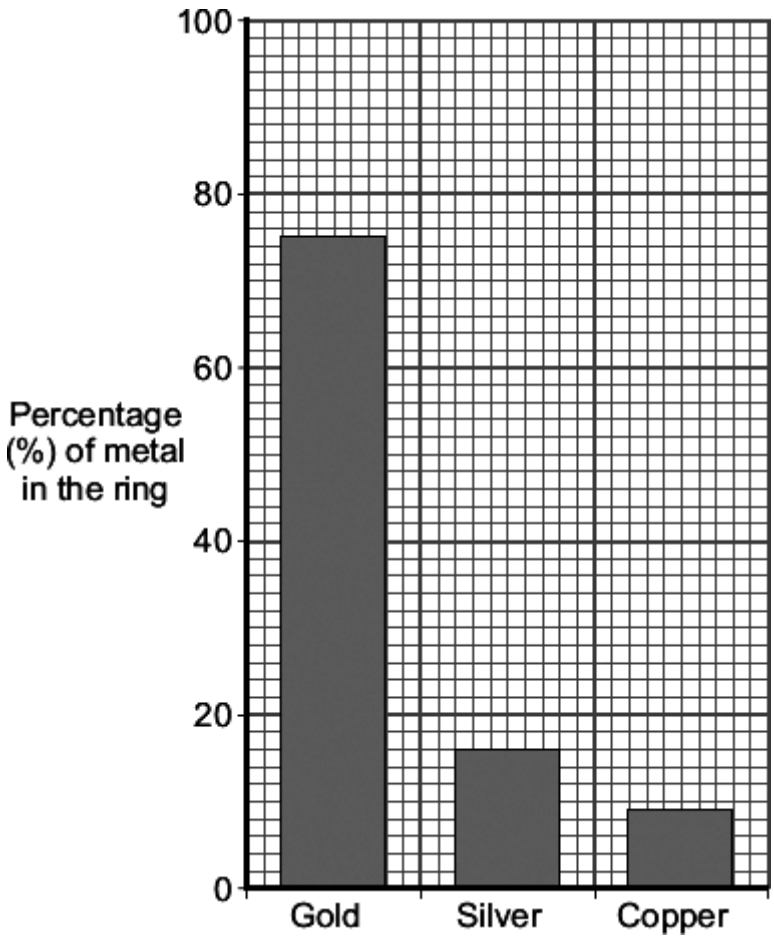
4-10 – Using resources – Chemistry

1.0 The picture shows a ring.

Photograph supplied by Comstock/Thinkstock

1.1 **Graph 1** shows the composition of the metals in the ring.

Graph 1



The metal in the ring had a mass of 8.5g. What was the mass of gold in the ring?
Give your answer to 2 significant figures.

[3 marks]

Mass = _____ g

1.2 Give **two** reasons why other metals are added to gold to make the ring.

[2 marks]

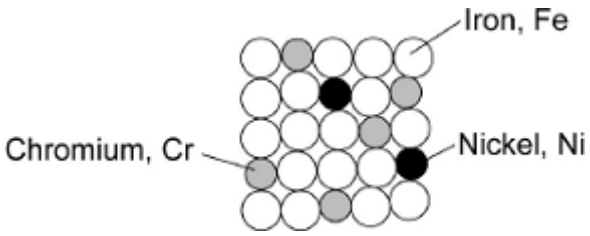
_____

_____

1.3 Stainless steel is an alloy of iron, chromium and nickel.

Figure 1 represents the particles in stainless steel.

Figure 1



Particle diagram of stainless steel

Calculate the percentage (%) of chromium in stainless steel.
Use information from **Figure 1**.

[2 marks]

Percentage (%) of chromium in stainless steel = _____ %

1.4 Different types of steel have different properties.

Draw **one** line from each type of steel to its properties.

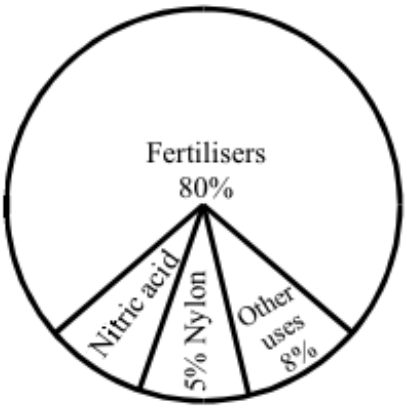
[1 mark]

type of steel	**property**
High carbon	Hard and resistant to corrosion
Low carbon	Soft and easy to shape
Stainless steel	Strong but brittle

2.0 Ammonia is an important chemical. Ammonia is used to make other substances.

Figure 2 shows substances made from ammonia.

Figure 2



2.1 131 million tonnes of ammonia are produced each year.

