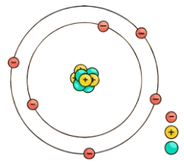
a

What is the radius of the nucleus of an atom?

_____

Label the diagram of an atom (nuclear model).



What is the radius of the nucleus compared to the atom?

_____

b

Fill in the blanks.

Electrons are arranged in different _____ around the _____. If electromagnetic _____ is absorbed, then electrons move _____ from the _____ (a higher energy level). If electromagnetic _____ is emitted, then the electrons move to a _____ (closer to the nucleus).

c

Why does an atom have no overall charge?

_____

_____

What happens to an atom if:

it loses one or more electrons? _____

it gains one or more electrons? _____

Give the definition of an isotope.

_____

_____

Mass number is

_____

_____

Atomic number is

_____

_____

d

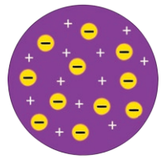
For the following isotopes of chlorine, what are the numbers of protons and neutrons?

$^{35}_{17}$Cl protons = neutrons =

$^{37}_{17}$Cl protons = neutrons =

e

Describe the plum pudding model of the atom.



_____

f

Why was the plum pudding model replaced?

_____

_____

_____

_____

_____

_____

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_____

g

Summarise the key developments of the nuclear model.

_____

_____

_____

_____

_____

_____

_____

_____

h

What effect can new evidence have on models?

_____

i

Define radioactive decay.

_____

_____

_____

_____

j

Complete the following sentences.

The activity of a radioactive source is _____

_____

It is measured in _____

Count rate is _____

k

Complete the table:

Type of Radiation	Description	Penetration	Range in Air	Ionising Power

l

Write how alpha and beta radiation are represented.

m

Complete the following equations:

$^{222}_{88}$Radium ➔ + $^{4}_{2}$He + energy

$^{14}_{6}$Carbon ➔ + $^{0}_{-1}$e + energy

n

Why doesn't a gamma ray change the mass number or atomic number?

_____

_____

o

What effect do alpha and beta decay have on the mass of the nucleus?

alpha - _____

_____

beta - _____

_____

p

My main areas for improvement in this topic are:

_____

_____

_____

_____

_____

_____

_____

_____

_____

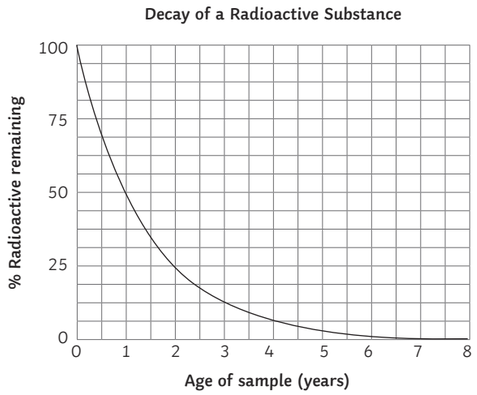
a

Define half-life of a radioactive isotope.

A radioactive isotope has an initial count rate of 600Bq. After 20 minutes its count rate is 150Bq. What is its half-life?

b

What is the half-lifeof the radioactive isotope shown by the graph?



Phosphorus-32 has a half-life of 14 days. What fraction of the original isotope will remain after 42 days?

c

Describe what radioactive contamination is.

Describe irradiation.

Compare irradiation and contamination.

d

What precautions should be taken when irradiating an object?

e

List some sources of background radiation.

What factors affect a person's level of exposure to background radiation?

What is radiation dose measured in?

State some medical uses for nuclear radiation.

f

Explain why alpha radiation would not be used as a medical tracer.

Explain the effect that half-life has on the choice of a medical tracer.

g

Describe nuclear fission.

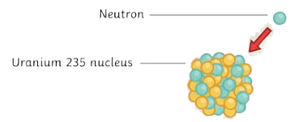
What type of energy is released in a fission reaction?

Apart from neutrons and energy, what else is emitted during fission?

How can fission lead to a chain reaction?

h

Complete the diagram of a chain reaction.



i

Control rods are used to absorb neutrons in a nuclear reactor. Explain the effect that this has on the amount of energy released.

j

Explain how an explosion could occur in a nuclear reactor.

k

Describe the process of nuclear fusion.

Explain why high temperatures are needed for nuclear fusion.

Where does nuclear fusion occur naturally?

Give one similarity and one difference between nuclear fission and fusion.

