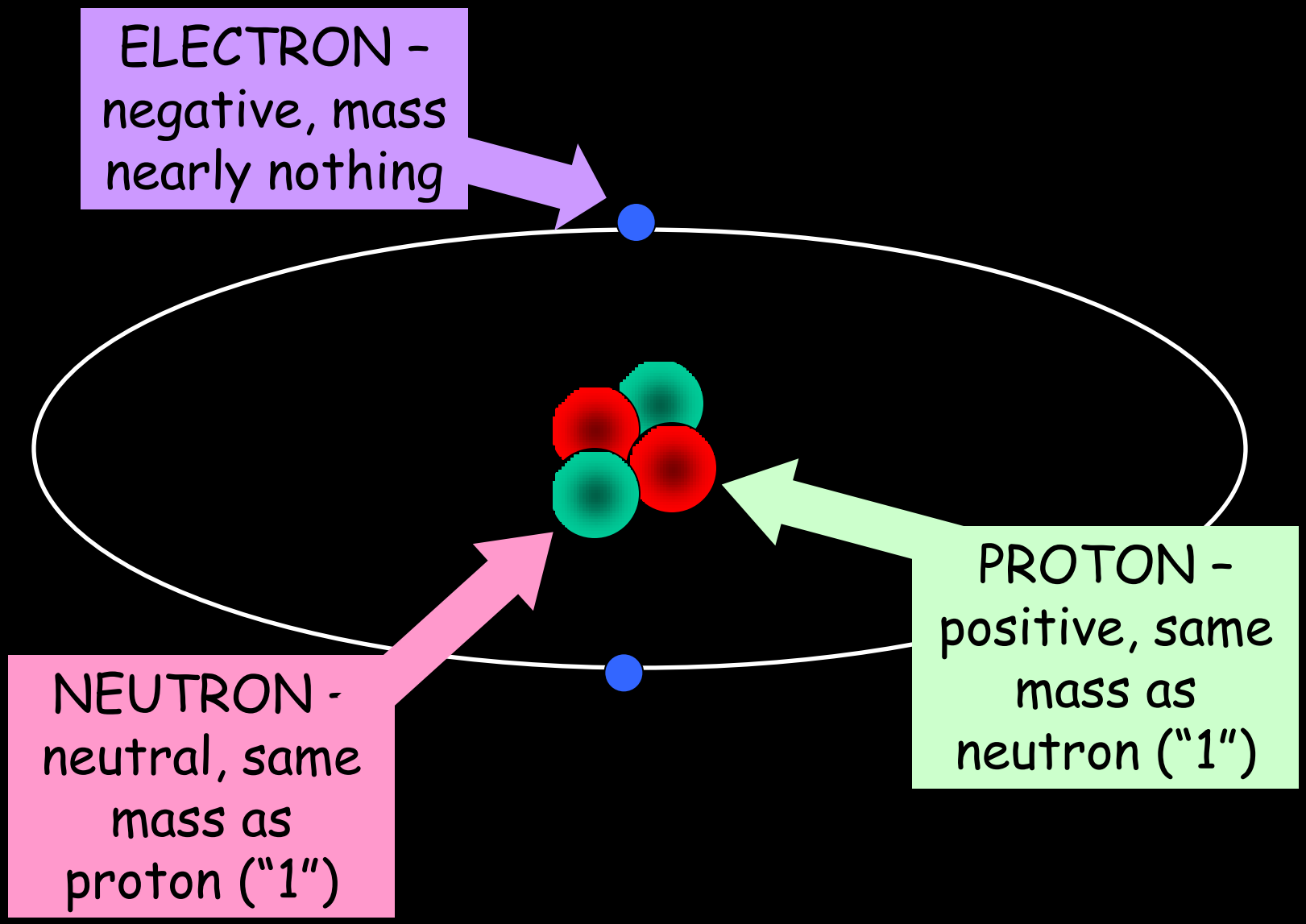
Radioactive Materials

(OCR)

The structure of the atom



Isotopes

An isotope is an atom with a different number of neutrons:

Notice that the mass number is different. How many neutrons does each isotope have?

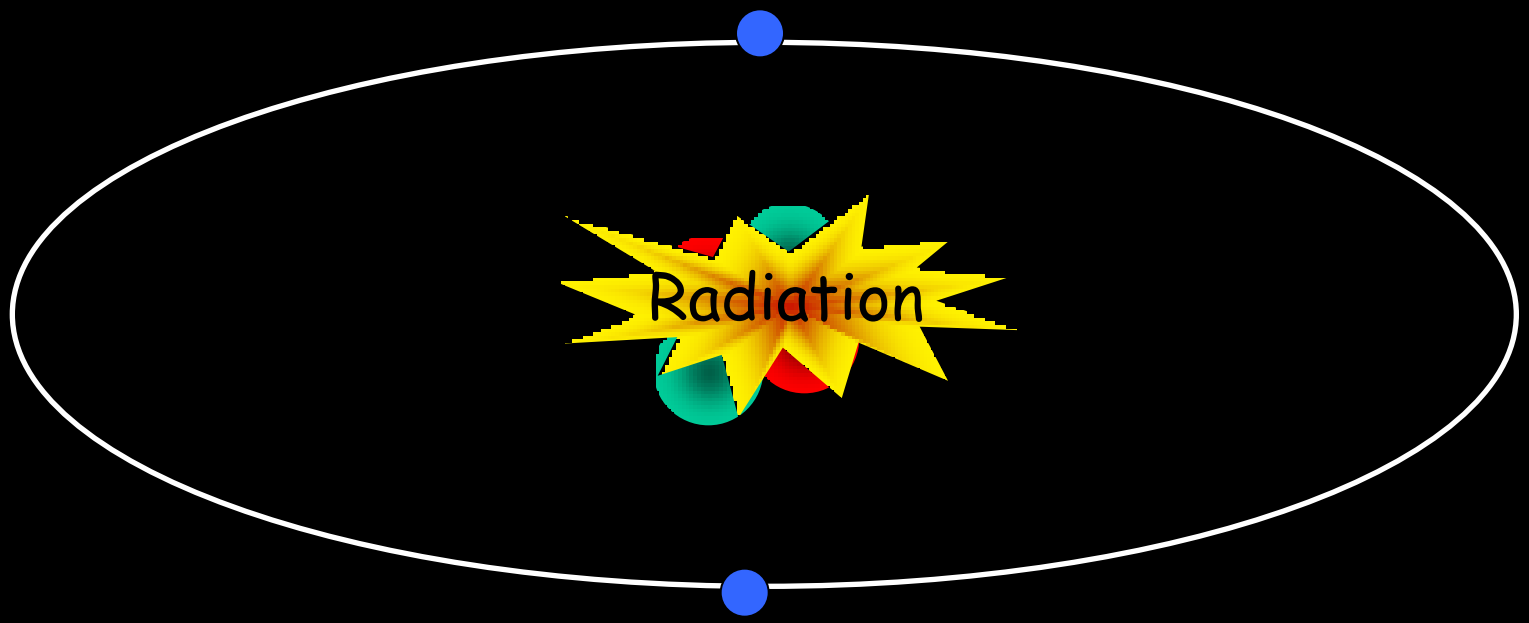
16	17	18
O	O	O
8	8	8

Each isotope has 8 protons – *if it didn't then it just wouldn't be oxygen any more.*

A "radioisotope" is simply an isotope that is radioactive – e.g. carbon 14, which is used in carbon dating.

