

Name: \_\_\_\_\_

# Atomic Structure & Periodic Table part 4 AQA Triple Chemistry

Date: \_\_\_\_\_

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Time: **73 minutes**

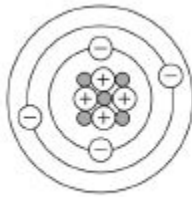
Marks: **70 marks**

Comments:

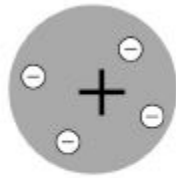
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1.

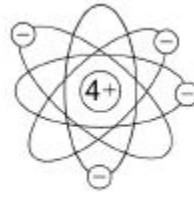
The diagram below represents different models of the atom.



A



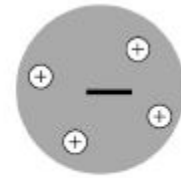
B



C



D



E

(a) Which diagram shows the plum pudding model of the atom?

Tick **one** box.

A	
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B	
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C	
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D	
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E	
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(1)

(b) Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

Tick **one** box.

A	
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B	
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C	
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D	
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E	
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(1)

(c) Which diagram shows the model of the atom resulting from Bohr's work?

Tick **one** box.

A	
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B	
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C	
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D	
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E	
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(1)

(d) Define the mass number of an atom.

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(1)

(e) Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of  $^{69}\text{X}$
- 40% of  $^{71}\text{X}$

Estimate the relative atomic mass of element **X**.

Tick **one** box.

< 69.5

Between 69.5 and 70.0

Between 70.0 and 70.5

> 70.5

(1)

(f) Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

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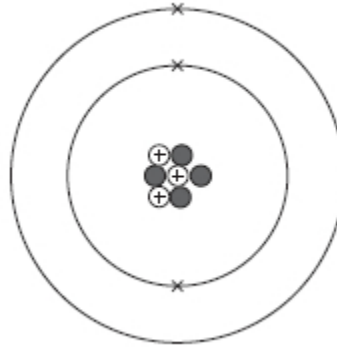
(3)

(Total 8 marks)

**2.**

This question is about atomic structure.

The figure below represents the structure of a lithium atom.



- (a) Name the particle in the atom that has a positive charge.

\_\_\_\_\_

**(1)**

- (b) Name the particle in the atom that has the smallest mass.

\_\_\_\_\_

**(1)**

- (c) Complete the sentences.

Choose the answers from the box.

<b>3</b>	<b>4</b>	<b>7</b>	<b>10</b>
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The mass number of the lithium atom is \_\_\_\_\_.

The number of neutrons in the lithium atom is \_\_\_\_\_.

**(2)**

(d) What are lithium atoms with different numbers of neutrons called?

Tick (✓) **one** box.

Compounds

Ions

Isotopes

Molecules

(1)

(e) Name the particle in the atom discovered by James Chadwick.

\_\_\_\_\_ .

(1)

(f) An element has two isotopes.

The table shows information about the isotopes.

	Mass number	Percentage (%) abundance
Isotope 1	10	20
Isotope 2	11	80

Calculate the relative atomic mass ( $A_r$ ) of the element.

Use the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope 1} + (\text{mass number} \times \text{percentage}) \text{ of isotope 2}}{100}$$

Give your answer to 1 decimal place.

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Relative atomic mass ( $A_r$ ) = \_\_\_\_\_

(2)

(g) The radius of an atom is 0.2 nm

The radius of the nucleus is  $\frac{1}{10000}$  the radius of the atom.

Calculate the radius of the nucleus.

Give your answer in standard form.

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Radius = \_\_\_\_\_ nm

(2)

(Total 10 marks)

3.

This question is about atoms.

(a) What does the number 19 represent in  ${}^{19}_{9}\text{F}$  ?

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(1)

(b) How many atoms are present in one mole of fluorine atoms?

Tick (✓) **one** box.

$2.03 \times 10^{26}$

$2.06 \times 10^{23}$

$6.02 \times 10^{23}$

$6.02 \times 10^{26}$

(1)

(c) The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.

Compare the plum pudding model with the nuclear model of the atom.

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(4)

(d) An element has three isotopes.

The table shows the mass numbers and percentage of each isotope.

	Isotope 1	Isotope 2	Isotope 3
Mass number	24	25	26
Percentage (%)	78.6	10.1	11.3

Calculate the relative atomic mass ( $A_r$ ) of the element.

Give your answer to 3 significant figures.

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Relative atomic mass = \_\_\_\_\_

(2)

(Total 8 marks)

4.

