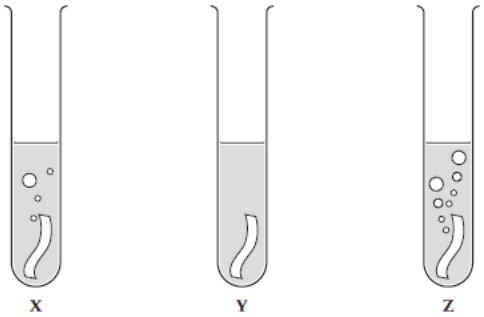
A. Reactivity of metals – The reactivity series, metal oxides and extractions

1. Three metals, X, Y and Z were put into water. The reactions are shown below:



a) Use the diagrams to put metals X, Y and Z in order of reactivity, starting with the most reactive. (1)

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b) When a metal reacts with water, it produces hydrogen gas and a metal hydroxide. Describe how you can test for the products. (2)

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c) Give two variables that should be controlled in this investigation. (2)

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2. A piece of magnesium ribbon was added to dilute hydrochloric acid.

a) Give two observations that are evidence for a chemical reaction taking place. (2)

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b) Write the word and balanced symbol equation, including state symbols, for the reaction. (4)

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3. The reaction between aluminium powder and iron(III) oxide (Fe_2O_3) is used in the rail industry.

a) Write a word equation and balanced symbol equation for the reaction that takes place. (3)

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b) Compare the reaction above to the reaction with powdered aluminium and copper(II) oxide and explain why there is a difference. (2)

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4. A student carried out some displacement reactions using three metals and three sulfate solutions. The results are shown in the table below:

	Iron sulfate ($FeSO_4$)	**Copper sulfate ($CuSO_4$)**	**Magnesium sulfate ($MgSO_4$)**
Iron (Fe)		✓	×
Copper (Cu)	×		×
Magnesium (Mg)	✓	✓	

a) i) Explain what is observed when iron reacts with copper sulfate. (2)

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ii) HT: Write an ionic equation for the reaction between iron and copper sulfate solution. (2)

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b) Explain why there is no observation between copper and iron sulfate. (2)

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c) i) Explain what is observed when magnesium reacts with iron sulfate. (2)

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ii) HT: Write a half equation to show the reduction of iron ions (Fe^{2+}) when magnesium reacts with iron sulfate. Use the half equation to explain why Fe^{2+} ions are reduced. (2)

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B. Reactions of metals part 1 – Metals & acids and strong & weak acids (HT)

1. Zinc reacts with hydrochloric acid.

a) Write a word and a balanced symbol equation with state symbols to show this reaction. (2)

zinc + hydrochloric acid → zinc chloride + hydrogen

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b) HT: write an ionic equation for the reaction. (2)

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c) HT: Give both half equations to show the electron transfers taking place. (2)

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d) HT: Explain why this reaction is a redox reaction. (4)

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2. a) HT: Explain why ethanoic acid (found in vinegar) is described as a weak acid, whereas nitric acid is a strong acid. (4)

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b) HT: Magnesium reacts with ethanoic acid and nitric acid. What difference would you see if magnesium carbonate was reacted with ethanoic acid of the same concentration as nitric acid? (2)

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C. Reactions of metals part 2 – pH scale, neutralisation, salt and titration (chem)

1. Magnesium carbonate reacts with nitric acid. The equation is shown below:

$$MgCO_3(aq) + 2\ HNO_3(aq) \text{ ---> } Mg(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

Extended writing:

Plan a method to produce dry crystals of magnesium nitrate. (6)

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2. i) HT: You are given a 0.50mol/dm^3 solution of nitric acid (strong) and ethanoic acid (weak). Calculate the concentration of each acid, giving your answer in g/dm^3 to 3 significant figures. (2)

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ii) The solution of ethanoic acid has a pH of 4 and the solution of nitric acid a pH of 1. How many times greater is the concentration of H+ ions in the nitric acid compared to the concentration in the ethanoic acid? (1)

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3. **CHEMISTRY ONLY:**

a) A titration is carried out between hydrochloric acid and sodium hydroxide.

The following results show the volumes of acid added to neutralize the sodium hydroxide.

