Theatre of Science IGCSE Physics Radioactivity 1: Atoms!

Today we'll:
Describe the structure of an atom in terms of a positively charged nucleus and negatively charged electrons in orbit around the nucleus

((Describe how the scattering of alpha (α) particles by a sheet of thin metal supports the nuclear model of the atom, by providing evidence for: (a) a very small nucleus surrounded by mostly empty space (b) a nucleus containing most of the mass of the atom (c) a nucleus that is positively charged)) **Cambridge only**

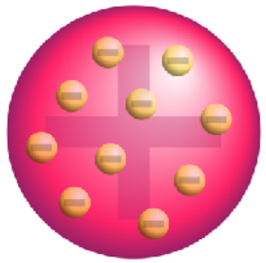
Describe the composition of the nucleus in terms of protons and neutrons

State the relative charges of protons, neutrons and electrons as +1, 0 and –1 respectively

Define the terms proton number (atomic number) Z and nucleon number (mass number) A
and be able to calculate the number of neutrons in a nucleus

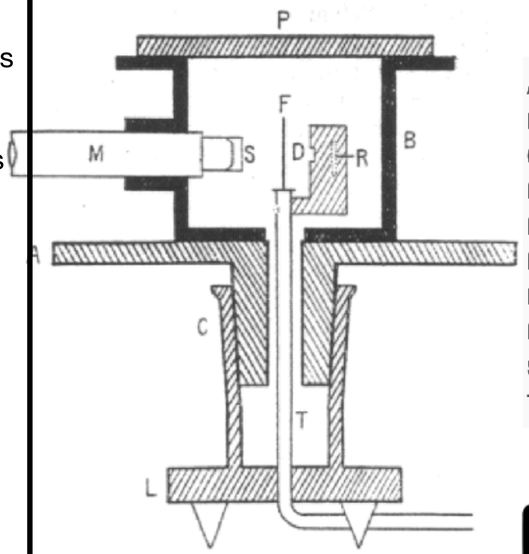
Use the nuclide notation A ZX

Explain what is meant by an isotope and state that an element may have more than one isotope

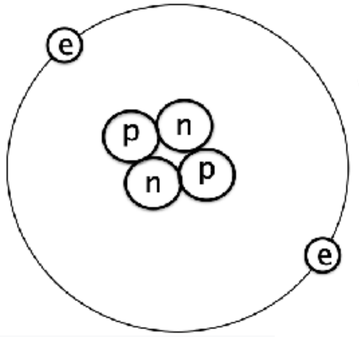


JJ Thompson's Plum Pudding model of an atom.

Disproved by Ernest Rutherford. (This diagram drawn by his assistants!)



A - rotating platform
B - metal cylinder
C - airtight joint
D - diaphragm (to create a narrow beam of particles).
F - metal foil
M - microscope
P - glass plate
R - radium
S - zinc sulfide screen
T - tube for pumping out air



Look at this diagram of a helium atom.

Write down at least two ways it could be changed to make it more accurate!

Subatomic Particle	Location	Charge	Mass
Proton p^+	Nucleus	1+	1
Neutron n^0	Nucleus	0	1
Electron e^-	Shells	1-	'Negligible' or $\frac{1}{2000}$

To join in bring: bicarbonate of soda and vinegar, and/or salt and water.

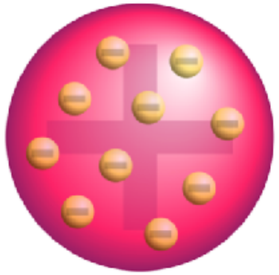
What's the relative charge of the helium atom above?

And the relative mass?

Support me on Kofi to receive nice things: it's the only way this can be my job!

Questions!
Please turn this page over until we do them at the end of the lesson. They're supposed to try and make you struggle remember what you've learned to fuse some neurons. Filling them in as we go won't do that!

1) What historical model of the atom is shown in the picture?



_____

2) Who proved this model was wrong?

A: Ernest Rutherford

B: JJ Thompson

C: Marie Curie

3) Which particles are found in the nucleus of an atom?