Introduction to Radioactivity

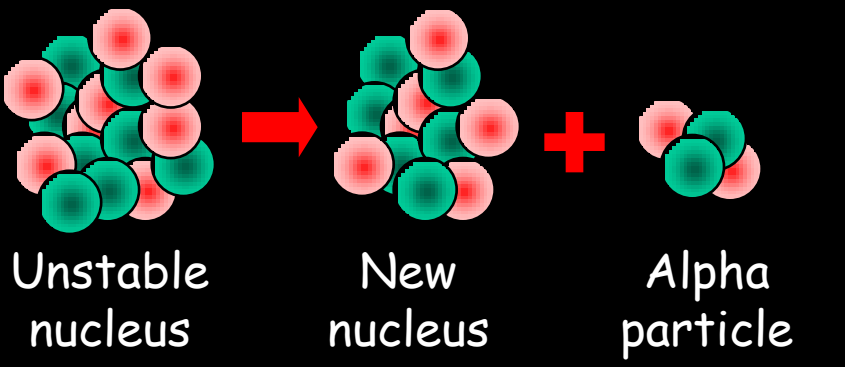
Some substances are classed as "radioactive" – this means that they are unstable and continuously give out radiation:



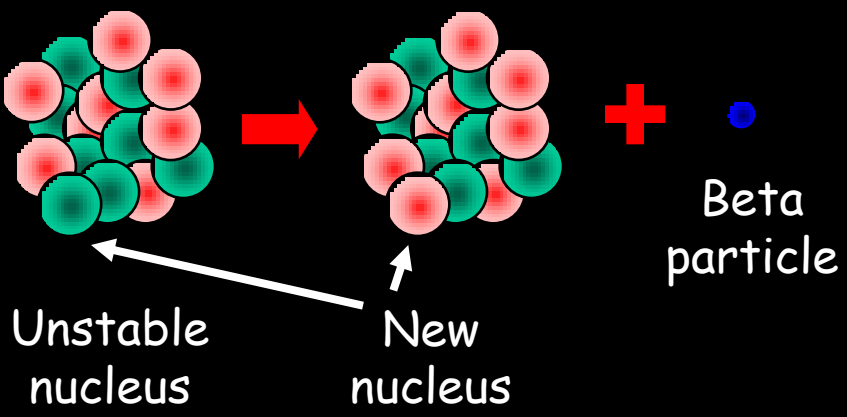
The nucleus is more stable after emitting some radiation – this is called "radioactice decay".

Types of radiation

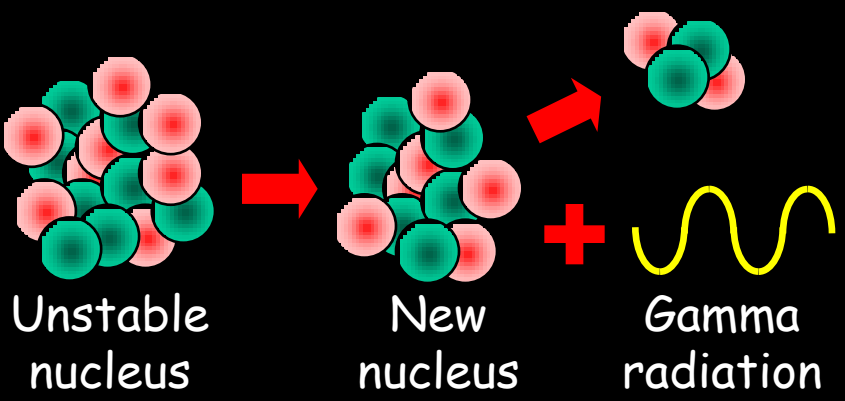
15/12/2011



1) Alpha (α) – an atom decays into a new atom and emits an alpha particle (2 protons and 2 _____ – the nucleus of a _____ atom)



2) Beta (β) – an atom decays into a new atom by changing a neutron into a _____ and electron. The fast moving, high energy electron is called a _____ particle.

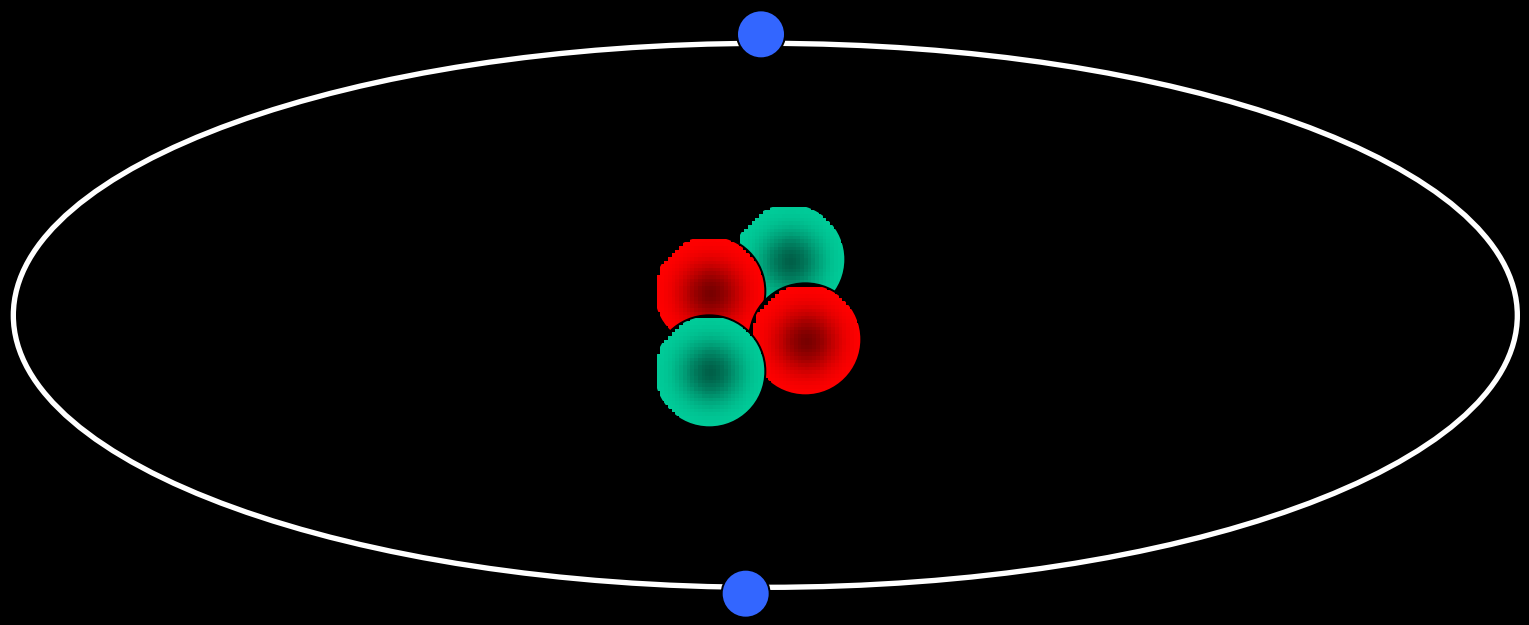


3) Gamma – after α or β decay surplus _____ is sometimes emitted. This is called gamma radiation and has a very high _____ with short wavelength. The atom is not changed.

