

AQA AS Atomic Structure, Specific Charge and Nuclear Stability worksheet

35-40 minutes independent practice + 15-20 minutes review | 39 marks

Specification points covered

- 3.2.1.1(a-e) Describe atoms and nuclei; use particle charge and mass, nuclide notation, isotopes and specific charge.
- 3.2.1.2(a-b) Describe the strong nuclear force, including attraction to about 3 fm and repulsion below about 0.5 fm.
- 3.2.1.2(c-d) Describe unstable nuclei and write alpha and beta-minus decay equations.
- 3.2.1.2(e) Explain why a neutrino is needed in beta decay to conserve energy.

Isotope-separation and probe calibration facility

Engineers identify ions by charge and mass, then choose nuclear calibration sources for an autonomous probe. Track proton number, nucleon number and emitted particles carefully; use nuclear-force language rather than saying nuclei simply 'want to be stable'.

1. Constituents and nuclides

1. State the relative charge and relative mass of a proton, neutron and electron. [4 marks]

2. An aluminium-27 ion has proton number 13 and contains 10 electrons. State its numbers of protons, neutrons and electrons and its charge in units of e. [4 marks]

3. Define isotopes and explain which feature of their nuclei is the same and which is different. [2 marks]

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk



2. Specific charge

4. Calculate the specific charge of a hydrogen-3 nucleus. Use $e = 1.60 \times 10^{-19} \text{ C}$ and nucleon mass $= 1.67 \times 10^{-27} \text{ kg}$. [2 marks]

5. An oxygen-18 ion has gained two electrons. Calculate its specific charge, including the sign. Neglect electron mass. [3 marks]

6. The nuclei of hydrogen-1, hydrogen-2 and hydrogen-3 all have charge $+e$. State the ratio of their specific charges and explain the trend. [2 marks]

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk



3. Nuclear equations

7. Write complete nuclear equations for: (a) alpha decay of polonium-210 to lead; (b) beta-minus decay of carbon-14 to nitrogen. Include every emitted particle needed at AS level. [4 marks]

8. A thorium-234 nucleus, proton number 90, undergoes one alpha decay followed by two beta-minus decays. Determine the nucleon number and proton number of the final nucleus and identify its element. [3 marks]

9. Explain why the electron antineutrino is required in beta-minus decay. [2 marks]

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk



4. Nuclear stability

10. Describe how the strong nuclear force varies with nucleon separation and explain how this behaviour contributes to nuclear stability. [4 marks]

11. Stable heavy nuclei contain more neutrons than protons. Explain this imbalance by comparing the strong nuclear interaction with electrostatic repulsion. [4 marks]

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk



5. Unfamiliar application

12. A space probe carries two calibration sources. Source X is polonium-210 and source Y is carbon-14. Deduce the daughter nucleus from each decay and explain, using nuclear forces and conservation, why the two decay processes change nucleon and proton numbers differently. [5 marks]

Review and improve

- ☐ I distinguish charge, mass, proton number and nucleon number.
- ☐ I calculate specific charge using the total charge and total mass.
- ☐ I explain stability using the range and particles affected by each interaction.

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk

