Renewable energy sources

Advantages

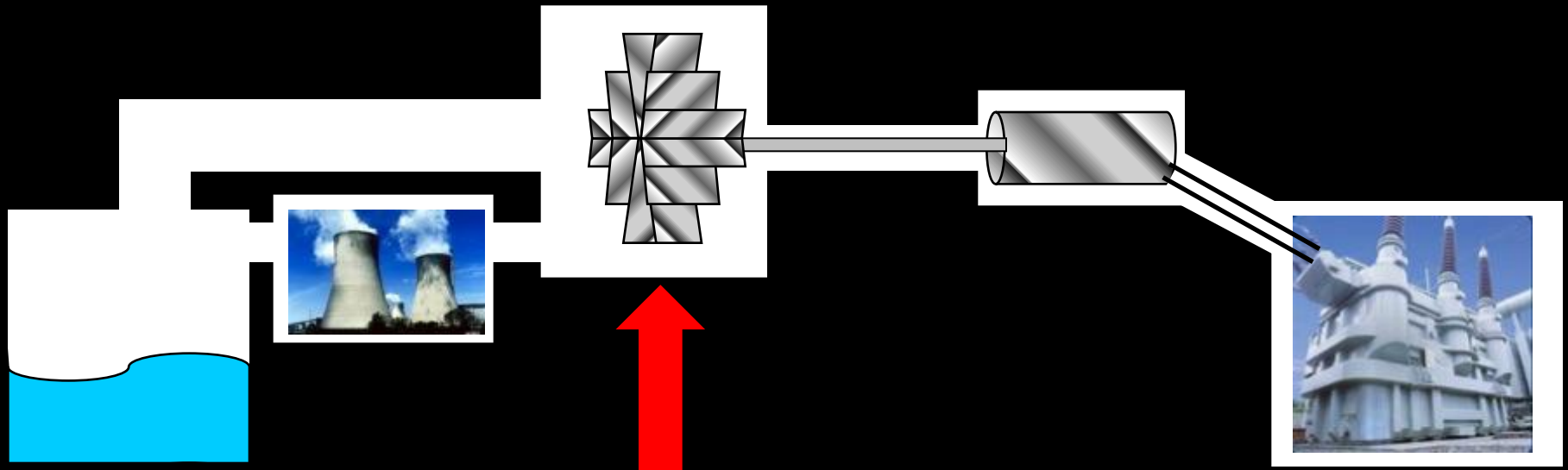
- Clean
- Won't run out
- Easily accessible

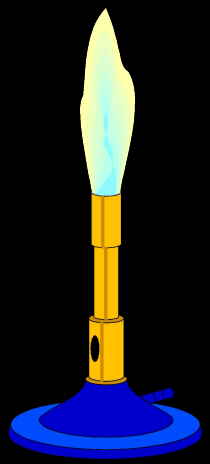
Wind, tidal, solar etc

Disadvantages

- Often depend on the weather – is it sunny???
- Look ugly
- Energy is "dilute" – in other words, it's very spread out

Other ways of generating electricity

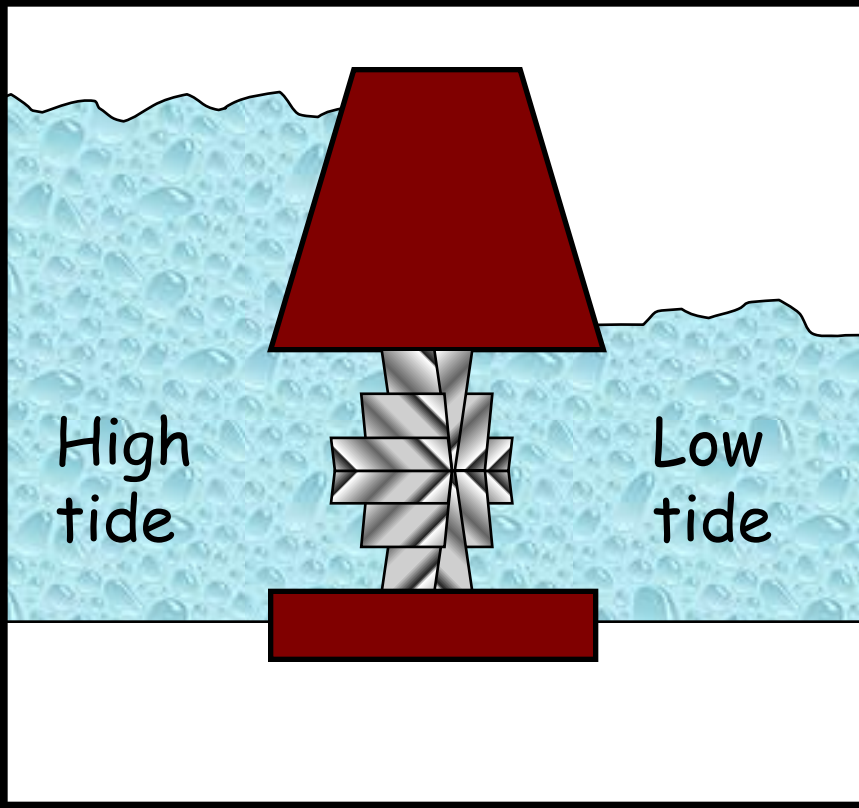




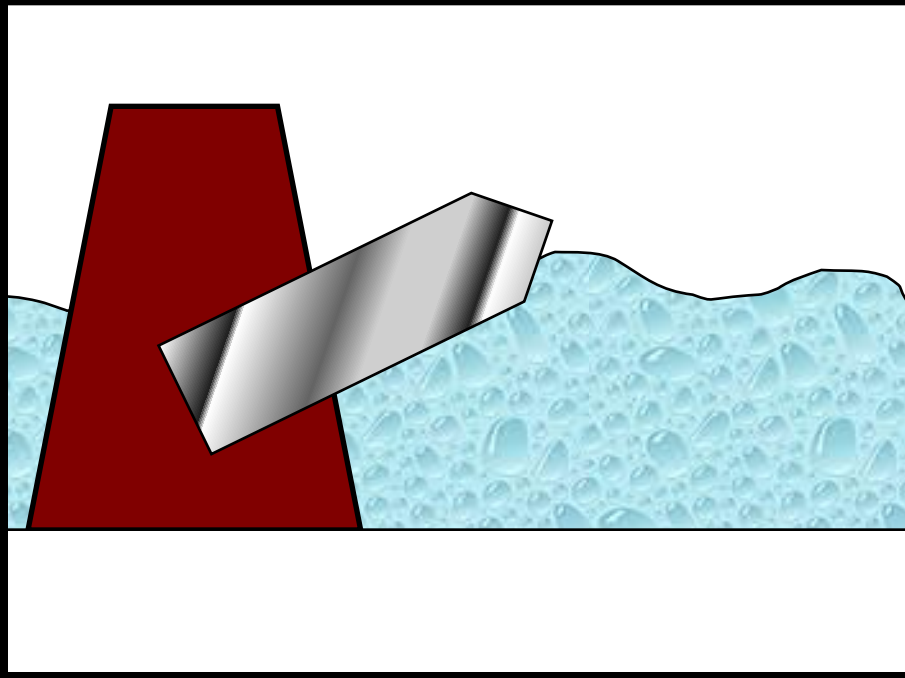
Can we drive the turbine directly without burning any fossil fuels?