A: Protons and electrons

B: Protons neutrons and electrons

C: Protons and neutrons

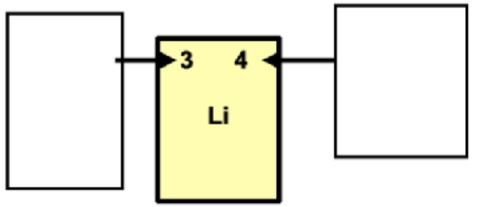
4) And which particles have a charge?

A: Protons and electrons

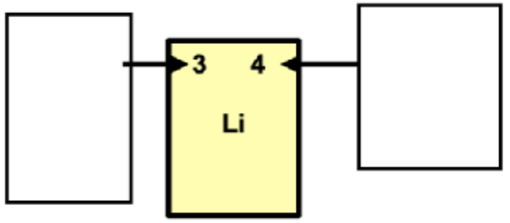
B: Protons neutrons and electrons

C: Protons and neutrons

5) What do these numbers on the periodic table mean?!



6) And what are they called?!



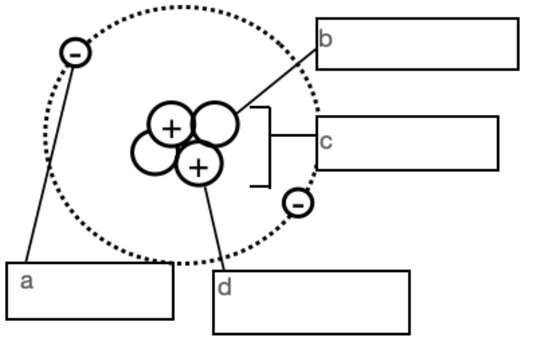
7) Two atoms with the same number of protons but a different number of neutrons are called:

A: Isobars

B: Isotropes

C: Isotopes

8) Label this diagram of an atom:



Theatre of Science IGCSE Physics Radioactivity 2: Radiation

Nothing to bring!

Today we'll:
Use the nuclide notation ${}^{A}_{Z}X$

Describe the effects on the atomic and mass numbers of a nucleus of the emission of each of the four main types of radiation (alpha, beta, gamma and neutron radiation)

Understand how to balance nuclear equations in terms of mass and charge

Describe the emission of radiation from a nucleus as spontaneous.

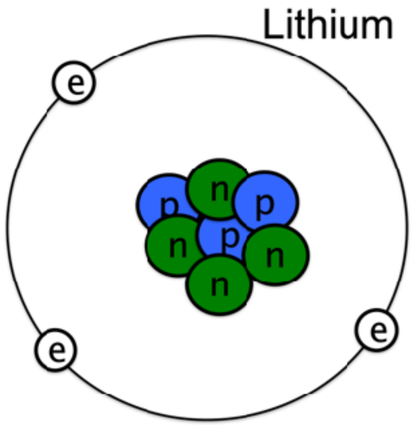
Nucleon number of Lithium?

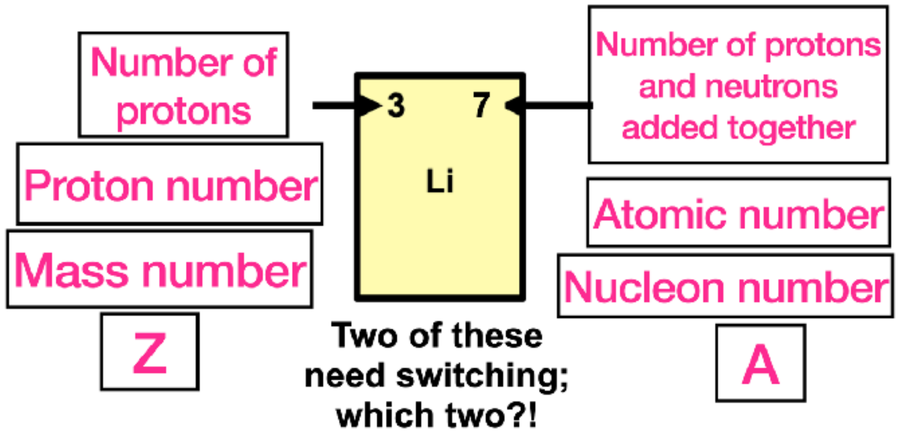
Proton number?

Atomic number?