A student investigated the law of conservation of mass.

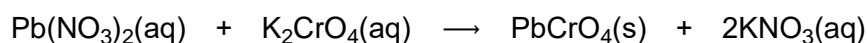
The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

1. Pour lead nitrate solution into a beaker labelled **A**.
2. Pour potassium chromate solution into a beaker labelled **B**.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:



(a) What would the student see when the reaction takes place?

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(1)

(b) The table shows the student's results.

	Mass in g
Beaker <b>A</b> and contents before mixing	128.71
Beaker <b>B</b> and contents before mixing	128.97
Beaker <b>A</b> and contents after mixing	154.10
Beaker <b>B</b> after mixing	103.58

Show that the law of conservation of mass is true.

Use the data from the table above.

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(2)

(c) What is the resolution of the balance used to obtain the results in the table?

Tick (✓) **one** box.

0.01 g     0.1 g     1 g     100 g

(1)

(d) Calculate the relative formula mass ( $M_r$ ) of lead nitrate  $\text{Pb}(\text{NO}_3)_2$

Relative atomic masses ( $A_r$ ): N = 14    O = 16    Pb = 207

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Relative formula mass = \_\_\_\_\_

(2)

(e) The formula of potassium chromate is  $K_2CrO_4$

The charge on the potassium ion is +1

What is the formula of the chromate ion?

Tick (✓) **one** box.

$CrO_4^+$

$CrO_4^{2+}$

$CrO_4^-$

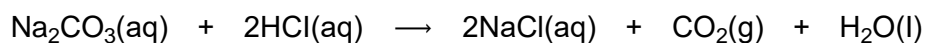
$CrO_4^{2-}$

(1)

(f) Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.

This is the equation for the reaction.



Explain why this student's results would **not** appear to support the law of conservation of mass.

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(3)

(Total 10 marks)



(e) Which element has three electron shells?

Tick (✓) **one** box.

**J**

**L**

**M**

**Q**

**R**

(1)

(f) In the 1860s scientists were trying to organise elements.

**Figure 2** shows the table published by John Newlands in 1865.

The elements are arranged in order of their atomic weights.

**Figure 2**

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co,Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce,La	Zr	Di,Mo	Ro,Ru
Pd	Ag	Cd	U	Sn	Sb	Te

**Figure 3** shows the periodic table published by Dmitri Mendeleev in 1869.

**Figure 3**

H																
Li	Be	B	C	N	O	F										
Na	Mg	Al	Si	P	S	Cl										
K	Cu	Ca	Zn	?	?	Ti	?	V	As	Cr	Se	Mn	Br	Fe	Co	Ni
Rb	Ag	Sr	Cd	Y	In	Zr	Sn	Nb	Sb	Mo	Te	?	I	Ru	Rh	Pd

Mendeleev's table became accepted by other scientists whereas Newlands' table was not.

Evaluate Newlands' and Mendeleev's tables.

You should include:

- a comparison of the tables
- reasons why Mendeleev's table was more acceptable.

Use **Figure 2** and **Figure 3** and your own knowledge.

(6)  
(Total 11 marks)

**6.**

This question is about halogens and their compounds.

The table below shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Element	Boiling point in °C	Colour in aqueous solution
Fluorine	-188	colourless
Chlorine	-35	pale green
Bromine	X	orange
Iodine	184	brown

(a) Why does iodine have a higher boiling point than chlorine?

Tick **one** box.

Iodine is ionic and chlorine is covalent

Iodine is less reactive than chlorine

The covalent bonds between iodine atoms are stronger

The forces between iodine molecules are stronger

(1)

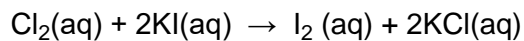
(b) Predict the boiling point of bromine.

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(1)

(c) A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:



Look at table above.

What is the colour of the final solution in this reaction?

Tick **one** box.

Brown

Orange

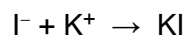
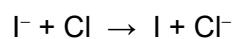
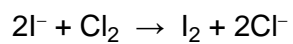
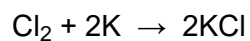
Pale green

Colourless

(1)

(d) What is the ionic equation for the reaction of chlorine with potassium iodide?

Tick **one** box.



(1)

(e) Why does potassium iodide solution conduct electricity?

Tick **one** box.

It contains a metal

It contains electrons which can move

It contains ions which can move

It contains water

(1)

(f) What are the products of electrolysis of potassium iodide solution?

Tick **one** box.

