SeaHawk Tutors

AQA Chemistry GCSE Topic 4.4 - Chemical Changes

Topic 4.4 only

1. The table shows an **incomplete** reactivity series.
   a. The three elements in the table on the right below need to be inserted into the table on the left. State the letter that shows where each of the three elements should be placed. For example, if element X should be placed below Potassium and above Sodium it is in spot B. [3]

_____	A
Potassium	
_____	B
Sodium	
_____	C
Calcium	
_____	D
Zinc	
_____	E
Carbon	
_____	F
Iron	
_____	G
Hydrogen	
_____	H

Lithium	
Copper	
Magnesium	

   b. Some metals exist in the earth's crust as the metal itself. An example of this is Gold. Others exist in the earth's crust as ores. An example of this is Aluminium.

      i. Define the term 'ore'. [1]

      _____

      _____

      ii. State why Aluminium exists in the earth's crust as an ore but Gold exists as the metal. [1]

      _____

   c. Companies involved in metal extraction use various chemical reactions to extract metal from ores. One common process uses a displacement reaction. Displacement reactions involve a more reactive substance replacing a less

reactive one in a compound. State which of the following is / are a displacement reaction: [2]

☐ $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$

☐ $2\ NaI + Cl_2 \rightarrow 2\ NaCl + I_2$

☐ $2\ Al + Fe_2O_3 \rightarrow 2\ Fe + Al_2O_3$

☐ $CaCO_3 \rightarrow CaO + CO_2$

d. Potassium is a highly reactive element which will displace almost any other metal from a compound. It could therefore be used to extract other metals such as Iron from its ore. State why it would not be practical to use Potassium for this purpose. [1]

_____

_____

e. Calcium Oxide is the fourth most abundant substance in the earth's crust. Mark with a tick which of the following methods would be effective in producing Calcium metal from its oxide. [1]

☐ Electrolysis of an aqueous solution of a Calcium compound

☐ Electrolysis of molten Calcium Oxide

☐ Reduction with Carbon

Total marks [9]

2. A silversmith is a metal worker who makes silver jewelry and other items. Some silver objects are made of solid silver and other items are made of another metal and plated with silver.

a. Suggest why a silversmith might not use solid silver for some objects. [1]

_____

Silver is one of a relatively few metals that exist in the earth's crust as the metal itself rather than as a compound of that metal.

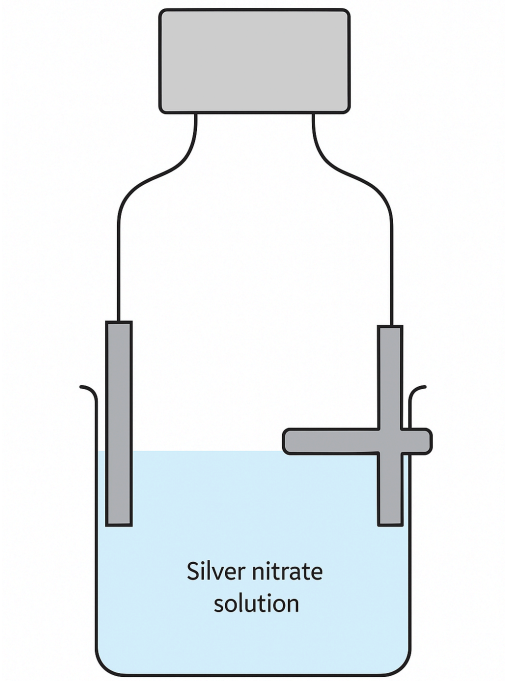
b. State why Silver can be found as the metal whereas other metals cannot. [1]

Silver plating is a chemical process where silver metal is deposited on another metal via electrolysis.

c. Draw lines to show the correct definition of the terms on the left with the appropriate definition on the right.

	A positive (metal) ion
Electrode	
	A negative (non-metal) ion
Electrolyte	
	A liquid that can conduct electricity
Cation	
	An electrical conductor inserted into a liquid

A silversmith uses an aqueous solution of Silver Nitrate to plate a steel object. He uses the arrangement shown in the diagram. The grey box at the top is the power supply, and the cross-shaped object is the item to be plated.



d. Draw a ring around the correct word to make this sentence correct:

For the plating to work, the object to be plated must be the anode / cathode.