Words – frequency, proton, energy, neutrons, helium, beta

Ionisation

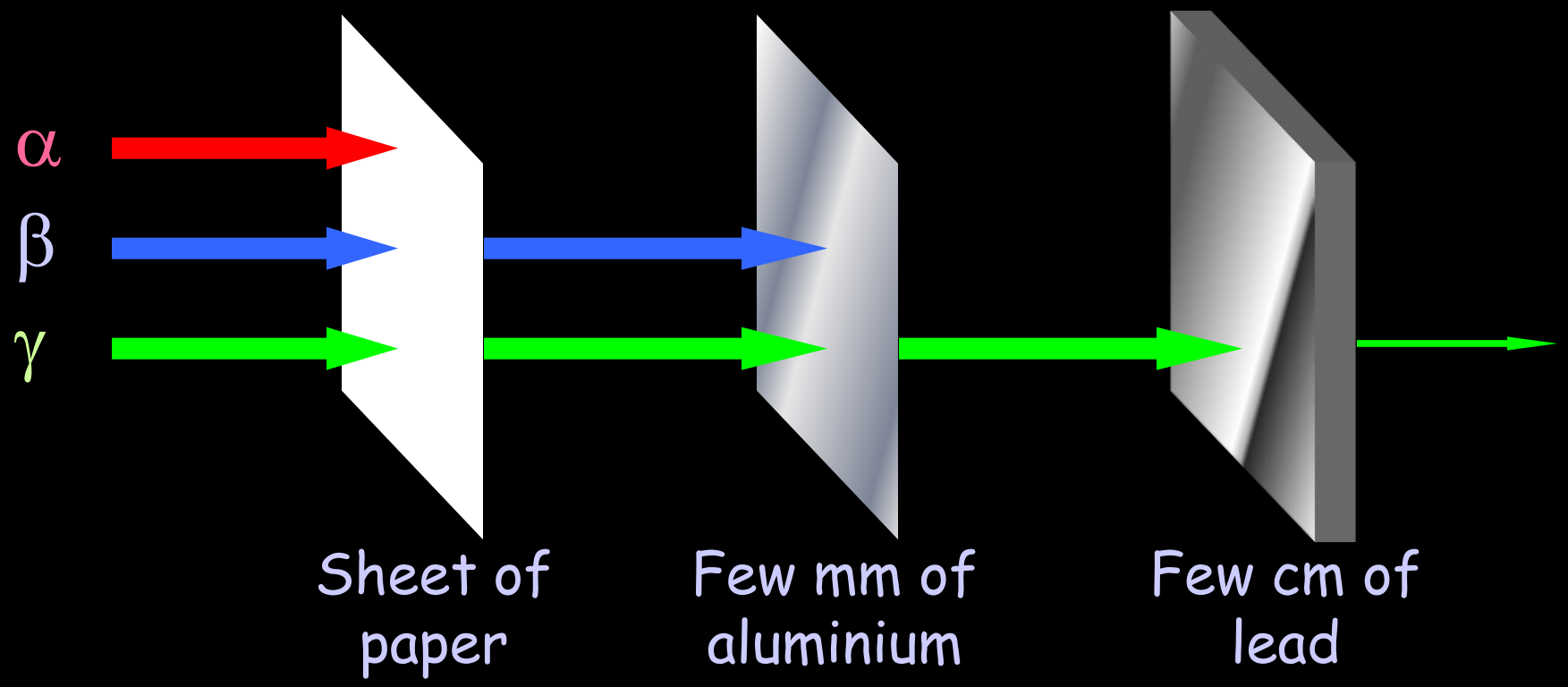
Radiation is dangerous because it "ionises" atoms – in other words, it turns them into ions by "knocking off" electrons:



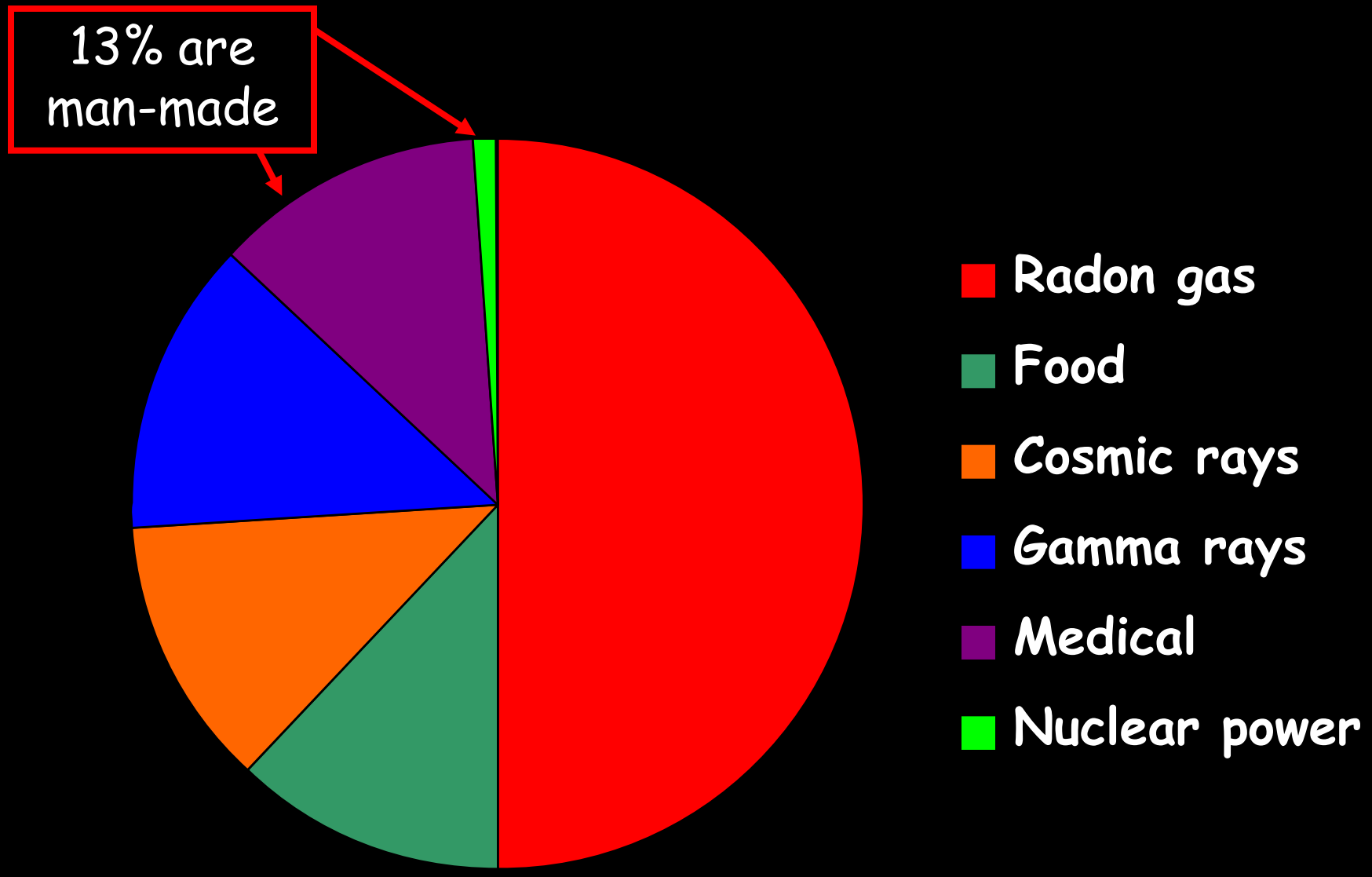
Alpha radiation is the most ionising (basically, because it's the biggest). Ionisation causes cells in living tissue to mutate, usually causing cancer.

