

Atomic Structure 1

Name: _____

Class: _____

Date: _____

Time: **75 minutes**

Marks: **69 marks**

Comments:

1. **Figure 1** represents an atom of sulfur.

Figure 1



(a) Complete the table below.

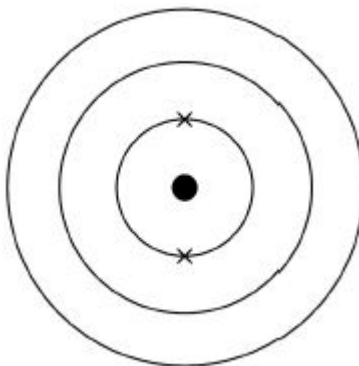
Particle	Number of particles in a sulfur atom
Electron	16
Neutron	
Proton	16

(1)

(b) Sulfur is in Group 6 of the periodic table.

Complete the electronic structure of the sulfur atom represented in **Figure 2**

Figure 2



(1)

(c) Sulfur reacts with oxygen to produce sulfur dioxide.

Complete the word equation for this reaction.

sulfur + _____

(1)

(d) What effect is caused by sulfur dioxide?

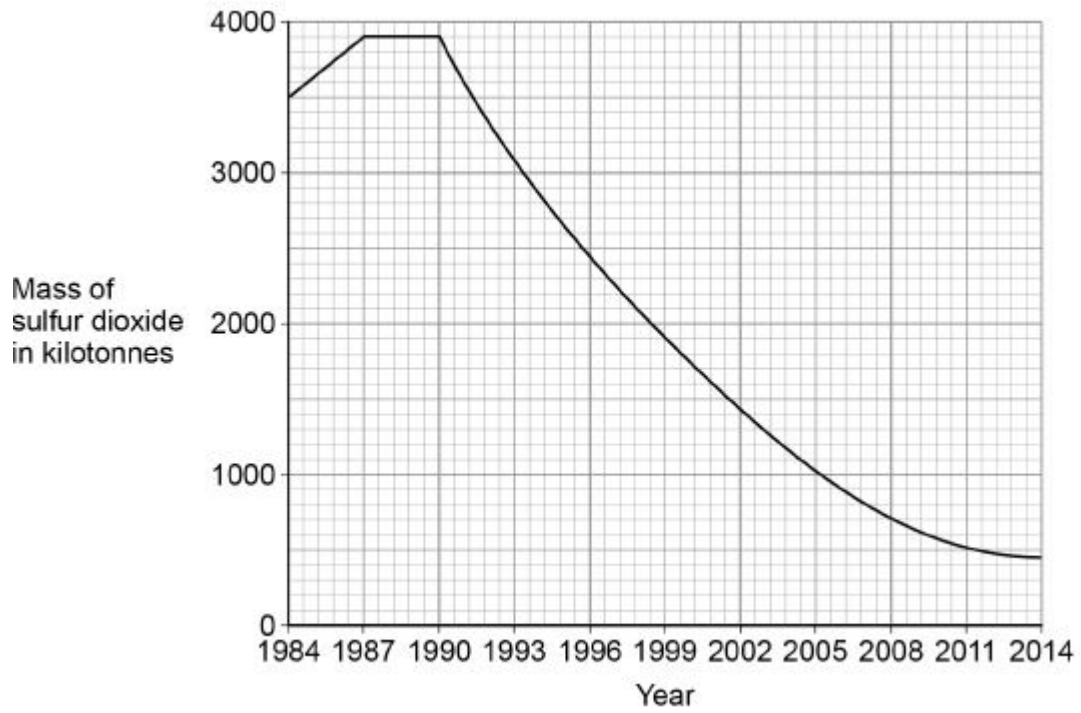
Tick **one** box.

