Improving Processes and Products (H)

1. The table shows some information about four alloys.

	Alloy	Main metals	Typical Uses
A	brass	copper and tin	musical instruments
B	bronze	copper and zinc	bells
C	duralumin	aluminium and copper	aircraft parts
D	solder	iron and tin	bridges

Which row of the table gives correct information about an alloy?

Your answer [ ] **[1]**

2. Phytoextraction is one way to extract copper from low-grade ores.

The table shows the main stages involved in phytoextraction.

Stage	Process
1	Copper ions accumulate in the roots, shoots and leaves of plants.
2	Copper is extracted from ash with a high concentration of copper compounds.
3	Plants absorb dissolved copper ions through their roots.
4	A crop is planted in soil containing low-grade copper ore.
5	Plants are harvested and burned.

What is the correct order for the stages?

A   1, 3, 4, 5, 2
B   4, 1, 3, 2, 5
C   4, 3, 1, 5, 2
D   1, 4, 3, 5, 2

Your answer [ ] **[1]**

3. Bioleaching is one method used to extract copper from ores.

Reactions involving bacteria slowly convert copper sulfide to a mixture of copper sulfate solution and sulfuric acid.

   i. Describe **two advantages** of extracting copper using bioleaching instead of traditional mining.

   1

   2

   ----

   [2]

   ii. Suggest **one** reason why the sulfuric acid produced during bioleaching may be harmful to the environment.

   --**[1]**

4 (a). The Haber process is used to manufacture ammonia, NH_3

Ammonia is used to make fertilisers, which farmers use on their crops.

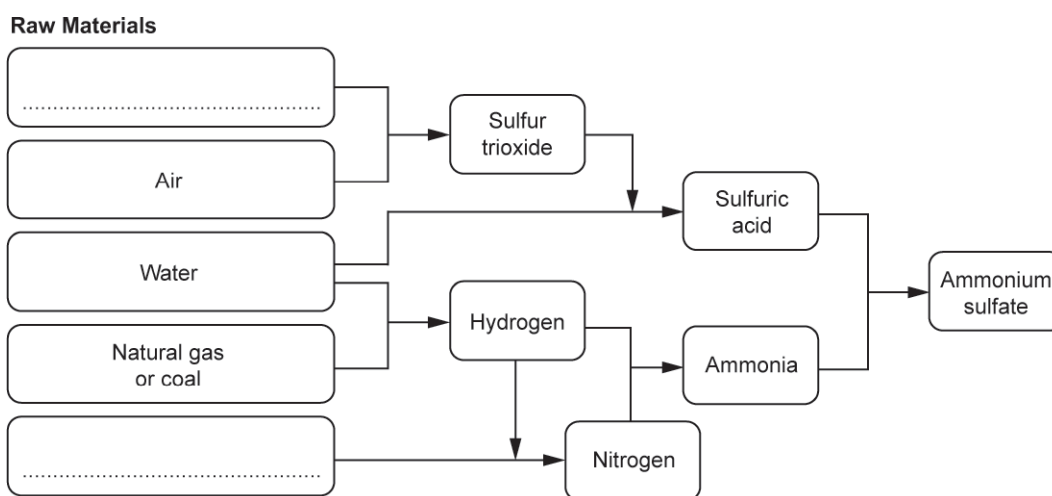Explain why fertilisers are so important in the agricultural production of crops.

   --**[2]**

 (b). Ammonium sulfate is a fertiliser made from ammonia and sulfuric acid.

The diagram shows the stages in the industrial production of ammonium sulfate.

Complete the diagram to show the **raw materials** in the production of ammonium sulfate.

Raw Materials

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┌─────────────────────┐
│ ..................  │────┐
└─────────────────────┘    │      ┌──────────┐
┌─────────────────────┐    └─────▶│  Sulfur  │───┐
│        Air          │──────────▶│ trioxide │   │
└─────────────────────┘           └──────────┘   ▼
┌─────────────────────┐           ┌──────────┐  ┌─────────┐
│       Water         │──────────▶│ Sulfuric │  │         │
└─────────────────────┘           │   acid   │  │Ammonium │
┌─────────────────────┐  ┌──────┐ └──────────┘  │ sulfate │
│    Natural gas      │─▶│Hydro-│      │         └─────────┘
│     or coal         │  │ gen  │──┐   ▼
└─────────────────────┘  └──────┘  │ ┌─────────┐
┌─────────────────────┐      │     └▶│ Ammonia │
│ ..................  │──┐   ▼       └─────────┘
└─────────────────────┘  │ ┌──────────┐
                         └▶│ Nitrogen │
                           └──────────┘
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   [2]

5 (a). This question is about the properties of materials.