Similarity -

Difference -

l

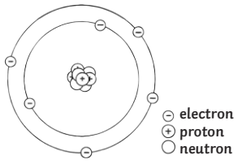
My main areas for improvement in this topic are:

a

What is the radius of the nucleus of an atom?

1×10^{-10} metres

Label the diagram of an atom (nuclear model).



What is the radius of the nucleus compared to the atom?

The radius is less than $\frac{1}{10\,000}$ of the radius of the atom.

b

Fill in the blanks.

Electrons are arranged in different **energy levels** around the **nucleus**. If electromagnetic **radiation** is absorbed, then electrons move **further** from the **nucleus** (a higher energy level). If electromagnetic **radiation** is emitted, then the electrons move to a **lower energy level** (closer to the nucleus).

c

Why does an atom have no overall charge?

Atoms have the same number of electrons (negatively charged) and protons (positively charged).

What happens to an atom if:

it loses one or more electrons? **It becomes positively charged.**

it gains one or more electrons? **It becomes negatively charged.**

Give the definition of an isotope.

An isotope is an element with the same number of protons but a different number of neutrons.

Mass number is

the total number of protons and neutrons in an atom.

Atomic number is

the number of protons in the atom of an element.

d

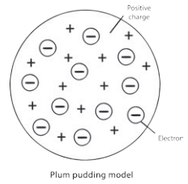
For the following isotopes of chlorine, what are the numbers of protons and neutrons?

$^{35}_{17}$Cl protons = **17** neutrons = **18**

$^{37}_{17}$Cl protons = **17** neutrons = **20**

e

Describe the plum pudding model of the atom.



The atom is a ball of charge with electrons embedded within it.

f

Why was the plum pudding model replaced?

Rutherford and Marsden carried out an alpha particle scattering experiment. If the plum pudding model was correct then the particles would have passed straight through. Most particles passed straight through but some were deflected or reflected. The ones that were reflected must have been repelled by a positive charge that was heavier than the alpha particle.

g

Summarise the key developments of the nuclear model.

Niels Bohr suggested that electrons orbited the nucleus at specific distances. His calculations supported the experimental evidence.

Other experiments suggested that the positive charge was made up of smaller positively charged particles, which were named protons.

James Chadwick's experiments provided evidence for another particle in the nucleus; the neutron.

h

What effect can new evidence have on models?

Models can be further modified to incorporate the new findings.

i

Define radioactive decay.

A random process where unstable atomic nuclei give out radiation and become more stable.

j

Complete the following sentences.

The activity of a radioactive source is **the rate at which it decays.**

It is measured in **becquerels (Bq).**

Count rate is **the number of decays recorded each second by a detector.**

k

Complete the table:

Type of Radiation	Description	Penetration	Range in Air	Ionising Power
alpha (α)	**helium nucleus – 2 protons and 2 neutrons**	**Stopped by a few millimetres of paper.**	**A few centimetres**	**strong**
beta (β)	**a high speed electron ejected from the nucleus as a neutron turns into a proton**	**Stopped by a few millimetres of aluminium.**	**Several metres**	**medium**
gamma (γ)	**electromagnetic radiation from the nucleus**	**Stopped by many centimetres of lead.**	**At least a kilometre**	**weak**

l

Write how alpha and beta radiation are represented.

alpha $^{4}_{2}$**He**

beta $^{0}_{-1}$**e**

m

Complete the following equations:

$^{222}_{88}$Radium → $^{218}_{86}$ **Radon** + $^{4}_{2}$He + energy

$^{14}_{6}$Carbon → $^{14}_{7}$ **Nitrogen** + $^{0}_{-1}$e + energy

n

Why doesn't a gamma ray change the mass number or atomic number?

Gamma radiation is a wave.

o

What effect do alpha and beta decay have on the mass of the nucleus?

alpha - **mass number decreases by 4 and the atomic number decreases by 2.**

beta - **no effect on mass number, increases the atomic number by 1.**

p

My main areas for improvement in this topic are:

a

Define half-life of a radioactive isotope.

The time taken for the number of nuclei of an isotope to halve.

The time taken for the count rate from a sample containing the isotope to fall to half its initial level.