	Rough	**Trial 1**	**Trial 2**	**Trial 3**
Volume of acid added (cm^3)	15.70	15.30	15.25	15.30

Calculate the mean volume of solution added and explain your answer. (3)

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b) HT: In another investigation, it takes 27.00cm^3 of hydrochloric acid to neutralise 25.00cm^3 of sodium hydroxide at a concentration of 1.0 mol/dm^3. Calculate the concentration of hydrochloric acid in g/cm^3. (4)

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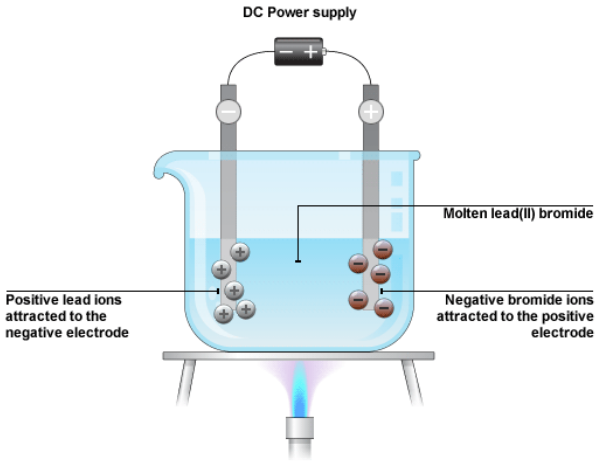
D. Electrolysis part 1 – Electrolysis of a molten and solution

1. The diagram shows how molten lead bromide is electrolysed.

Lead bromide contains Pb^{2+} and Br^- ions.



a) Explain why molten lead bromide conducts electricity. (1)

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b) HT: Write the half equations, including the state symbols for the changes at the anode and cathode. (4)

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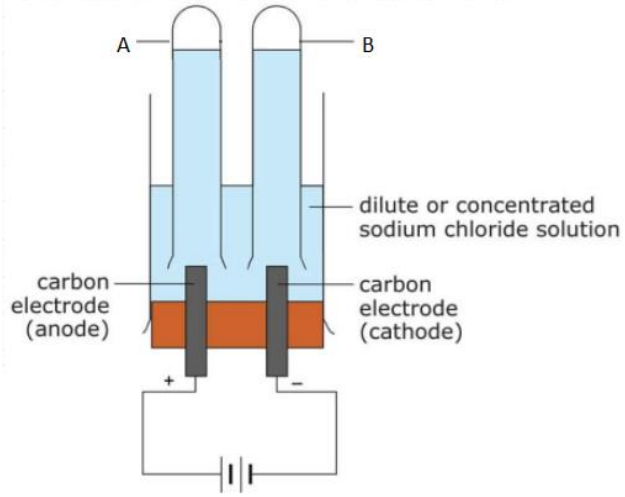
2. The diagram shows how sodium chloride is electrolysed in the laboratory:



a) Name the products A and B? (2)

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b) Give one use of substance A. (1)

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c) A few drops of universal indicator was added to the solution after the reaction and it turned blue. Explain why. (2)

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d) HT: Write the half equations, including the state symbols for the changes as the anode and cathode. (4)

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E. Electrolysis part 2 – Using electrolysis to extract metals

1. Aluminium is extracted from Aluminium oxide (Al_2O_3) by electrolysis.

Aluminium contains Al^{3+} and O^{2-} ions.

a) Suggest why aluminium was only discovered in the 1800s, despite it being a common element in the Earth's crust. (3)

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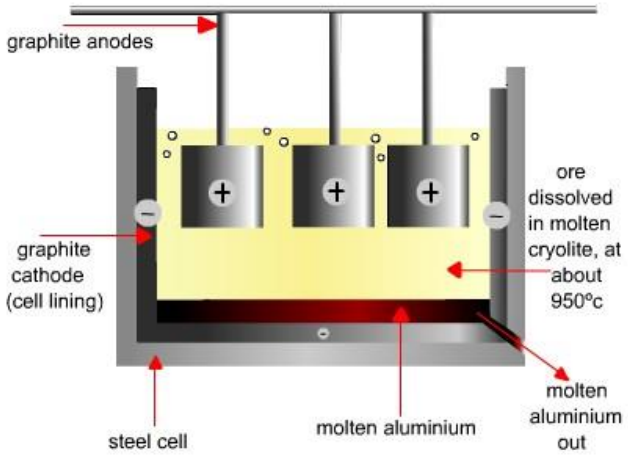
The following diagram shows how aluminium is extracted from aluminium oxide by electrolysis:



b) Why is molten aluminium oxide dissolved in molten cryolite? (2)

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c) Why are the carbon anodes replaced regularly in the industrial electrolysis of aluminium oxide? (2)

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d) HT: Write half equations for the changes at each electrode and explain which of the ions are oxidised and reduced. (4)

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