Blocking Radiation

Each type of radiation can be blocked by different materials:



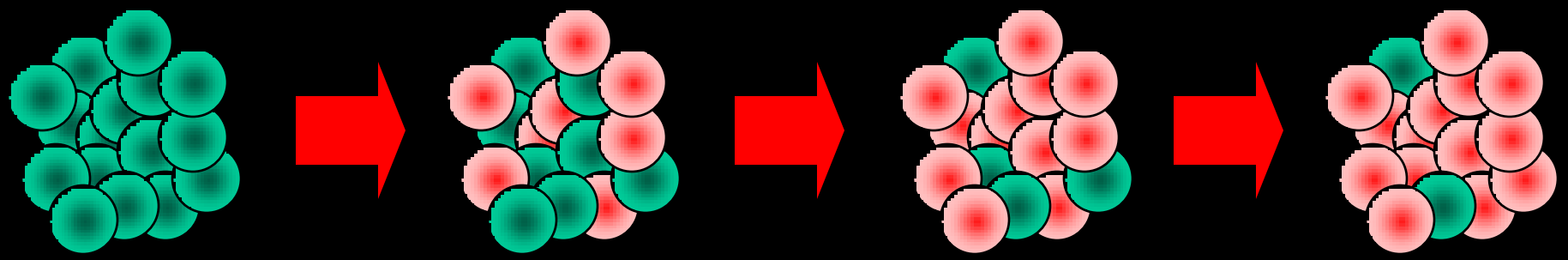
Background Radiation



Half life

The decay of radioisotopes can be used to measure the material's age. The HALF-LIFE of an atom is the time taken for HALF of the radioisotopes in a sample to decay…

= radioisotope = new atom formed



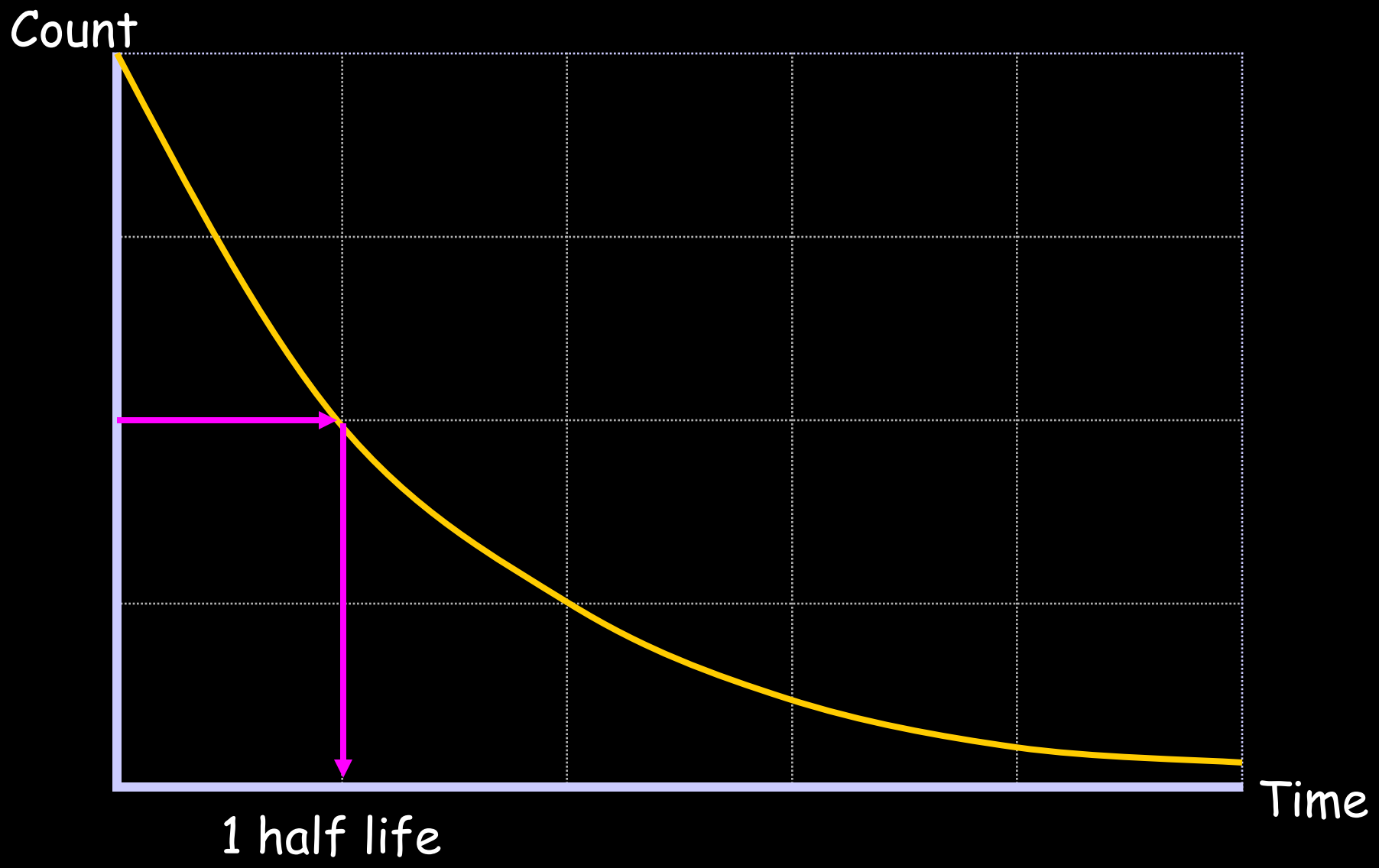
At start there are 16 radioisotopes

After 1 half life half have decayed (that's 8)

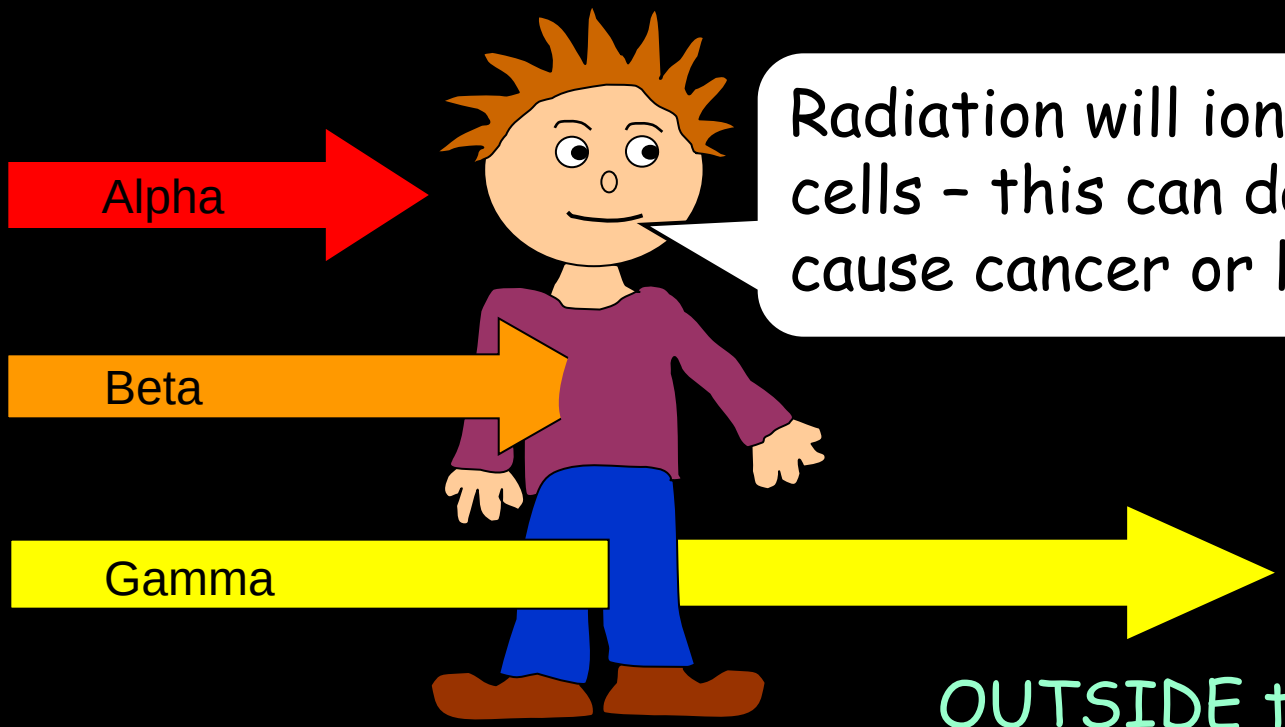
After 2 half lives another half have decayed (12 altogether)

After 3 half lives another 2 have decayed (14 altogether)

A radioactive decay graph



Dangers of radioactivity



Radiation will ionise atoms in living cells – this can damage them and cause cancer or leukaemia.

OUTSIDE the body β and γ are more dangerous as α radiation is blocked by the skin.

INSIDE the body an α source causes the most damage because it is the most ionising.

Alexander Litvinenko

Timeline of Events

Video of risks from polonium 210

Uses of Gamma Radiation

Sterilising medical instruments and food

Gamma rays can be used to kill and sterilise germs without the need for heating.

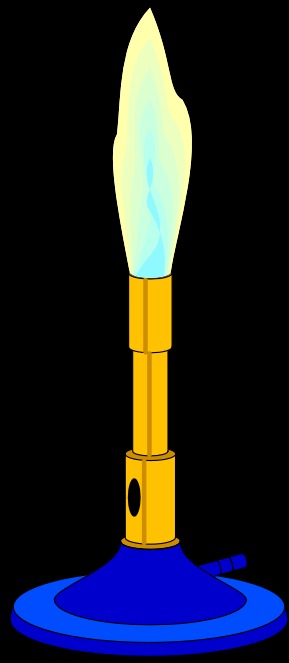
Treating Cancer

High energy gamma radiation can be used to kill cancerous cells. However, care must be taken in order to enure that the gamma radiation does not affect normal tissue as well.

Radioactive iodine can be used to treat thyroid cancer. Iodine is needed by the thyroid so it naturally collects there. Radioactive iodine will then give out beta radiation and kill cancerous cells.

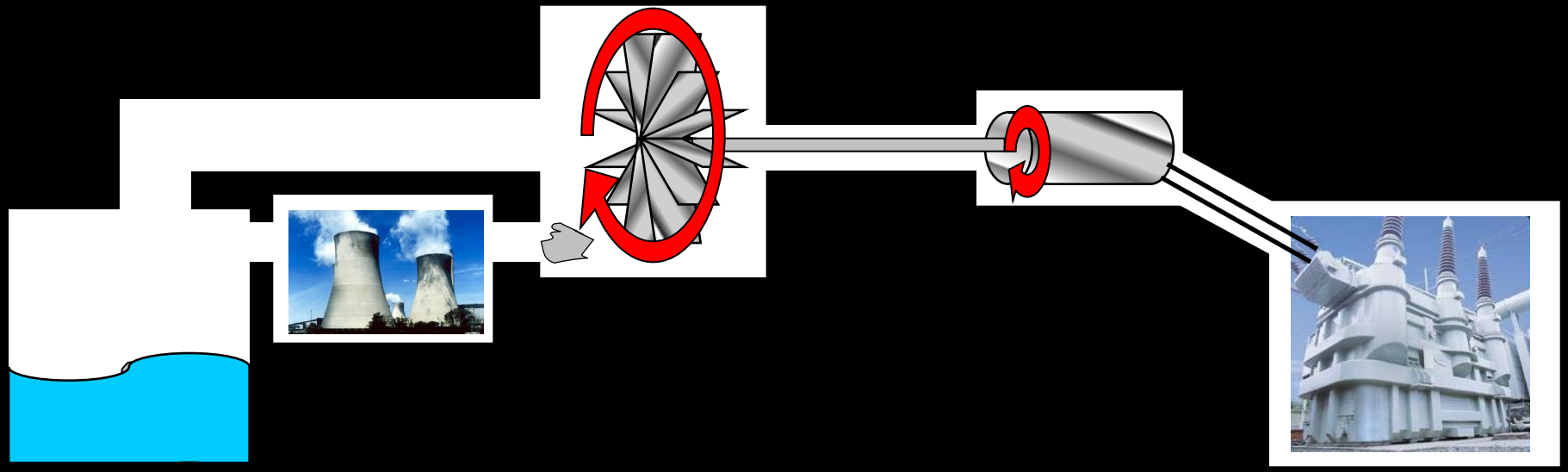
Fuels

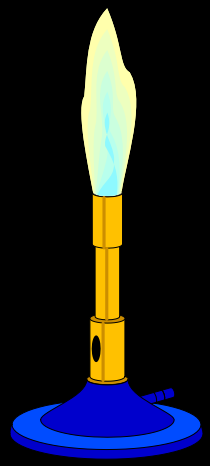
A "fuel" is something that can be burned to release heat and light energy. The main examples are:



Coal, oil and gas are called "fossil fuels". In other words, they were made from fossils.

