

2.5 Use atomic numbers, isotopes and bonding models correctly

Name: _____ Class: _____ Date: _____

Total: 24 marks

KEY WORDS atomic number 原子序数 • mass number 质量数 • isotope 同位素

Objective

Use atomic numbers, isotopes and bonding models correctly. This is original GAC023-aligned practice, not an official assessment. All supplied case data and review records are fictional; explicitly cited background is factual. The case data are invented for learning; they are not findings about a real school, country or population. Use the supplied evidence and do not invent missing observations.

1 Key knowledge and worked examples

■ Key knowledge: particle counts distinguish elements, isotopes and ions

The **atomic number** 原子序数 is the proton count and identifies an element. The **mass number** 质量数 counts protons plus neutrons. An **isotope** 同位素 has the same proton count as another isotope of its element but a different neutron count. A neutral atom has equal proton and electron counts; changing electrons can form an ion without changing the element. Ionic bonding is electrostatic attraction between oppositely charged ions; electron transfer can explain their formation. Covalent bonding involves shared electron pairs.

■ Source A: text or task brief

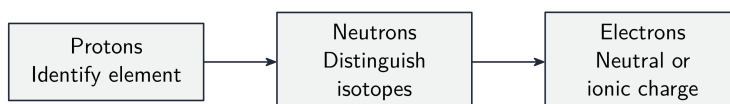
Supplied introductory models: neutral sodium-23 has atomic number 11 and mass number 23; neutral sodium-24 has atomic number 11 and mass number 24. Chlorine-35 has atomic number 17 and mass number 35. In a simplified ionic formation model, one sodium atom loses one electron to form Na^+ and one chlorine atom gains one electron to form Cl^- . The ions attract; the model is not a practical instruction to react these materials.

The periodic table orders elements by atomic number. In the introductory main-group model, outer electron arrangements help explain similarities in group behaviour. For a covalent example, two hydrogen atoms share an electron pair in H_2 . Hydrogen-1 has one proton and no neutron.

■ Source B: response or review record

Student note: “Sodium-23 has 23 neutrons. Sodium-24 is a different element because its mass changed. Na^+ has twelve electrons and Cl^- has sixteen. Ionic bonds are simply the act of transferring an electron, with no attraction afterwards. Every atom must contain a neutron. Elements in a group are identical because all their electrons are the same.”

■ Worked example: count particles before describing charge



Known: sodium-23 has proton number 11 and mass number 23. Why subtract proton number? The mass number counts protons and neutrons together.

$$N = A - Z$$

$$N = 23 - 11 = 12$$

The neutral atom has 11 electrons. Losing one gives Na^+ with 10 electrons, not 12. The positive charge arises because protons outnumber electrons by one; the proton count is unchanged.

2 Practice

2.1 State the meanings of atomic number and mass number. [2]

2.2 Calculate the neutron counts of sodium-23 and sodium-24. [2]

2.3 Give the electron counts of Na^+ and Cl^- and explain one charge. [3]

2.4 Explain why the two sodium isotopes are the same element but not identical atoms. [3]

3 Exam-style questions

3.1 Correct the bonding, hydrogen and group claims using six points. [6]

[8]

Solutions

2.1

: atomic number counts protons.: mass number counts protons plus neutrons.

2.2

: $N = A - Z = 23 - 11 = 12$.: $N = 24 - 11 = 13$.

2.3

: Na^+ has 10 electrons.: Cl^- has 18 electrons.: Na loses one electron while retaining 11 protons, or Cl gains one while retaining 17 protons, giving the stated imbalance.

2.4

: both have 11 protons.: proton number identifies the element.: neutron counts/mass numbers differ, 12 versus 13 neutrons.

3.1

each: ionic attraction is between opposite charges; transfer describes ion formation rather than the whole bond; covalent H_2 involves a shared pair; supplied hydrogen-1 has no neutron; main-group similarities relate to outer electron arrangements; group elements have different proton numbers/full structures and are not identical.

3.2

Local analytic rubric, 8 ×: define proton identity; give sodium neutron counts; retain same element; correct Na^+ electron count; correct Cl^- electron count; distinguish attraction from transfer; identify covalent sharing; recognise hydrogen-1 exception; coherent truthful 80–110 word response. Example: “Atomic number counts protons, while mass number counts protons and neutrons. Sodium-23 therefore has twelve neutrons and sodium-24 thirteen. Both remain sodium because each has eleven protons. A neutral sodium atom has eleven electrons; losing one produces Na^+ with ten. Neutral chlorine has seventeen electrons; gaining one produces Cl^- with eighteen. Electron transfer explains formation of these ions, while their opposite charges produce ionic attraction. In the supplied hydrogen molecule, an electron pair is shared, giving a covalent model. Not every atom contains a neutron: hydrogen-1 has one proton and no neutron.”