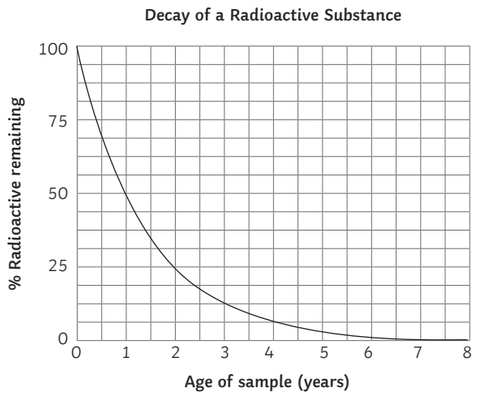
A radioactive isotope has an initial count rate of 600Bq. After 20 minutes its count rate is 150Bq. What is its half-life?

10 minutes.

b

What is the half-lifeof the radioactive isotope shown by the graph?

1 year.



Phosphorus-32 has a half-life of 14 days. What fraction of the original isotope will remain after 42 days?

$\frac{1}{8}$

c

Describe what radioactive contamination is.

It is the unwanted presence of materials containing radioactive atoms on other materials.

Describe irradiation.

This is the process of exposing an object to nuclear radiation, without it becoming radioactive.

Compare irradiation and contamination.

Irradiation does not cause the object to become radioactive but contamination does.

d

What precautions should be taken when irradiating an object?

Wear protective clothing.

Handle sources using tongs.

Use low-activity sources for a short period of time.

e

List some sources of background radiation.

Rocks

Cosmic rays from space

Nuclear weapons testing and nuclear accidents.

Medical

What factors affect a person's level of exposure to background radiation?

Occupation, e.g. pilot exposed to higher levels of cosmic rays.

Location, e.g. some areas have higher levels of radon gas.

What is radiation dose measured in?

sieverts (Sv)

State some medical uses for nuclear radiation.

Looking at internal organs – ingestion or injection an isotope, e.g. test kidney function, look for blockages or damage in the small intestine. Destroying tumours.

f

Explain why alpha radiation would not be used as a medical tracer.

It is the most ionising radiation so would cause the most damage to cells/DNA in the body.

Explain the effect that half-life has on the choice of a medical tracer.

The half-life needs to be long enough to ensure that medical staff can get the results required, but not so long that the patient is left radioactive for a long time.

g

Describe nuclear fission.

A neutron is absorbed by a large atomic nucleus, e.g. uranium-235. The nucleus becomes unstable and splits into two smaller nuclei. Two or three neutrons are also released.

What type of energy is released in a fission reaction?

Kinetic energy

Apart from neutrons and energy, what else is emitted during fission?

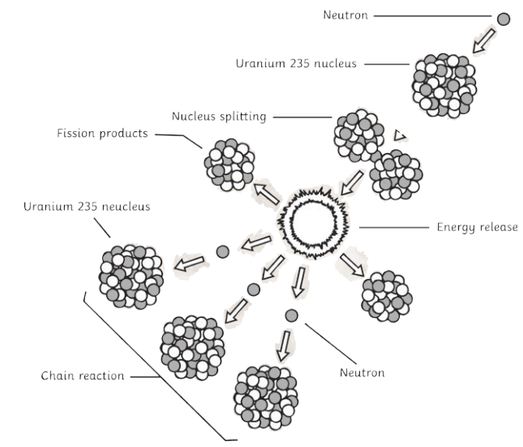
Gamma rays

How can fission lead to a chain reaction?

Each neutron emitted can be absorbed by other nuclei, which then release more neutrons.

h

Complete the diagram of a chain reaction.



i

Control rods are used to absorb neutrons in a nuclear reactor. Explain the effect that this has on the amount of energy released.

There will be fewer neutrons so the chain reaction slows down, causing less energy to be released.

j

Explain how an explosion could occur in a nuclear reactor.

If the neutrons aren't moderated, then there could be an uncontrolled chain reaction where fission releases large amounts of energy. Increasing numbers of neutrons are released and increasing numbers of fission reactions occur until there is an explosion.

k

Describe the process of nuclear fusion.

Two light nuclei join together to form a heavier nucleus.

Some of the mass is lost and energy is released.

Explain why high temperatures are needed for nuclear fusion.

High temperatures are needed because the nuclei repel.

This is because they are both positively charged.

Where does nuclear fusion occur naturally?

In the sun/stars.

Give one similarity and one difference between nuclear fission and fusion.

Similarity - **both release energy.**

Difference - **fusion is the joining of small nuclei, fission is the splitting of large nuclei.**

l

My main areas for improvement in this topic are: