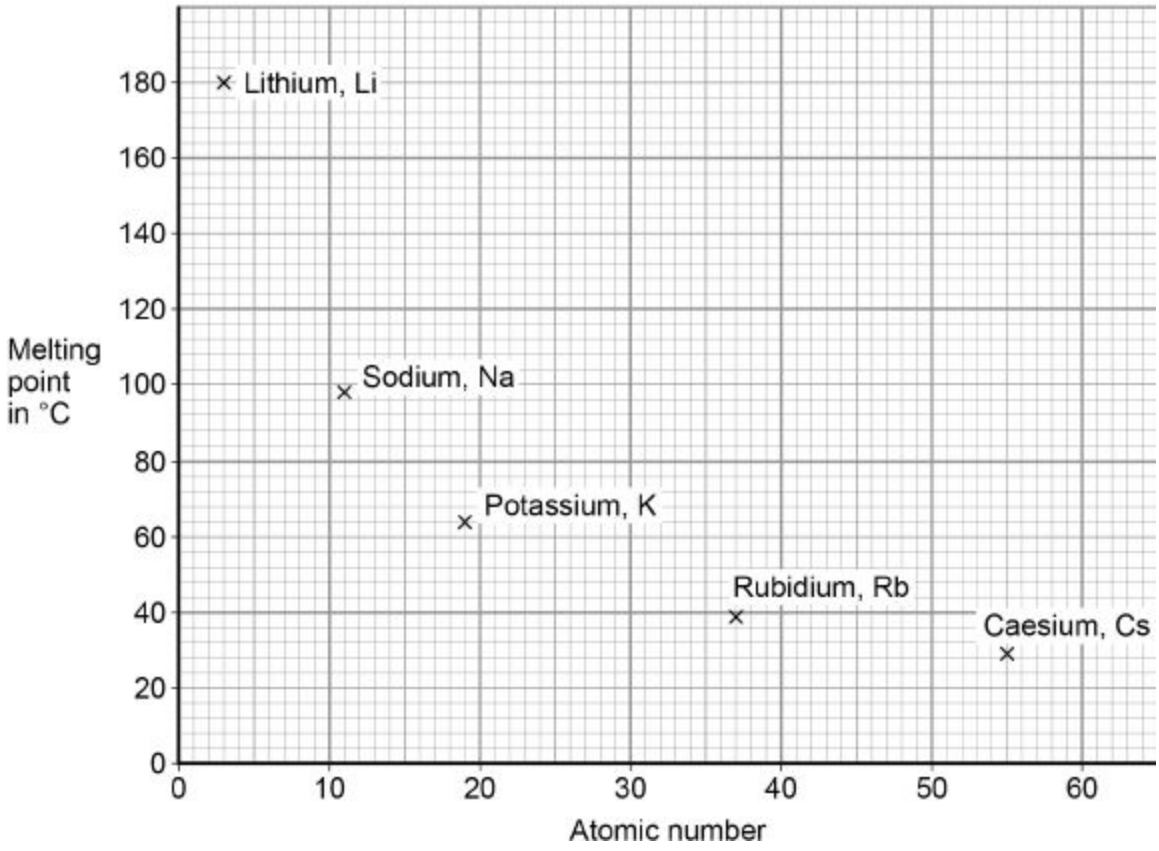
1 This question is about Group 1 metals.

The graph below shows the melting points of Group 1 metals plotted against their atomic number.



(a) Describe the trend shown by the melting points of Group 1 metals as the atomic number increases.

_____

_____

(1)

(b) Determine the atomic number and melting point of caesium.

Use the graph above.

Atomic number of caesium = _____

Melting point of caesium = _____ °C

(1)

Lithium is a Group 1 metal.

(c) A lithium atom can be shown as $^{7}_{3}Li$

How many electrons does the **outer shell** of a lithium atom contain?

Tick **one** box.

1 ☐

3 ☐

4 ☐

7 ☐

(1)

(d) Lithium reacts with oxygen to produce lithium oxide.

Draw **one** line from each substance to the correct description of the substance.

Substance	Description
	compound
Lithium oxide	element
	metal
Oxygen	mixture
	polymer

(2)

(e) Balance the equation for the reaction of lithium with oxygen.

$$\_\_\_\_Li + O_2 \longrightarrow 2Li_2O$$

(1)

(f) What type of bonding is present in lithium oxide?

Tick **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

(g) Calculate the relative formula mass (M_r) of lithium oxide (Li_2O).

Relative atomic masses (A_r): Li = 7 O = 16

_____

_____

_____

Relative formula mass = _____

(2)

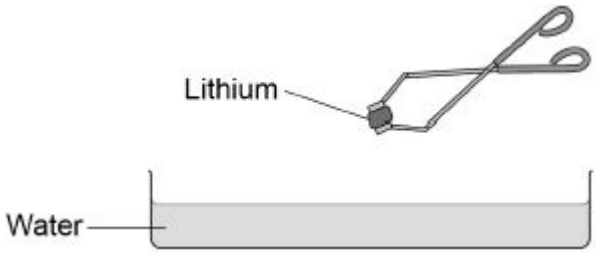
(Total 9 marks)

2 This question is about Group 1 elements.

A teacher demonstrated the reaction of Group 1 elements with water.

Figure 1 shows the apparatus.

Figure 1



(a) What name is given to Group 1 elements?

Tick **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Non-metals ☐

(1)

(b) The teacher wore safety glasses and used tongs to handle the elements.

Suggest **one** other safety precaution the teacher should take.

_____

_____

(1)

Table 1 shows the teacher's results.

Table 1

Element	**Observations**
Lithium	• bubbles form • lithium moves slowly on surface
Sodium	• bubbles form • sodium moves quickly on surface • sodium melts to form a ball
Potassium	• bubbles form • potassium moves very quickly on surface • potassium melts to form a ball • a lilac flame is seen

(c) Describe the trend in reactivity in Group 1.

Give **two** observations from **Table 1** which provide evidence for the trend.

_____

_____

_____

_____

_____

_____

(3)

(d) Rubidium is a Group 1 element.

Rubidium is below potassium in the periodic table.

Suggest why the teacher did **not** demonstrate the reaction between rubidium and water.

_____

_____

(1)

(e) Complete the balanced equation for the reaction between sodium and water.

$$\_\_\_\_\_\ Na + \_\_\_\_\_\ H_2O \longrightarrow \_\_\_\_\_\ NaOH + H_2$$

(1)

(f) What is the name of the compound with the formula NaOH?

Tick **one** box.

Sodium dioxide ☐

Sodium hydrate ☐

Sodium hydroxide ☐

Sodium oxide ☐

(1)

Table 2 shows the diameter of atoms of Group 1 elements.

Element	**Diameter of atom in nanometres**
Lithium	0.304
Sodium	0.372
Potassium	**X**
Rubidium	0.496
Caesium	0.530

(g) Predict value **X** in **Table 2**.

X = _____ nanometres

(1)

(h) 1 nanometre is 10^{-9} metres.

What is the diameter of a lithium atom in metres?

Tick **one** box.

