WJEC A-Level Physics

3.5 Nuclear Decay

Flashcards

Describe briefly how Rutherford carried out his alpha scattering experiment.

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Rutherford directed a stream of high speed alpha particles at a very thin sheet of gold foil and observed how these particles were affected by it.

What was the expected outcome of Rutherford's experiment?

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Most of the alpha particles were expected to pass straight through the foil with very little deflection.

What was observed by Rutherford?

What was observed by Rutherford?

- Most particles passed through with no deflection.
- Some particles were deflected by large angles.
- A few particles were deflected by more than 90 degrees.

What conclusion can be drawn from the observation that most particles passed straight through?

What conclusion can be drawn from the observation that most particles passed straight through?

In can be concluded that most of the atom must be empty space.

What conclusion can be drawn from the observation that some particles were deflected by large angles?

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It suggests that the centre of the atom must have a large positive charge which can repel these particles.

What conclusion can be drawn from the observation that some particles were deflected by more than 90 degrees?

What conclusion can be drawn from the observation that some particles were deflected by more than 90 degrees?

It suggests that the centre of the atom must be very small but also very dense since it changed the direction of fast-moving particles.

Name 3 types of radiation.

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1. Alpha
2. Beta (plus and minus)
3. Gamma

Order alpha, gamma and beta radiation starting with the most ionising.

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- Alpha
- Beta
- Gamma

Order alpha, gamma and beta radiation starting with the most penetrating.

Order alpha, gamma and beta radiation starting with the most ionising.

- Gamma
- Beta
- Alpha

A sheet of paper can block which type of radiation?

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Alpha radiation.

When a nucleus decays through gamma radiation, how does the atomic number and mass number change?

When a nucleus decays through gamma radiation, how does the atomic number and mass number change?

They remain the same as the number of protons and neutrons remains constant.

Why is ionising radiation seen as dangerous?

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Ionising radiation can kill or mutate cells, which could lead to mutations and cause conditions such as cancer.

Which radiation is more harmful inside a human body, alpha or gamma?

Which radiation is more harmful inside a human body, alpha or gamma?

Alpha radiation - because it has a high ionising power so it would damage more cells. It is also very poorly penetrating, therefore it is not be able to leave the body, whereas gamma radiation is highly penetrating.

Give an example of a real life use of Beta decay and explain why Beta is chosen for this.

Give an example of a real life use of Beta decay and explain why Beta is chosen for this.

Beta radiation can be used to measure the thickness of paper or aluminium foil. Alpha isn't used as it is less penetrative and wouldn't reach the detector on the other side of the sheet. Gamma radiation is too penetrative and would pass through everything.

Which type of radiation follows the inverse square law?

Which type of radiation follows the inverse square law?

Gamma radiation.

What does the inverse square law state?

What does the inverse square law state?

The intensity is inversely proportional to the square of the distance from the source.

What is intensity measured in?

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Watts, W

Describe an experiment which can be used to show the inverse square law and gamma rays.

Describe an experiment which can be used to show the inverse square law and gamma rays.

- Firstly measure background radiation (using Geiger Muller tube), without the gamma source in the room.
- Then put the gamma source at a set distance (1m) from the GM tube and measure the count rate per minute. Record 3 measurements for each distance and take an average.
- Do this for many distances going up in 10cm intervals.
- Take away the background radiation from each reading.
- Square each of the distances.
- Plot a graph of the count rate per minute against 1 over distance squared ($1/d^2$).
- If it is a straight line through the origin then it confirms they are directly proportional.

What is background radiation?

What is background radiation?

Radiation that is constantly in the surroundings from sources such as rocks and food.

What is the decay constant (λ)?

What is the decay constant?

The probability of a nucleus decaying per second.

What are the units for the decay constant (λ)?

What are the units for the decay constant?

s^{-1}

What is half life?

What is half life?

The time it takes for half of the unstable nuclei in a substance to decay.

What equation can you use to work out the half life of an object?

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$$T_{1/2} = ln(2)/\lambda$$

Derive $T_{1/2} = \ln(2)/\lambda$

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From the equation for radioactive decay $N = N_o e^{-\lambda t}$

Sub in $T_{1/2}$ and for $N/N_o = e^{-\lambda T1/2} = ½$

$$e^{\lambda T1/2} = 2$$

$$\lambda T_{1/2} = \ln 2$$

$$T_{1/2} = \ln(2)/\lambda$$

Complete the equation. λN =?

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Activity

What is activity measured in?

What is activity measured in?

Bq (decays per second).

True or false? Radioactive isotopes decay exponentially.

True or false? Radioactive isotopes decay exponentially.

True.

i.e . $N=N_0e^{-\lambda t}$

Why is Technetium 99m useful in medicine?

Why is Technetium 99m useful in medicine?

- It releases gamma radiation.
- It has a short half life therefore it doesn't stay highly radioactive for long.
- Half life of 6 hours: long enough for it to be detected.
- It can be made near to the hospital.
- Easy to detect outside the patient.
- 'Clears away' after a few days.