Mass number?

Z: _____ A: _____





Nucleon number of Fluorine? 19

Proton number? 9

Atomic number?

Mass number?

Z: _____ A: _____

How many neutrons?

F

Nucleon number of Carbon? 12

Proton number? 6

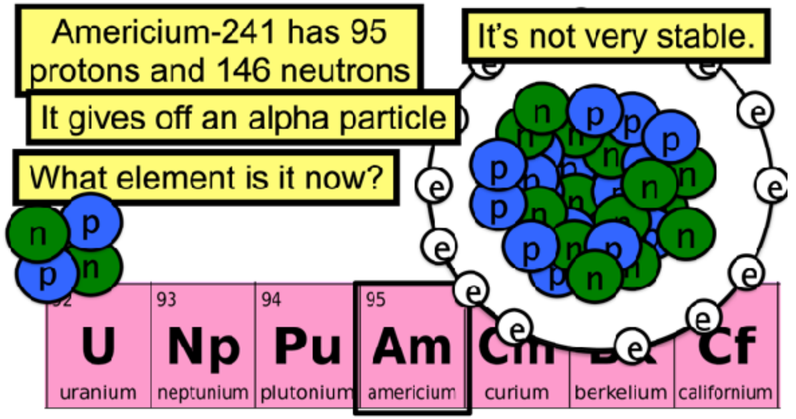
Atomic number?

Mass number?

Z: _____ A: _____

How many neutrons?

C



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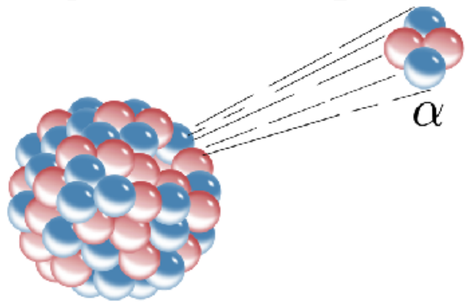
Alpha Decay



$$^{238}_{92}U \rightarrow {}^{?}_{?}Th + {}^{4}_{2}He$$

Uranium-238. The most common isotope of uranium.

Decays into a nucleus of the element Thorium

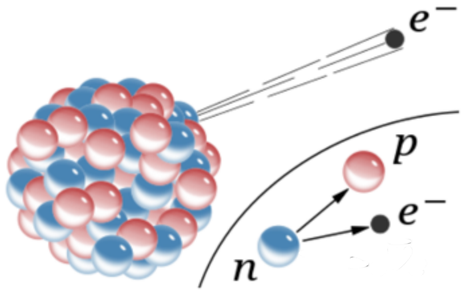
And an alpha particle

1) How many protons and neutrons does Uranium-238 have?

2) Can you fill in the gaps to show how many Thorium has?

$$^{226}_{88}Ra \rightarrow {}^{?}_{?}Rn + {}^{4}_{2}He$$

Beta Decay



$$^{14}_{6}C \rightarrow {}^{14}_{?}N + {}^{?}_{?}e\text{-}$$

1) How many neutrons does boron have?

A: 5

B: 6

C: 11

$$^{11}_{5}B$$

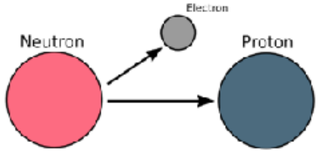
2) What is 'A'?

A: Atomic number

B: Proton number

C: Nucleon number

3) What type of decay is happening here?



