

Electron Configuration

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	AQA
Module	3.1 Physical Chemistry
Topic	3.1.1 Atomic Structure
Sub-Topic	3.1.1.3 Electron Configuration
Booklet	Question Paper 1

Time Allowed: **60 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

Q1. This question is about the elements in Group 2 and their compounds.

(a) Use the Periodic Table to deduce the full electron configuration of calcium.

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(1)

(b) Write an ionic equation, with state symbols, to show the reaction of calcium with an excess of water.

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(1)

(c) State the role of water in the reaction with calcium.

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(1)

(d) Write an equation to show the process that occurs when the first ionisation energy of calcium is measured.

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(1)

(e) State and explain the trend in the first ionisation energies of the elements in Group 2 from magnesium to barium.

Trend

Explanation

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(3)
(Total 7 marks)

Q2. This question is about the elements in Period 3 of the Periodic Table.

- (a) State the element in Period 3 that has the highest melting point.
Explain your answer.

Element

Explanation

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(3)

- (b) State the element in Period 3 that has the highest first ionisation energy.
Explain your answer.

Element

Explanation

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(3)

- (c) Suggest the element in Period 3 that has the highest electronegativity value.

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(1)

- (d) Chlorine is a Period 3 element.
Chlorine forms the molecules ClF_3 and CCl_2

- (i) Use your understanding of electron pair repulsion to draw the shape of ClF_3 and the shape of CCl_2
Include any lone pairs of electrons that influence the shape.

Shape of ClF_3

Shape of CCl_2

(2)

(ii) Name the shape of CCl_2

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(1)

(iii) Write an equation to show the formation of one mole of ClF_3 from its elements.

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(1)

(Total 11 marks)

Q3.(a) Table 1 shows some data about fundamental particles in an atom.

Table 1

Particle	proton	neutron	electron
Mass / g	1.6725×10^{-24}	1.6748×10^{-24}	0.0009×10^{-24}

(i) An atom of hydrogen can be represented as ^1H

Use data from Table 1 to calculate the mass of this hydrogen atom.

.....

(1)

(ii) Which **one** of the following is a fundamental particle that would **not** be deflected by an electric field?

A electron

B neutron

C proton

Write the correct letter, **A**, **B** or **C**, in the box.

(1)

- (b) A naturally occurring sample of the element boron has a relative atomic mass of 10.8.

In this sample, boron exists as two isotopes, ^{10}B and ^{11}B

- (i) Calculate the percentage abundance of ^{10}B in this naturally occurring sample of boron.

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(2)

- (ii) State, in terms of fundamental particles, why the isotopes ^{10}B and ^{11}B have similar chemical reactions.

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(1)

- (c) Complete **Table 2** by suggesting a value for the third ionisation energy of boron.

Table 2

	First	Second	Third	Fourth	Fifth
Ionisation energy / kJ mol^{-1}	799	2420		25 000	32 800

(1)

- (d) Write an equation to show the process that occurs when the **second** ionisation energy of boron is measured. Include state symbols in your equation.

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(1)

- (e) Explain why the second ionisation energy of boron is higher than the first ionisation energy of boron.

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(1)
(Total 8 marks)

Q4.(a) Nickel is a metal with a high melting point.

- (i) State the block in the Periodic Table that contains nickel.

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(1)

- (ii) Explain, in terms of its structure and bonding, why nickel has a high melting point.

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(2)

- (iii) Draw a labelled diagram to show the arrangement of particles in a crystal of nickel.
In your answer, include at least six particles of each type.

(2)

- (iv) Explain why nickel is ductile (can be stretched into wires).

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(1)

- (b) Nickel forms the compound nickel(II) chloride (NiCl₂).

- (i) Give the full electron configuration of the Ni²⁺ ion.

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(1)

- (ii) Balance the following equation to show how anhydrous nickel(II) chloride can be obtained from the hydrated salt using SOCl₂. Identify **one** substance that could react with both gaseous products.



Substance

(2)

(Total 9 marks)

Q5.Aluminium and thallium are elements in Group 3 of the Periodic Table.

Both elements form compounds and ions containing chlorine and bromine.

- (a) Write an equation for the formation of aluminium chloride from its elements.

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(1)

- (b) An aluminium chloride molecule reacts with a chloride ion to form the AlCl₄⁻ ion.

Name the type of bond formed in this reaction. Explain how this type of bond is formed in the AlCl₄⁻ ion.

Type of bond

Explanation

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(2)

- (c) Aluminium chloride has a relative molecular mass of 267 in the gas phase.

Deduce the formula of the aluminium compound that has a relative molecular mass of 267

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(1)

- (d) Deduce the name or formula of a compound that has the same number of atoms, the same number of electrons and the same shape as the AlCl_4^- ion.

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(1)

- (e) Draw and name the shape of the TlBr_5^{2-} ion.

Shape of the TlBr_5^{2-} ion.

Name of shape

(2)

- (f) (i) Draw the shape of the TlCl_2^+ ion.

(1)

- (ii) Explain why the TlCl_2^+ ion has the shape that you have drawn in part (f)(i).

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(1)

(g) Which **one** of the first, second or third ionisations of thallium produces an ion with the electron configuration [Xe] 5d¹⁰6s¹?

Tick (✓) one box.

First	<input type="checkbox"/>
Second	<input type="checkbox"/>
Third	<input type="checkbox"/>

(1)
(Total 10 marks)

Q6. Which change requires the largest amount of energy?

- A** $\text{He}^+(\text{g}) \longrightarrow \text{He}^{2+}(\text{g}) + \text{e}^-$
- B** $\text{Li}(\text{g}) \longrightarrow \text{Li}^+(\text{g}) + \text{e}^-$
- C** $\text{Mg}^+(\text{g}) \longrightarrow \text{Mg}^{2+}(\text{g}) + \text{e}^-$
- D** $\text{N}(\text{g}) \longrightarrow \text{N}^+(\text{g}) + \text{e}^-$

(Total 1 mark)

Q7. The table below shows some successive ionisation energy data for atoms of three different elements **X**, **Y** and **Z**.

Elements **X**, **Y** and **Z** are Ca, Sc and V but not in that order.

	First	Second	Third	Fourth	Fifth	Sixth
X	648	1370	2870	4600	6280	12 400
Y	590	1150	4940	6480	8120	10 496
Z	632	1240	2390	7110	8870	10 720

(a) Which element is calcium?

X

Y

Z

(1)

(b) Which element is vanadium?

X

Y

Z

(1)

(c) Justify your choice of vanadium in part (b)

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(1)

(d) An acidified solution of NH_4VO_3 reacts with zinc.

Explain how observations from this reaction show that vanadium exists in at least two different oxidation states.

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(2)

- (e) The vanadium in 50.0 cm³ of a 0.800 mol dm⁻³ solution of NH₄VO₃ reacts with 506 cm³ of sulfur(IV) oxide gas measured at 20.0 °C and 98.0 kPa.

Use this information to calculate the oxidation state of the vanadium in the solution after the reduction reaction with sulfur(IV) oxide.

Explain your working.

The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

Oxidation state =

(6)

(Total 11 marks)