Using non-renewable fuels in power stations





1) A fossil fuel is burned in the ***boiler***

2) Water turns to steam and the steam drives a ***turbine***

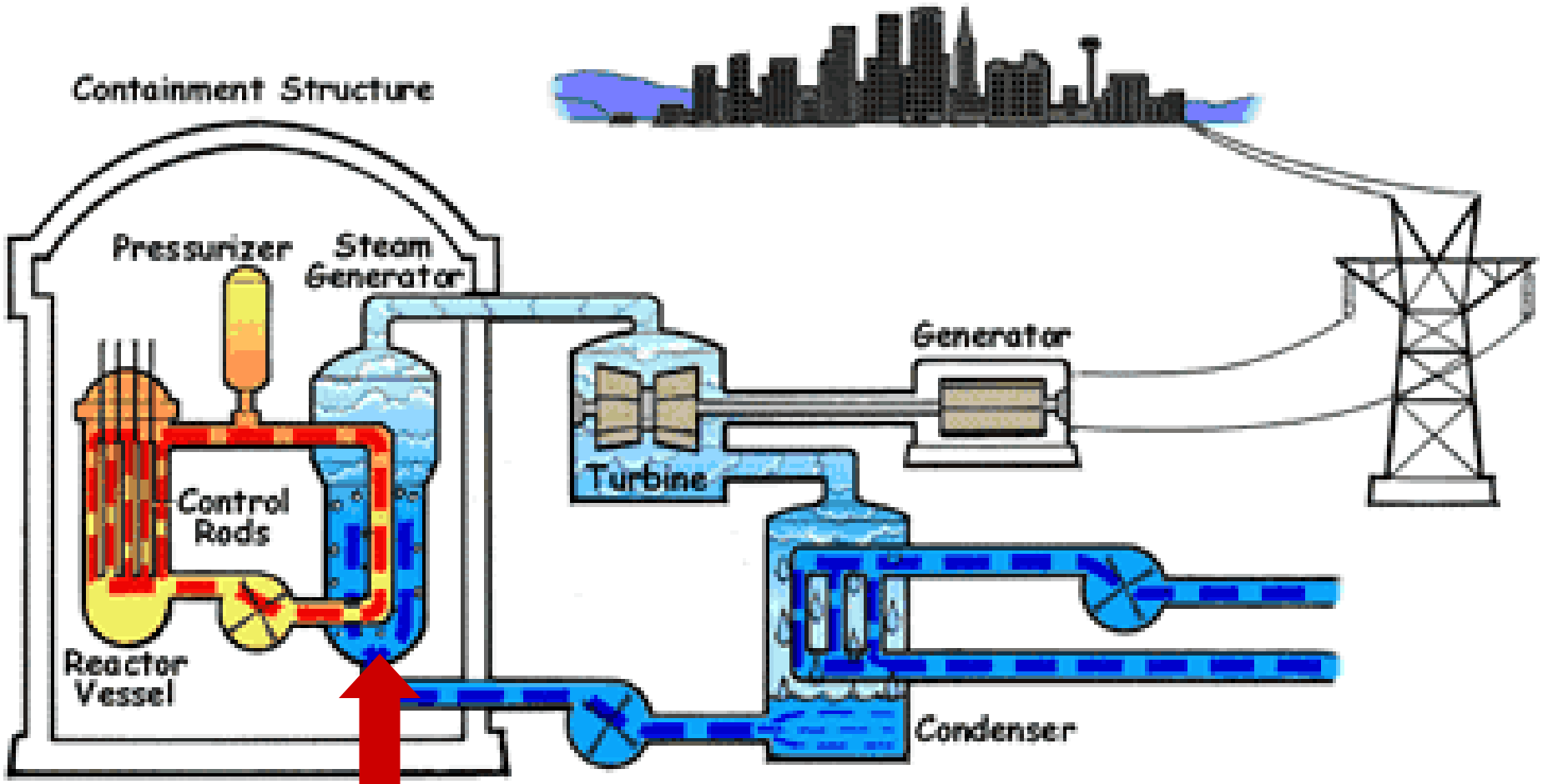
3) The turbine turns a ***generator***

4) The output of the generator is connected to a ***transformer***

5) The steam is cooled down in a ***cooling tower*** and reused

Nuclear power stations

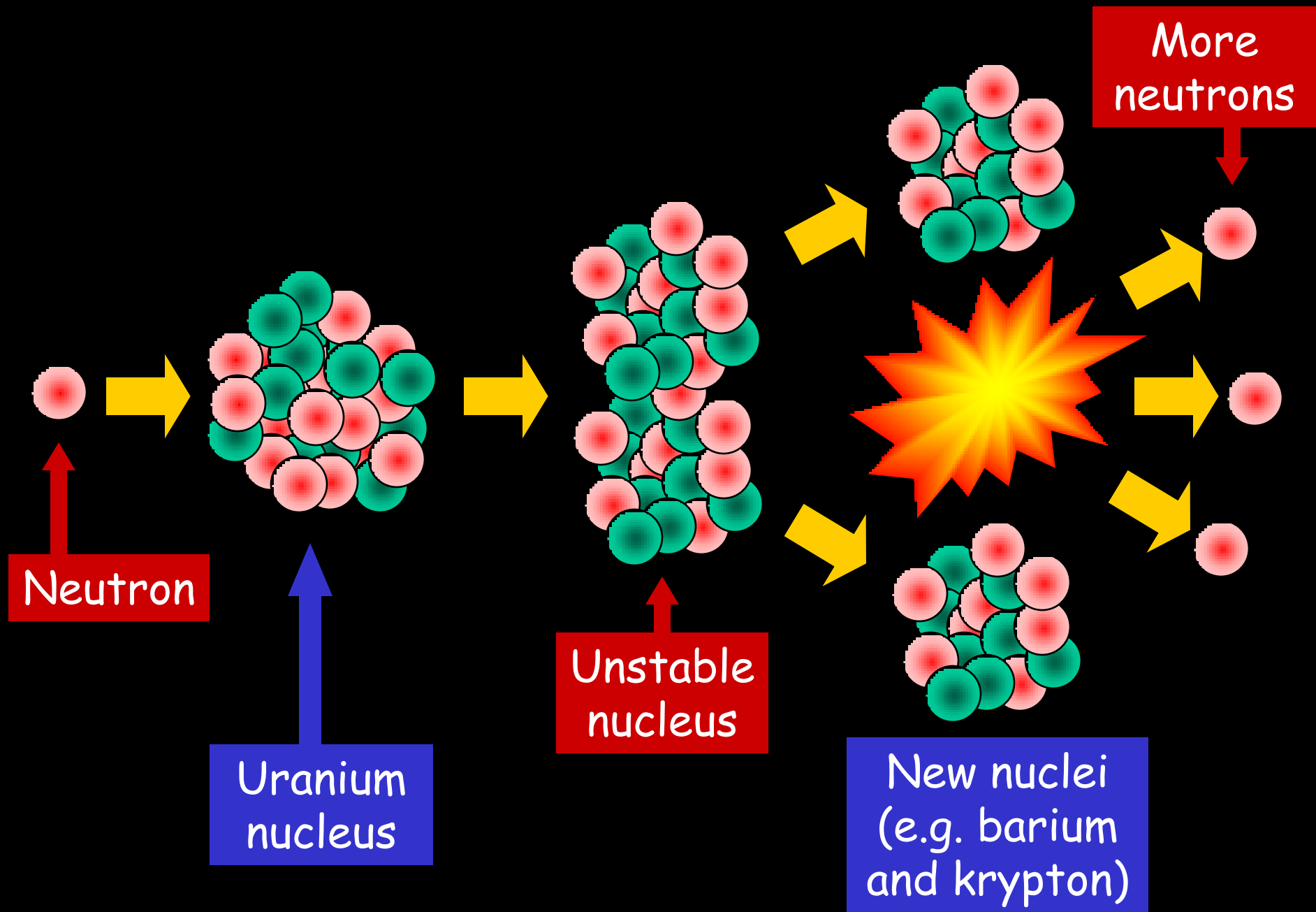
These work in a similar way to normal power stations:



The main difference is that the nuclear fuel is NOT burnt – it is used to boil water in a "heat exchanger"