A: β–

B: Alpha +

C: β+

D: Alpha -

4) Fill in the gaps

$$^{239}_{94}Pu \rightarrow {}^{?}_{?}U + {}^{4}_{2}He$$

Theatre of Science IGCSE Physics Radioactivity 3: Nuclear Fission

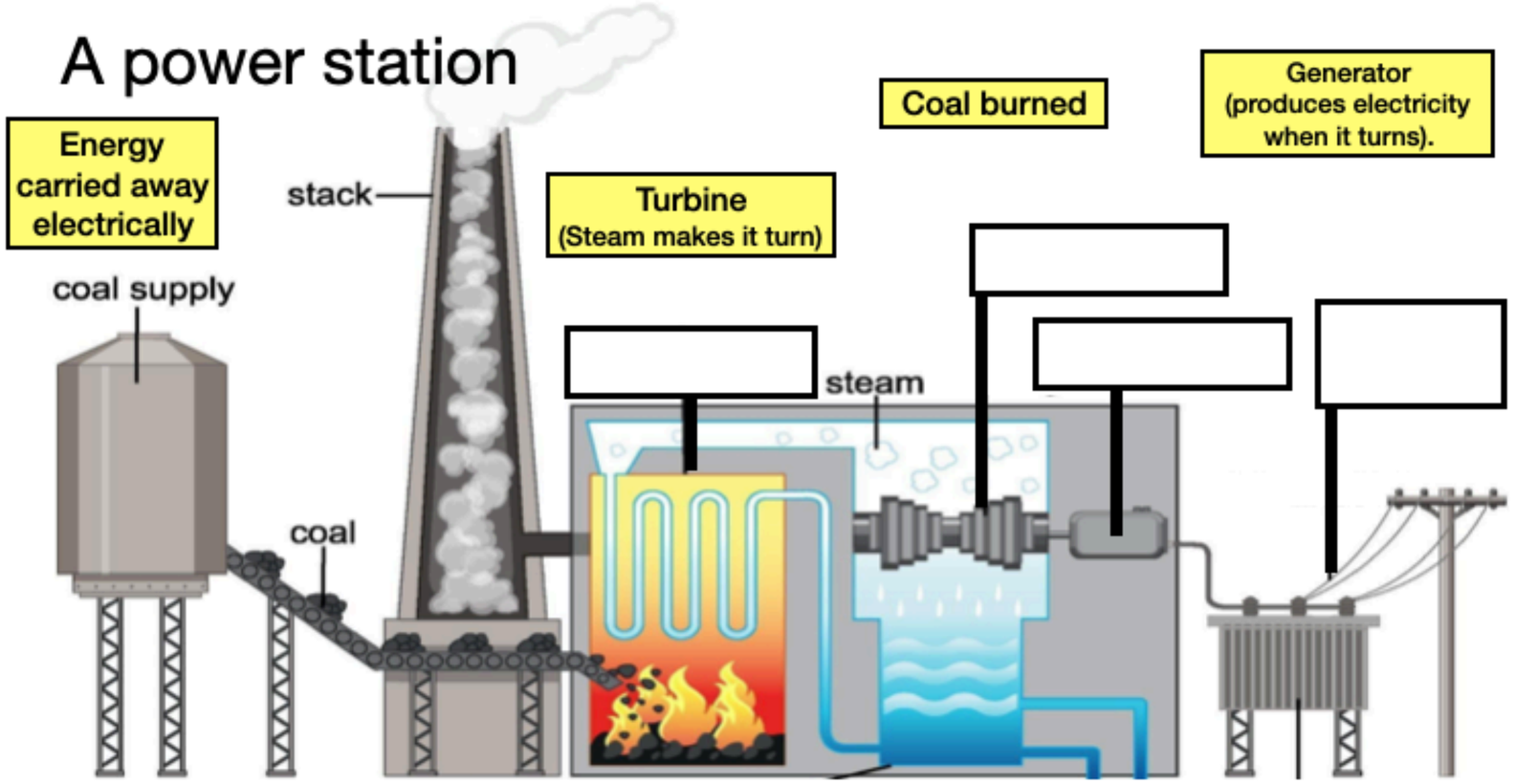
This lesson will cover the following spec points:
Know that alpha (α) particles, beta (β–) particles, and gamma (γ) rays are ionising radiations emitted from unstable nuclei in a random process

describe the dangers of ionising radiations, including: • that radiation can cause mutations in living organisms • that radiation can damage cells and tissue • the problems arising from the disposal of radioactive waste and how the associated risks can be reduced