- Acid rain
- Global dimming
- Global warming
- Sea levels rising

(1)

(e) **Figure 3** shows the mass of sulfur dioxide in the Earth's atmosphere between 1984 and 2014

Figure 3



A student said:

'the mass of sulfur dioxide in the atmosphere decreased every year
between 1984 and 2014'

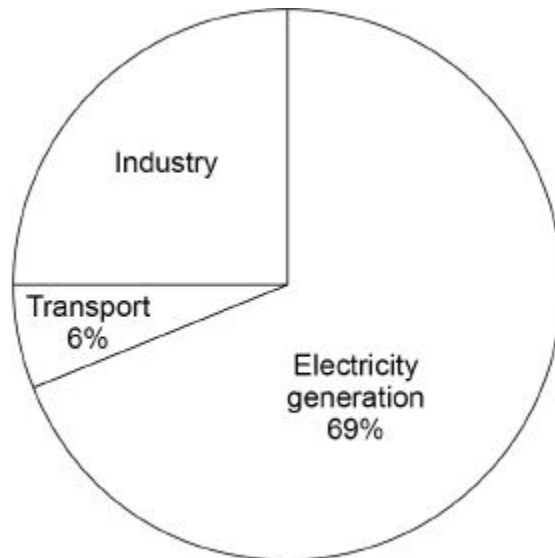
Is the student correct?

Use data from **Figure 3** to justify your answer.

(3)

(f) **Figure 4** shows the percentage of sulfur dioxide released by human activities.

Figure 4



Calculate the percentage of sulfur dioxide released by industry.

Percentage = _____ %

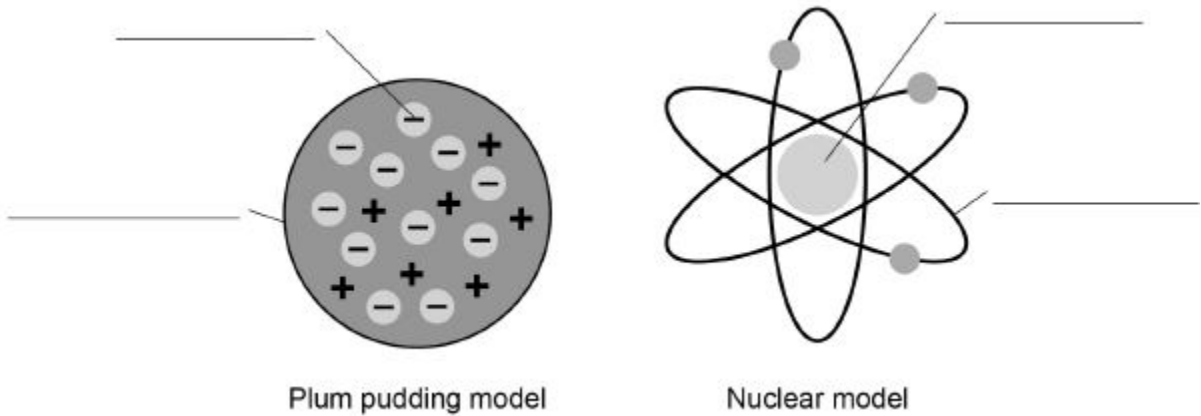
(2)

(Total 9 marks)

2.

Figure 1 shows two models of the atom.

Figure 1



(a) Write the labels on **Figure 1**

Choose the answers from the box.

atom	electron	nucleus
neutron	orbit	proton

(4)

(b) Explain why the total positive charge in every atom of an element is always the same.

(2)

- (c) The results from the alpha particle scattering experiment led to the nuclear model.
Alpha particles were fired at a thin film of gold at a speed of 7% of the speed of light.
Determine the speed of the alpha particles.