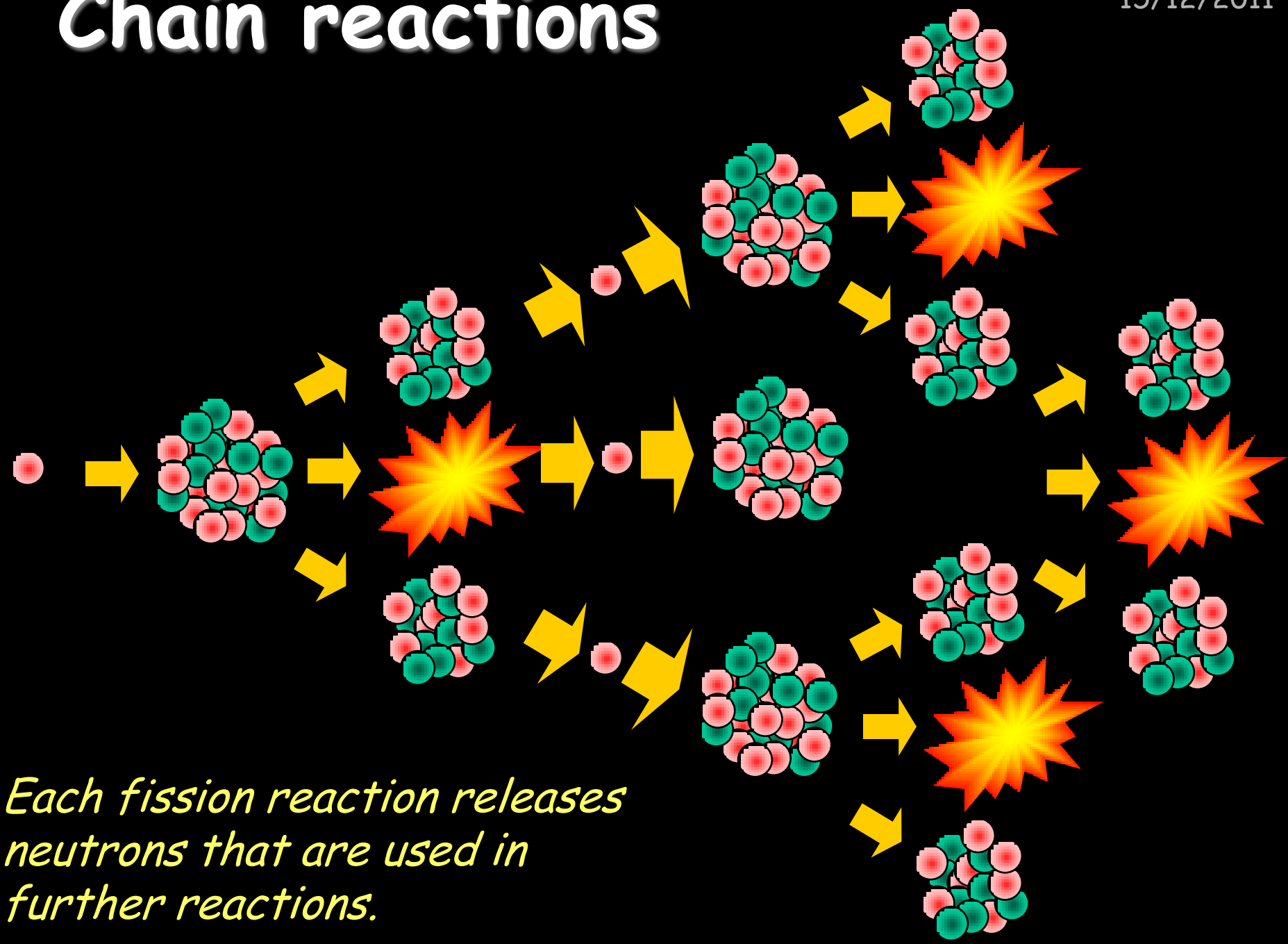
Nuclear fission

15/12/2011



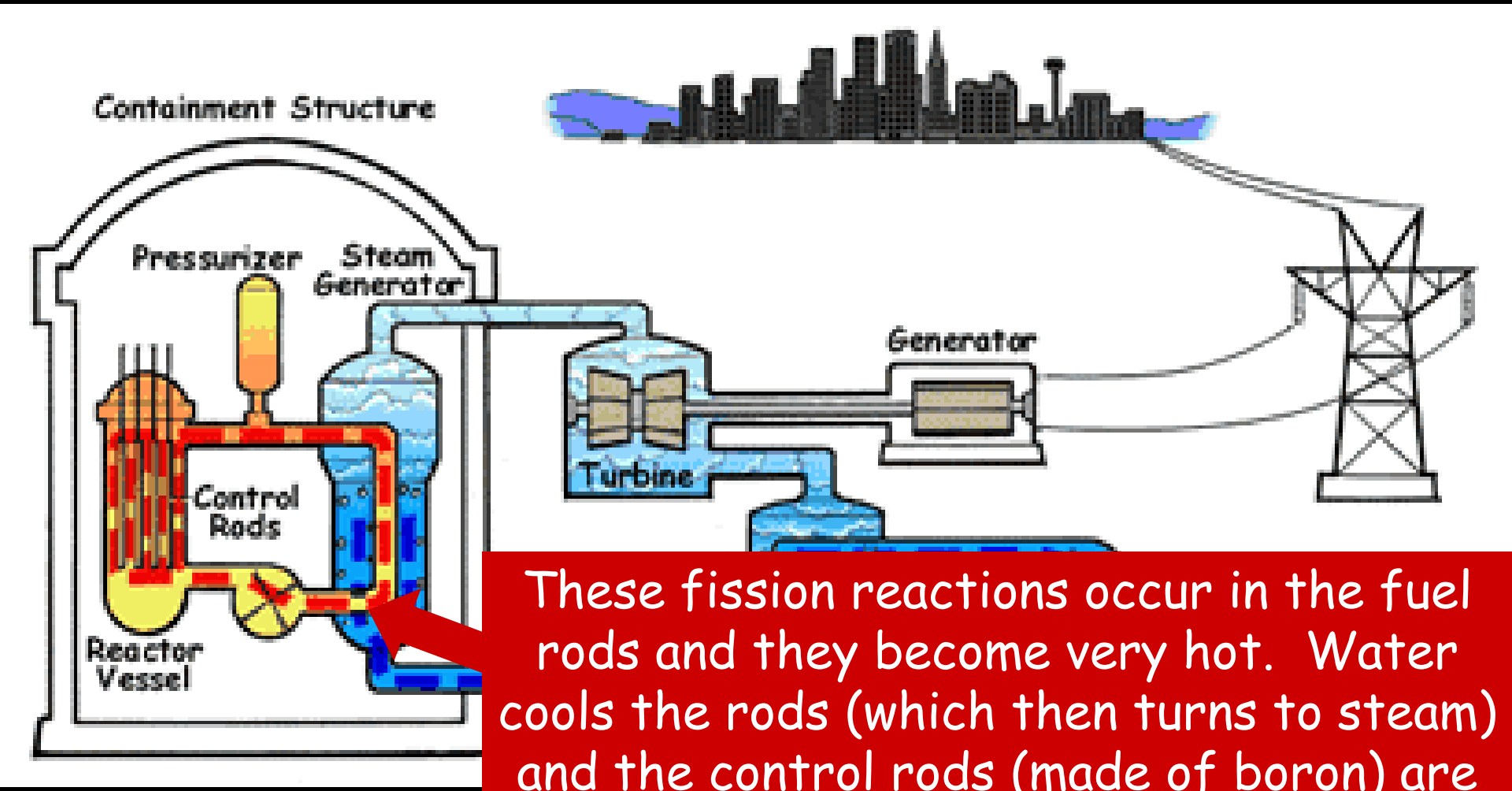
Chain reactions

15/12/2011



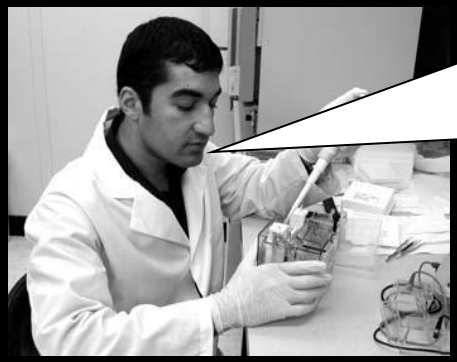
Each fission reaction releases neutrons that are used in further reactions.

Fission in Nuclear power stations



These fission reactions occur in the fuel rods and they become very hot. Water cools the rods (which then turns to steam) and the control rods (made of boron) are moved in and out to control the amount of fission reactions taking place.

Disposing of radioactive waste

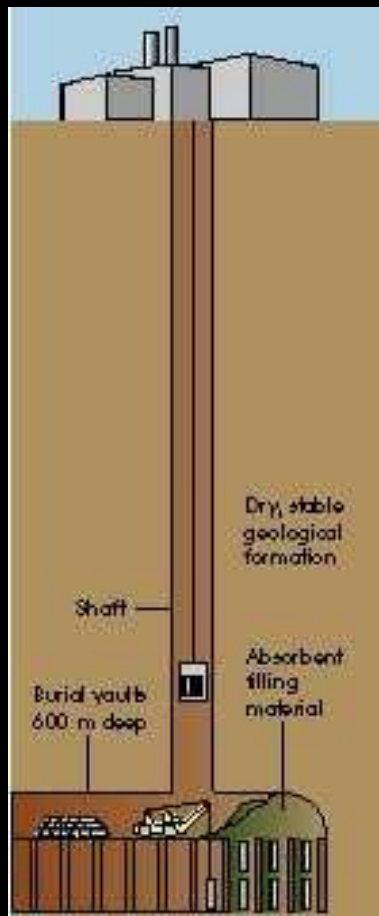


The key to dealing with radioactive waste is to IMMOBILISE it. There are a number of ways of doing this depending on how _____ the waste is:

High level waste is immobilised by mixing with _____ making ingredients, melting and pouring the glass into steel containers.