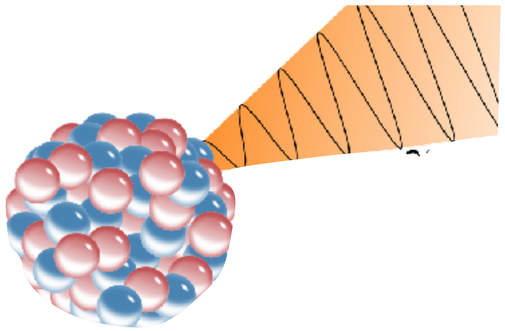
understand how a nucleus of U-235 can be split (the process of fission) by collision with a neutron and that this process releases energy as kinetic energy of the fission products 7.19 know that the fission of U-235 produces two radioactive daughter nuclei and a small number of neutrons 7.20 describe how a chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei 7.21 describe the role played by the control rods and moderator in the fission process 7.22 understand the role of shielding around a nuclear reactor

If you came to our energy lessons (module now saved on my website!) see if you can remember how to label this diagram!

(If you didn't see those lessons, you can try too but there's less pressure on you).

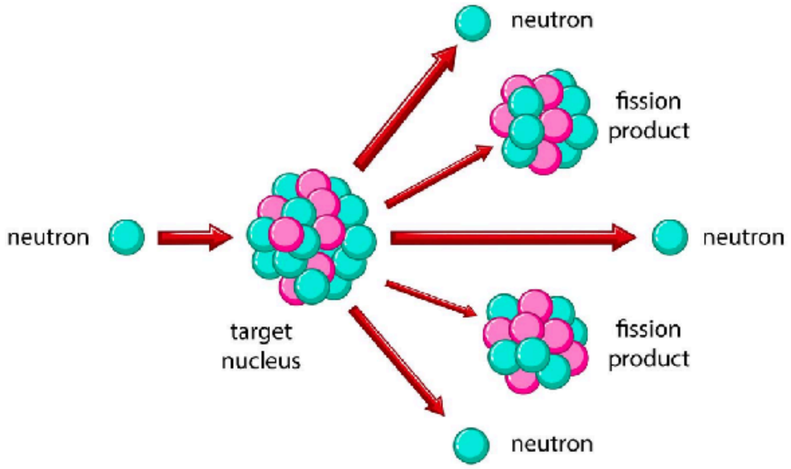


Gamma radiation



$$^{238}_{92}U \rightarrow {}^{?}_{?}U + \gamma$$

Nuclear Fission



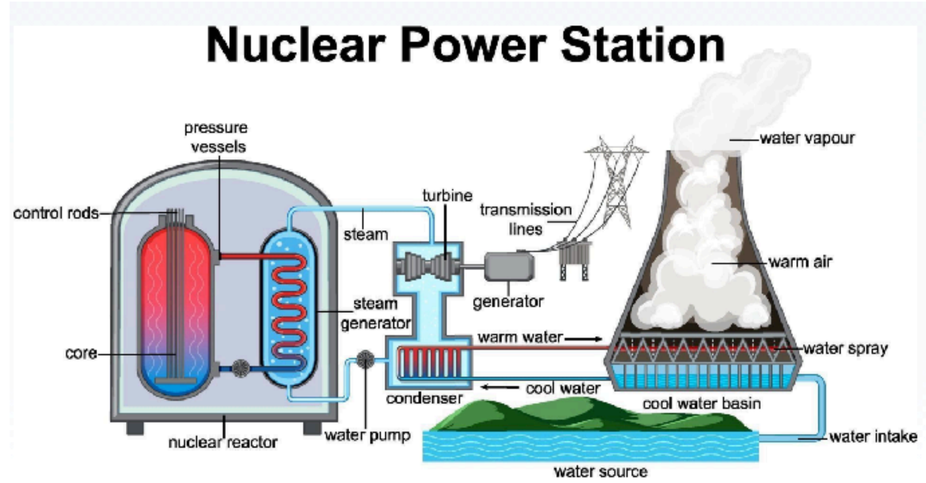
Complete the following:

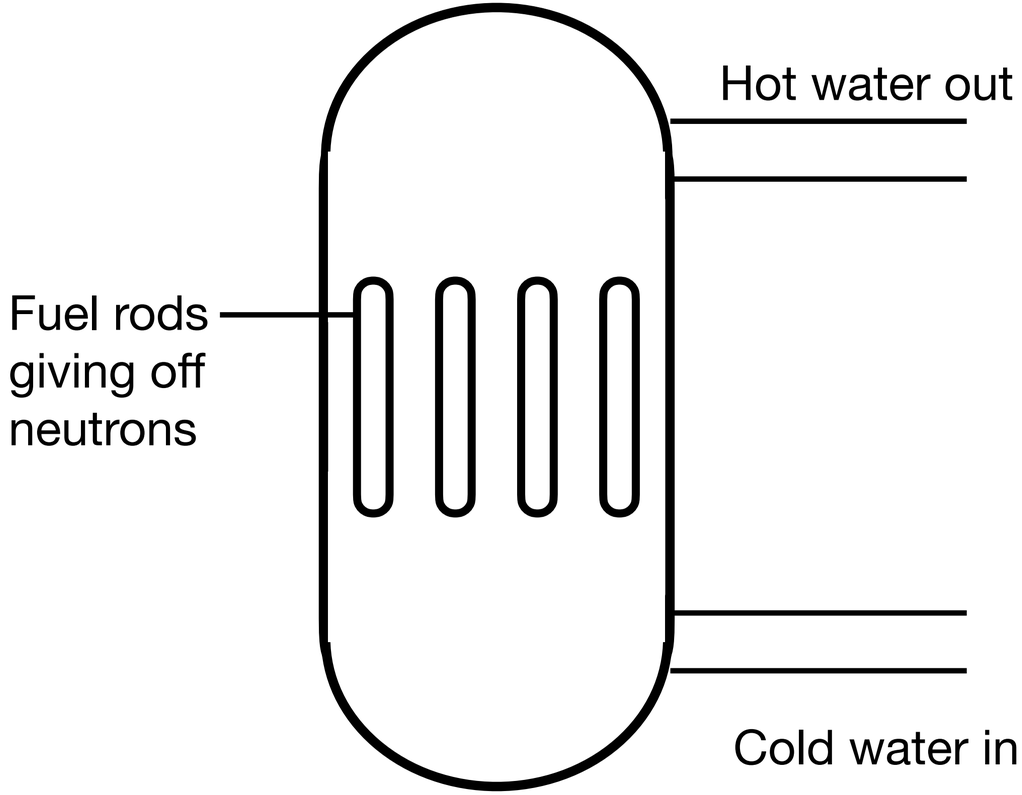
Some atoms have a nucleus which is un_____. So they release radiation: we say atoms like this are _____. The nucleus of an unstable atom can be _____ by firing _____ at it. This process is called nuclear _____.

Done?! Explain, as thoroughly as you can, how heat can be used to generate electricity.

Support me on Kofi to receive nice things: it's the only way this can be my job!

This diagram might be useful for notes!





Theatre of Science IGCSE Physics Radioactivity 4: Properties of Radiation

To join in bring: paper, pen, baking tray, sellotape, chopping board

This lesson will cover the following spec points:
Know how atoms may form positive ions by losing electrons or form negative ions by gaining electrons

Identify alpha (α), beta (β) and gamma (γ) emissions from the nucleus by recalling: (a) their nature (b) their relative ionising effects (c) their relative penetrating abilities

State the effects of ionising nuclear radiations on living things, including cell death, mutations and cancer

Explain their relative ionising effects with reference to: (a) kinetic energy (b) electric charge

Describe the deflection of α-particles, β-particles and γ-radiation in electric fields and magnetic fields

practical: investigate the penetration powers of different types of radiation using either radioactive sources or simulations

Know that ionising nuclear radiation can be measured using a detector connected to a counter
Use count rate measured in counts/s or counts/minute

Matching activity: which of these words and pictures mean the same thing?!