Wind Power

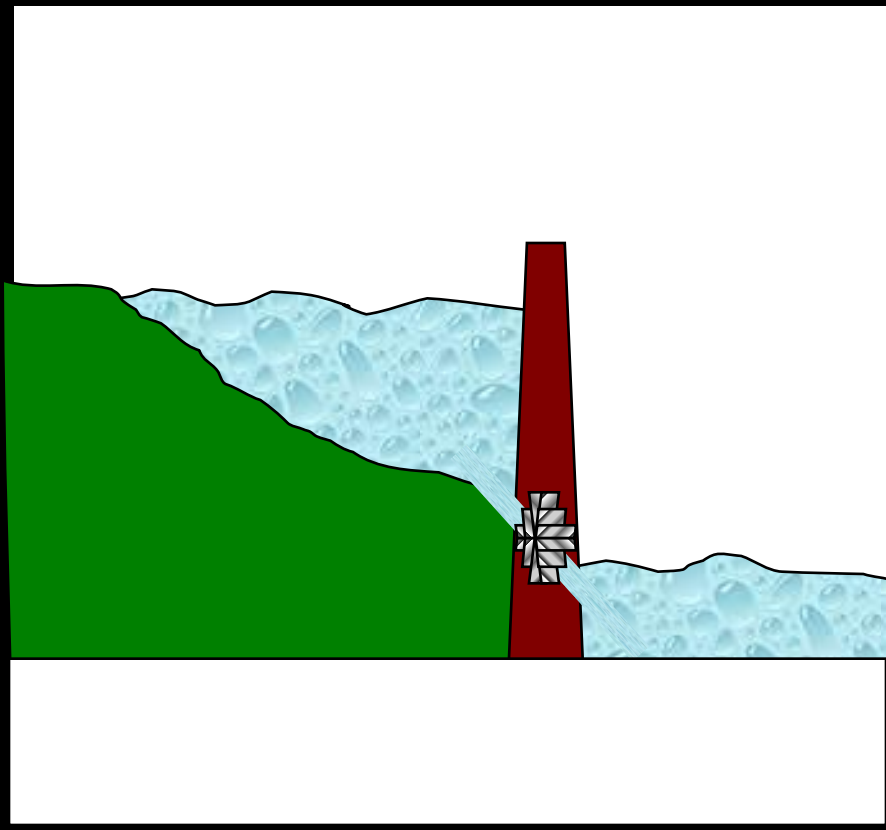
Tidal Power



Wave Power



Hydroelectric Power



Biomass

Biofuels

Biomass can be used as a fuel in a number of ways:

1) Fast-growing trees that can be _____
2) Manure or other waste that can be used to release _____ (biogas)
3) Corn or sugar cane that can be broken down in a fermenter to produce _____ like bio-ethanol.

Biofuels have two main advantages over traditional fuels – they are _____ and _____. However, they still release _____ _____.

Words – alcohols, cleaner, burnt, renewable, methane, carbon dioxide

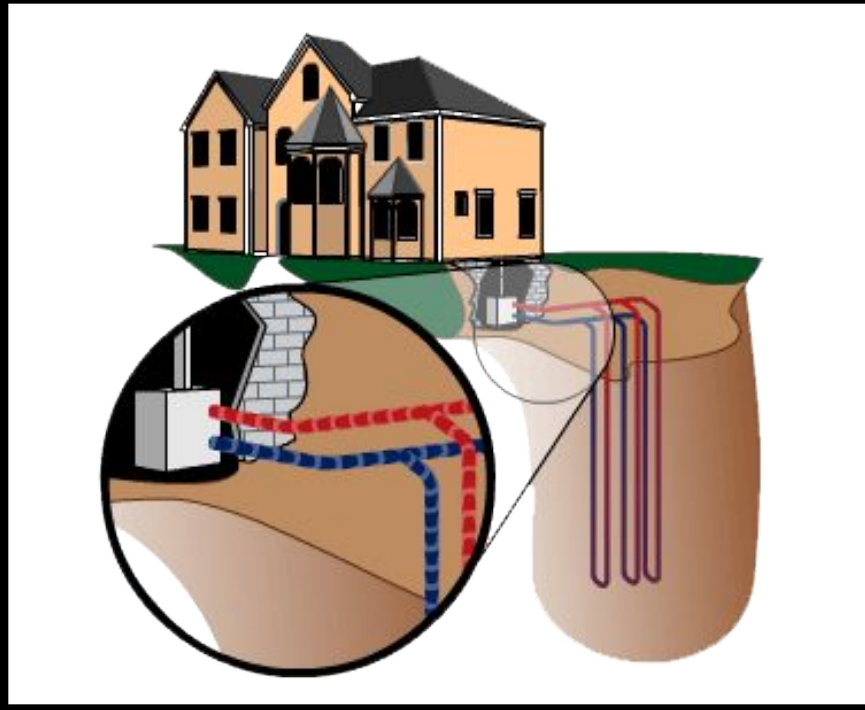
Solar Energy

Solar panels – convert sunlight directly into electricity. Sunlight knocks electrons loose from the crystal structure and the loose electrons form an electric current. The amount of power depends on the area of the panel and the light intensity.

Heating for homes – these pipes carry water that absorbs heat energy and transfers it to the house.

Geothermal Energy

Geothermal Energy



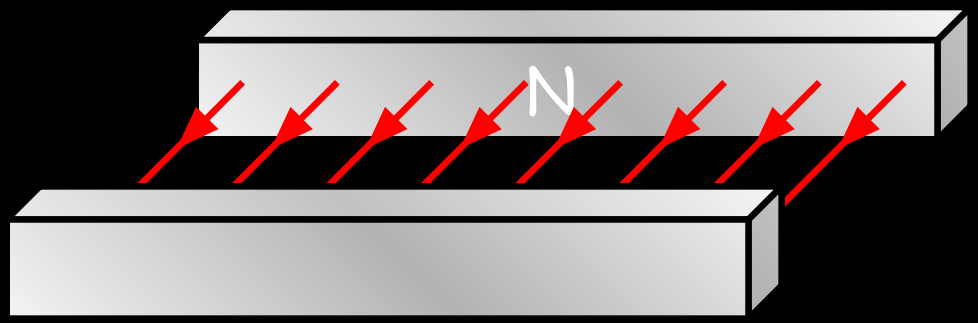
Geothermal energy can be used in _____ areas such as _____. In a geothermal source cold water is pumped down towards _____ _____. The water turns to steam and the steam can be used to turn _____. In some areas the _____ rising at the surface can be captured and used directly.

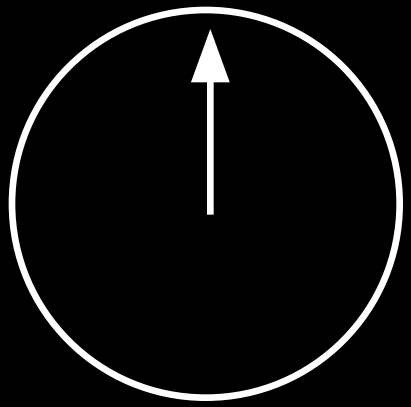
Words – steam, Iceland, volcanic, turbines, hot rocks

Solar Panels and Thermal Towers

Using Solar Energy in remote places

Electromagnetic Induction



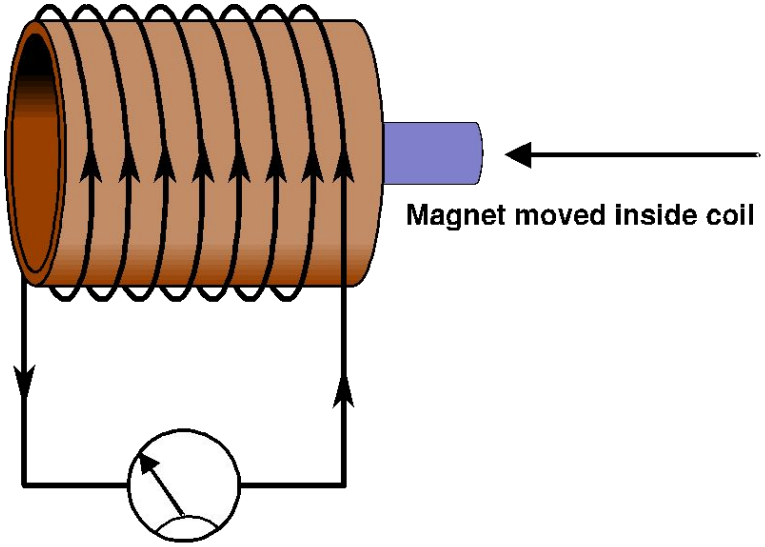


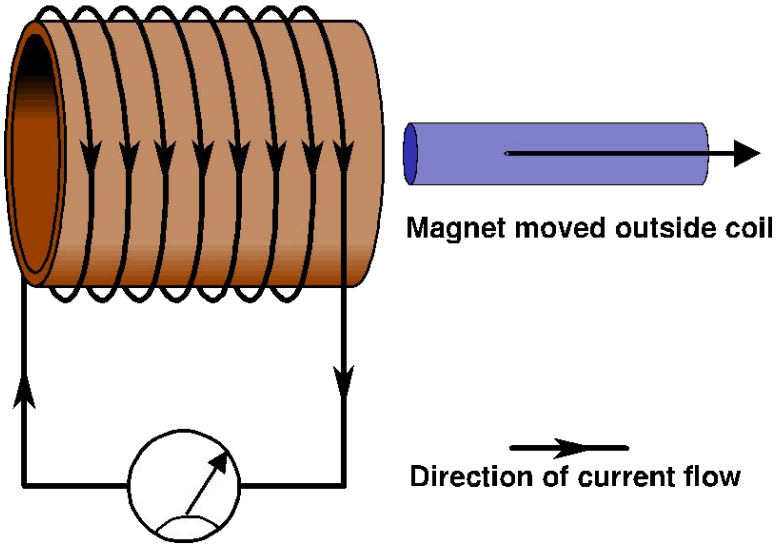
The direction of the induced current is reversed if…

1) *The wire is moved in the opposite direction*
2) *The field is reversed*

The size of the induced current can be increased by:

1) *Increasing the speed of movement*
2) *Increasing the magnet strength*





Electromagnetic induction

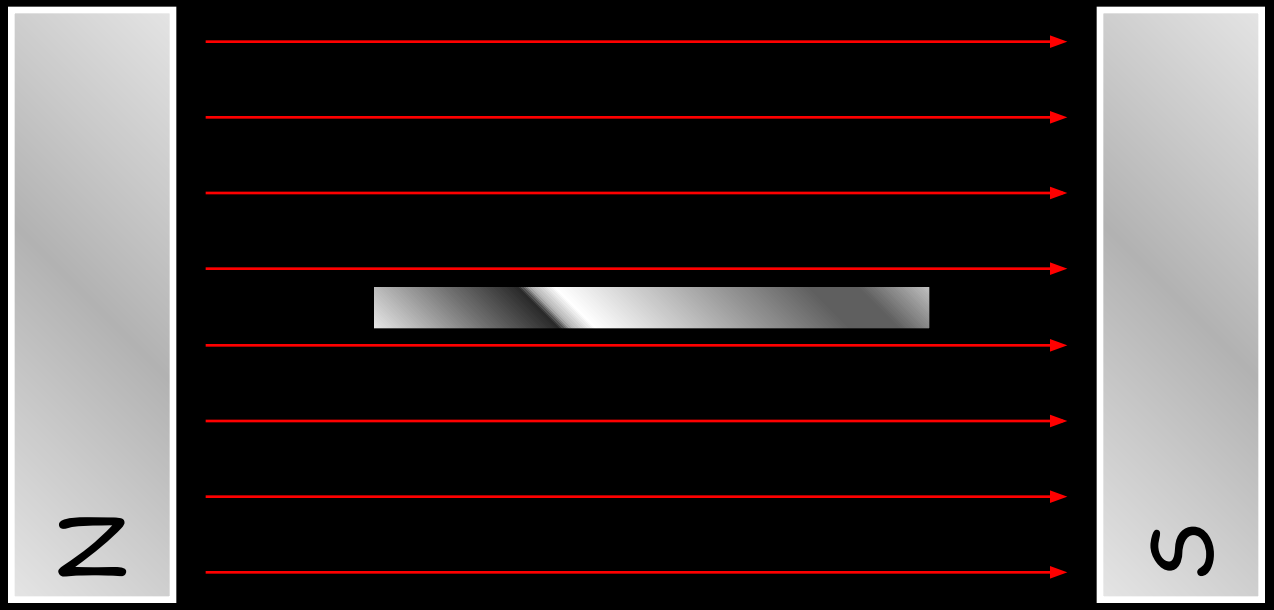
The direction of the induced current is reversed if…

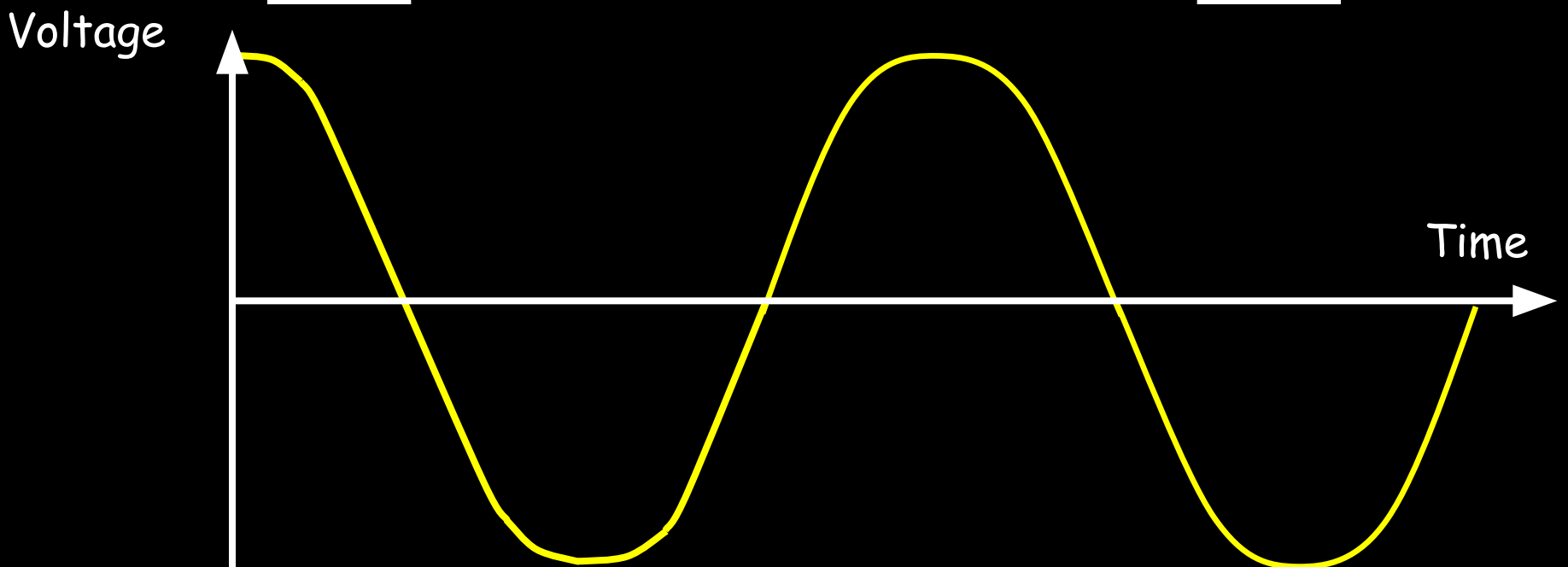
1) *The magnet is moved in the opposite direction*
2) *The other pole is inserted first*

The size of the induced current can be increased by:

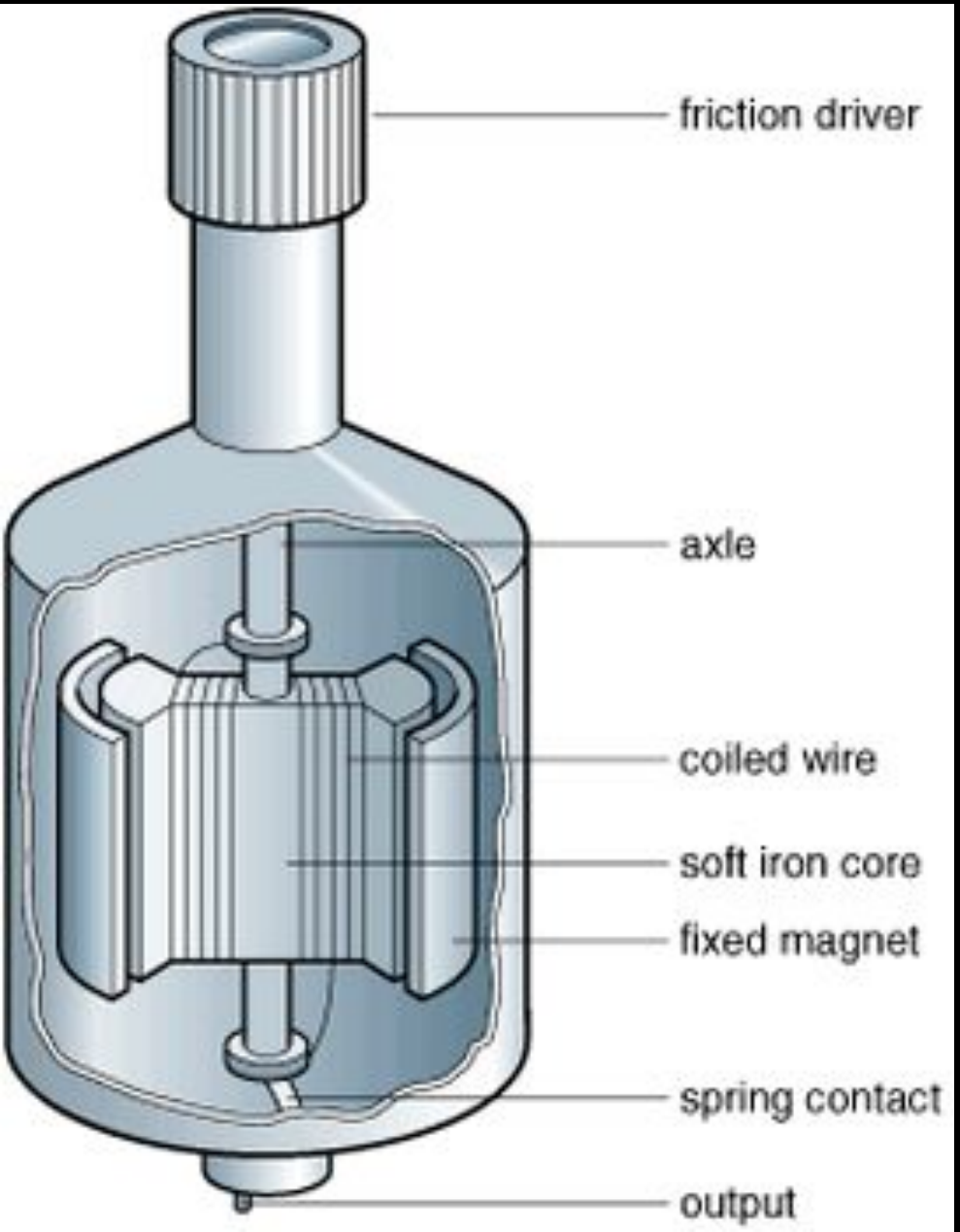
1) *Increasing the speed of movement*
2) *Increasing the magnet strength*
3) *Increasing the number of turns on the coil*

AC Generators





Other generators



A dynamo works by the same principle.

1) How can you make its output bigger?

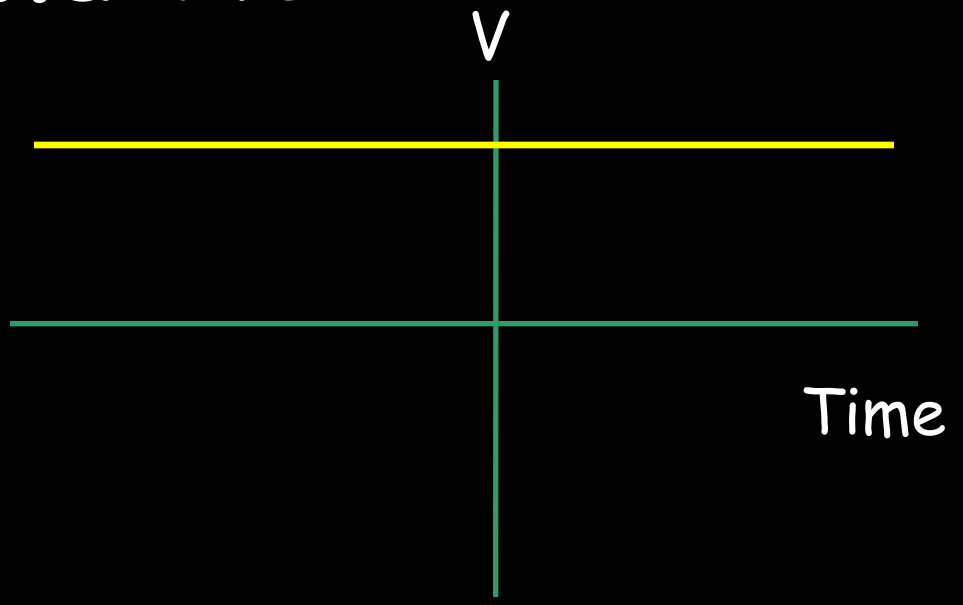
2) How can you reverse the direction of its output current?

Large-scale production of Electricity

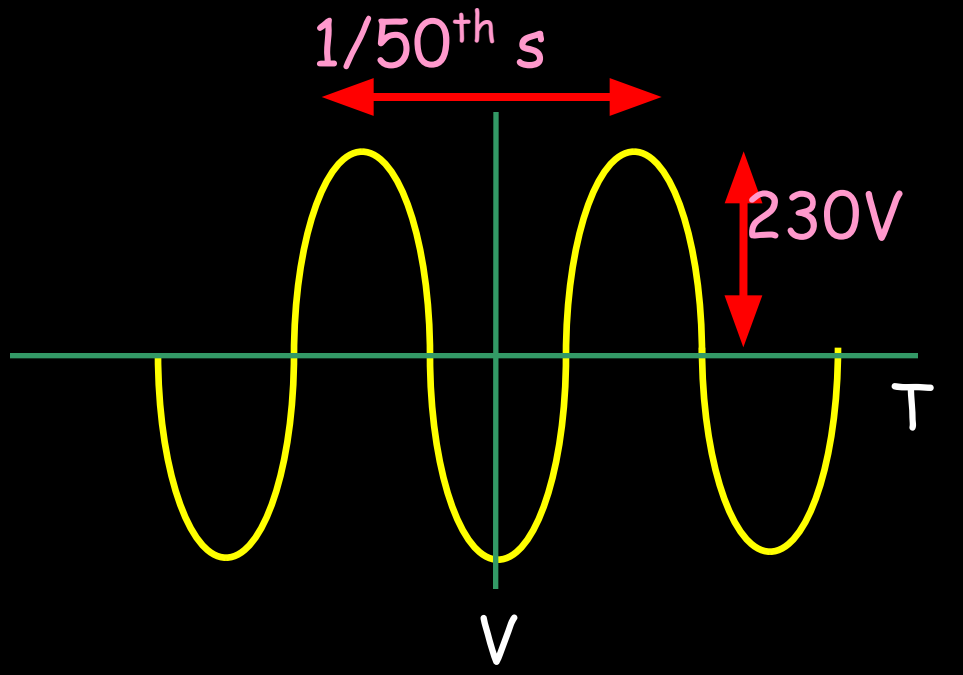
A generator at Drax power station in England

DC and AC

DC stands for "Direct Current" – the current only flows in one direction:



AC stands for "Alternating Current" – the current changes direction 50 times every second (frequency = 50Hz)

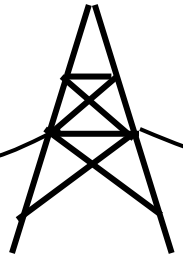


The National Grid

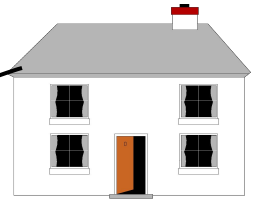
Electricity reaches our homes from power stations through the National Grid:

Power station

Step up transformer



Step down transformer

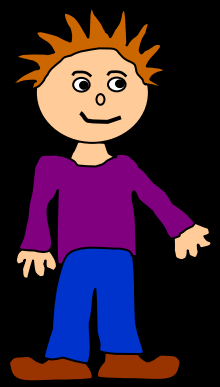


Homes

If electricity companies transmitted electricity at 240 volts through overhead power lines there would be too much _____ loss by the time electricity reaches our homes. This is because the current is ____. To overcome this they use devices called transformers to "step up" the voltage onto the power lines. They then "____ ____" the voltage at the end of the power lines before it reaches our homes. This way the voltage is _____ and the current and power loss are both ____.

Words – step down, high, power, low, high

Power Lines



Here's my new shed. I want to connect it to the electricity I my house. Should I use an overhead cable or bury the cable underground?

Transformers

Transformers are used to _____ __ or step down _____. They only work on AC because an _____ current in the primary coil causes a constantly alternating _____ _____. This will "_____" an alternating current in the secondary coil.

Words – alternating, magnetic field, induce, step up, voltage

We can work out how much a transformer will step up or step down a voltage:

$$\frac{\text{Voltage across primary } (V_p)}{\text{Voltage across secondary } (V_s)} = \frac{\text{No. of turns on primary } (N_p)}{\text{No. of turns on secondary } (N_s)}$$

Some transformer questions

Primary voltage V_p	Secondary voltage V_s	No. of turns on primary N_p	No. of turns on secondary N_s	Step up or step down?
12V	24V	100	?	?
400V	200V	20	?	?
25,000V	50,000V	1,000	?	?
23V	230V	150	?	?

Some example questions

Primary voltage V_p	Secondary voltage V_s	No. of turns on primary N_p	No. of turns on secondary N_s	Step up or step down?
6V	24V	100	?	?
400,000V	200V	?	1,000	?
25,000V	?	20,000	20	?
?	230V	150	1,500	?

1) A transformer increases voltage from 10V to 30V. What is the ratio of the number of turns on the primary coil to the number of turns on the secondary coil?

2) A step-down transformer has twice as many turns on the primary coil than on the secondary coil. What will be the output (secondary) voltage if the input voltage is 50V?

The Cost of Electricity

Electricity is measured in units called "kilowatt hours" (kWh). For example…

A 3kW fire left on for 1 hour uses 3kWh of energy

A 1kW toaster left on for 2 hours uses 2kWh

A 0.5kW hoover left on for 4 hours uses __kWh

A 200W TV left on for 5 hours uses __kWh

A 2kW kettle left on for 15 minutes uses __kWh

The Cost of Electricity

To work out how much a device costs we do the following:

Cost of electricity = Power (kW) x time (h) x cost per kWh (p)

For example, if electricity costs 8p per unit calculate the cost of the following…

1) A 2kW fire left on for 3 hours — 48p
2) A 0.2kW TV left on for 5 hours — 8p
3) A 0.1kW light bulb left on for 10 hours — 8p
4) A 0.5kW hoover left on for 1 hour — 4p

Reducing Energy Consumption

60W older bulb, roughly 70p, to be banned in the EU from 2012.

25W "energy efficient" light bulb, £7.30 on Amazon

1) Which one is more cost-effective?

2) Jane wants to replace all the bulbs in her house with energy-efficient ones. If she has 10 light bulbs in her house calculate the following:

   a) How much will it cost her to buy the bulbs?

   b) What will the total power consumption be reduced by?