[1]

e. On the diagram, label the power supply to show the correct orientation of + and -. [1]

f. Write the ionic half equation that occurs on the object being plated. [2]

In the electrolysis of aqueous solutions, there will always be two positive ions and two negative ions. One positive and one negative ion comes from the solute. The other positive ion is H^+, and the other negative ion is OH^-. These both come from the water.

To know which of each type of ion will be electrolysed we have two rules.

g. Complete these sentences to make the rules correct. [3]

For the positive ions, the _____ reactive of the solute ion and H^+ will be electrolysed.

For the negative ions, if a _____ ion is present that will be electrolysed. If not, the OH^- ion will be electrolysed releasing _____.

h. Complete the table to show what will be produced at the two electrodes in the electrolysis of the substances shown. [4]

Electrolyte	Produced at Anode	Produced at Cathode
Aqueous Copper Sulphate		
Molten Sodium Nitride		
Aqueous Potassium Chloride		

Total marks [13]

3. Salts are formed when an acid is neutralised by a base, an alkali or a carbonate.

a. State the salt that will be formed in the reaction between:

i. Sulphuric acid and Copper Oxide [1]

ii. Nitric acid and Strontium Carbonate [1]

b. Describe in detail an experiment to produce a clean, dry sample of Sodium Chloride crystals. You are provided with solid Sodium Oxide. You must decide on the other reactant(s) you wish to use as well as any normal equipment from the laboratory. [6]

Total marks [8]

4. This question is about titration.

Titration is a process that allows the measurement of the precise volume of an acid that exactly neutralises a given volume of alkali (or vice versa). If the concentration of one of the reactants is known, the concentration of the other can be calculated.

A typical titration is described in the following 11 steps, but they are out of sequence.

a. Number the steps in the table to produce the correct sequence. [5]

1	A pipette is used to put a specified volume of alkali of known concentration into a conical flask and a few drops of indicator are added.
	When the indicator shows that the solution in the flask is pH 7, no further acid is added.
	The ending reading on the burette is recorded.
	The starting reading on the burette is recorded.
	Quantitative chemistry is used to calculate the concentration of the acid.
	The process is repeated several times.
	The burette is filled with acid of unknown concentration.
	The titre is calculated by subtracting the ending reading from the starting reading.
	Any non-concordant readings are eliminated.
	Acid is added slowly to the flask.
	The mean titre is calculated from the concordant titres.

b. Before the titration began the pipette and burette were rinsed to ensure that there were no impurities that might distort the titration. Draw a line from the equipment on the left to the substance on the right to show the correct substance to rinse each with. You may use each substance once, more than once or not at all. [2]

	Distilled water
Pipette	Pure Ethanol
	Concentrated Hydrochloric Acid
Burette	The acid used in the titration
	The alkali used in the titration

c. Universal indicator is not a good choice for use in a titration.

i. Explain why universal indicator is not a good choice. [1]

_____

_____

ii. Name an appropriate indicator for a titration. [1]

d. State one reason why a non-concordant titre might occur. [1]

Total marks [10]

5. This question is about acids.

a. Some substances will neutralise acids. Mark with a tick which of the following will neutralise dilute Sulphuric Acid. [3]

☐ Copper, Cu

☐ Copper Carbonate, $CuCO_3$

☐ Copper Oxide, CuO

☐ Copper Sulphate, $CuSO_4$

☐ Copper Chloride, $CuCl_2$

☐ Copper Hydroxide, $Cu(OH)_2$

b. Sodium Hydroxide is an alkali. It will undergo a neutralisation reaction with dilute Hydrochloric acid.

i. State an estimate for the pH of Sodium Hydroxide solution. [1]

ii. State an estimate for the pH of dilute Hydrochloric acid. [1]

iii. Assuming that the reaction was done so that the number of moles of each reactant was equal, state the pH of the liquid in the reaction vessel at the end of the reaction. [1]

c. Hydrochloric Acid will also react with some metals.

i. State one metal with which it will NOT react. [1]

ii. Write the word equation for the reaction between a metal and an acid. [1]

iii. Write the balanced chemical equation for the reaction between Lithium and Hydrochloric Acid. Include state symbols. [3]

Total marks [11]

6. This question is about the extraction of Aluminium from its Oxide.

In the electrolysis, Aluminium Oxide is melted and a current is passed through it to separate it into its component elements.

a. Cryolite is added to the Aluminium Oxide before it is melted. Explain the purpose of the cryolite. [2]

The electrodes in the process are made of Graphite.

b. State two essential physical properties of the electrodes in this process. [2]

c. Write the ionic half equation for the reaction at the cathode. [2]

d. At the anode, Oxygen gas is produced. However, Oxygen is not recorded at abnormally high levels in the air inside the electrolysis chamber. Explain why the process does not seem to increase the O_2 levels in the air. [2]

e. The answer to (d) has various impacts. Explain:

i. One industrial or process impact; [2]

ii. One environmental impact. [2]

Total marks [12]

7. This question is about acids.

a. Complete the following sentence using the words in the table below.