alpha particle

Helium nucleus

Gamma ray

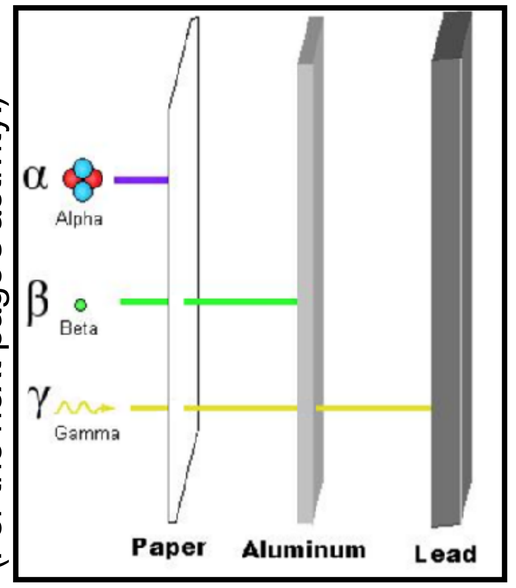
Beta - particle

proton

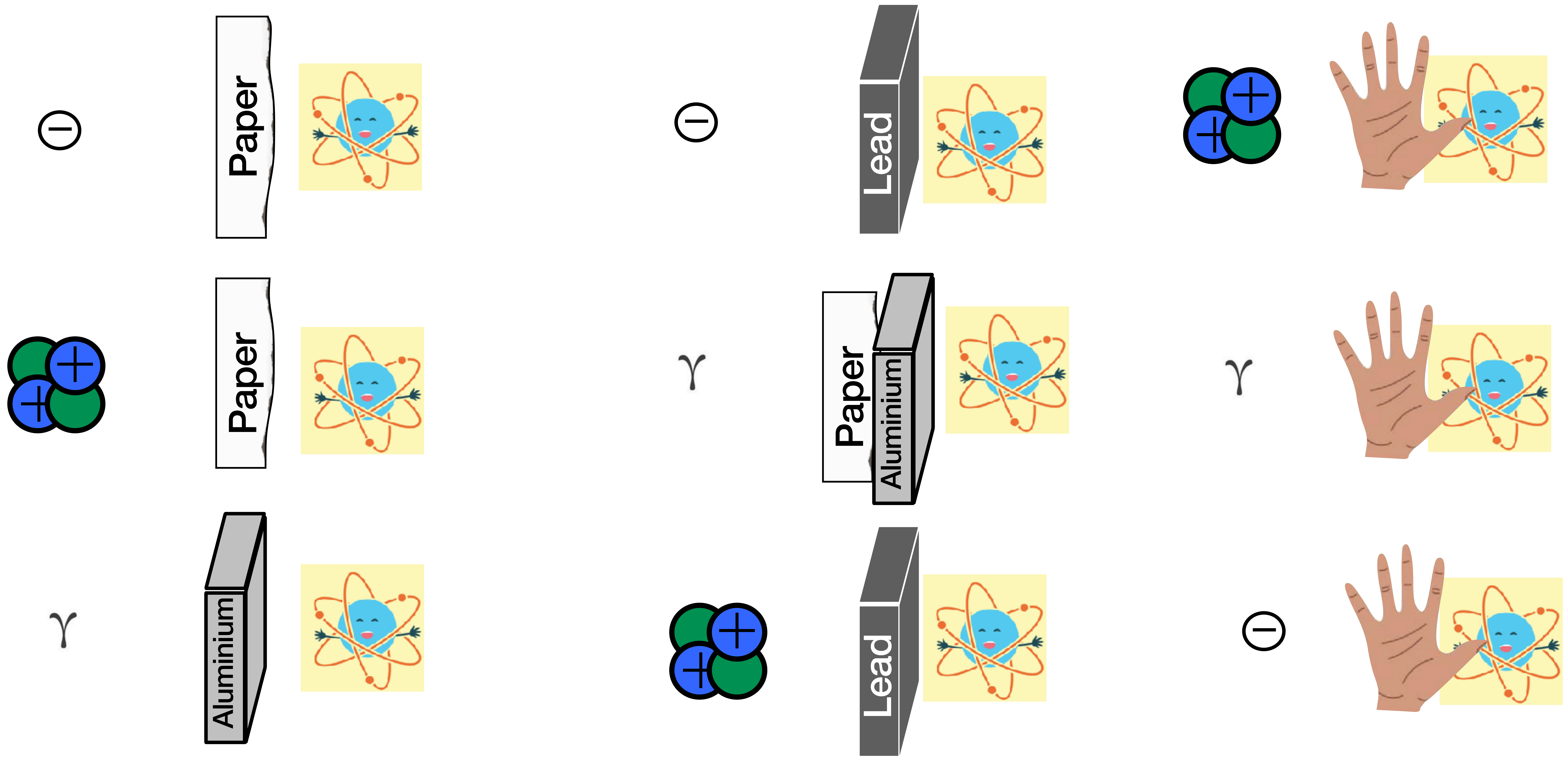
Electron

Electromagnetic wave

(For the next page's activity!)