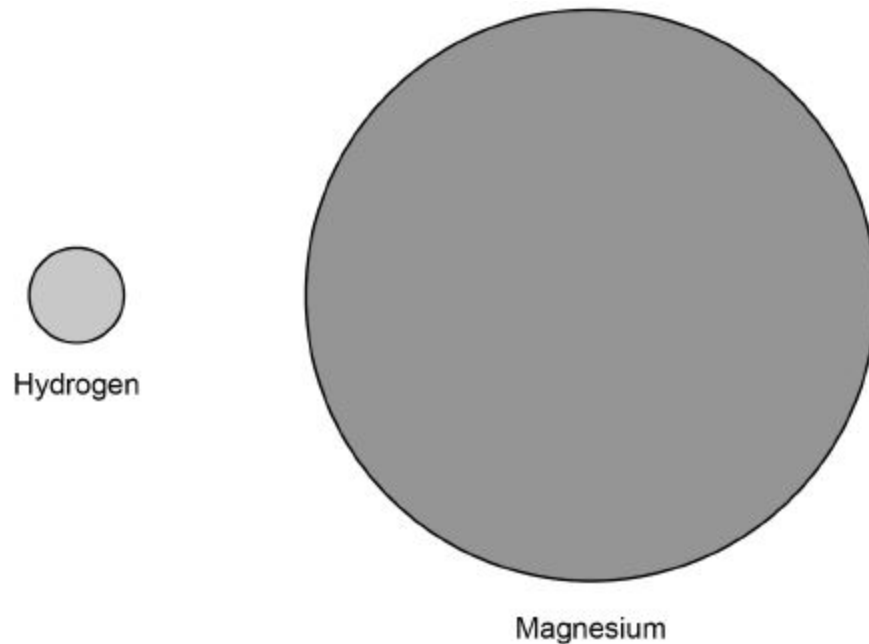
Speed of light = 300 000 000 m/s

Speed = _____ m/s

(2)

- (d) **Figure 2** shows two atoms represented as solid spheres.

Figure 2



A hydrogen atom has a radius of 2.5×10^{-11} m

Determine the radius of a magnesium atom.

Use measurements from **Figure 2**

Radius = _____ m

(2)

(Total 10 marks)

3.

This question is about atoms and chemical elements.

Mendeleev's periodic table has groups of elements with similar properties.

Figure 1 shows part of Mendeleev's periodic table.

Figure 1

1	1 H							
2	7 Li	9.4 Be	11 B	12 C	14 N	16 O	19 F	
3	23 Na	24 Mg	27.3 Al	28 Si	31 P	32 S	35.5 Cl	
4	39 K	40 Ca	44	48 Ti	51 V	52 Cr	55 Mn	56 59 59 63 Fe, Co, Ni, Cu

(a) Compare Mendeleev's periodic table with the modern periodic table.

Which group is missing from Mendeleev's periodic table?

Tick **one** box.

Group 1

Group 2

Group 7

Group 0

(1)

(b) In the early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame some of these problems in his periodic table.

Give **two** ways Mendeleev did this.

1. _____

2. _____

(2)

Atoms were thought to be tiny spheres that could not be divided.

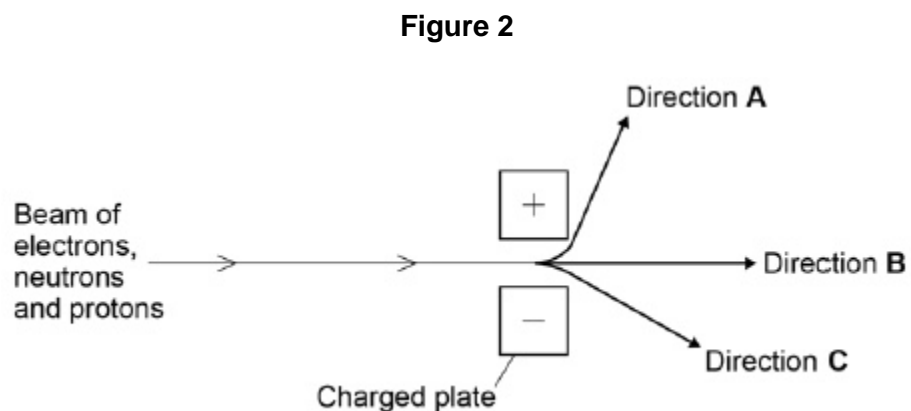
(c) Draw **one** line from each scientist to the discovery the scientist made.

Scientist	Discovery the scientist made
Neils Bohr	Discovered electrons
	Electrons orbit the nucleus
	Existence of neutrons
James Chadwick	Mass of atom concentrated at centre
	Proton found in nucleus

(2)

- (d) A beam of electrons, neutrons and protons can be separated by passing them through an electric field.

Figure 2 shows the directions of the three particles after entering the electric field.



Charged particles are attracted to the oppositely charged plate in the electric field.

Which direction, **A**, **B** or **C**, does each particle follow?

Complete the table.

Particle	Direction
Electron	
Neutron	
Proton	

(2)

(e) Calculate the mass of one atom of sodium.

Use the equation:

$$\text{mass of one atom of sodium} = \frac{\text{relative atomic mass}}{\text{Avogadro constant}}$$

Avogadro constant = 6.02×10^{23}

Give your answer to 2 significant figures.

Mass = _____ g

(3)

(f) The radius of a sodium atom is 227 picometres.

1 picometre = 10^{-12} metres (m)

The radius of a nucleus is $\frac{1}{10\,000}$ of that of the atom.

Which calculation shows the radius of a sodium atom's nucleus?

Tick **one** box.

$227 \times 10\,000$ m

$227 \times \frac{1}{10\,000}$ m

$227 \times 10^{-12} \times 10\,000$ m

$227 \times 10^{-12} \times \frac{1}{10\,000}$ m

(1)

(Total 11 marks)

4. This question is about subatomic particles.

(a) Subatomic particles in an atom are electrons, protons and neutrons.

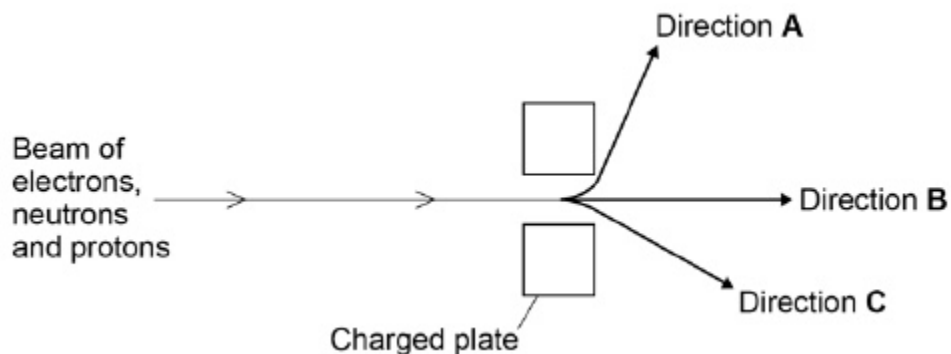
Complete the table to show when each subatomic particle was discovered.

Date of discovery	Subatomic particle
1897	
1920	
1932	

(2)

- (b) A beam of electrons, neutrons and protons travelling at the same speed is passed through two oppositely charged plates.

The diagram shows the directions of three particles after passing through the charged plates.



The charges on the electric plates are **not** shown.

The heavier the particle the less the deflection.

Explain which directions the electrons, neutrons and protons will take.

(4)

(c) Calculate the mass of one atom of sodium.

Avogadro constant = 6.02×10^{23} per mole.

Give your answer to 3 significant figures.

Mass of one atom of sodium = _____ g

(2)

(d) The radius of a sodium atom is 227 picometres (pm)

1 picometre = 1×10^{-12} m

What is the approximate radius of the nucleus of a sodium atom?

Tick **one** box.

2.27×10^{-12} m

2.27×10^{-14} m

2.27×10^{-24} m

4.54×10^{-14} m

(1)

(Total 9 marks)

5.

John Newlands arranged the known elements into a table in order of atomic weight.

Figure 1 shows part of Newlands' table.

Figure 1

Group	1	2	3	4	5	6	7
	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca				

(a) What are the names of the elements in Group 5 of Newlands' table?

Tick **one** box.

Calcium and sulfur

Carbon and silicon

Chlorine and silver

Chromium and tin

(1)

(b) In what order is the modern periodic table arranged?

Tick **one** box.

Atomic mass

Atomic number

Atomic size

Atomic weight

(1)

- (c) Give **two** differences between Group 1 of Newlands' table and Group 1 of the periodic table.

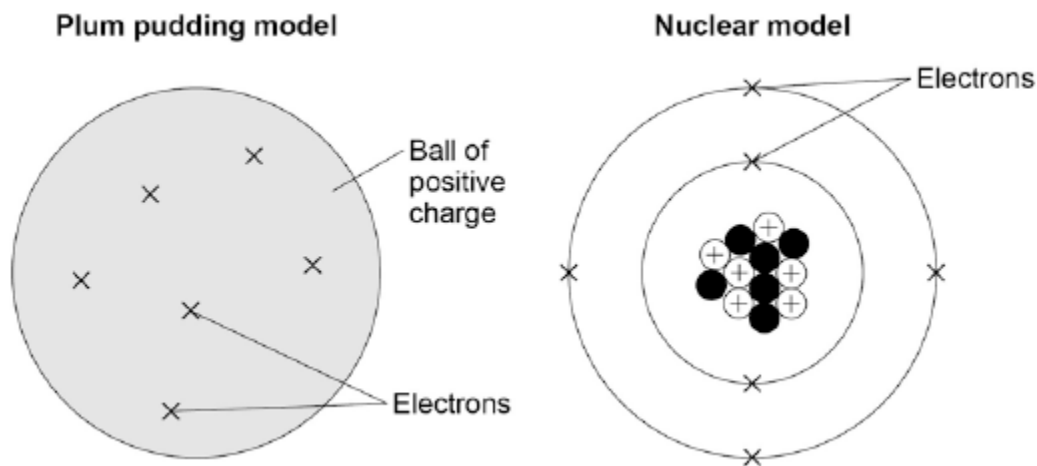
(2)

- (d) In 1864, atoms were thought to be particles that could not be divided up into smaller particles.

By 1898, the electron had been discovered and the plum pudding model of an atom was proposed.

Figure 2 shows the plum pudding model of an atom of carbon and the nuclear model of an atom of carbon.

Figure 2




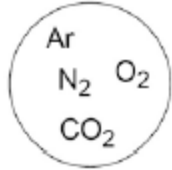

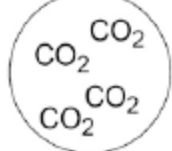
Compare the position of the subatomic particles in the plum pudding model with the nuclear model.

(4)

(e) Models are used to show the differences between elements, compounds and mixtures.

Which circle shows a model of a mixture?

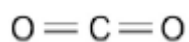
Tick **one** box.

	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>

(1)

(f) **Figure 3** shows a model of carbon dioxide.

Figure 3



What does each line between the atoms in **Figure 3** represent?

Tick **one** box.

- | | |
|----------------------|--------------------------|
| Covalent bond | <input type="checkbox"/> |
| Intermolecular force | <input type="checkbox"/> |
| Ionic bond | <input type="checkbox"/> |
| Metallic bond | <input type="checkbox"/> |

(1)

(Total 10 marks)

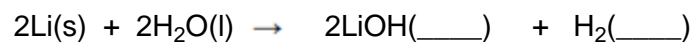
6.

The three states of matter are solid, liquid and gas.

(a) Lithium reacts with water to produce lithium hydroxide solution and hydrogen.

