1 Lithium, potassium and caesium are three metals in Group 1 of the Periodic Table.

(a) A small piece of each metal is placed on water in separate large troughs.

Complete the table by giving the correct metal, lithium, potassium or caesium, for each description.

(2)

Description of reaction	Metal
explodes on contact with water	
fizzes gently	
reacts violently and forms a lilac flame	

(b) (i) Give the name and formula of the gas formed when potassium reacts with water.

(2)

name .....

formula .....

(ii) Give the name and formula of the compound formed when lithium reacts with water.

(2)

name .....

formula .....

(iii) Describe how you could show that an alkaline solution is formed when caesium reacts with water.

(2)

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.....

(Total for Question 1 = 8 marks)

2 Solutions of lead(II) nitrate and sodium chloride react together to form a precipitate of lead(II) chloride.

The equation for the reaction is

$$Pb(NO_3)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaNO_3(aq)$$

A student carries out a series of experiments to find how much precipitate is formed when different volumes of lead(II) nitrate are added.

She uses this method.

- place 15 cm^3 of sodium chloride solution into a boiling tube
- add 2.0 cm^3 of lead(II) nitrate solution
- allow the precipitate to settle
- measure the height of the precipitate
- repeat the experiment using different volumes of lead(II) nitrate solution

The table shows the student's results.

Volume in cm^3 of lead(II) nitrate added	Height of precipitate in cm
2.0	0.6
4.0	1.2
6.0	1.8
8.0	2.1
10.0	2.5
12.0	2.1
14.0	2.1

(a) Suggest why the height of the precipitate eventually stops increasing as more lead(II) nitrate solution is added.

(1)

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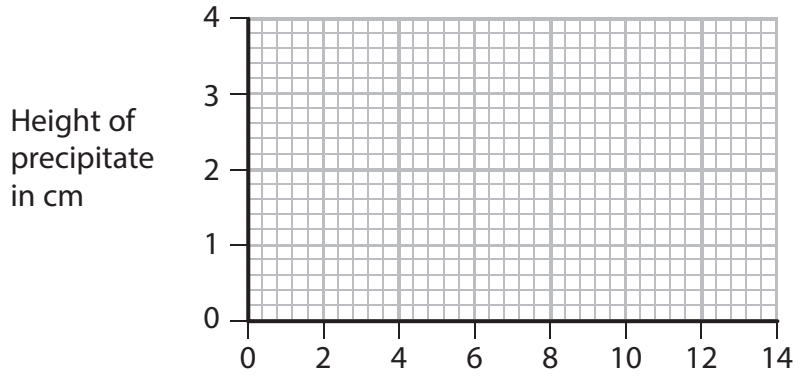
.....

(b) (i) Plot the student's results on the grid.

Draw a straight line of best fit through the origin and the first three points, and another straight line of best fit through the last four points.
Make sure that the two lines cross.

(4)



(ii) Draw a circle on the grid around the point that represents the anomalous result.

(1)

(iii) Which statement is a possible explanation for this anomalous result?

(1)

☒ **A** the precipitate was not allowed to settle before its height was measured

☒ **B** only 1 cm^3 of sodium chloride solution was added instead of 2 cm^3

☒ **C** 20 cm^3 of lead(II) nitrate solution was used

☒ **D** the reaction was carried out at a higher temperature

(iv) Why should the graph line pass through the origin?

(1)

.....

.....

(v) Use your graph to estimate the volume of lead(II) nitrate solution that would be required to react completely with 15 cm^3 of the sodium chloride solution.

(1)

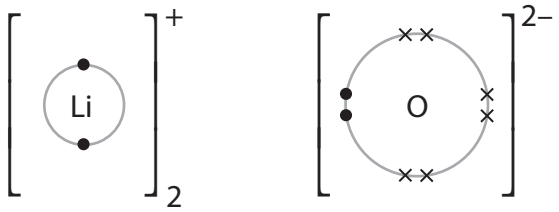
volume = ... cm^3

(Total for Question 2 = 9 marks)

3 When lithium is burned in air, the two compounds lithium oxide (Li_2O) and lithium nitride (Li_3N) are formed.

Both compounds are ionic and their ions can be represented by dot and cross diagrams.

The dot and cross diagram for the ions in lithium oxide is



(a) Draw a dot and cross diagram for the ions in lithium nitride.

(3)

(b) The chemical equation for the reaction between lithium and oxygen is

$$4Li + O_2 \rightarrow 2Li_2O$$

Write a chemical equation for the reaction between lithium and nitrogen.

(2)

(c) (i) Lithium nitride reacts violently with water to form a solution of lithium hydroxide and ammonia gas.

Complete the following equation by inserting the appropriate state symbols.

(1)

$Li_3N(s) + 3H_2O(\ldots\ldots) \rightarrow 3LiOH(\ldots\ldots) + NH_3(\ldots\ldots)$

(ii) Suggest a value for the pH of the solution formed.

Give a reason for your answer.

(2)

pH.....

reason.....

.....

(d) Solid lithium nitride conducts electricity and is used in batteries.

Why would you expect solid lithium nitride **not** to conduct electricity?

(1)

.....

.....

(Total for Question 3 = 9 marks)

4 This question is about elements in Group 1 of the Periodic Table.

(a) Which statement about lithium is correct?

(1)

☒ **A** It is a good electrical conductor and forms an acidic oxide

☒ **B** It is a poor electrical conductor and forms an acidic oxide

☒ **C** It is a good electrical conductor and forms a basic oxide

☒ **D** It is a poor electrical conductor and forms a basic oxide

(b) A small piece of sodium is added to a large trough of water.

(i) State two observations that could be made.

(2)

1 .....

.....

2 .....

.....

(ii) Complete the equation for this reaction by inserting the appropriate state symbols.