Is your pet atom safe? Tick or cross!



Theatre of Science IGCSE Physics Radioactivity 5: Half Life

To join in bring: paper, pen, felt pen, ruler, pencil, scissors

Sketch your table of results here.

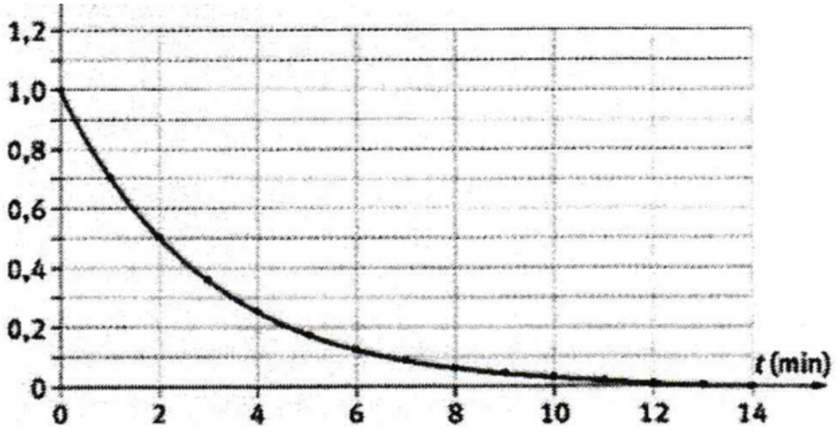
This lesson will cover the following spec points:

Define the half-life of a particular isotope as the time taken for half the nuclei of that isotope in any sample to decay; recall and use this definition in simple calculations, which might involve information in tables or decay curves (calculations will not include background radiation)

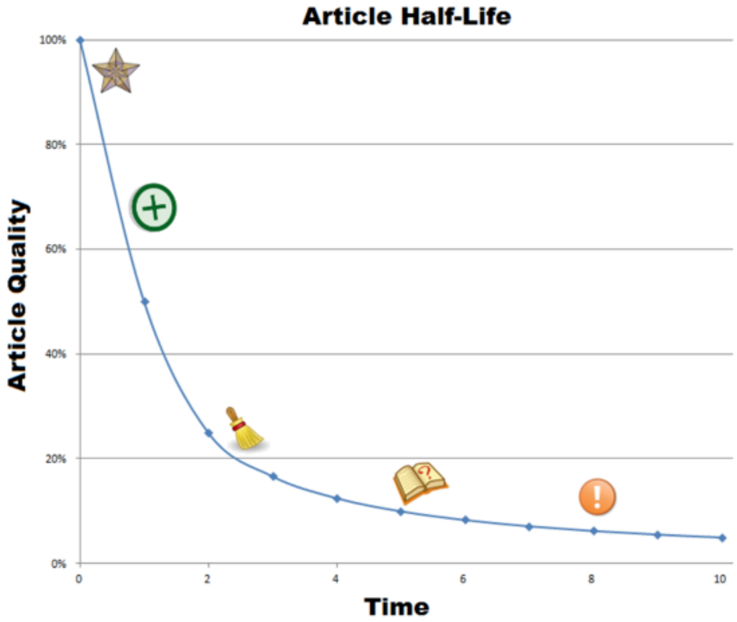
Calculate half-life from data or decay curves from which background radiation has not been subtracted

know that the activity of a radioactive source decreases over a period of time and is measured in becquerels
know the definition of the term 'half-life' and understand that it is different for different radioactive isotopes
use the concept of the half-life to carry out simple calculations on activity, including graphical methods

Draw lines on the graphs to show…



What is the half life of this radioactive sample?



…And a wikipedia article?!

The half life of cobalt-60 is 5 years.

Radioactive rock contains 1kg of cobalt-60. The rock weighs 3kg altogether.

How many grams of cobalt-60 will be left after 5 years?

How much will be left after 10 years?

How much would you expect the piece of rock to weigh after 5 years?

About 2kg
About 2.5kg
About 3kg