Use the correct state symbols from the box to complete the chemical equation.

aq	g	l	s
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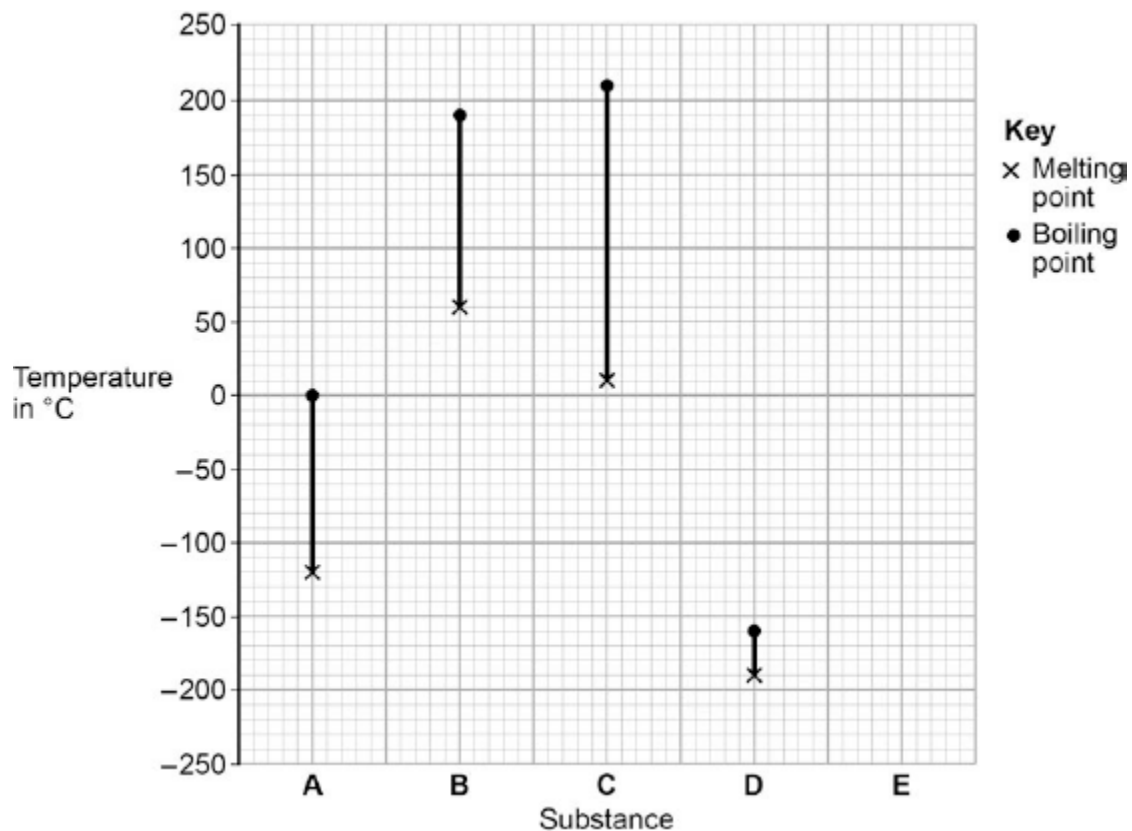


lithium + water \rightarrow lithium hydroxide + hydrogen

(2)

(b) **Figure 1** shows the melting points and the boiling points of four substances, **A**, **B**, **C** and **D**.

Figure 1



Which substance is liquid over the greatest temperature range?

Tick **one** box.

- A
- B
- C
- D

(1)

(c) Which **two** substances are gases at 50 °C?

Tick **one** box.

A and B

B and C

C and D

A and D

(1)

(d) A different substance, **E**, has:

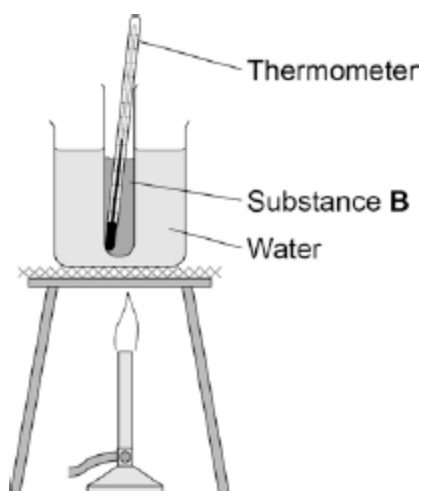
- a melting point of $-50\text{ }^{\circ}\text{C}$
- a boiling point of $+120\text{ }^{\circ}\text{C}$

Plot these two values on **Figure 1**.

