1 Some foods contain additives.

An emulsifier stops oil and water in a food from separating.

(a) Phil finds some information about four substances.

Look at this information.

Substance	Is it poisonous?	Does it have a smell?	Cost of making 1g of substance in pence	Does it stop oil and water from separating?
A	yes	no	3	yes
B	no	no	6	yes
C	no	no	1	no
D	no	yes	5	yes

Which substance is the most suitable to be used as an emulsifier in food?

Explain your answer.

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..... **[3]**

(b) A processed food contains an emulsifier.

(i) Draw a diagram of an emulsifier molecule.

Label the **two** important parts of the molecule.

[2]

(ii) The processed food also contains cooked potato.

Potato is easier to digest when it is cooked rather than raw.

Explain why.

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..... **[2]**

2 Cosmetics such as perfumes must be tested to ensure they are safe to use.

Many scientists believe that cosmetics should not be tested on animals.

In the EU the testing of cosmetics on animals has been banned.

Explain why.

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..... **[2]**

3 This question is about construction materials.

(a) Cement is used in the construction of buildings.



Cement is made when **two** substances are heated together.

Which two?

Put a tick (✓) in the correct box.

sand and water	☐
limestone and sand	☐
limestone and clay	☐
limestone and granite	☐
sand and clay	☐

[1]

(b) Concrete is another construction material.

Concrete is quite strong.

It is reinforced using a mesh of steel rods.

This is called **reinforced concrete**.

(i) Reinforced concrete is a better construction material for making bridges than non-reinforced concrete.

Explain why.

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..... **[2]**

(ii) Look at the table.

It gives some information about three types of steel used to reinforce concrete.

Type of steel	Relative strength	Density in g/cm^3	Cost of 1 m × 2 m mesh	Resistance to corrosion	Other properties
A	386	7.85	£26.99	limited	easily shaped
B	414	7.90	£40.35	limited	hard, more difficult to shape
C	515	7.80	£50.52	very good	easily shaped

Which type of steel would be best to reinforce concrete?

Use information from the table to suggest why.

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..... **[2]**

4 Martin investigates the corrosion of different metals and alloys.

He places pieces of the metals or alloys in different concentrations of sulfuric acid.

He does his experiment at three different temperatures.

Look at his results.

Temperature in °C	Sulfuric acid concentration in %	Resistance to corrosion		
		Niobium	Zirconium	Hastelloy
20	10	excellent	excellent	poor
	40	excellent	excellent	good
	70	excellent	excellent	excellent
	90	good	poor	excellent
40	10	poor	excellent	poor
	40	poor	excellent	poor
	70	poor	excellent	poor
	90	poor	poor	poor
60	10	poor	excellent	poor
	40	poor	excellent	poor
	70	poor	good	poor
	90	poor	poor	poor

(a) Martin concludes that:

- all three metals or alloys are more resistant to corrosion at lower concentrations of sulfuric acid
- all three metals or alloys are more resistant to corrosion at lower temperatures.

Is he correct?

Use information from the table to explain your answer.

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..... **[2]**

(b) Martin does another experiment.

He investigates how the pH of an acid affects the rate of corrosion of one alloy.

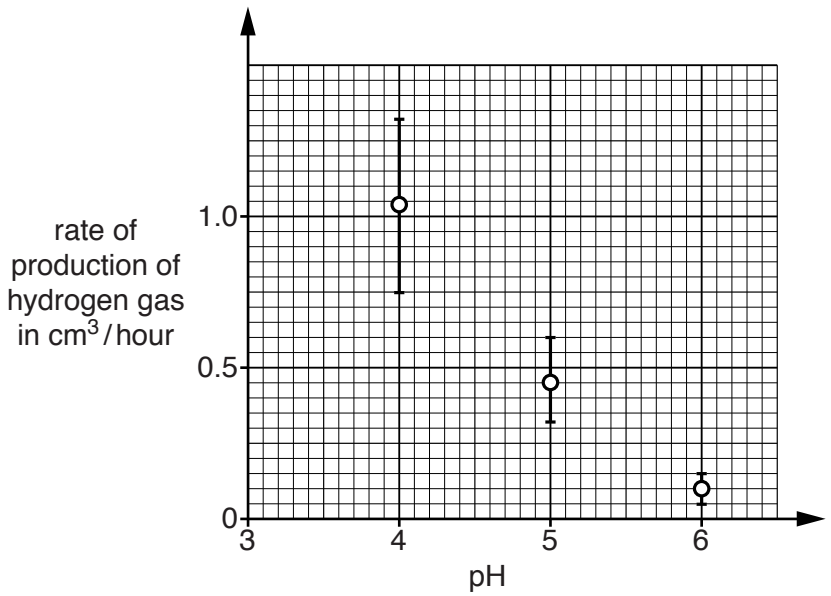
The alloy reacts with the acid to produce hydrogen gas.

