy transferred in to a system that is transferred USEFULLY.

The transfers we consider useful depend on the system.

e.g. energy being transferred from the chemical store of a battery in a phone to sound and light waves is useful, but the transfer to the thermal store of the phone is wasted.

$$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

This will give you a value between 0 and 1. We can 'x 100' to turn this into a percentage if we wish.

In most circumstances when energy is 'wasted' it is in the form of a transfer to the thermal stores of the surroundings.

We can improve the efficiency of some energy transfers by;

Streamlining to reduce drag, lubricating to reduce friction, insulating to reduce heat transfers.

Doing 'Work'

3rd Dec

When energy is transferred from one store to another we say that WORK is being done

Amount of energy transferred = work done

We can calculate the amount of work done by a force when it moves an object using:

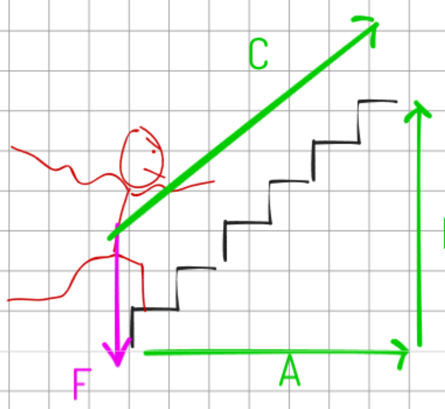
Work done = Force x distance

$W = Fs$

W in joules, J; F in newtons, N; s in metres, m

Name	Weight /N	distance /m	Work done /J	Time 1	Time 2	Time 3	Mean	Power /W
Mr Sutherland	850	3.5	2975	9.44	9.26	8.56	9.09	327
Sasnwat	460	3.5	1610	4.72	~~4.24~~ 4.81	~~3.91~~ 4.59	4.71	342
Riley	623	3.5	2181	3.78	4.24	3.91	3.98	548
Rasper	575	3.5	2013	7.91	7.89	7.90	7.90	255
Amelia	650	3.5	2275	5.06	5.48	4.94	5.16	441
Josie	475	3.5	1663	9.34	9.95	9.91	9.73	171

When calculating the work done it is important that the force we use in the equation acts parallel to the distance that we use.



If we measured a vertical force, such as weight, then we would use distance B in the W = Fs equation.

Power is the RATE of doing WORK/TRANSFERRING ENERGY.

Power = $\frac{\text{Energy transferred}}{\text{time}}$ Power = $\frac{\text{work done}}{\text{time}}$ Energy Transferred = power x time

$P = \frac{E}{t}$ $P = \frac{W}{t}$ $E = Pt$

in watts, W

in seconds, s

in joules, J