(2)

- (e) **Figure 2** shows the apparatus a student used to determine the melting point and the boiling point of substance **B** in **Figure 1**.

Figure 2



Explain why the student could not use this apparatus to determine the boiling point of substance **B**.

(2)

- (f) Suggest **one** reason why the student could not use this apparatus to determine the exact melting point of substance **B**.

(1)

(Total 9 marks)

7.

Elements are made up of atoms.

(a) What is the approximate radius of an atom?

Tick **one** box.

$1 \times 10 \text{ m}$

$1 \times 10^{-1} \text{ m}$

$1 \times 10^{-10} \text{ m}$

$1 \times 10^{-100} \text{ m}$

(1)

(b) The figure below shows the atoms of five elements.



The letters are **not** the symbols of these elements.

Complete the sentence.

All of the elements in the figure above are in Group

_____ of the periodic table.

(1)

(c) Which **two** atoms in the figure above are isotopes of the same element?

Explain your answer fully.

(3)

Mark schemes

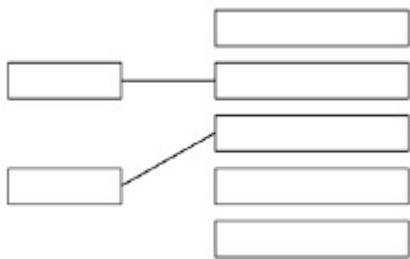
- 1.** (a) 16 1
- (b) 8 e⁻ in 2nd shell
6 e⁻ in 3rd shell
allow •, x, e⁻ or any combination 1
- (c) oxygen → sulfur dioxide
allow = in place of →
*do **not** accept sulfur oxide*
ignore symbols 1
- (d) acid rain 1
- (e) yes / no
- any **two** from:
- increases
allow goes up
 - constant
allow similar
 - decreases
allow goes down
allow levels off (at the end) 2
- correct date range for any one of the above
- (increases) 1984–1987
 - (constant) 1987–1990
 - (decreases) 1990–2014 1
- (f) (69 + 6 =) 75 1
- 100 – 75 = 25(%)
allow a final percentage calculated from an incorrect value in the first step 1
- an answer of 25(%) scores **2** marks*

[9]

2.	(a) electron	1
	atom	1
	nucleus	1
	orbit	1
	(b) positive charge is provided by protons	1
	(every atom of the same element contain the) same number of protons <i>do not accept same number of protons and neutrons</i> <i>ignore reference to electrons</i>	1
	(c) $v = 300\,000\,000 \times \left(\frac{7}{100}\right)$ <i>allow any correct method of determining 7% of 300 000 000</i>	1
	$v = 21\,000\,000$ (m/s) <i>allow 2.1×10^7 (m/s)</i> <i>an answer of 21 000 000 scores 2 marks</i>	1
	(d) $r = 6 \times 2.5 \times 10^{-11}$ <i>allow a ratio in the range of 5.7–6.3 or measurements that would give this range, correctly substituted</i>	1
	$r = 1.5 \times 10^{-10}$ (m) <i>allow 1.4×10^{-10} to 1.6×10^{-10}</i> <i>their ratio $\times 2.5 \times 10^{-11}$ correctly calculated scores 1 mark</i> <i>an answer in the range 1.4×10^{-10} to 1.6×10^{-10} scores 2 marks</i>	1
		[10]

3.	(a) group 0	1
	(b) left gaps	1
	in some places changed the order based on atomic weights	1

(c)



1
1

(d) (electron) **A**

(neutron) **B**

(proton) **C**

3 correct answers scores 2 marks

1/2 correct answers scores 1 mark

2

(e)
$$\frac{23}{6.02 \times 10^{-23}}$$

1

$3.820598... \times 10^{-23}$

1

3.8×10^{-23}

an answer of 3.8×10^{-23} scores 3 marks

1

(f) $227 \times 10^{-12} \times \frac{1}{10\,000} \text{ m}$

1

[11]

4.

