Reactivity of Metals

Total mark – 21

Q1.

This question is about Group 1 elements.

(a) Complete **Table 1** to show the electronic structure of a potassium atom.

Table 1

Atom	Number of electrons	Electronic structure
Sodium	11	2,8,1
Potassium	19	

(1)

(b) Why do Group 1 elements have similar chemical properties?

Tick (✓) **one** box.

They have the same number of electron shells. ☐

They have the same number of outer shell electrons. ☐

They have two electrons in the first shell. ☐

(1)

(c) What is the type of bonding in sodium?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

Table 2 shows observations made when lithium, potassium and rubidium react with water.

Table 2

Element	Observations
Lithium	Bubbles slowly Floats Moves slowly
Sodium	1 _____ 2 _____
Potassium	Bubbles very quickly Melts into a ball Floats Moves very quickly Flame
Rubidium	Sinks Melts into a ball Explodes with a flame

(d) Give **two** observations you could make when sodium reacts with water.

Write your answers in **Table 2**.

(2)

(e) How does the reactivity of the elements change going down Group 1?

_____

_____

(1)

(f) Give **two** ways in which the observations in **Table 2** show the change in reactivity going down Group 1.

1 _____

_____

2 _____

_____

(2)

(g) Which gas is produced when Group 1 elements react with water?

Tick (✓) **one** box.

Carbon dioxide ☐

Hydrogen ☐

Nitrogen ☐

Oxygen ☐

(1)

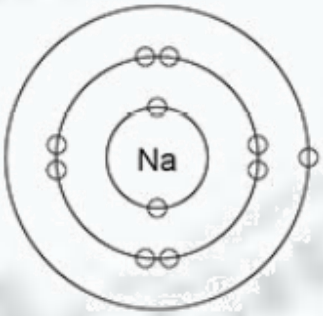
(h) Sodium fluoride is an ionic compound.

The diagram below shows dot and cross diagrams for a sodium atom and a fluorine atom.

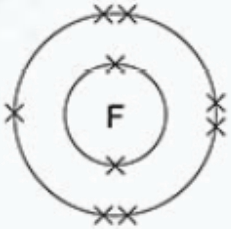
Complete the diagram below to show what happens when a sodium atom and a fluorine atom react to produce sodium fluoride.

You should:

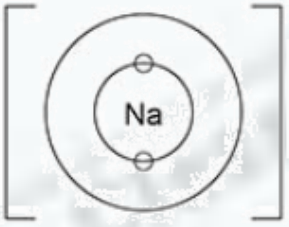
- complete the electronic structures of the sodium ion and the fluoride ion
- give the charges on the sodium ion and the fluoride ion.



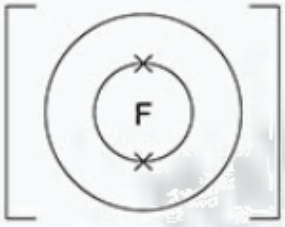
Sodium atom



Fluorine atom



Sodium ion



Fluoride ion

(3)

Mark Scheme

Q1.

(a) 2,8,8,1

1

(b) they have the same number of outer shell electrons

1

(c) metallic

1

(d) any **two** from:

- bubbles (very) quickly
- melts (into a ball)
- floats
- moves (very) quickly

allow flame

2

(e) (reactivity) increases (down the group)

1

(f) any **two** from:

- increasing speed of movement
- increasing rate of bubble production
- doesn't melt → melts
- no flame → flame

or

flame → explosion

2

(g) hydrogen

1

(h) sodium ion structure 2,8

1

fluoride ion structure 2,8

allow any combination of circles, dots, crosses or $e^{(-)}$)

1

+ charge on sodium ion **and**
– charge on fluoride ion

an answer of

sodium ion fluoride ion

scores **3** marks

1

Q2.

A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

The table below shows the student's results.

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	**X**
Zinc	18	16	18	20	18

(a) Calculate the mean temperature increase **X** for magnesium in the table above.

Do **not** include the anomalous result in your calculation.

_____

_____

X = _____ °C

(2)

(b) Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use the table above.

Most reactive _____

_____

Least reactive _____

(1)

(c) The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use the table above.

The mean temperature increase for zinc is 18 ± _____ °C

(1)

(d) What type of variable is the volume of hydrochloric acid in this investigation?

Tick (✓) **one** box.

Control ☐

Dependent ☐

Independent ☐

(1)

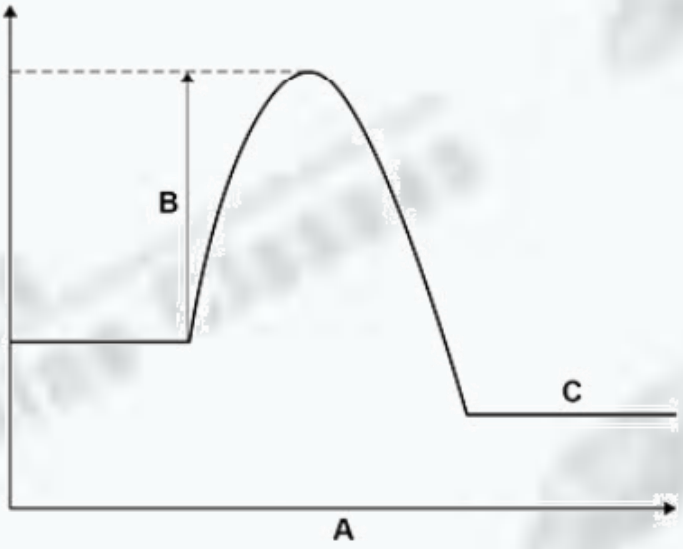
(e) Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

_____

_____

(1)

(f) The figure below shows a reaction profile for the reaction of magnesium with hydrochloric acid.



What do labels **A**, **B** and **C** represent on the figure above?

Choose answers from the box.

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

A _____

B _____

C _____

(3)

Mark Scheme

Q2.

(a) $\frac{54 + 50 + 55}{3}$ **1**

= 53 (°C)

*if no other mark awarded allow **1** mark for*

$\frac{54 + 50 + 37 + 55}{4}$ = *49 (°C)* **1**

(b) (most reactive) magnesium zinc
(least reactive) cobalt

*allow ecf from question **(a)*** **1**

(c) (18 ±) 2 (°C) **1**

(d) control **1**

(e) use the same mass of metal / powder **1**

(f) (A) progress of reaction **1**

(B) activation energy **1**

(C) products **1**