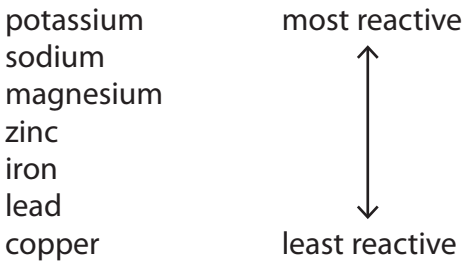
Questions are for both separate science and combined science students unless indicated in the question

1 This question is about different metals.

The list shows part of the reactivity series of metals.



(a) Name a metal from the list that is extracted by electrolysis. **(separate only)**

(1)

(b) Uranium is a metal that is in between magnesium and zinc in the reactivity series.

Equal sized pieces of these three metals are placed in separate solutions of dilute hydrochloric acid of the same concentration and at the same temperature.

The observations for magnesium and zinc are shown in the table.

Complete the table by stating the observations that would be made for uranium.

(2)

Metal	Observations
magnesium	Bubbles of gas produced very rapidly. Solid disappears very quickly.
zinc	Bubbles of gas produced slowly. Solid disappears slowly.
uranium	

(c) (i) Metals high in the reactivity series react readily with water.

Name the compound formed when potassium reacts with water.

(1)

.....

(ii) Give the formula of the compound formed when magnesium reacts with steam.

(1)

.....

(d) Zinc can be extracted by heating zinc oxide with carbon.

The equation for the reaction is

$$ZnO + C \rightarrow Zn + CO$$

(i) Explain whether zinc or carbon is the more reactive element.

(1)

.....

.....

.....

(ii) Explain which element is acting as a reducing agent in this reaction.

(2)

.....

.....

.....

.....

(Total for Question 1 = 8 marks)

2 This question is about the insoluble salt lead(II) bromide.

(a) A student uses the precipitation method to prepare lead(II) bromide.

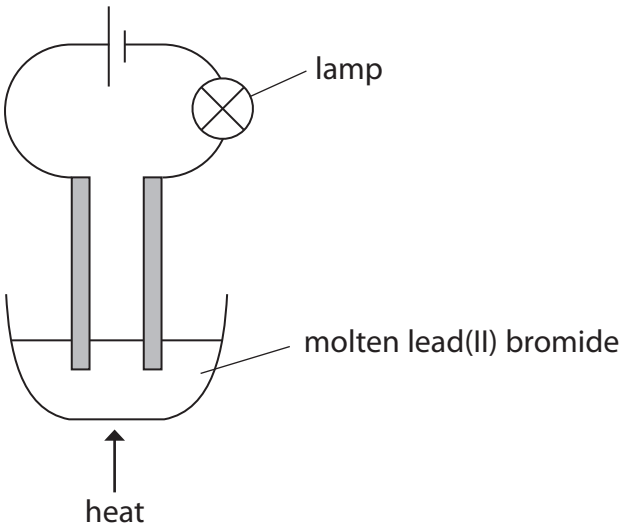
The equation for the reaction she uses is

$$Pb(NO_3)_2(aq) + 2NaBr(aq) \rightarrow PbBr_2(s) + 2NaNO_3(aq)$$

Describe how she could use solutions of lead(II) nitrate and sodium bromide to obtain a pure, dry sample of lead(II) bromide.

(5)

(b) The student's teacher uses this apparatus to electrolyse a pure sample of molten lead(II) bromide.



The student records these observations.

a small blob of a silvery liquid appears at one electrode

a brown substance forms at the other electrode

the lamp stops working soon after the teacher stops heating the lead(II) bromide

(i) Which is the correct statement about this electrolysis? **(separate only)**

(1)

☒ **A** the brown substance is bromide

☒ **B** the products are both elements

☒ **C** the silvery liquid forms at the positive electrode

☒ **D** the silvery liquid is molten lead(II) bromide

(ii) The student writes this half-equation to show the reaction in which the brown substance forms.

$$2Br^- + 2e^- \rightarrow 2Br$$

Identify the two mistakes in her half-equation. **(separate only)**

(2)

1 .....

.....

2 .....

.....

(iii) Explain why the lamp stops working after the teacher stops heating the lead(II) bromide. **(separate only)**

(1)

.....

.....

.....

(Total for Question 2 = 9 marks)

3 The reactivity of metals can be studied using displacement reactions. In these reactions, one metal is added to a solution of a salt of a different metal.

If a displacement reaction occurs, there is a temperature rise.

A student used the following method in a series of experiments.

- Pour some metal salt solution into a polystyrene cup supported in a glass beaker and record the temperature of the solution.
- Add a known mass of a metal and stir.
- Record the maximum temperature of the mixture.

(a) Suggest **three** variables that should be kept the same for the student's experiments to be a fair test.

