AQA · GCSE · PHYSICS • EXERCISE SHEET

4.1 Atomic structure and isotopes

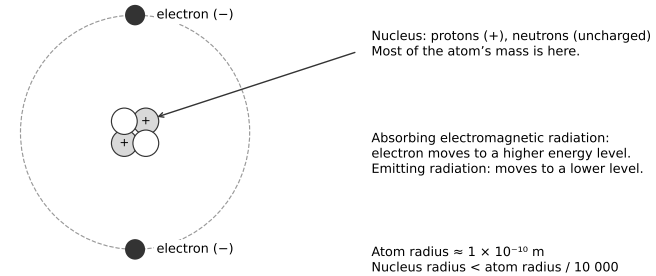
Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS isotopes

Objective

Compute protons, neutrons and electrons from A and Z, use isotope notation, and describe the atom's scale and energy levels. Original questions for spec statements 4.4.1.1–4.4.1.2.

1 Key knowledge and worked examples



Neutral helium atom; schematic, not to scale

The nucleus holds most of the mass in less than 1/10 000 of the radius.

Fact	Value
atom radius	about 1×10^{-10} m
nucleus radius	less than 1/10 000 of the atom's
charge of nucleus	positive (protons +, neutrons no charge)
electrons	negative, at different distances (energy levels)

Notation ${}^{A}_{Z}X$: Z = **atomic number** = protons; A = **mass number** = protons + neutrons.

Wanted	Rule
protons	Z
electrons (neutral atom)	$= Z$
neutrons	$A - Z$

Isotopes : same element (same Z), **different neutrons** (different A). Losing outer electrons makes a **positive ion**.

Energy levels: **absorbing** electromagnetic radiation moves an electron **out** to a higher level; **emitting** moves it **in**.

Worked example. Uranium-235: ${}^{235}_{92}\mathrm{U}$.

- Protons 92, electrons 92, neutrons $235 - 92 = 143$.
- Uranium-238 has the same Z but 146 neutrons: isotopes of uranium.

2 Practice

2.1 Carbon-13: state the number of protons, neutrons and electrons. [3]

2.2 What is an isotope? Use hydrogen-1 and hydrogen-2 in your answer. [2]

2.3 State two facts about the nucleus of an atom, one about its size and one about its mass. [2]

3 Exam-style questions

3.1 The table shows three atoms.

Atom	A	Z
P	31	15
Q	32	16
R	31	16

(a) Which two atoms are isotopes of the same element? Explain. [2]

(b) State the number of neutrons in atom P. [1]

(c) Atom P loses three electrons. State its new charge and the name for what it has become. [2]

3.2 An electron in an atom absorbs electromagnetic radiation and moves to a higher energy level.

(a) Describe what happens to its distance from the nucleus. [1]

(b) Later the electron emits radiation. Describe the change of level and where the emitted energy comes from. [2]

3.3 The radius of an atom is 2.0×10^{-10} m; the radius of its nucleus is 1.0×10^{-14} m.

(a) Calculate how many times larger the atom's radius is than the nucleus's. Give your answer in standard form. [2]

(b) The spec says the nucleus is "less than 1/10 000 of the radius of the atom". Does this atom satisfy that? Show working. [2]