Look at the table. It shows information about two materials.

	Polymer	Metal
Melting Point (°C)	100–260	1100
Density (kg / m³)	940	8940
Relative electrical conductivity (10 = good, 1 = poor)	2	10
Flexibility	high	high

Electrical cables are made of metal wires surrounded by a polymer coating.
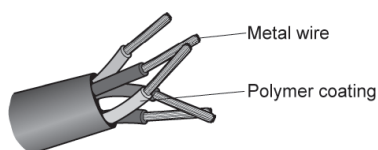
Explain why
* the wire is made of metal
* the metal wire is coated with a polymer.

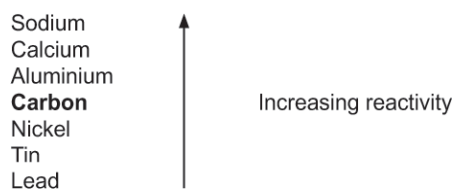Use information from the table in your answer.

--**[3]**

(b). Aluminium is a metal.

Aluminium is extracted from an ore called bauxite.

Electrolysis is used to extract the aluminium.

Use the reactivity series to explain why aluminium cannot be extracted from bauxite by heating the bauxite with carbon.

Sodium
Calcium
Aluminium
Carbon   Increasing reactivity
Nickel
Tin
Lead

--**[1]**

(c). Drinks cans are often made from aluminium.

4.0 kg of bauxite makes 1.0 kg of aluminium.

285000 kJ of energy is needed to make 1.0 kg of aluminium from bauxite.

Aluminium can be **recycled**.

4.0 kg of recycled aluminium makes 3.8 kg of aluminium.

14250 kJ of energy is needed to produce 1 kg of aluminium from recycled aluminium.

    i.   Describe how aluminium is recycled.

---**[2]**

    ii.   Describe and explain **two** advantages of recycling aluminium.
             Use the information in the question in your answer.

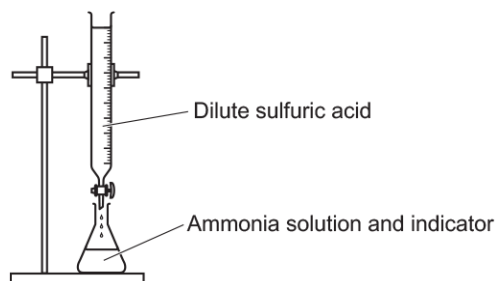---**[3]**

6. Ammonia is used to make fertilisers such as ammonium sulfate.

A student makes some ammonium sulfate crystals in a laboratory.

She uses a titration method, as shown in the diagram.

She adds an indicator to ammonia solution in a conical flask. She then adds dilute sulfuric acid from a burette until the indicator changes colour.

The student then crystallises the solution. She is left with **impure** ammonium sulfate crystals.

    i.   What should the student have done to obtain **pure** ammonium sulfate crystals?

--**[2]**

    ii.   In industry the same reaction is used to make ammonium sulfate.

            The method used is different.

            Give **one** reason why the laboratory method to make ammonium sulfate is **not** used in industry.

--**[1]**

7. This question is about properties of materials.

Police bullet-resistant vests could be made from steel or Kevlar®.

The table shows some information about steel and Kevlar®.

	Steel	**Kevlar®**
Density (g / cm³)	7.85	1.44
Relative strength	1	5
Flexibility	low	High
Resistance to corrosion	low	High

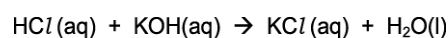Describe and explain **two** reasons why bullet-resistant vests are made from Kevlar® instead of steel.

1

2

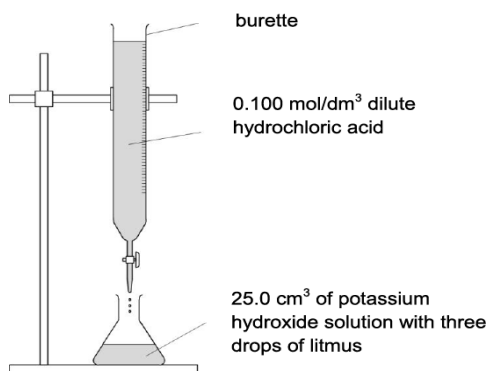
[4]

8(a). Sarah does three titrations with dilute hydrochloric acid and potassium hydroxide solution.

