1 **(a)** Potassium iodide is an ionic compound.

(i) Describe what happens, in terms of electron loss and gain, when a potassium atom reacts with an iodine atom.

.....

.....

.....

..... [2]

(ii) Describe the structure of solid potassium iodide. You may draw a diagram.

.....

.....

..... [2]

(iii) Explain why potassium iodide has a high melting point.

.....

.....

..... [2]

(b) Potassium iodide and lead nitrate are both soluble. Lead iodide is insoluble.

(i) Describe how a pure dry sample of lead iodide could be made from solid potassium iodide and solid lead nitrate.

.....

.....

.....

.....

.....

..... [4]

(ii) Write an ionic equation for the formation of lead iodide, PbI_2, when potassium iodide and lead nitrate react with each other.
State symbols are **not** required.

..... [2]

(c) When chlorine gas is bubbled through an aqueous solution of potassium iodide, a redox reaction takes place.

$$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$$

(i) State the colour change expected in this reaction.

start colour .....

end colour .....
[2]

(ii) Identify the reducing agent in this reaction. Explain your answer.

.....

.....

..... [2]

[Total: 16]

2 Calcium reacts with nitrogen to form the ionic compound calcium nitride, Ca_3N_2.

(a) Draw a diagram, based on the correct formula, which shows the charges on the ions and the arrangement of the electrons around the negative ion.

Use o to represent an electron from a calcium atom.
Use x to represent an electron from a nitrogen atom.

[3]

(b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3 : 2.

(i) What is meant by the term *lattice*?

.....

..... [2]

(ii) In terms of ionic charges, explain why the ratio of ions is 3 : 2.

.....

..... [2]

(c) The reaction between calcium and nitrogen to form calcium nitride is a redox reaction.

In terms of electron transfer, explain why calcium is the reducing agent.

.....

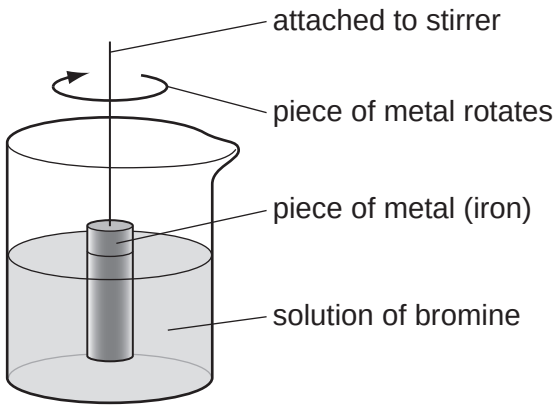
.....

.....

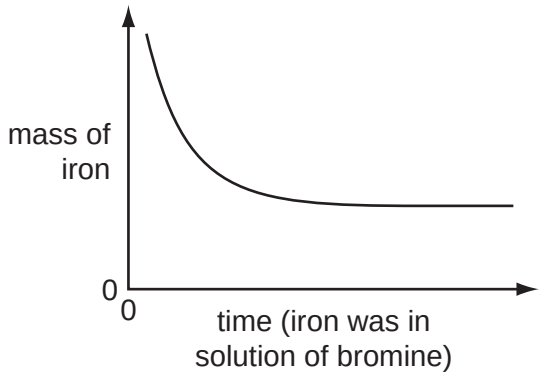
..... [3]

[Total: 10]

3 The rate of the reaction between iron and aqueous bromine can be investigated using the apparatus shown below.



(a) A piece of iron was weighed and placed in the apparatus. It was removed at regular intervals and the clock was paused. The piece of iron was washed, dried, weighed and replaced. The clock was restarted.
This was continued until the solution was colourless.
The mass of iron was plotted against time. The graph shows the results obtained.



(i) Suggest an explanation for the shape of the graph.

.....

.....

..... [3]

(ii) Predict the shape of the graph if a similar piece of iron with a much rougher surface had been used.
Explain your answer.

.....

..... [2]

(iii) Describe how you could find out if the rate of this reaction depended on the speed of stirring.

.....

.....

..... [2]

(b) Iron has two oxidation states +2 and +3. There are two possible equations for the redox reaction between iron and bromine.

$$Fe + Br_2 \rightarrow Fe^{2+} + 2Br^-$$

$$2Fe + 3Br_2 \rightarrow 2Fe^{3+} + 6Br^-$$

(i) Indicate, on the first equation, the change which is oxidation. Give a reason for your choice.

.....

..... [2]

(ii) Which substance in the first equation is the reductant (reducing agent)?

..... [1]

(c) Describe how you could test the solution to find out which ion, Fe^{2+} or Fe^{3+}, is present.

.....

.....

..... [3]

[Total: 13]

4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked *, their common oxidation states are given.

* bariu	Ba
* lanthanu	La (+3)
magnesium	
zinc	
* chromiu	Cr (+2), (+3), (+6)
iron	
copper	
* palladiu	(+2)

Choose metal(s) from the above list to answer the following questions.

(i) Which **two** metals would not react with dilute hydrochloric acid?

.....

[2]

(ii) Which **two** unfamiliar metals (*) would react with cold water?

.....

[2]

(iii) What is the oxidation state of barium?

.....

[1]

(iv) Name an unfamiliar metal (*) whose oxide cannot be reduced by carbon.

.....

[1]

(v) Why should you be able to predict that metals such as iron and chromium have more than one oxidation state?

.....

.....

[1]

[Total: 7]

5 In 1909, Haber discovered that nitrogen and hydrogen would react to form ammonia. The yield of ammonia was 8%.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3$ **(g)** the forward reaction is exother

catalyst platinum
temperature 600 °C
pressure 200 atm

(a) Describe how hydrogen is obtained for the modern process.

.....

..... [2]

(b) What is the catalyst in the modern process?

..... [1]

(ii) Explain why the modern process, which uses a lower temperature, has a higher yield of 15%.

.....

..... [2]

(c) Complete the following table that describes the bond breaking and forming in the reaction between nitrogen and hydrogen to form ammonia.

bonds	energy change /kJ	exothermic or endothermic
1 mole of N ≡ N broken	+94	.....
3 moles of ..... broken	+130	.....
6 moles of N – H formed	-232	.....

[3]

(ii) Explain, using the above data, why the forward reaction is exothermic.

.....

..... [2]