**Product at cathode**

**Product at anode**

hydrogen

iodine

hydrogen

oxygen

potassium

iodine

potassium

oxygen

(1)

(Total 6 marks)

7.

This question is about atomic structure and elements.

(a) Complete the sentences.

(i) The atomic number of an atom is the number of \_\_\_\_\_

(1)

(ii) The mass number of an atom is the number of \_\_\_\_\_

\_\_\_\_\_

(1)

(b) Explain why an atom has no overall charge.

Use the relative electrical charges of sub-atomic particles in your explanation.

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**(2)**

(c) Explain why fluorine and chlorine are in the same group of the periodic table.

Give the electronic structures of fluorine and chlorine in your explanation.

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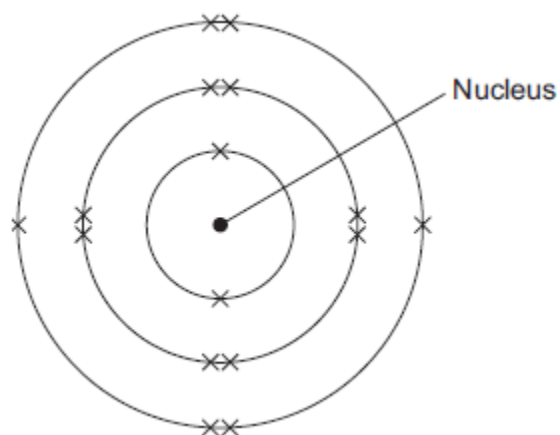
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**(2)**

(d) The diagram shows the electronic structure of an atom of a non-metal.



What is the chemical symbol of this non-metal?

Tick (✓) **one** box.

Ar

O

S

Si

(1)

(e) When elements react, their atoms join with other atoms to form compounds.

Complete the sentences.

(i) Compounds formed when non-metals react with metals consist of particles called \_\_\_\_\_ .

(1)

(ii) Compounds formed from only non-metals consist of particles called \_\_\_\_\_ .

(1)

(Total 9 marks)

8.

This question is about atoms and isotopes.

(a) Atoms contain protons, neutrons and electrons.

A lithium atom has the symbol  ${}^7_3\text{Li}$

Explain, in terms of sub-atomic particles, why the mass number of this lithium atom is 7.

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(3)

(b) Amounts of substances can be described in different ways.

Complete the sentences.

One mole of a substance is the relative formula mass in

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The relative atomic mass of an element compares the mass of an atom of an element with the mass of an atom of

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(2)

(c) Two isotopes of oxygen are  ${}^{18}_8\text{O}$  and  ${}^{16}_8\text{O}$

Describe the similarities and differences between the isotopes  ${}^{18}_8\text{O}$  and  ${}^{16}_8\text{O}$

You should refer to the numbers of sub-atomic particles in each isotope.

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(3)

(Total 8 marks)

## Mark schemes

- 1.** (a) B 1
- (b) C 1
- (c) A 1
- (d) sum of protons and neutrons  
*allow number of protons and neutrons* 1
- (e) between 69.5 and 70.0 1
- (f) Chadwick provided the evidence to show the existence of neutrons  
*allow Chadwick discovered neutrons* 1
- (this was necessary because) isotopes have the same number of protons  
*allow (this was necessary because) isotopes have the same atomic number*
- or**
- (this was necessary because) isotopes are atoms of the same element  
*ignore isotopes have the same number of electrons* 1
- but with different numbers of neutrons  
*allow but with different mass (numbers)* 1
- [8]**
- 2.** (a) proton 1
- (b) electron 1
- (c) 7 1
- 4 1
- in this order only*
- (d) isotopes 1
- (e) neutron 1

(f)  $\frac{(10 \times 20) + (11 \times 80)}{100}$

1

= 10.8

1

*an answer of 10.8 scores 2 marks*

(g)  $\frac{0.2}{10000}$

1

=  $2 \times 10^{-5}$  (nm)

*allow 0.00002 (nm)*

1

*an answer of  $2 \times 10^{-5}$  (nm) scores 2 marks*

**[10]**

**3.**

(a) mass number

*allow the number of protons + neutrons*

1

(b)  $6.02 \times 10^{23}$

1

- (c) **Level 2 (3-4 marks):**  
Scientifically relevant features are identified; the ways in which they are similar / different is made clear.

**Level 1 (1-2 marks):**

Relevant features are identified and differences noted.

**Level 0**

No relevant content.