Calculate the amount of ammonia used to make nitric acid.

[3 marks]

_____ million tonnes

2.2 Ammonia is an alkali in solution.

What type of reaction takes place when ammonia solution reacts with nitric acid?

[1 mark]

_____

2.3 Much of the nitric acid produced is then reacted with ammonia to make a salt which is used as a fertiliser.

Name the salt produced by reacting ammonia with nitric acid.

[1 mark]

_____

2.4 The reaction between ammonia and nitric acid produces a single product.

The chemical formula of ammonia is NH_3.

Write a balanced symbol equation for ammonia and nitric acid.

[2 marks]

NH_3 + _____ → _____

3.1 What does 'potable water' mean?

[1 mark]

_____

_____

3.2 How is 'potable water' different to 'pure water'?

[1 mark]

_____

_____

3.3 Name **two** ways of sterilising water.

[2 marks]

1 _____

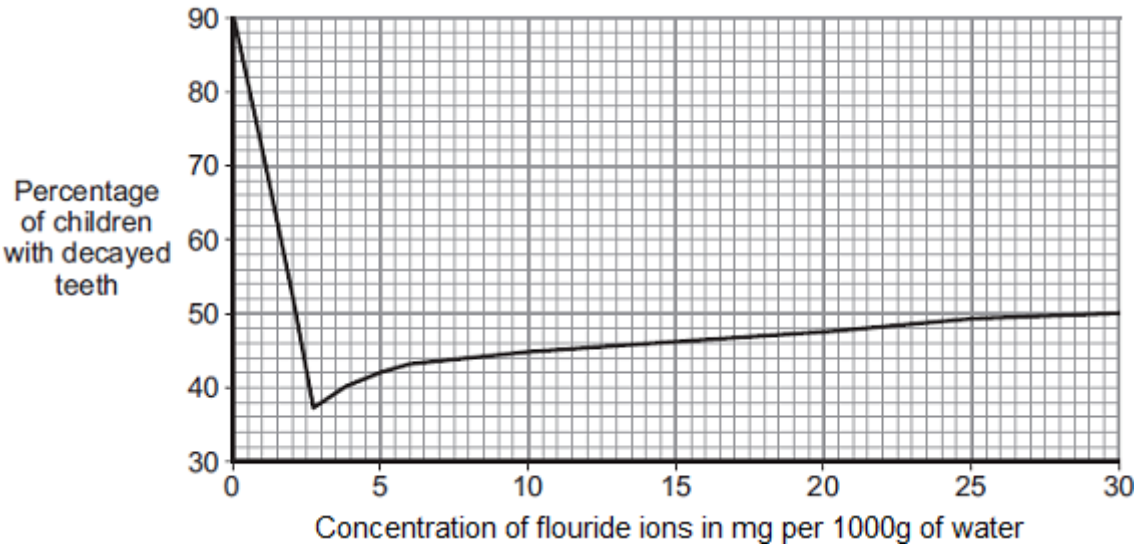
2 _____

Compounds containing fluoride ions are added to some drinking water supplies.

Scientists investigated the effect of fluoride ions on tooth decay.

Graph 2 shows the concentration of fluoride ions against the percentage of children with decayed teeth.

Graph 2



3.4 Suggest the best concentration of fluoride ions to use in drinking water.
Give **a** reason for your answer.

[2 marks]

Best concentration = _____ mg per 1000g water

Reason:_____

_____

_____

3.5 Describe two patterns shown by **Graph 2**.

[2 marks]

_____

_____

_____

_____

4.0 Desalination of seawater can be carried out by processes that use membranes such as reverse osmosis.

4.1 Describe one **other** way to desalinate sea water in a school laboratory.

You may include a labelled diagram in your answer. **[4 marks]**

4.2 A student investigated how much solid was dissolved in sea water.

The student:

1. Measured the mass of an empty evaporating basin.
2. Measured 50 cm^3 of sea water and poured it into the evaporating basin.
3. Heated the evaporating basin gently until all of the water had evaporated.
4. Measured the mass of the evaporating basin containing the solid residue.
5. Reheated the evaporating basin and solid residue.
6. Measured the mass of the evaporating basin and solid residue.
7. Repeated steps 5 and 6 until the mass was constant.

Name two different pieces of apparatus that would be suitable for measuring:

- the mass of the evaporating basin
- 50 cm^3 of sea water.

[2 marks]

Equipment to measure the mass of the evaporating basin_____

Equipment to measure 50 cm^3 of sea water _____

4.3 Why did the student keep reheating the evaporating basin and solid residue until a constant mass was obtained?

[1 mark]

_____

_____

4.4 The results the student obtained using 50 cm^3 of sea water are:

mass of empty evaporating basin = 23.57 g
mass of evaporating basin and dry solid residue = 25.23 g

Calculate the mass of solid dissolved in **1000 cm^3** of the sea water.

