Nano and the Environment

Module 8
Nano & the Environment

Module 7 – Nano and the Environment

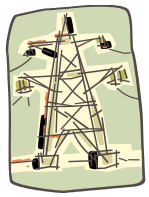
In this module…….

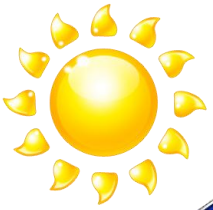
We will look at how **nanoscience** and nanotechnology are playing a critical role in **environmental issues**.




Nanotechnology can help to

1. Develop more **effective** forms of **energy capture**.
2. Create a more **efficient** method of **energy storage** and **distribution**.
3. Develop **inexpensive** and **reliable** ways of providing clean **drinking water**.

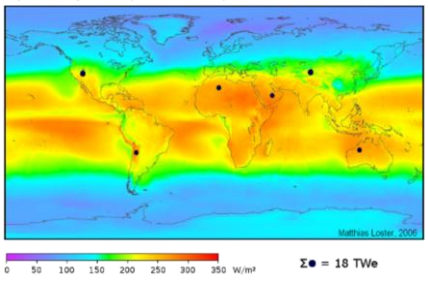





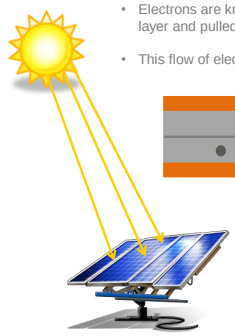
- As almost all of our **energy comes from the sun** eventually, we will look at **solar power** first and how we capture this form of energy.

How much solar energy do we need?

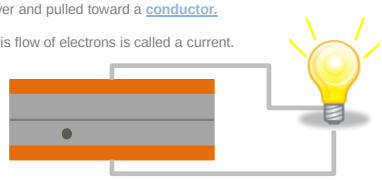
- **Not much**! Light from the sun contains so much energy that if solar cells were installed in the areas marked by the dark disks, sunlight hitting these panels could power the whole world.



How do solar panels work?



- Electrons are knocked loose from the silicon layer and pulled toward a conductor.
- This flow of electrons is called a current.

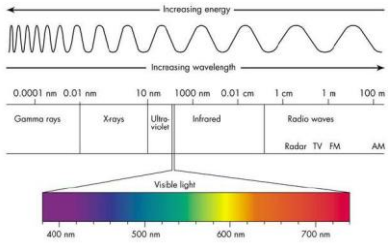


- This electrical current travels around the circuit powering items.

Semiconductors are materials whose ability to conduct electricity is half way between a conductor and insulator.

There is a problem…

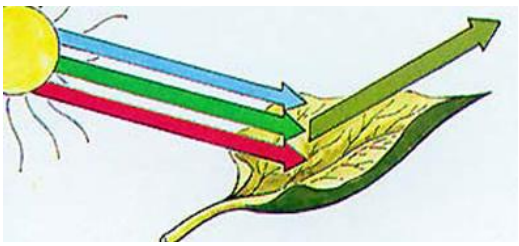
- As we know, **light from the sun** is composed of **many different colours** of light, each with a different **wavelength**.
- Solar cells can only absorb specific wavelengths of light which means they do not convert all the energy they trap into electricity.



There is a problem..

We see a similar situation with Chlorophyll molecules:

- Absorb blue and red light.
- Reflect green light.

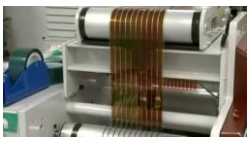


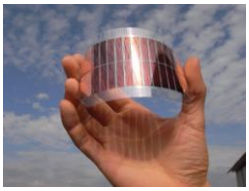
There are other issues with traditional solar panels

1. They **cost** a lot to produce due to the materials used to make them.
2. The crystal panels are very **delicate** making the panels fragile- as a result they need to be coated in glass which makes them heavy.
3. Dirt and dust reduce efficiency, panels must be cleaned regularly.

Dye solar cells: the next generation

- Replacing silicon crystals with **semiconducting nanomaterials** embedded in a conductive plastic.
- Ink of semiconducting nanoparticles is sprayed on to a plastic or foil surface (just like printing a page of a book).
- No special equipment required.
- Resulting cells are thin, light and because nanomaterials have large surface area these cells are proving more efficient.





Applications

- Solar powered stations where you can sit and charge your laptop for free.
- In Japan leaf and flower shaped solar batteries have been designed.
- Thin solar cells can be used to coat the roofs of houses.

As for transport

- Solar cars may have started life looking a bit impractical but even this may be a reality in the future.

Nanotechnology is helping to realise wind energy's enormous potential

- Nanocoatings allow for **self cleaning** and prevent organic growth improving efficiency.
- Lubricants containing nanoparticles **reduce friction** and vibrations generated by the turbines.
- This helps **increase the life** span of the turbine by decreasing wear and tear.
- It also **reduces noise pollution**.
- Nano materials are used to construct the blades making them **lighter and stronger**.

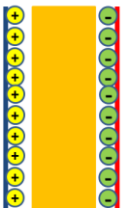
Energy Storage and Transfer

Storing energy in batteries

- Energy in batteries is **stored and released slowly** via chemical reactions.
- These chemical reactions take time - quick charging and release of energy difficult.
- **Advantage** - batteries can store a lot of energy and release it over a long time.

Capacitors

- Use **static electricity** to store energy.
- They contain two conducting metal plates with an **insulating** material.
- Positive and negative electrical charges build up on the plates the insulator stops them coming in contact.