**Indicative content**

**similarities**

- both have positive charges
- both have (negative) electrons
- neither has neutrons

**differences**

plum pudding model	nuclear model
ball of positive charge (spread throughout)	positive charge concentrated at the centre
electrons spread throughout (embedded in the ball of positive charge)	electrons outside the nucleus
no empty space in the atom	most of the atom is empty space
mass spread throughout	mass concentrated at the centre

4

(d) 
$$\frac{(24 \times 78.6) + (25 \times 0.1) + (26 \times 11.3)}{100}$$

or

$$(24 \times 0.786) + (25 \times 0.101) + (26 \times 0.113)$$

$$= 24.3$$

1

1

*an answer of 24.3 scores 2 marks*

**[8]**

**4.**

- (a) precipitate / solid formed  
*allow colour change*

1

(b) total mass before = 257.68 g  
total mass after = 257.68 g

1

so the mass of products equals  
the mass of the reactants

1

(c) 0.01 g

1

(d)  $207 + (2 \times 14) + (6 \times 16)$   
**or**  
 $207 + 2 \times [14 + (3 \times 16)]$

1

= 331

1

*an answer of 331 scores 2 marks*

(e)  $\text{CrO}_4^{2-}$

1

(f) carbon dioxide is a gas  
*allow a gas is produced*

1

the gas escapes during the reaction

1

(so) the mass at the end is less than expected

1

[10]

5.

(a) **J**

1

(b) **M and Q**  
*either order*

1

(c) **Q**

1

(d) **M**

1

(e) **L**

1

- (f) **Level 3 (5-6 marks):**  
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

**Level 2 (3-4 marks):**  
Some logically linked reasons are given. There may also be a simple judgement.

**Level 1 (1-2 marks):**  
Relevant points are made. They are not logically linked.

**Level 0**  
No relevant content

### Indicative content

#### comparative points

- both tables have more than one element in a box
- both have similar elements in the same column
- both are missing the noble gases
- both arranged elements in order of atomic weight

#### advantages of Mendeleev / disadvantages of Newlands

- Newlands did not leave gaps for undiscovered elements
- Newlands had many more dissimilar elements in a column
- Mendeleev left gaps for undiscovered elements
- Mendeleev changed the order of some elements (e.g. Te and I)

#### points which led to the acceptance of Mendeleev's table

- Mendeleev predicted properties of missing elements
- elements with properties predicted by Mendeleev were discovered
- Mendeleev's predictions turned out to be correct
- elements were discovered which fitted the gaps

6

[11]

6.

- (a) The forces between iodine molecules are stronger

1

- (b) anything in range +30 to +120

1

- (c) Brown

1

- (d)  $2 I^- + Cl_2 \rightarrow I_2 + 2 Cl^-$

1

- (e) It contains ions which can move

1

- (f) hydrogen iodine

1

[6]

- 7.** (a) (i) protons  
*allow "protons or electrons", but do not allow "protons and electrons"* 1
- (ii) protons plus / and neutrons 1
- (b) (because the relative electrical charges are)  $- (1)$  for an electron and  $+ (1)$  for a proton  
*allow electrons are negative and protons are positive* 1
- and the number of electrons is equal to the number of protons  
*if no other mark awarded, allow 1 mark for the charges cancel out* 1
- (c) (the electronic structure of) fluorine is 2,7 and chlorine is 2,8,7  
*allow diagrams for the first marking point* 1
- (so fluorine and chlorine are in the same group) because they have the same number of or 7 electrons in their highest energy level or outer shell  
*if no other mark awarded, allow 1 mark for have the same / similar properties* 1
- (d) S 1
- (e) (i) ions 1
- (ii) molecules 1
- [9]**
- 8.** (a) because this lithium atom has  
3 protons 1
- and 4 neutrons 1
- mass number is total of neutrons and protons  
*accept protons and neutrons have a mass of 1*  
*accept number of neutrons =  $7 - 3(\text{protons})$*   
*ignore mass of electron is negligible* 1

(b) grams

*accept g*

1

$^{12}\text{C}$

*allow carbon-12 or C-12*

*ignore hydrogen or H*

1

(c) any **three** from:

*max 2 if no numbers given*

*numbers if given must be correct*

- both have 8 protons

*accept same number of protons*

- $^{18}\text{O}$  has 10 neutrons

- $^{16}\text{O}$  has 8 neutrons

*accept different number of neutrons or  $^{18}\text{O}$  has two more neutrons for 1 mark*

- both have 8 electrons.

*accept same number of electrons*

3

[8]