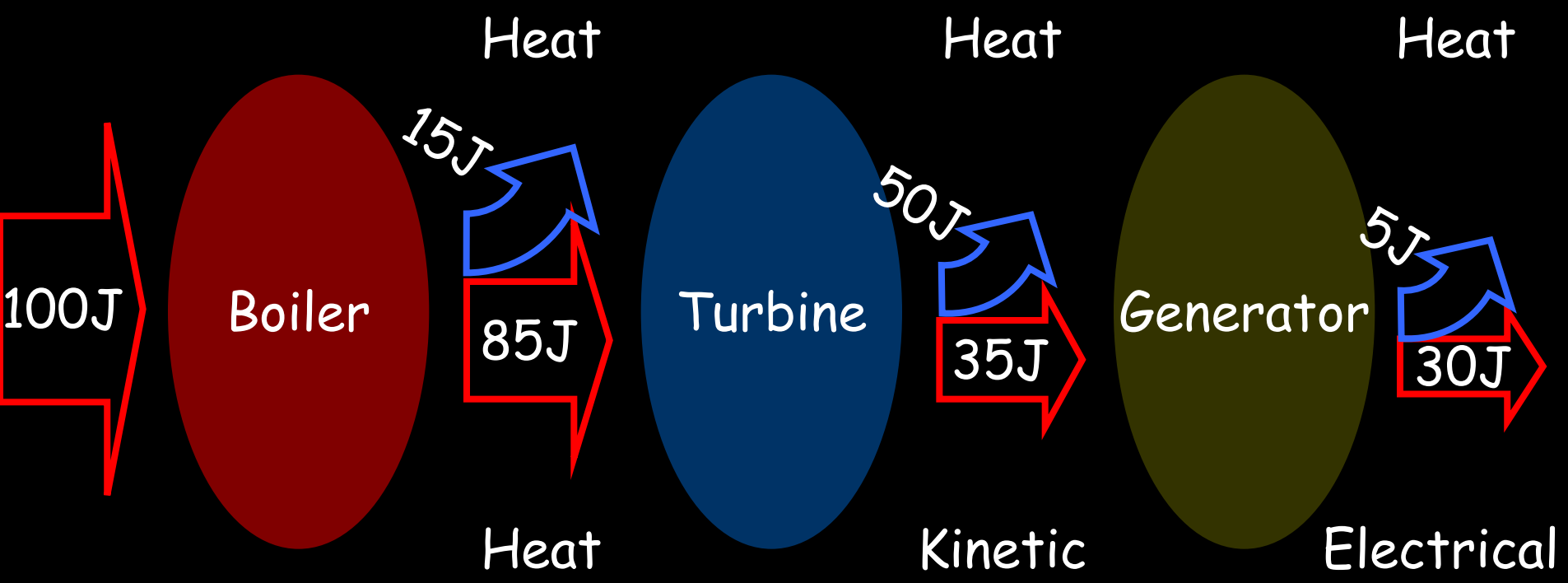
Intermediate waste is set in cement in _____ drums.

The containers are then kept in stores, often _____.

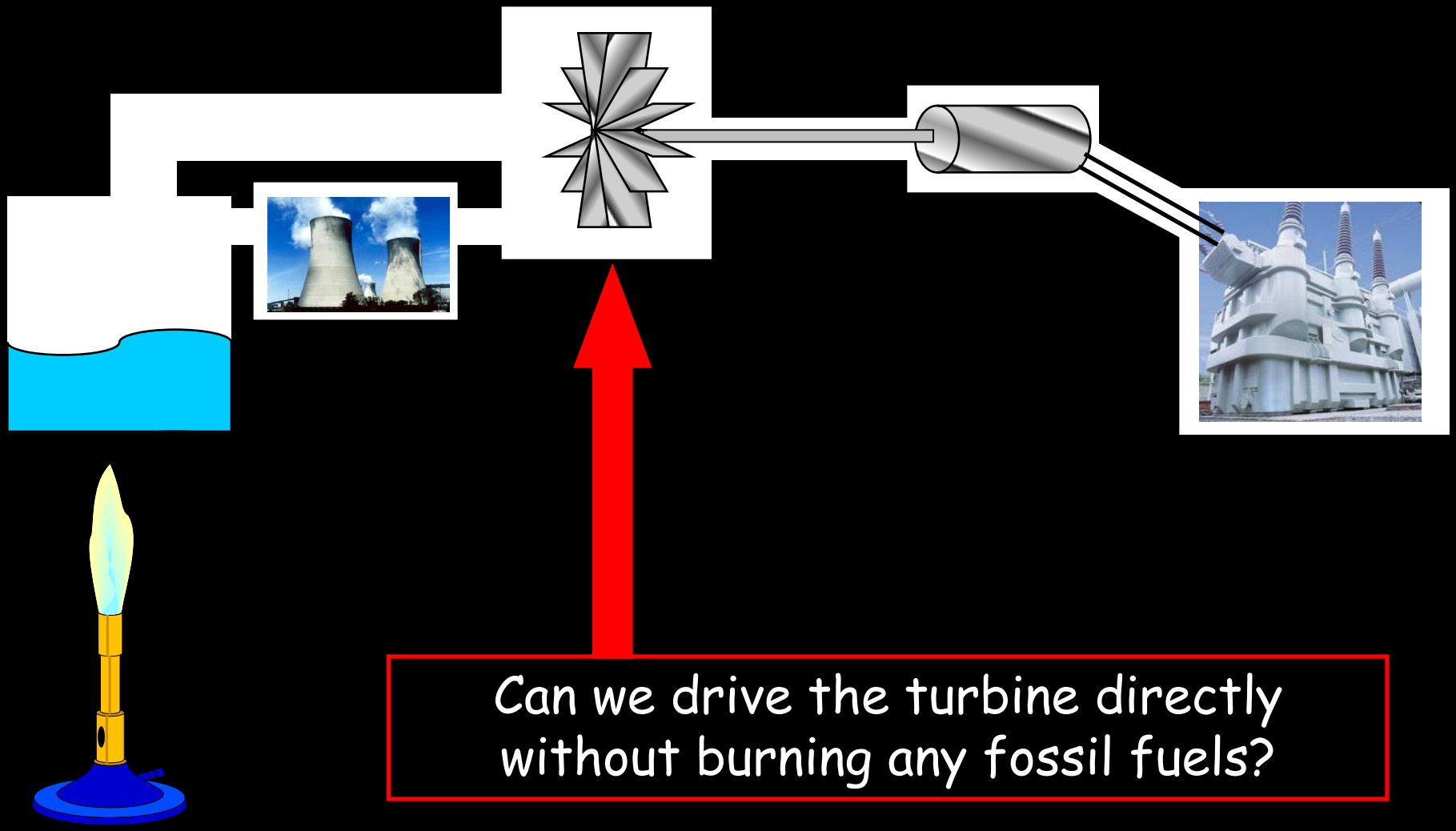


Words – glass, steel, underground, radioactive

Efficiency of Power Stations



Other ways of generating electricity



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

Wind Power

Hydroelectric Power