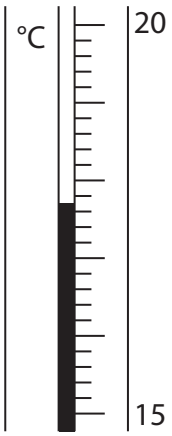
(3)

1 .....

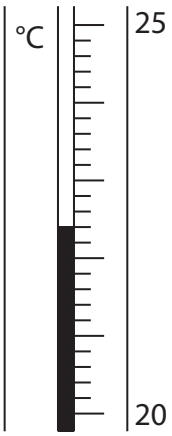
2 .....

3 .....

(b) The student used a thermometer to measure the temperature rise. The diagrams show the thermometer readings before and after adding the metal.



before adding metal



after adding metal

Use the diagrams to complete the table.

(3)

Temperature after adding the metal in °C	
Temperature before adding the metal in °C	
Temperature change in °C	

(c) The student used copper(II) sulfate solution in all her experiments. She used five different metals. She did not know the identity of the metal labelled **X**.

The student did each experiment twice. The table shows her results.

Metal	Temperature rise in °C		Average temperature rise in °C
	Run 1	Run 2	
magnesium	10.5	15.5	13.0
silver	0.0	0.0	0.0
iron	3.5	4.5	4.0
X	0.0	0.0	0.0
zinc	8.0	9.0	8.5

(i) Which of the metals gave the least reliable temperature rise?

Explain your choice.

(2)

Metal .....

Explanation .....

.....

.....

(ii) Identify the most reactive of the metals used.

Explain how the results show that it is the most reactive.

(2)

Metal .....

Explanation .....

.....

.....

(iii) Why is there no temperature rise when silver is added to copper(II) sulfate solution?

(1)

.....

.....

.....

(iv) Why do the results make it impossible to decide which of the metals is the least reactive?

(1)

.....

.....

.....

(d) A word equation for one of the reactions is

zinc + copper(II) sulfate → copper + zinc sulfate

Write a chemical equation for this reaction.

(1)

.....

(Total for Question 3 = 13 marks)

4 Some students investigated displacement reactions involving three different metals and solutions of their salts. This equation represents one of these reactions:

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

This reaction occurs because zinc is more reactive than copper.

When a displacement reaction occurs, there is a temperature rise. The bigger the difference in reactivity between the two metals, the bigger the temperature rise.

(a) What word is used to describe reactions in which there is a temperature rise?

(1)

.....

(b) The students used this method.

- Pour some metal salt solution into a beaker, place a thermometer in the beaker and record the temperature
- Add some of the metal and stir the mixture
- Record the maximum temperature

(i) State **two** variables that the students should keep the same to ensure that the experiment was valid.

(2)

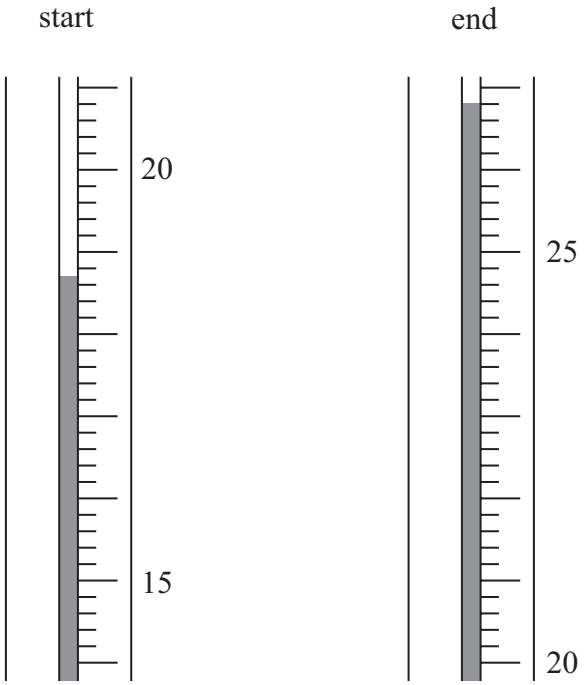
1 .....

.....

2 .....

.....

(ii) The diagrams show the thermometer readings at the start and at the end of one of the experiments.



Record the temperatures and calculate the temperature rise in this experiment.

(3)

Temperature at start ..... °C

Temperature at end ..... °C

Temperature rise ..... °C

(iii) Each experiment was repeated twice. The table shows the average temperatures obtained.

Metal and metal salt used	Average temperature rise in °C
Zn + $CuSO_4$	12.2
X + $CuSO_4$	8.3
X + $ZnSO_4$	0.0
Cu + $ZnSO_4$	0.0
Zn + XSO_4	2.7
Cu + XSO_4	0.0

Use these results to identify the more reactive metal in each of the following pairs.

(2)

Zn and X .....

Cu and X .....

(c) Write an equation for the reaction with a temperature rise of 2.7 °C.

(1)

.....

(d) Suggest why the students did not use calcium metal in their experiments.

(1)

.....

.....

.....

(Total for Question 4 10 marks)