An acid is a solution that contains _____ ions. Acids can be strong or weak and concentrated or dilute. A strong acid is one that undergoes complete ionisation or _____ when in _____ solution. A weak acid undergoes _____ ionisation. A dilute acid has a higher proportion of _____ to acid than a concentrated acid. [3]

aqueous	water	OH^-	solution
chloride	H^+	partial	dissociation

b. The pH scale is used to measure the degree of acidity or alkalinity of a solution.

i. State the range of values that the pH scale uses. [1]

State the pH that you would estimate if a drop of universal indicator in a solution turned the following colours:

ii. Green _____

iii. Deep blue _____

iv. Orange _____ [3]

Acids are neutralised by bases.

c. An alkali is a type of base. State what distinguishes a base from an alkali. [1]

d. An alkali contains OH^- ions. Write the **ionic** equation for a neutralisation reaction. Include state symbols. [3]

Total marks [11]

8.

a. Complete the following sentence:

Oxidation can be considered as the gain of _____ or the loss of _____. [2]

A chemist is conducting a series of tests to establish the relative reactivities of three metals, labeled X, Y & Z. He carefully places a small sample of each metal first in a beaker of dilute Hydrochloric Acid and then a second sample in a beaker of water. He records the following observations, which are a complete record of what was seen.

	Dilute HCl (aq)	Water
Metal X	Sample sinks, gentle bubbling	Very occasional bubbles
Metal Y	No observable reaction	No observable reaction
Metal Z	Violent reaction, vigorous effervescence.	Sample floats, moves on surface of water, vigorous effervescence

b. The chemist knows that one sample is Copper and one is Magnesium. Suggest which sample these could be.

Copper _____ Magnesium _____ [2]

c. Suggest which metal the other sample might be. _____ [1]

d. Identify the gas responsible for the bubbles observed:

i. When Metal X reacts with water _____ [1]

ii. When Metal Z reacts with dilute acid _____ [1]

e. Complete the following sentence using elements from the table below:

Metal Y is the only one of the three metals in this analysis that can be extracted by electrolysis of _____ . This can be deduced by the fact that Metal Y has no reaction with _____ which means that Metal Y is _____ reactive than _____ . [4]

dilute acid	less	Carbon	more
molten salt	water	aqueous solution	Hydrogen

Total marks [11]

Synoptic questions involving 4.4

9. A chemist titrates 25cm^3 samples of 0.08 mol/dm^3 Sodium Carbonate (Na_2CO_3) solution with Sulphuric Acid of unknown concentration.

   She records her results in the table below.

cm^3	Titration 1	Titration 2	Titration 3
Initial reading	47.5	43.4	44.1
End reading	18.6	14.9	15.3
Titre			

   a. Name the piece of equipment used to measure the Sodium Carbonate solution. [1]

   b. State the name for the type of reaction in this titration. [1]

   c. The indicator the chemist used was phenolphthalein. State the colour change she is looking for to show that she should stop adding the acid. [1]

   d. Calculate the mean titre, excluding any non-concordant titres. [2]

   e. Write the balanced equation for the reaction between Sodium Carbonate and Sulphuric Acid. [1]

   f. Calculate the concentration of the acid used in the titration. Give your answer to 2 significant figures. [3]

Total marks [9]

Synoptic topics: 4.2, 4.3

10. A student takes 52.3g of Barium Hydroxide, $Ba(OH)_2$, and dissolves it in 150 cm^3 of distilled water to create Barium Hydroxide solution.

    a. Calculate the concentration of the solution she created in g/dm^3. [2]

    b. Calculate the Mr of Barium Hydroxide. [1]

    c. Calculate the concentration of the solution in mol/dm^3. [2]

She uses a 25cm^3 sample of the solution to test a sample of Hydrochloric acid of unknown concentration. By titrating them she wishes to determine the concentration of the acid.