(2)

$$2Na(s) + 2H_2O(\quad) \rightarrow 2NaOH(\quad) + H_2(\quad)$$

(c) Potassium reacts in a similar way to sodium, but is more reactive.

State one observation that could be made when a small piece of potassium is added to a large trough of water, but would not be observed with sodium.

(1)

.....

.....

(d) Explain why elements in Group 1 have similar reactions.

(1)

.....

.....

(Total for Question 4 = 7 marks)

5 Three aqueous solutions are sodium chloride, sodium iodide and silver nitrate. They are in containers labelled X, Y and Z. It is not known which solution is in each container.

The solutions are mixed together as shown in the table, and the observations recorded.

Experiment	Observation
solution X added to solution Y	yellow precipitate formed
solution X added to solution Z	no change
solution Y added to solution Z	white precipitate formed

(a) Explain how the results show that Y is aqueous silver nitrate.

(1)

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.....

(b) Explain how the results can be used to identify both X and Z.

(2)

.....

.....

.....

.....

(c) Aqueous chlorine is added to separate aqueous solutions of sodium chloride and sodium iodide.

Explain how the observations made can be used to distinguish between sodium chloride and sodium iodide.

(2)

.....

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.....

(Total for Question 5 = 5 marks)

6 Lithium and magnesium both react with nitrogen.

The chemical equation for the reaction between lithium and nitrogen is

$$6Li + N_2 \rightarrow 2Li_3N$$

(a) Write the chemical equation for the reaction between magnesium and nitrogen.

(2)

.....

(b) The equation for the reaction between lithium nitride and water is

$$Li_3N(s) + 3H_2O(l) \rightarrow 3LiOH(aq) + NH_3(g)$$

(i) Describe a chemical test to show that the gas given off is ammonia.

(2)

.....

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.....

.....

(ii) A sample of 1.40 g of lithium nitride is added to an excess of water.

Calculate the amount, in moles, of Li_3N in the sample of lithium nitride.

(2)

amount of Li_3N = ... mol

(iii) Calculate the amount, in moles, of LiOH in the lithium hydroxide formed.

(1)

(iv) Calculate the volume of 0.500 mol/dm^3 sulfuric acid required to neutralise exactly the amount of lithium hydroxide calculated in (b)(ii).

Give an appropriate unit.

The equation for the reaction is

$$2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$$

(3)

volume of sulfuric acid = ... unit .....

(Total for Question 6 = 10 marks)

7 This question is about elements in Group 1 of the Periodic Table.

(a) Which statement is correct about lithium?

(1)

- ☒ **A** lithium is a non-metal
- ☒ **B** lithium forms a sulfate with the formula $LiSO_4$
- ☒ **C** lithium reacts with water to form an alkali
- ☒ **D** lithium reacts with water to form a white precipitate

(b) Lithium and potassium have similar chemical properties because their atoms

(1)

- ☒ **A** have the same number of electrons in the outer shell
- ☒ **B** have the same number of protons
- ☒ **C** have two electrons in the first shell
- ☒ **D** form positive ions

(c) Small pieces of lithium and potassium are added to separate large troughs of water.

State one observation that would be similar for each element, and one that would be different for each element.

(2)

similar .....

.....

different .....

.....

(d) Suggest the formula of the compound formed when potassium reacts with oxygen, and when potassium reacts with chlorine.

(2)

oxygen .....

chlorine .....

(e) Complete the equation for the reaction between rubidium and water by inserting state symbols.

(1)

$2Rb(\ldots\ldots) + 2H_2O(\ldots\ldots) \rightarrow 2RbOH(\ldots\ldots) + H_2(\ldots\ldots)$

(f) The table shows information about the isotopes in a sample of rubidium.

Isotope	Number of protons	Number of neutrons	Percentage of isotope in sample
1	37	48	72
2	37	50	28

Use information from the table to calculate the relative atomic mass of this sample of rubidium. Give your answer to one decimal place.

(2)

relative atomic mass = ...

(Total for Question 7 = 9 marks)

8 The table gives information about the first three elements in Group 1 of the Periodic Table.

Element	Atomic number	Relative atomic mass	Electronic configuration	Density in g / cm³	Melting point in °C
lithium	3	7	2.1	0.53	180
sodium	11	23	2.8.1	0.97	98
potassium	19	39	2.8.8.1	0.86	64

(a) Which information shows that the elements have similar chemical properties?

Give a reason for your choice.

(2)

Information .....

Reason .....

.....

(b) The elements in Group 1 show a clear trend (regular pattern) in some of their **physical** properties.

Identify the physical property that shows a clear trend.

(1)

.....

.....

(c) The elements also show a clear trend in their **chemical** properties, such as their reaction with water.

When a small piece of lithium is added to water it fizzes gently and eventually disappears to form a solution.

(i) Describe a test to show that the gas given off is hydrogen.

(1)

.....

.....

(ii) Complete the equation for the reaction by inserting the state symbols.

(1)

$2Li(\ldots\ldots) + 2H_2O(\ldots\ldots) \rightarrow 2LiOH(\ldots\ldots) + H_2(\ldots\ldots)$

(iii) State and explain the effect that the solution formed has on red litmus paper.

(2)

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(d) State two similarities and two differences between the reactions of lithium and potassium with water.

(4)

Similarities .....

.....

.....

Differences .....

.....

.....

(e) When lithium burns in oxygen it forms lithium oxide (Li_2O).

(i) Write a chemical equation for the reaction between lithium and oxygen.

(2)

.....

(ii) When sodium burns in oxygen, one of the products is sodium peroxide (Na_2O_2).

Balance the equation to show the formation of sodium peroxide.

(1)

..... Na + ... O_2 → .....Na_2O_2

(Total for Question 8 = 14 marks)