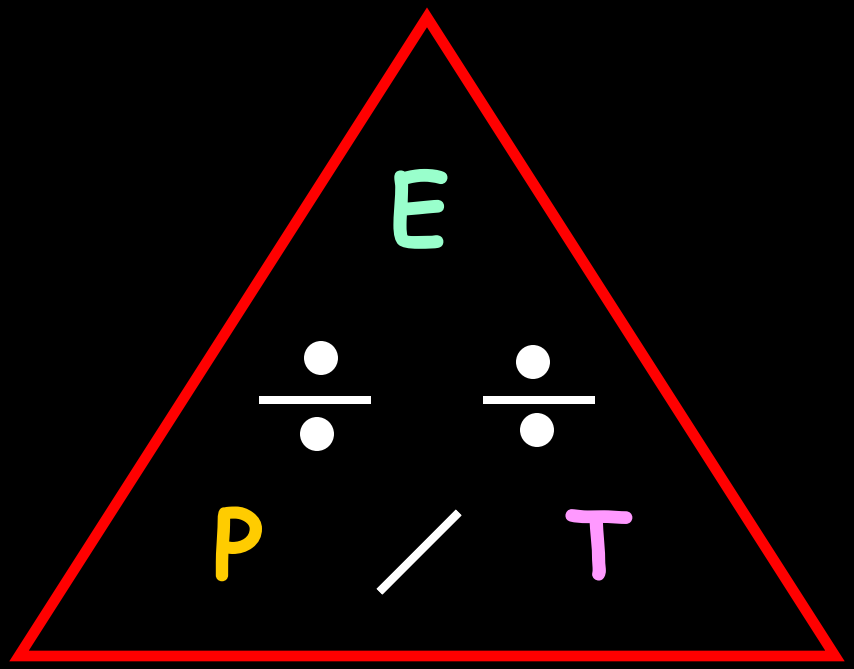
   c) If she uses the bulbs for 5 hours per day and electricity costs 10p per unit how much money will she save?

   d) How long will it take her to repay the cost of the bulbs?

Energy and Power

The POWER RATING of an appliance is simply how much energy it uses every second.

In other words, 1 Watt = 1 Joule per second



E = Energy (in joules)

P = Power (in watts)

T = Time (in seconds)

Some example questions

1) What is the power rating of a light bulb that transfers 120 joules of energy in 2 seconds?

2) What is the power of an electric fire that transfers 10,000J of energy in 5 seconds?

3) Farhun runs up the stairs in 5 seconds. If he transfers 1,000,000J of energy in this time what is his power rating?

4) How much energy does a 150W light bulb transfer in a) one second, b) one minute?

5) Shaun's brain needs energy supplied to it at a rate of 40W. How much energy does it need during a physics lesson?

6) Damien's brain, being more intelligent, only needs energy at a rate of about 20W. How much energy would his brain use in a normal day?

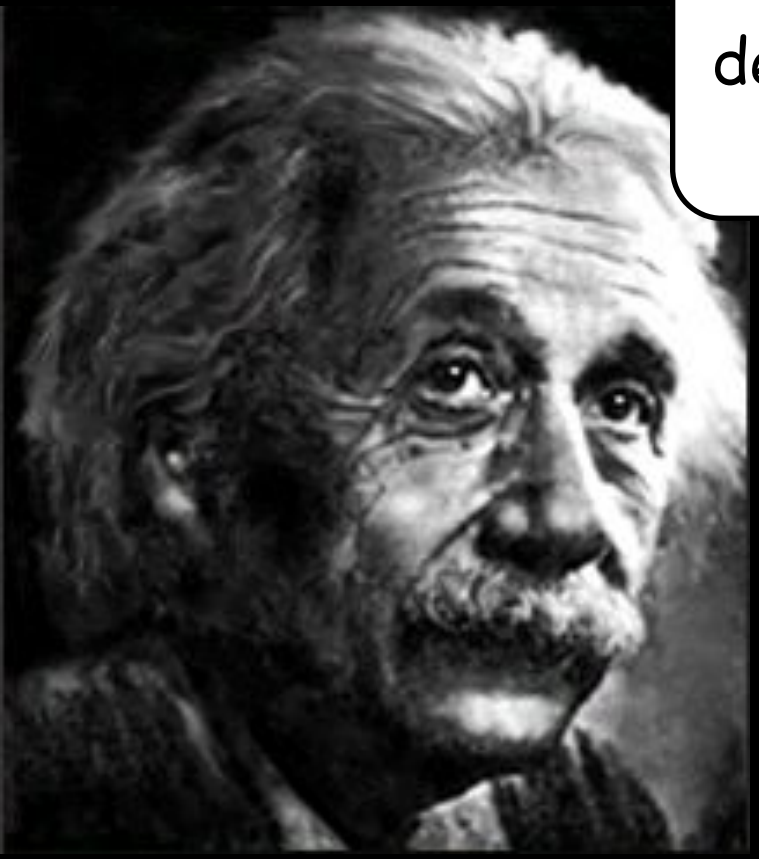
Topic 6 – Energy and the Future

The 9 types of energy

Type	3 example sources
Heat	
Kinetic (movement)	
Nuclear	
Sound	
Light	
Chemical	
Electrical	
Gravitational potential	
Elastic potential	

The Laws of Physics

There are many laws of physics, but one of the most important ones is:



Energy cannot be created or destroyed, it can only be converted from one form to another

Energy changes

To describe an energy change for a light bulb we need to do 3 steps:

1) Write down the starting energy:

2) Draw an arrow

3) Write down what energy types are given out:

Electricity → Light + heat

What are the energy changes for the following…?

1) An electric fire
2) A rock about to drop
3) An arrow about to be fired

Conservation of Energy

In any energy change there is ALWAYS some "waste" energy:

e.g. a light bulb:

Electricity → Light + heat

In this example HEAT is wasted and it is transferred to the surroundings, becoming very difficult to use.

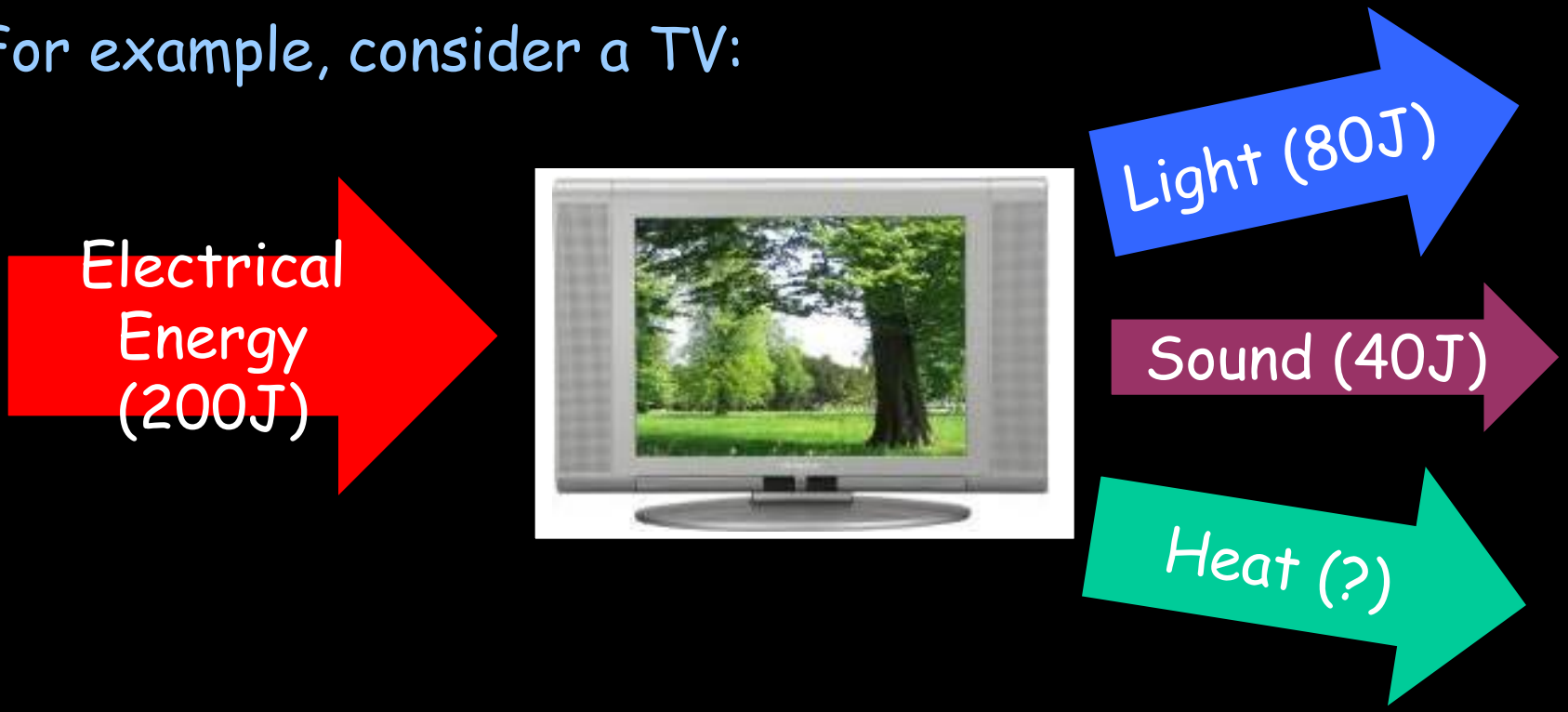
Describe the following energy changes and state the "waste" energy or energies:

1) A vacuum cleaner
2) A TV
3) A dynamo/generator

Efficiency

Efficiency is a measure of how much USEFUL energy you get out of an object from the energy you put INTO it.

For example, consider a TV:



$$\text{Efficiency} = \frac{\text{Useful energy out}}{\text{Energy in}} \times 100\%$$

Some examples of efficiency…

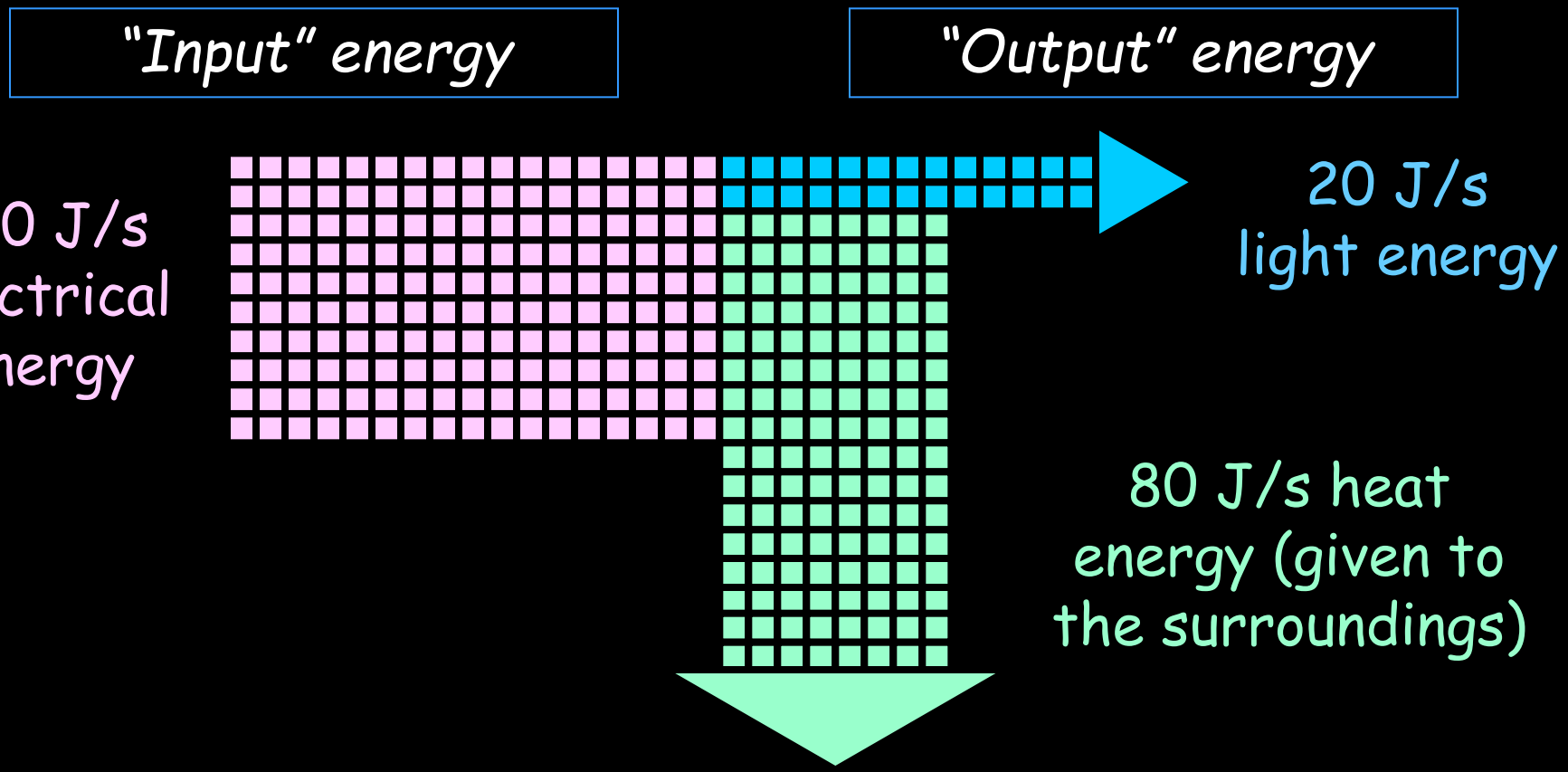
1) 5000J of electrical energy are put into a motor. The motor converts this into 100J of movement energy. How efficient is it?

2) A laptop can convert 400J of electrical energy into 240J of light and sound. What is its efficiency? Where does the rest of the energy go?

3) A steam engine is 50% efficient. If it delivers 20,000J of movement energy how much chemical energy was put into it?