She runs three titrations, and the start and end readings on the burette are shown below.

cm^3	Titration 1	Titration 2	Titration 3
Initial reading	48.6	44.5	45.1
End reading	28.9	24.5	25.2
Titre			

    d. Complete the table by calculating the titres. [1]

Concordant titres are those that are within 0.1 cm^3 of each other. Non-concordant titres are eliminated from the analysis.

e. State which titre should she exclude. [1]

f. Calculate the mean titre of the concordant results. [1]

g. Write the balanced equation for the reaction between Barium Hydroxide solution and Hydrochloric acid. Include state symbols. [2]

h. Calculate the concentration of the acid in mol/dm^3 to 3sf. [4]

Total Marks - 14

Synoptic topics: 4.3

11. This question is about the extraction of metals.

Iron and Aluminium both exist in the earth's crust as their oxides. Iron is a transition metal.

a. State one physical property of transition metals. [1]

Transition metals are capable of forming ions with different charges. Iron can form Fe^{2+} and Fe^{3+} ions. In these states it is referred to as Iron (II) and Iron (III) respectively.

The most common iron compound found on earth is Iron (II) Oxide but Iron (III) Oxide (and other oxides of iron) also exist.

b. State the chemical formulae of

i. Iron (II) Oxide; _____ [1]

ii. Iron (III) Oxide. _____ [1]

Iron can be extracted from its oxides by means of a reduction reaction with Carbon or Carbon Monoxide.

c. State, in terms of Oxygen, what is meant by reduction. [1]

_____

Aluminium cannot be extracted from its oxide in the same way as Iron.

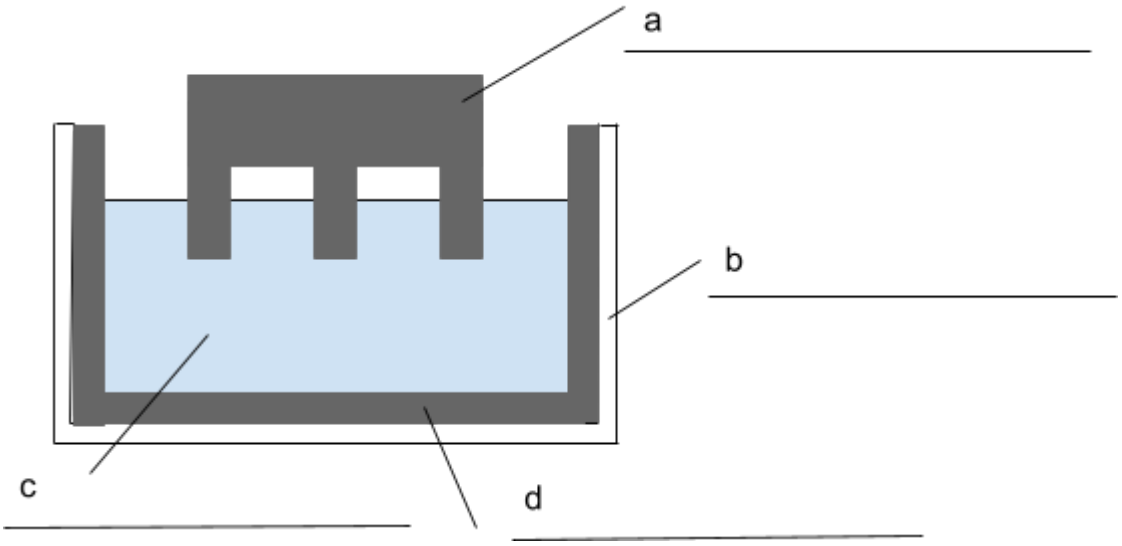
d. Explain, with reference to reactivity, why this is the case. [2]

_____

_____

_____

Instead, Aluminium is extracted from its oxide by electrolysis. The diagram below shows a typical arrangement of an industrial process for the electrolytic extraction of Aluminium. Label the elements of the diagram. For a, b and d state both the name of the component and the material from which it is made. For c give the physical state of the marked area also. [8]



Total marks [14]

Synoptic topics: 4.2, 4.3

Answers

1.
   a. Lithium C, Copper H, Magnesium D
   b.
      i. A naturally occurring rock that contains (a high concentration) of a mineral such as a metal compound
      ii. Al is more reactive than Au
   c. Boxes 2 & 3. Deduct one mark for each incorrect box ticked / not ticked
   d. Cost / expensive / Potassium is more valuable than Iron. Ignore 'reaction too violent'
   e. Just box 2

2.
   a. Cost / silver is expensive; strength / silver is not as hard as eg steel.
   b. Unreactive / less reactive than other metals eg Sodium
   c. Electrical conductor / liquid that conducts / Positive ion
   d. Cathode
   e. + on left
   f. $Ag^+ + e^- \rightarrow Ag$
   g. Less; halide (allow halogen); Oxygen / O_2
   h. Oxygen; Copper; Nitrogen; Sodium; Chlorine; Hydrogen. Deduct one mark for each incorrect answer. If columns are reversed throughout, award maximum of 2 marks.

