

SCHOOL: Your school name

SENIOR FOUR CHEMISTRY
END OF TERM EXAMINATION · FREE SAMPLE
MARKING SCHEME (TEACHER'S COPY)

Academic year: 20..... – 20.....

Date:/...../20.....

Duration: 2 hours

Total marks: 39

Content covered: Unit 1: Structure of an atom and mass spectrum · Unit 2: Electron configurations of atoms and ions · Unit 3: Formation of ionic and metallic bonds · Unit 4: Covalent bond and molecular structures

INSTRUCTIONS

1. A full paper has THREE sections and 100 marks: A 55 marks (all questions), B 30 marks (any three of four), C 15 marks (one of two).
2. This free sample shows one extract of each section.
3. Write your answers in the answer booklet provided.
4. Use correct chemical terms and balanced equations and show units in calculations.

SECTION A (extract of 55 marks)

Attempt ALL questions.

1. Carbon-14 is used in: (1 mark)

- A. fertilisers
B. water treatment
C. making steel
D. dating ancient objects

Answer: D. dating ancient objects**Explanation:** Its half-life allows age estimation.

2. Which element has the highest first ionisation energy? (1 mark)

- A. Neon
B. Helium
C. Lithium
D. Hydrogen

Answer: B. Helium**Explanation:** Small atom with a full shell.

3. Magnesium oxide has a higher melting point than sodium chloride because: (1 mark)

- A. it has free electrons
B. it is covalent
C. its ions carry higher charges and are smaller
D. it is a metal

Answer: C. its ions carry higher charges and are smaller**Explanation:** Stronger electrostatic attraction.

4. Matching. Match each item in column A with the correct answer in column B. Write the letter in the answer column. (4 marks)

Column A	Answer	Column B
1. Ionic compounds dissolve in water because:	b	a. $1s^2 2s^2 2p^6 3s^2 3p^6$
2. The spectral lines of hydrogen get closer together at higher frequency because:	d	b. polar water molecules surround and separate the ions
3. The formula of the ionic compound between Al^{3+} and S^{2-} is:	c	c. Al_2S_3
4. The configuration of the Cl^- ion (Cl Z = 17) is:	a	d. energy levels get closer together at higher n

Answer: 1 → b, 2 → d, 3 → c, 4 → a**Marking:** 1 mark for each correct match (4 marks).

5. Fill in the blanks. Use the words in the box to complete the sentences. One word in the box is not needed. (3 marks)

two isotopes · increase · 5 · 3

- (i) The number of orbitals in a d sub-level is **5**.
- (ii) A spectrum shows two peaks for an element at m/z 63 (69%) and 65 (31%). The element has **two isotopes**.
- (iii) Successive ionisation energies of an element always **increase**.

Answer: (i) 5; (ii) two isotopes; (iii) increase

Marking: 1 mark for each correct word (3 marks).

6. What does a large jump between the 2nd and 3rd ionisation energies show? (4 marks)

Model answer: The element has 2 outer electrons (group 2); the 3rd comes from an inner shell.

Marking: 1 mark for each correct key point in the model answer, up to 4 marks. Accept other correct wording.

Common mistake: Saying it has 3 outer electrons.

SECTION B (extract of 30 marks)

Attempt any *THREE* questions.

7. **Formation of ionic and metallic bonds** (10 marks)

- (a) Use the electron-sea model to explain why alloys such as steel are harder but conduct less well than pure iron. (5 marks)

Model answer: In pure iron, identical ions form regular layers that slide easily. [1]
Carbon atoms of a different size distort the lattice and block sliding, so steel is harder. [2]
The distorted lattice also scatters moving electrons more, so electrical conductivity decreases. [2]

Marking: Give the marks shown in brackets [] for each step. Accept any correct equivalent answer.

Watch out: Hardness and conductivity both depend on the regularity of the lattice.

- (b) Lattice energies (kJ/mol): NaCl –787, KCl –718, MgO –3850. (5 marks)
- (i) Explain why MgO has the largest value. [2]
(ii) Explain why KCl is smaller than NaCl. [2]
(iii) Predict which has the higher melting point, NaCl or KCl. [1]

Model answer: (a) Charges 2+ and 2–, smaller ions. [2]

(b) K^+ is larger than Na^+ . [2]

(c) NaCl. [1]

Marking: Give the marks shown in brackets [] for each point. Accept other correct wording.

SECTION C (extract of 15 marks)*Attempt only ONE question.***8. Electron configurations of atoms and ions (15 marks)**

Street lamps in Kigali use sodium vapour, which gives a yellow light, while fireworks use metal salts for different colours.

Key unit competence: Interpret Bohr's model of the atom, the hydrogen spectrum, electronic configurations and ionisation energies.

(a) State what happens to an electron when an atom absorbs energy. (1 mark)

Model answer: It jumps to a higher energy level (excited state).

Marking: Remember level: 1 mark for a complete, correct answer; part marks for correct points.

(b) Explain why sodium lamps give a particular yellow colour. (2 marks)

Model answer: Electrons fall from 3p to 3s, emitting photons of a definite energy (wavelength 589 nm).

Marking: Understand level: 2 marks for a complete, correct answer; part marks for correct points.

(c) Calculate the energy of one photon of wavelength 589 nm ($h = 6.63 \times 10^{-34}$ J s, $c = 3.00 \times 10^8$ m/s). (2 marks)

Model answer: $E = hc/\lambda = 6.63 \times 10^{-34} \times 3.00 \times 10^8 \div 5.89 \times 10^{-7} = 3.38 \times 10^{-19}$ J.

Marking: Apply level: 2 marks for a complete, correct answer; part marks for correct points.

(d) Why do different metals give different flame colours? (3 marks)

Model answer: Each element has different energy-level gaps, so emits different frequencies.

Marking: Analyse level: 3 marks for a complete, correct answer; part marks for correct points.

(e) Compare sodium lamps with LED street lamps for a city. (3 marks)

Model answer: Sodium: efficient but poor colour rendering; LEDs: white light, longer life, lower energy use, but higher initial cost.

Marking: Evaluate level: 3 marks for a complete, correct answer; part marks for correct points.

(f) Design a simple flame-test experiment to identify unknown salts at school. (4 marks)

Model answer: Clean nichrome wire with HCl; dip in salt; hold in blue flame; record colour (Na yellow, K lilac, Ca brick-red, Cu blue-green); compare with known samples.

Marking: Create level: 4 marks for a complete, correct answer; part marks for correct points.

END