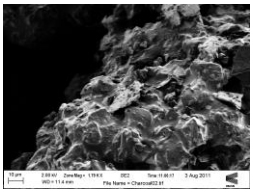


Advantages of capacitors over batteries:

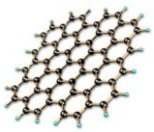
- Weigh less.
- No harmful chemicals or toxic metals.
- Charge and discharged quickly.
- Don't wear out as quick.

Nanoscience and supercapacitors

- Supercapacitors use **porous materials** (activated charcoal) instead of metal electrodes.
- Extra surface area - ability to store more charge (they become **electricity sponges**).
- Graphene sheets for advanced energy storage - materials' strength, chemical stability, high surface area and it is an excellent conductor of electricity.

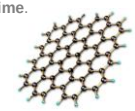


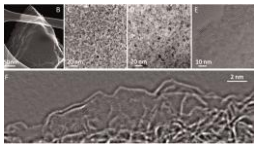
Electron microscope image of charcoal.



Recent developments

- Scientists in the US have modified graphene to make it **more porous** and **increase the surface area**.
- These modified graphene structures can be incorporated into "**supercapacitor**".
- These devices will combine a remarkably **high storage** capacity with **quick energy release and recharge time**.





Graphene + Water = Super Battery!

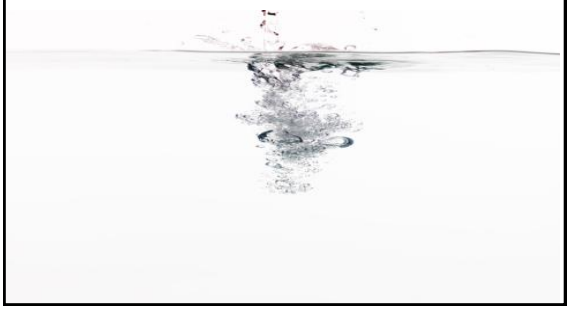
Monash University research team believes mixing graphite and water could create a gel-like super battery that could someday **charge a mobile device in a few seconds**.

Electric cars

- Electric cars with zero emissions are seen as the future of transport.
- At the moment they are **not practical enough** to use every day.
- They take a very **long time to charge** and are **not suitable for long trips**.
- Batteries used in the cars are very **heavy** so it take a lot of energy to move them around.

It is hoped the next generation of **supercapacitor** will allow for quick charge times and longer use between charges making electric cars a more realistic option.

Nanoscience and Water



The Problem!

884 million people have **inadequate access** to safe drinking water.

Waterborne diseases are one of the leading causes of death worldwide.

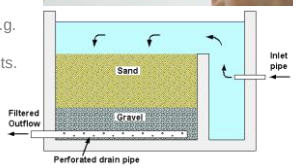
97% of the water on earth is **salt water**.

Most fresh water is in ice caps. **Less than 1%** of fresh water on earth is **accessible**.

Making water drinkable

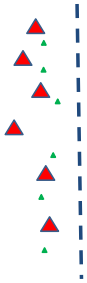
- Clean, safe drinking water is expensive to produce.
- There are inexpensive ways of cleaning water e.g. powering water through charcoal, sand and gravel.
- However this method doesn't remove smaller contaminants e.g. bacteria which are usually removed by additional treatments.

1. **Membrane filtration.**
2. **Reverse osmosis filtration.**



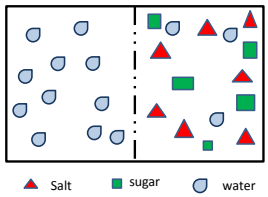
Membrane filtration

- Water is filtered through a membrane - a thin material containing holes (pores) of a specific size.
- This allows for larger particles to become trapped while smaller particles (like water) fall through.
- The type of membrane used depends on the size of the particle you want to filter.

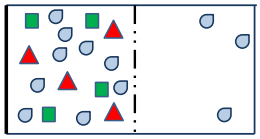


Reverse osmosis

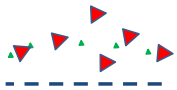
- **Osmosis** is the **movement of water** across a membrane, from an area of high concentration to an area of low concentration.



- **Reverse Osmosis** is when water is moved form a more concentrated area to a less concentrated area through a membrane under **high pressure.**



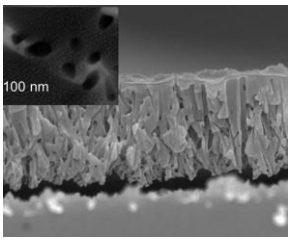
- While **reverse osmosis** is the **best technique,** as it can remove even the smallest membrane, there are drawbacks.
- Its the most **expensive** type of filtration.



- The pores are so **small** they become **easily clogged**.

Nanofilters

- Nanomembranes filter water and contain **nanoparticles that are toxic** to bacteria.
- Hydrophilic nanotubes **attract water** but **repel other particles**.
- The membrane surfaces are also being designed to **repel dirt** preventing blockage by materials.



Special membranes that have pores only nanometres wide.

Applications of nanomembranes

- This 'Lifesaver' bottle contains nanomembranes that have a pore size of only **15 nanometres**.
- Water is forced through the membranes leaving the dirt and contamination behind.

Summary

1. How does nanotechnology influence more **effective** forms of **energy capture**?
2. How will nanotechnology help find more **efficient** methods of **energy storage** and **distribution**?
3. Nanotechnologies role in producing **inexpensive** and **reliable** ways of providing clean **drinking water**.