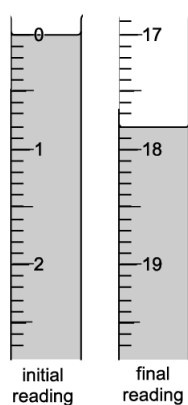Hydrochloric acid neutralises the alkali potassium hydroxide.

$$HCl\,(aq)\ +\ KOH(aq)\ \rightarrow\ KCl\,(aq)\ +\ H_2O(l)$$

Look at the apparatus she uses.

burette

0.100 mol/dm³ dilute hydrochloric acid

25.0 cm³ of potassium hydroxide solution with three drops of litmus

Look at the diagrams. They show parts of the burette during the first titration.

First titration

initial reading

final reading

Here is Sarah's results table:

Titration number	1	2	3
final reading (cm³)		37.5	32.1
initial reading (cm³)		20.4	15.0
titre (volume of acid added) (cm₃)		17.1	17.1

Use the diagrams and table to help you calculate the mean titre.

Explain your answer.

Mean titre = …………………………………………………… cm³   **[2]**

(b). Sarah uses 25.0 cm^3 of potassium hydroxide solution, KOH.

She also uses hydrochloric acid with a concentration of 0.100 mol/dm^3.

Calculate the concentration, in mol/dm^3, of the KOH(aq).

Concentration of KOH(aq) = …………………………………………………… mol/dm^3 **[2]**

(c). Use your answer to **(b)** to calculate the concentration of the KOH(aq) in g/dm^3.
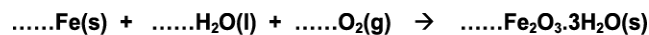
Concentration of KOH(aq) = …………………………………………………… g/dm^3 **[2]**

9 (a). Iron rusts when it gets wet.

The word equation for rusting is

iron + water + oxygen → rust (hydrated iron(III) oxide)

Balance the symbol equation for the formation of rust.

......Fe(s) + ...H$_2$O(l) + ...O$_2$(g) → ......Fe$_2$O$_3$.3H$_2$O(s)

[2]

(b). A 1.0 kg iron bar is left outside in the rain.

All of the iron turns to rust.

The rust forms at a rate of 60 g per day.

Calculate how long it will take for the iron bar to turn completely to rust.

Give your answer to the nearest day.

…………………………………………………… days

10(a). Aluminium is extracted from its ore using electrolysis.

Copper is extracted from its ore by heating with carbon.

Explain why different methods are used to extract aluminium and copper.

-- **[2]**

(b). Molten aluminium oxide contains Al^{3+} and O^{2-} ions.

The electrolysis of molten aluminium oxide makes aluminium and oxygen.

  i.   Write the **balanced symbol** equation for the electrode reaction that happens at the cathode.

Use the symbol e⁻ to represent an electron.

--**[1]**

  ii.   Solid aluminium oxide cannot be electrolysed.

Explain why.

--**[1]**

11 (a). Kasia investigates the corrosion of different metals.

She places a small strip of each metal in different samples of air.

She leaves the metals for one week before collecting her results.

Look at her table of results.

Metal	Original appearance of metal	Appearance of metal after one week in			
		moist acidic air	moist alkaline air	dry air	moist air
aluminium	shiny silver	dull silver	dull silver	shiny silver	shiny silver
copper	shiny red-orange	dull red-orange	green red-orange	shiny red-orange	dull red-orange
iron	shiny silver	brown coating	brown coating	shiny silver	brown coating
magnesium	shiny silver	whitish coating	dull silver	shiny silver	dull silver
zinc	shiny silver	dark coating	dark coating	shiny silver	dull silver

Suggest, with a reason, one change to the experimental procedure that would improve the quality of the results.

--**[1]**

(b). Explain the conclusions that can be made from Kasia's results.

--**[3]**

12(a). Ammonium sulfate, $(NH_4)_2SO_4$, is a fertiliser.

Ammonium sulfate can be manufactured from ammonia and sulfuric acid.

The Haber Process is used to manufacture ammonia. Scientists think that the Haber Process is one of the most important chemical reactions.

Explain the importance of the Haber Process in agriculture.

---**[2]**

(b). Ammonium sulfate is a salt.

It is made using the reaction between the alkali ammonia and sulfuric acid.
$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$
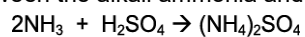
   i.   Describe how a sample of solid ammonium sulfate is prepared in a laboratory.

        Explain why this method is not suitable to be used industrially.

---**[4]**

   ii.   Predict the maximum mass of ammonium sulfate that can be made from 51 tonnes of ammonia.

Maximum mass = …………………………………………………… tonnes

END OF QUESTION PAPER