a

Complete the diagram below to show where in an atom you would find the protons, neutrons and electrons.
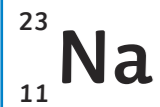
- _____
+ _____
○ _____

Explain why atoms have no overall charge.

_____

_____

b

Complete the sentences by deleting the incorrect answer.

Most of the mass of an atom is concentrated in the nucleus/electron shells. The radius of the nucleus is 1000/10 000 times smaller/larger than the radius of the atom.

The element sodium is shown below.

$$^{23}_{11}\text{Na}$$

Sodium has the following number of...

protons: _____

neutrons: _____

electrons: _____

c

Two isotopes of carbon are shown below:

$$^{12}_{6}\text{C} \qquad ^{14}_{6}\text{C}$$

Define the term isotope.

_____

_____

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

_____

_____

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

_____

_____

d

Describe the plum pudding model of the atom.

_____

_____

e

Radioactive decay is the process of the nucleus emitting ionising radiation.

The unit for radioactivity is...

_____

Explain the term count rate.

_____

Name the piece of equipment used to determine count rate.

_____

Name three safety precautions to be taken when handling a radioactive source.
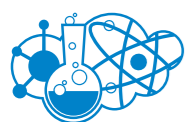
1. _____

2. _____

3. _____

f

State the difference between irradiation and contamination.
keywords: exposed, radioactive, contaminated, harmful

_____

_____

_____

_____

Complete the following equation for the alpha decay of uranium-234:

$$^{234}_{92}\text{U} \rightarrow \text{Th} + \text{He}$$

Complete the following equation for the beta decay of lead-214:

$$^{214}_{82}\text{Pb} \rightarrow \text{Bi} + \text{e}$$

a

Complete the following table.

Type of Radiation	Description	Penetration	Range in Air	Ionising Power
alpha	helium nucleus	stopped by _____	a few _____	_____
_____	high-speed electron	stopped by _____	several _____	_____
_____	EM radiation	stopped by _____	at least a _____	_____

b

Cobalt-60 has an activity rate of 1000Bq and a half-life of 5 years. What will be the activity after 10 years?

_____

_____

_____

_____

c

Fill in the blanks:

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

d

The equations below show the alpha decay of radon and the beta decay of carbon-14.

$$^{219}_{86}\text{radon} \longrightarrow {}^{215}_{84}\text{polonium} + {}^{4}_{2}\text{He}$$

$$^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}\text{e}$$
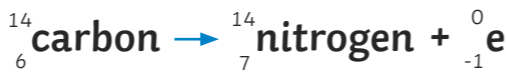
What effect do alpha and beta decay have on the mass of the nucleus?

alpha:

_____

_____

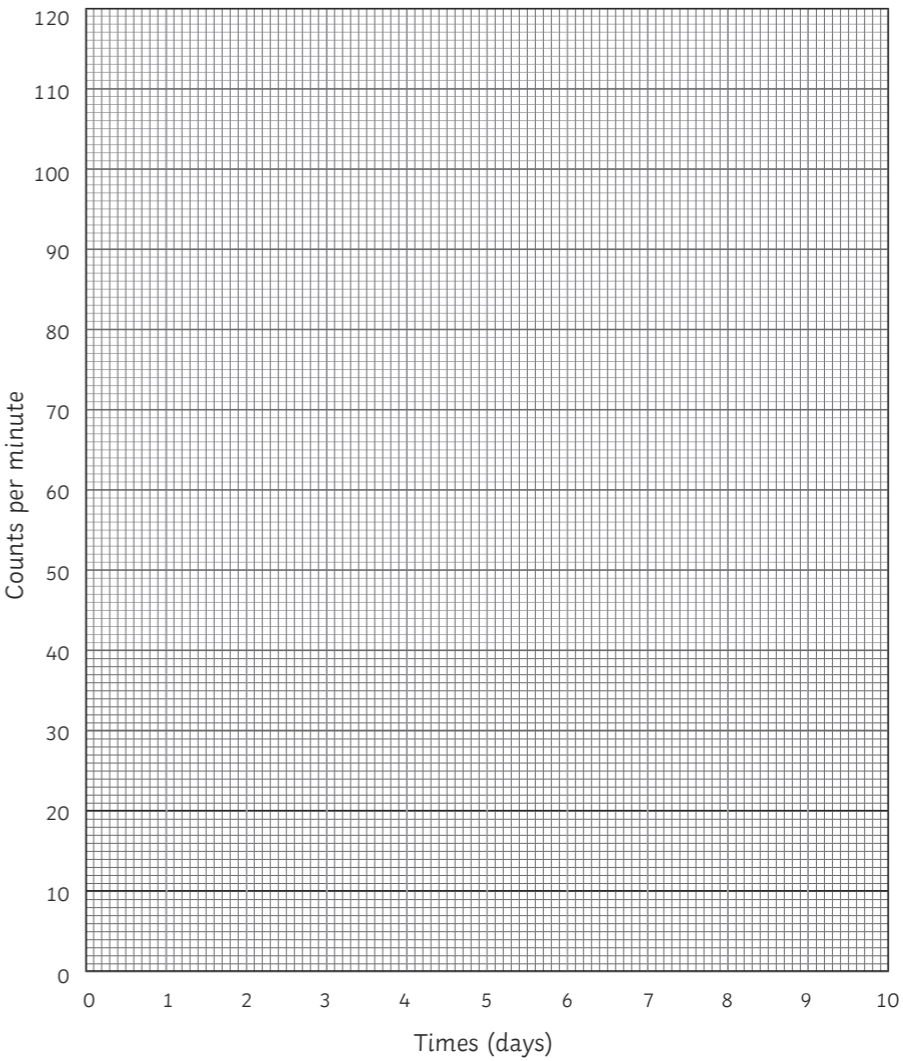_____

beta:

_____

_____

_____

e

Define the term half-life

_____

_____

Substance A is a radioactive material that will change with time. The data below shows the radioactivity of substance A.
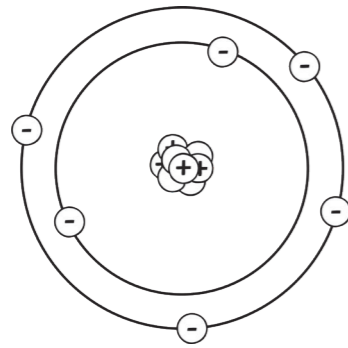
Time (days)	0	2	4	6	8	10
Count rate (counts/second)	120	60	30	15	7.5	3.75

Plot a half-life graph on the graph paper.

Use your graph to calculate the half-life.

_____

Counts per minute

Times (days)

a

Complete the diagram below to show where in an atom you would find the protons, neutrons and electrons.
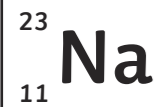

- ⊖ electrons
- ⊕ protons
- ◯ neutrons

Explain why atoms have no overall charge.
Atoms have no overall charge because the number of protons equals the number of electrons. This means the positive charges (protons) are equal to the negative charges (electrons).

b

Complete the sentences by deleting the incorrect answer.

Most of the mass of an atom is concentrated in the nucleus/~~electron shells~~. The radius of the nucleus is ~~1000~~/10 000 times smaller/~~larger~~ than the radius of the atom.

The element sodium is shown below.

$$^{23}_{11}Na$$

Sodium has the following number of...

protons: **11**

neutrons: **12**

electrons: **11**

c

Two isotopes of carbon are shown below:

$$^{12}_{6}C \qquad ^{14}_{6}C$$

Define the term isotope.
Different versions of the same element with the same number of protons but different numbers of neutrons.

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

d

Describe the plum pudding model of the atom.
Atoms are spheres of positive charge with negatively charged electrons stuck in them.

e

Radioactive decay is the process of the nucleus emitting ionising radiation.

The unit for radioactivity is...
Bq (becquerels)

Explain the term count rate.
The number of radiation counts per second.

Name the piece of equipment used to determine count rate.
Geiger-Müller tube.

Name three safety precautions to be taken when handling a radioactive source.

1. **Wear gloves.**
2. **Use tongs to hold the source.**
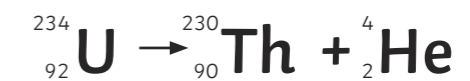3. **Wear protective clothing.**

f

State the difference between irradiation and contamination.
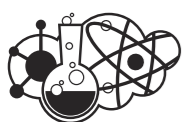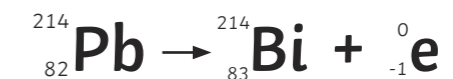**keywords:** exposed, radioactive, contaminated, harmful
Irradiation means an object has been exposed to a radioactive source but is not radioactive.
Contamination involves radioactive particles getting onto an object. It is contaminated and is harmful.

Complete the following equation for the alpha decay of uranium-234:

$$^{234}_{92}U \rightarrow ^{230}_{90}Th + ^{4}_{2}He$$

Complete the following equation for the beta decay of lead-214:

$$^{214}_{82}Pb \rightarrow ^{214}_{83}Bi + ^{0}_{-1}e$$

Science

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a

Complete the following table.

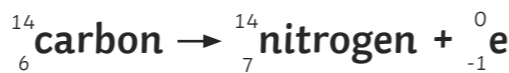| Type of Radiation	Description	Penetration	Range in Air	Ionising Power
alpha	helium nucleus	stopped by **paper**	a few **cms**	**strong**
beta	high-speed electron	stopped by **aluminium**	several **metres**	**medium**
gamma	EM radiation	stopped by **lead**	at least a **km**	**weak**

b

Cobalt-60 has an activity rate of 1000Bq and a half-life of 5 years. What will be the activity after 10 years?

250Bq

c

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** (to a higher energy level). If electromagnetic **radiation** is emitted, then the electrons move to a **lower energy level** (closer to the nucleus).

d

The equations below show the alpha decay of radon and the beta decay of carbon-14.

$$^{219}_{86}\text{radon} \rightarrow \, ^{215}_{84}\text{polonium} + \, ^{4}_{2}\text{He}$$

$$^{14}_{6}\text{carbon} \rightarrow \, ^{14}_{7}\text{nitrogen} + \, ^{0}_{-1}\text{e}$$

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

alpha:
The mass is reduced.

beta:
The mass is unchanged because a neutron changes into a proton.

e

Define the term half-life

The time taken for the radioactivity of a specified isotope to fall to half its original value.

Substance A is a radioactive material that will change with time. The data below shows the radioactivity of substance A.

Time (days)	0	2	4	6	8	10
Count rate (counts/second)	120	60	30	15	7.5	3.75

Plot a half-life graph on the graph paper.

Use your graph to calculate the half-life.

2 days