Martin measures the rate at which the hydrogen gas is made.

He does this at three different pH values.

He repeats his experiment five times at each pH and then plots a graph of his results.

Look at his graph.



(i) What was the **highest** rate of production of hydrogen gas that Martin measured at pH 5?

answer ..... cm^3/hour **[1]**

(ii) At which pH did Martin get the most **repeatable** results?

..... **[1]**

(c) Aluminium, A*l*, reacts with sulfuric acid, H_2SO_4.

Aluminium sulfate, $Al_2(SO_4)_3$, and hydrogen, H_2, are made.

Write a **balanced symbol** equation for this reaction.

..... **[2]**

5 This question is about fertilisers.

(a) Farmers add fertilisers to the soil.

Some people think that farmers should not use fertilisers.



Write down a reason **for** and a reason **against** the use of fertilisers.

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..... **[2]**

(b) Ammonium phosphate, $(NH_4)_3PO_4$, is a fertiliser.



(i) Complete the table to show the number of each **type of atom** in the formula $(NH_4)_3PO_4$.

Atom	Number
N	.....
H	.....
P	.....
O	.....

[2]

(ii) Ammonium phosphate solution is made by reacting an acid with an alkali in a **neutralisation** reaction.

Describe how pure, dry crystals of ammonium phosphate can be made, including the names of the **acid** and **alkali** needed.



The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

6 A pharmaceutical drug is made by a batch process.

(a) Write about **one** reason why pharmaceutical drugs are often made by a batch process.

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..... **[1]**

(b) It is expensive to develop and manufacture a new pharmaceutical drug.

Explain why.

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..... **[2]**

7 Nick is investigating ways of preventing iron from rusting.

He wants to protect the bottom of a ship.

The bottom of the ship is made from iron.



He treats samples of iron in different ways.

He leaves them in a damp place and sees how long it takes for the first signs of rust to appear.

Look at Nick's results.

Type of treatment	Time for rust to appear in days	Cost of treatment in £ per tonne of iron
untreated iron (no treatment)	1	
painted iron	10	100
iron mixed with chromium (alloying)	120	1000
iron with blocks of magnesium attached	50	500

Evaluate the **advantages** and **disadvantages** of each type of treatment for protecting the bottom of the ship from rusting.

Explain how attaching blocks of magnesium helps to prevent rusting.

 The quality of written communication will be assessed in your answer to this question.

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8 Many different materials are needed to build a car.



(a) (i) Suggest a property of glass that makes it useful for making a car windscreen.

..... **[1]**

(ii) Some car bodies are now built from aluminium instead of steel.

One advantage of using aluminium is that it is less dense than steel.

Write down **one other advantage** of building car bodies from aluminium instead of steel.

..... **[1]**

(b) Look at the table.

It shows information about some of the materials used to build a car.

Material	Density in g/cm^3	Electrical conductivity	Flexibility
aluminium	2.7	very high	low
glass	2.5	very low	low
PVC	1.4	very low	high
steel	7.8	high	low

Explain why PVC is used for covering the electrical wires in a car.

Use the information from the table.

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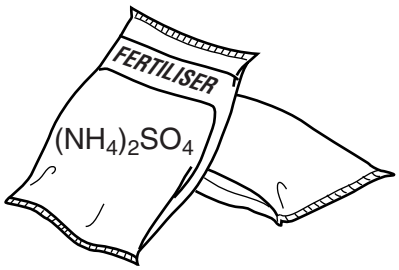
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[Total: 4]

9 This question is about fertilisers.

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



Complete the table to show the number of **atoms of each element** in the formula for ammonium sulfate.

Element	Number of atoms
nitrogen	……...
hydrogen	……...
sulfur	……...
oxygen	……...

[1]

(b) Ammonium sulfate is made by reacting an acid with an alkali.

Name the acid and alkali needed.

Describe how the acid and alkali are used to make a sample of ammonium sulfate.

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..... **[3]**

(c) Nitric acid is used to manufacture fertilisers.

Ammonia, NH_3, and oxygen, O_2 are used to manufacture nitric acid, HNO_3.

Water is the other product.