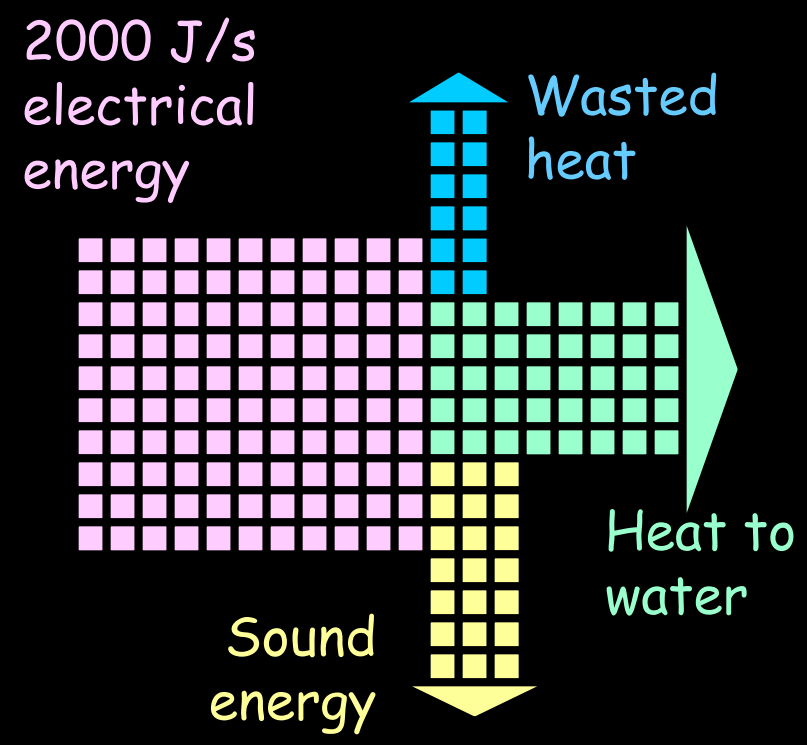
Energy Transfer ("Sankey") diagrams

Consider a light bulb. Let's say that the bulb runs on 100 watts (100 joules per second) and transfers 20 joules per second into light and the rest into heat. Draw this as a diagram:



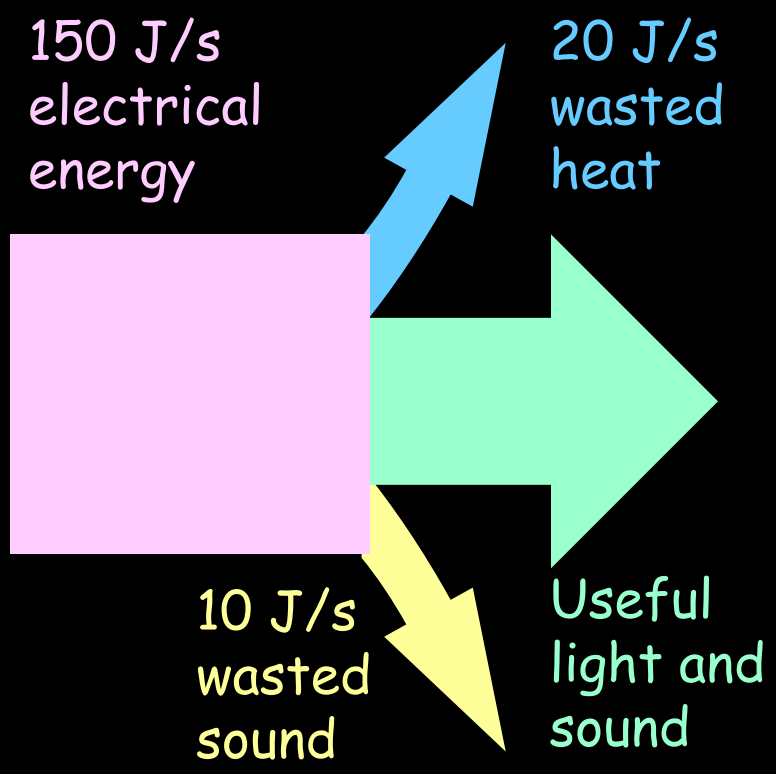
Example questions

Consider a kettle:



1) Work out each energy value.
2) What is the kettle's efficiency?

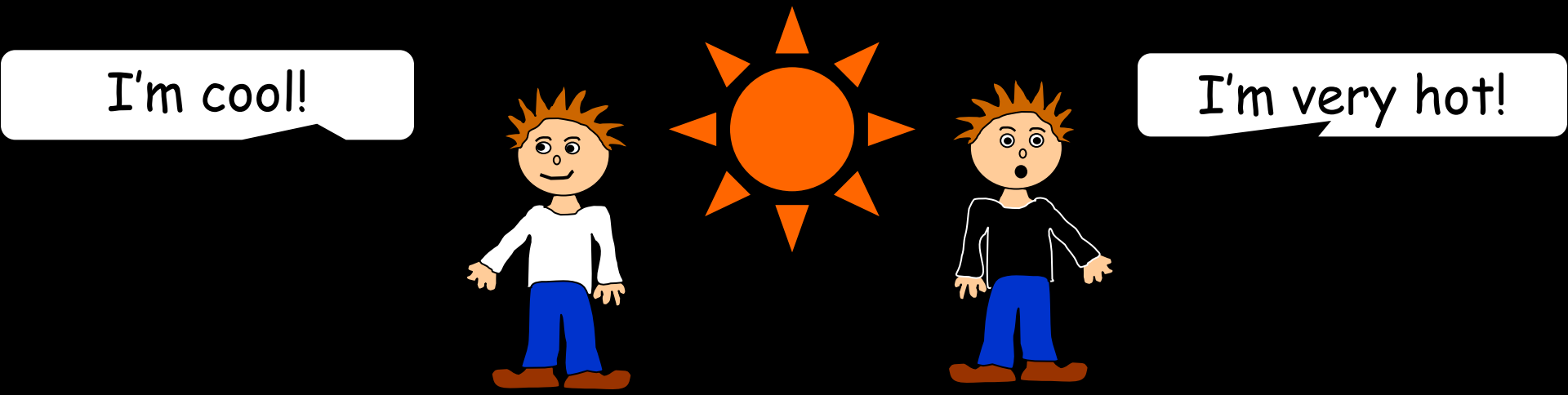
Consider a computer:



1) How much energy is converted into useful energy?
2) What is the computer's efficiency?

Radiation

An introduction…



Some examples of radiation

Some examples of radiation

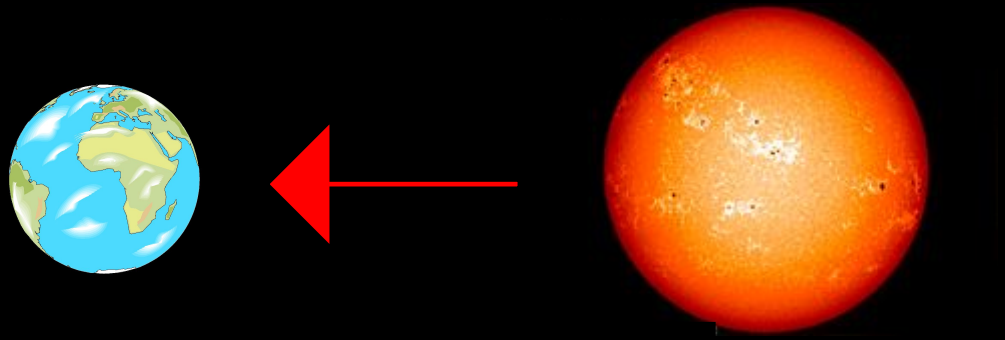
Heat Loss from a House

Radiation Practical

Time / min	Temperature in each container / ^{0}C		
	Black	Silver	Clear
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Radiation

Radiation is when heat moves around in electromagnetic _____ like light does. Any hot object will emit heat radiation – the hotter it is, the more radiation it emits. This type of radiation is called _____. Dark, matt colours will absorb AND emit the _____ infra-red radiation, and light, shiny colours will _____ it.



For a body to stay at constant temperature it must radiate the same average _____ that it absorbs.

Words – reflect, infra-red, waves, most, power