(a) electron
proton
neutron

this order only

all 3 correct = 2 marks

1 or 2 correct = 1 mark

2

(b) **A** = electron has less mass so is deflected more
or
electron deflected towards positive because it is negatively charged 1

B = neutron because the neutron's path does not change as not charged 1

C = proton and proton has greater mass (accept heavier) so is deflected less (than electron)
or
proton is deflected towards negative because it is positively charged 1

this is because the lower plate is negative
or
upper plate is positive 1

(c) $\frac{23}{6.02 \times 10^{23}}$ 1

3.82×10^{-23}
answer to 3 significant figures 1

(d) 2.27×10^{-14} 1

[9]

5.

(a) Carbon and silicon 1

(b) Atomic number 1

(c) Hydrogen / fluorine / chlorine are not in Group 1 of the periodic table
or
Hydrogen and fluorine / chlorine are not in the same group of the periodic table 1
Lithium / sodium / potassium are in Group 1 of the periodic table 1

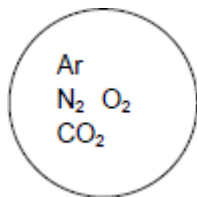
(d) plum pudding model has a single ball of positive charge and nuclear model has positive charges in the centre / nucleus 1

plum pudding model has electrons in random positions and nuclear model has electrons in fixed positions 1

plum pudding model has no nucleus and the nuclear model has a nucleus 1

plum pudding model has no neutrons and the nuclear model has neutrons in the nucleus 1

(e)



1

(f) Covalent bond

1

[10]

6.

(a) LiOH (aq)

this order

1

H₂ (g)

1

(b) **C**

1

(c) **A and D**

1

(d) point x at -10 °C

1

point • at +150 °C

1

(e) substance **B** will not reach its boiling point of 190 °C

1

because the boiling point of water is only 100 °C

1

(f) there is too much substance **B** to melt instantly.

allow answers based on thermal conductivity or temperature gradient from the wall of the test tube to the thermometer

1

[9]

7.

(a) 1×10^{-10} m

1

(b) 1 / one

allow alkali metals

1

(c) R and S

1

because they have the same number of protons

allow same atomic number, different mass number

1

and a different numbers of neutrons

1

(d) **Level 3 (5–6 marks):**

A relevant and coherent explanation of the trend in reactivity. The response makes logical links between the points raised and considers both the number of energy levels and the distance between the nucleus and the outer energy level.

Level 2 (3–4 marks):

Statements that are linked to provide a simple explanation of the trend in reactivity using either the number of energy levels or the distance between the nucleus and the outer energy level.

Level 1 (1–2 marks):

Simple statements made about the halogens or the trend in reactivity.

0 marks:

No relevant comment

Indicative content

Simple statements / descriptions

- have 7 electrons in the outer shell
- need to gain an electron
- form ions with a -1 charge
- halogens further down the group are less reactive (or vice versa)
- halogens further down the group have more shells or energy levels (or vice versa)

Linked statements / explanations

- have 7 electrons in the outer shell so need to gain an electron to have the electronic structure of a noble gas
- halogens further down the group are less reactive because they have more shells or energy levels (or vice versa)
- halogens further down the group have more shells or energy levels so less attractive force on the incoming electron (or vice versa)
- halogens further down the group have more shells or energy levels so more 'shielding' against the incoming electron (or vice versa)
- outer electrons of halogens further down group are further away from the attractive force of the nucleus (or vice versa)
- an electron is less easily gained because there are more shells or energy levels (or vice versa)
- an electron is less easily gained because the outer electrons are further from the attractive force of the nucleus (or vice versa)

6

[11]