[1 mark]

Mass dissolved in 1000 cm^3 = _____ g

5.0 The Haber process is used to make ammonia (NH_3).

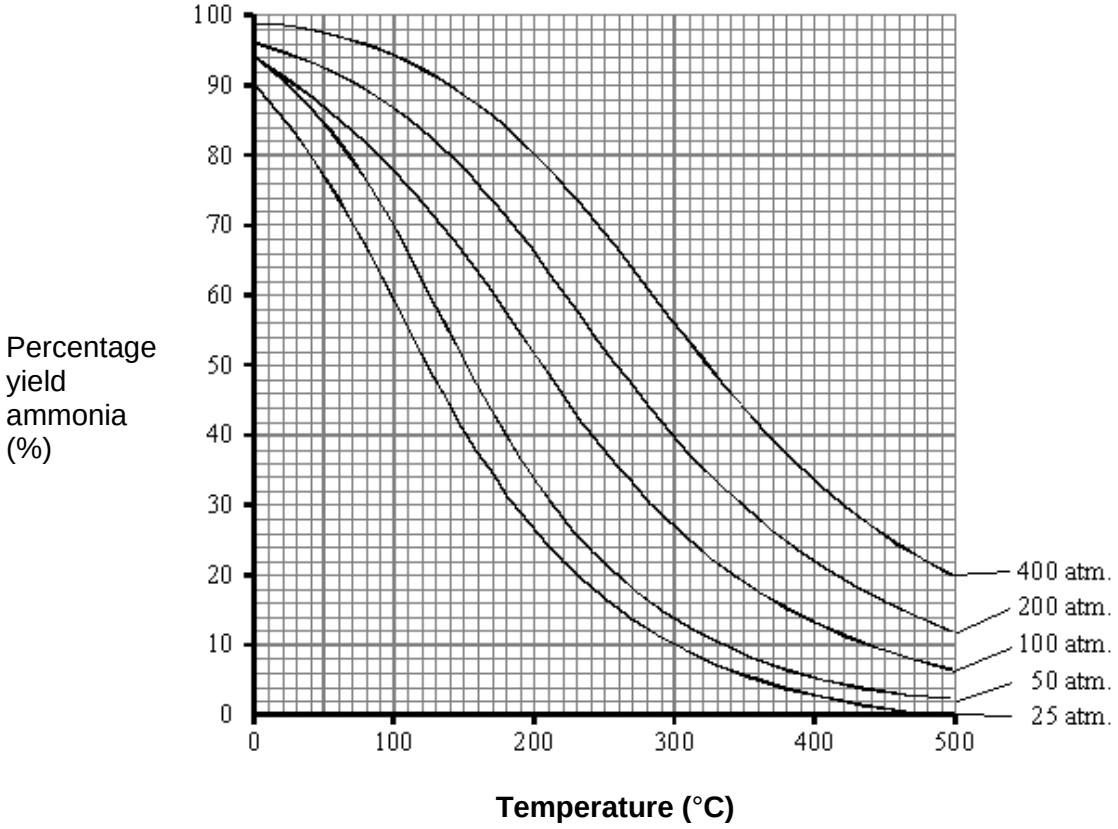
The equation shows the reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction is exothermic.

Graph 3 shows how the temperature and pressure affect the percentage of ammonia produced in the reaction.

Graph 3



5.1 The usual reaction conditions for making ammonia are 450 °C and 200 atmospheres.

Which change has the greatest effect:

- reducing the temperature to 300 °C or
- doubling the pressure to 400 atmospheres?

Explain your answer.

[2 marks]

5.2 Explain, as fully as you can, using the graph and your knowledge of the Haber process why 450 °C and 200 atmospheres are chosen as usual conditions for this process.

[6 marks]

6.0 This question is about extracting metals.

6.1 Describe how copper compounds are obtained by phytomining.

[2 marks]

6.2 Aluminium is extracted from an ore, called bauxite, by electrolysis of molten aluminium oxide.

Aluminium is also widely recycled and the metal is obtained from the recycling process.

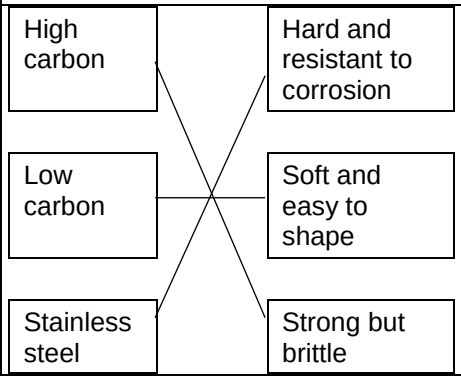
Use your knowledge and understanding to compare these methods of producing aluminium.

Your answer should include

- The energy requirement;
- Availability of resources;
- Purity of the products.

[6 marks]

MARK SCHEME

Qu No.		Extra Information	Marks
1.1	Percentage gold = 75% 8.5 x 0.75 = 6.375 = 6.4 to 2 significant figures	 Allow ecf from first marking point	1 1 1
1.2	Any **two** from: • (100% / pure) gold is soft • (alloyed) to make the metal hard(er) • gold is expensive or alloy is less expensive	Ignore references to colour / lustre / corrosion / rarity Allow (alloyed) to make the metal strong	2
1.3	$\frac{5}{25}$ 20 (%)	 Allow an answer of 20 (%) without working for two marks	1 1
1.4		All required for the mark	1

Qu No.		Extra Information	Marks
2.1	100-80-8-5 = 7% nitric acid 131 × 0.07 = 9.17		1 1 1
2.2	Neutralization		1
2.3	Ammonium nitrate		1
2.4	HNO_3 NH_4NO_3		1 1

Qu No.		Extra Information	Marks
3.1	Water that is fit/safe to drink		1
3.2	Pure water contains only molecules of water	Allow potable water contains low levels of dissolved salts	1
3.3	Any **two** from: • chlorine • ozone • ultraviolet / uv light • distillation	Ignore filtration and reverse osmosis If two answers together on one line, apply list rule.	2
3.4	2.75 (mg per 1000 g of water) As this has the greatest effect on tooth decay	Allow answers in range 2.5 – 3.0 Allow lowest rate of tooth decay	1 1
3.5	As the percentage of fluoride ions increases the number of children with tooth decay decreases until the fluoride ion concentration is 2.75 (mg per 1000 g of water) After a fluoride ion concentration of 2.75 (mg per 1000 g of water), the number of children with tooth decay increases as the fluoride ion concentration increases	Allow ecf in value from 3.5 Allow as the percentage of fluoride ions increases initially the number of children with tooth decay decreases	1 1

Qu No.		Extra Information	Marks
4.1	Distillation Heat a flask (containing sea water) until it boils Use of a condenser / delivery tube Collect (pure water) in a boiling tube / beaker / flask	 Allow evaporate sea water. The last three marks can be obtained from a suitably labelled diagram.	1 1 1 1
4.2	(Top pan) balance Measuring cylinder		1 1
4.3	To make sure that all of the water had evaporated		1
4.4	33.2 (g)		1

Qu No.		Extra Information	Marks
5.1	Usual conditions give yield of 16 (%) Reducing temperature gives yield of 40(%) / Increasing pressure gives yield of 24(%) so reducing temperature has greater effect	 Award second mark for one other reading from the graph and a valid conclusion.	1 1
5.2			
Level 3:	A detailed and coherent explanation is given, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.		5-6
Level 2:	An explanation is given which demonstrates a reasonable understanding of the key scientific ideas. Links are made but may not be fully articulated and / or precise.		3-4
Level 1:	Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised.		1-2
	No relevant content		0
Indicative content			
• The best **yield** is obtained at high pressure and low temperature. • It is a reversible reaction. • Formation of ammonia is favoured at low temperature. • (Because) the reaction is exothermic. • Formation of ammonia is favoured at high pressure. • Because greater number of gaseous reactant molecules than gaseous product molecules or because greater volume of reactant molecules than product molecules. • Pressure used is limited by cost/materials. • Rate of reaction slow at low temperatures. • Actual temperature and pressure used is a good compromise between a good yield and reasonable rate. • Removal of ammonia makes rate more important than yield.			

Qu No.		Extra Information	Marks
6.1	Grow plants on land containing copper ores, then burn the plants Ash (from burning) contains copper compounds		1 1
6.2			
Level 3:	A detailed and coherent comparison is given, which demonstrates a broad knowledge and understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.		5-6
Level 2:	A description is given which demonstrates a reasonable knowledge and understanding of the key scientific ideas. Comparisons are made but may not be fully articulated and / or precise.		3-4
Level 1:	Simple statements are made which demonstrate a basic knowledge of some of the relevant ideas. The response may fail to make comparisons between the points raised.		1-2
	No relevant content		0
Indicative content			
Extraction from bauxite • High temperature needed to melt bauxite/ore; • Large amount of electricity used; • Higher energy costs; • Uses more natural resources; • Bauxite must be quarried so more damage to the environment; • Purity of aluminium produced is higher. Recycling • Reduces waste going to landfill; • Uses less natural resources; • Lower energy costs; • Aluminium must be separated from other materials; • Purity of aluminium is lower.			