3.
   a.
      i. Copper Sulphate
      ii. Strontium Nitrate
   b. Standard mark scheme.
      1 mark for identifying Hydrochloric Acid.

4.
   a. 1,5,6,3,11,8,2,7,9,4,10
   b. Pipette = alkali used in titration; burette = acid used in titration
   c.
      i. Hard to tell when green/neutral/ph7 / gradual change of colour
      ii. Phenolphthalein / Methyl Orange
   d. Misreading of burette; miscalculation of titre; incorrectly filled pipette; overshoot / failure to observe change of indicator; contamination of one or other reactant

5.
   a. Boxes 1, 2 and 5. Deduct 1 mark for each incorrect or missing box
   b.
      i. 11–14
      ii. 0–3
      iii. 7 (no other number allowed)
   c.

i. Copper, Silver, Gold or any other metal below Hydrogen in the reactivity series
ii. Metal + Acid → Salt + Hydrogen
iii. 2 Li (s) + 2 HCl (aq) → 2 LiCl (aq) + H_2 (g)

6.

a. Lower / reduce **melting point** ; reduce **energy** required
b. Conduct electricity ; have higher melting point than mixture / not melt. Ignore 'does not react.'
c. Al^{3+} + 3 e^- → Al (Allow minus electrons on right) 1 mark for correct ion of Al; 1 mark for correctly balanced equation
d. O_2 **reacts** with anode forming **Carbon Dioxide** / CO_2
e. .
   i. The anode is **eaten away** and has to be regularly **replaced**
   ii. Release / production of **CO_2** which is **greenhouse gas** / causes global warming

7.

a. H^+; dissociation; aqueous; partial; water.
b.
   i. 0-14 (do not allow 1 instead of 0)
   ii. 7 (allow +/- 1 for each of these)
   iii. 12
   iv. 3
c. Alkalis are (water) soluble bases
d. H^+ (aq) + OH^- (aq) → H_2O (l)

8.

a. Oxygen (allow O_2); electrons (must be in correct order)
b. X = Magnesium; Y = Copper; Z = Sodium
c. Sodium (Na) or Lithium (Li). Ignore Potassium (no flame)
d. Hydrogen (H_2) for both
e. Aqueous solution; dilute acid; less; Hydrogen

9.

a. Pipette
b. Neutralisation
c. Pink to colourless
d. Exclude titration 2; mean = 28.85 cm^3
e. Na_2CO_3 + H_2SO_4 → Na_2SO_4 + H_2O + CO_2
f. Mols of Na_2CO_3 = 0.025 × 0.08 = 0.002
   Mols of H_2SO_4 = 0.002
   Concentration of H_2SO_4 = 0.002 ÷[0.02885] = 0.069 mol/dm

10.

a. 52.3 ÷ 0.150 = 349 g/dm^3
b. 171
c. 349 ÷ 171 = 2.05 mol/dm^3
d. 19.7; 20.0; 19.9
e. Titre 1
f. 19.95

g. $Ba(OH)_2 + 2\ HCl \rightarrow BaCl_2 + 2\ H_2O$
h. Mols of $Ba(OH)_2$ = [2.05] × 0.025 =0.0513
Ratio 1 : 2
Mols of HCl = 0.0513 × 2 = 0.103
Concentration of HCl = 0.103 ÷ [0.01995] = 5.14 mol/dm^3

11.

a. Hard; conduct electricity; malleable/ductile; form coloured salts; dense
b.
   i. FeO
   ii. Fe_2O_3
c. Removal / Loss of Oxygen
d. Al more reactive than C (ignore more reactive than Fe); C cannot reduce Al compounds / no reaction C with Aluminium Oxide.
e. a Graphite + Cathode (do not allow Carbon)
b Steel (allow metal) + bucket / container / tank oe
c Molten / Liquid + Aluminium Oxide / Al_2O_3
d Graphite + Anode
If electrode used in place of both Anode and Cathode score 1 mark