3.04×10^{-8} m ☐

3.04×10^{-9} m ☐

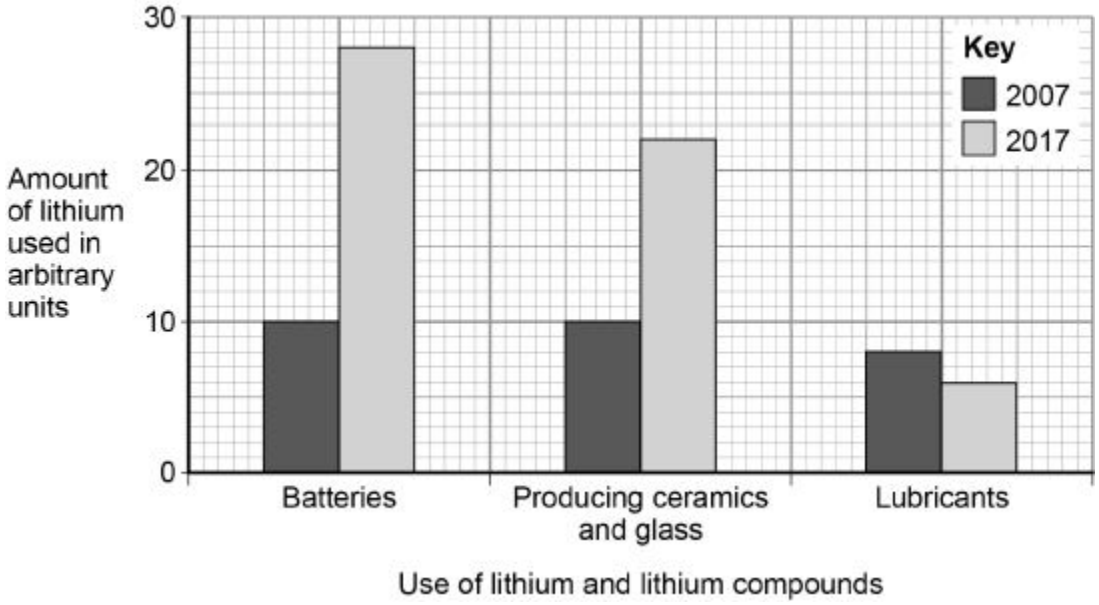
3.04×10^{-10} m ☐

3.04×10^{-11} m ☐

(1)

Figure 2 shows the use of lithium and lithium compounds in 2007 and 2017.

Figure 2



Use of lithium and lithium compounds

(i) Describe how the use of lithium and lithium compounds changed between 2007 and 2017.

You must include data from **Figure 2** in your answer.

_____

_____

_____

_____

_____

_____

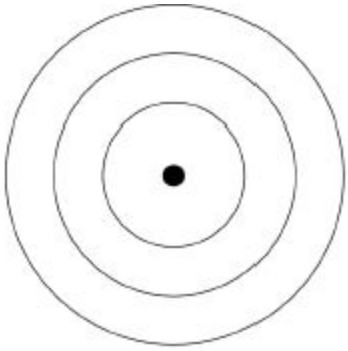
(3)

(Total 13 marks)

3 This question is about Group 1 elements.

(a) A sodium atom is represented as $^{23}_{11}Na$

Complete the diagram below to show the electronic structure of a sodium atom.



(1)

A teacher demonstrated the reaction between lithium and water.

The teacher repeated the demonstration using sodium and then potassium with water.

(b) The teacher wore eye protection.

Suggest **two** other safety precautions the teacher should take.

1. _____

_____

2. _____

_____

(2)

(c) Universal indicator is added to the solution formed in the reaction between potassium and water. The universal indicator becomes purple in colour.

Which ion causes universal indicator to turn purple?

Tick **one** box.

H^+ ☐

K^+ ☐

OH^- ☐

O^{2-} ☐

(1)

(d) The table below gives the diameter of atoms of Group 1 elements.

Element	**Diameter of atom in nm**
Lithium	0.304
Sodium	0.372
Potassium	0.454
Rubidium	0.496
Caesium	0.530

Explain how the diameter of the atom affects the reactivity of Group 1 elements.

(4)

(Total 8 marks)

4 The following article appeared recently in the *Manchester Gazette*.

> **Sodium Drum Blaze Scare**
>
> A 20 litre drum containing sodium burst into flames when it reacted violently with rainwater at a Manchester factory. It is believed that the sodium, which is normally stored under oil, had been accidentally left outside with the lid off.
>
> A factory worker put out the blaze before the fire services arrived, and a leading fire fighter said, "It was fortunate that potassium wasn't involved as it would have reacted more violently and exploded. These Group 1 *alkali metals* can be very dangerous".

(a) Group 1 metals are stored under oil.

Suggest why.

(1)

(b) Balance the equation which represents the reaction between sodium and water.

$$Na + H_2O \rightarrow NaOH + H_2$$

(1)

(c) Explain why the Group 1 metals are called the *alkali metals*.

(1)

(d) Explain, in terms of electrons, why potassium reacts more violently than sodium.

(3)

(Total 6 marks)

1

(a) melting points decrease (as the atomic number increases)

allow negative correlation

1

(b) 55
and
29 (°C)

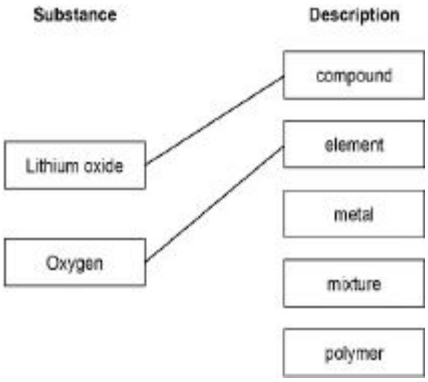
allow values in range 28−32 (°C)

1

(c) 1

1

(d)



1
1

(e) $4\ Li + O_2 \longrightarrow 2\ Li_2O$

allow correct multiples

1

(f) ionic

1

(g) $(M_r) = (2 \times 7) + 16$

1

$= 30$

1

*an answer of 30 scores **2** marks*

[9]

2

(a) alkali metals

1

(b) any **one** from:

- small piece of metal
- large volume of water
- use a (safety) screen
- keep a safe distance (between teacher / students and apparatus)

1

(c) reactivity increases down the group

1

any **two** from:

- speed increases (down the group)
- sodium / potassium melts but lithium does not
- flame is seen with potassium, but no flame with lithium / sodium

2

(d) rubidium is too reactive

allow reaction would be violent

1

(e) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

allow correct multiples

1

(f) sodium hydroxide

1

(g) an answer in the range 0.373−0.495 (nanometres)

1

(h) 3.04×10^{-10} m

1

(i) batteries increased from 10 to 28

or

batteries increased by 18

allow batteries increased approximately ×3

1

producing ceramics and / or glass increased from 10 to 22

or

producing ceramics and / or glass increased by 12

allow ceramics and / or glass increased by approximately ×2

1

lubricants decreased from 8 to 6

or

lubricants decreased by 2

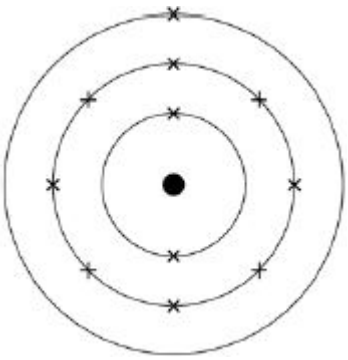
allow lubricants decreased by a quarter

1

*if no other marks awarded allow **1** mark for batteries and glass / ceramics increased, lubricants decreased, with no or incorrect data*

[13]

3 (a)



allow dot, cross, or e to show electrons

1

(b) any **two** from:

- use tongs / tweezers to handle metal
- use a (safety) screen
- use a small piece of metal
- use a large volume of water
- keep a safe distance between teacher / students and apparatus

ignore store metal under oil

2

(c) OH^-

1

(d) as diameter increases, reactivity increases

1

(because as diameter increases) outer electron is further from the nucleus

allow (because as diameter increases) outer shell is further from nucleus

1

(so) outer electron is less attracted to the nucleus

allow (so there is) increased shielding

1

(so) outer electron is lost (more) easily

1

[8]

4 (a) acts as barrier between sodium and air / oxygen / water (vapour)

accept because they are reactive

ignore oil will not react

1

(b) $\mathbf{2}Na + \mathbf{2}H_2O \rightarrow \mathbf{2}NaOH + H_2$

allow multiples / fractions

1

(c) these metals react with water producing an alkaline solution

or

produce solution with pH greater than 7 / high pH

owtte

allow produce OH. ions

not *these metals are / form alkalis*

ignore 'strong' pH

1

(d) *it = potassium*

*<u>outer</u> electron must be mentioned once for all **3** marks*

bigger atom

or

outer shell electron further from nucleus

or

more shells

or

converse argument for sodium less reactive provided sodium is specified

1

less attraction to nucleus

or

more shielding

not *less magnetic attraction*

1

outer electron more easily lost

ignore *potassium reacts more easily*

1

[6]