The reaction between ammonia and oxygen uses the following conditions:

- a temperature of 900 °C
- atmosphe ic pressure
- a platinum catalyst.

Construct the **balanced symbol** equation for the manufacture of nitric acid and explain the **advantages** and **disadvantages** of using these conditions.



The quality of written communication will be assessed in your answer to this question.

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[Total: 10]

10 This question is about metals.

(a) Phil wants to buy a new bicycle.



He uses the internet to research which metal is the most suitable for making the bicycle frame.

Look at the table.

It shows the information he finds out.

Metal	Density in g/cm^3	Relative strength (1= low, 10 = high)	Resistance to corrosion	Cost per tonne in £
aluminium	2.7	0.9	very good	2220
copper	8.9	2.1	good	5550
stainless steel	7.8	7.3	very good	900
titanium	4.5	10	very good	17000

Which metal is the most suitable for making Phil's bicycle frame?

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Explain your answer using information from the table.

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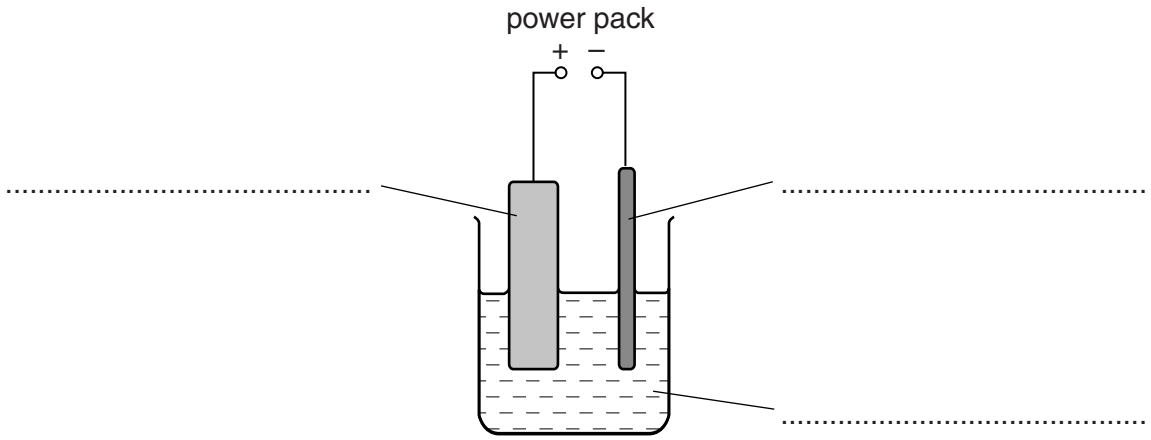
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(b) Pure copper is used for electrical wiring.

The copper is purified by **electrolysis**.

The diagram shows the apparatus used to purify copper.



Complete the labels on the diagram.

Choose your answers from the list.

copper sulfate solution

dilute sulfuric acid

impure copper anode

impure copper cathode

pure copper anode

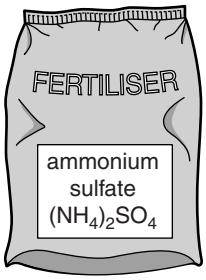
pure copper cathode

[2]

[Total: 5]

11 This question is about fertilisers.

(a) Ammonium sulfate is used as a fertiliser.



The formula for ammonium sulfate is $(NH_4)_2SO_4$.

(i) Write down the number of **different elements** in ammonium sulfate.

answer ..... **[1]**

(ii) Write down the number of **atoms** in this formula.

answer ..... **[1]**

(b) Amy and Chris decide to make some **solid ammonium sulfate** by neutralisation.

They use an acid and an alkali.

Name the acid and alkali they use and describe the experimental method they use.

The quality of written communication will be assessed in your answer to this question.

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[Total: 8]

12 Magnesium sulfate and magnesium nitrate are both used as fertilisers.

(a) Magnesium sulfate can be made in industry by a **continuous** process.

Explain why batch processes are used to make some pharmaceutical drugs but continuous processes are used to make fertilisers.

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..... **[2]**

(b) Magnesium nitrate is made by a neutralisation reaction.

Look at the equation for the reaction.

$$2HNO_3 + MgO \rightarrow Mg(NO_3)_2 + H_2O$$

Water is a waste product.

Show that the atom economy for the reaction is 89% and explain why it is important that the atom economy for a reaction is as high as possible.

The relative atomic masses (A_r) for H = 1, N = 14, O = 16 and Mg = 24.



The quality of written communication will be assessed in your answer to this question.

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[Total: 8]