# 2.5 Using Resources: 1-hour Pack

AQA 8462 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

**Answer ALL questions. Show all your working.**

**1** Recycling reduces the amount of raw material and energy needed to make new products.

**(a)** Describe how scrap metal, such as aluminium cans, is recycled. **(2)**

**(b)** Give one reason why recycling glass bottles uses less energy than manufacturing new glass from raw materials. **(1)**

**(Total for Question 1 is 3 marks)**

**2** A student lists four processes: extraction of metal from ore, polymer manufacture, water desalination, and electroplating a coating onto steel.

**(a)** State which one of these processes is used to produce potable water from seawater, and name the method typically used. **(2)**

**(b)** State which one of these processes can be used to help prevent corrosion of steel. **(1)**

**(Total for Question 2 is 3 marks)**


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**3** Ammonia is manufactured industrially by the Haber process, using nitrogen and hydrogen gas.

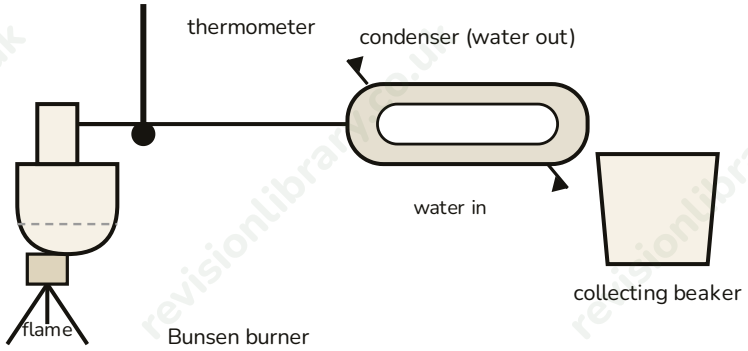
**(a)** Write the balanced symbol equation for the reaction between nitrogen and hydrogen to produce ammonia, including state symbols and the reversible reaction sign. **(2)**

**(b)** State the conditions (temperature, pressure and catalyst) used in the Haber process. **(3)**

**(Total for Question 3 is 5 marks)**


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**4** Required practical: a student, Priya, is investigating the purity of three water samples (tap water, water from a local pond, and water collected as rain) as part of the AQA required practical on the analysis and purification of water samples.




**(a)** Explain why the pond water is unlikely to be potable, even though it looks clear. **(2)**

**(b)** Describe how Priya could measure the mass of dissolved solids in a sample of the pond water by evaporation. **(3)**

**(c)** Priya evaporates 100 $cm^3$ of the pond water and finds that the mass of the dry residue left behind is 0.45 g. Calculate the concentration of dissolved solids in the pond water, in g/dm3. **(3)**


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**(d)** Priya wants to check how pure her distilled sample of pond water is. Describe how she could use distillation and a thermometer to test this, and explain what result would show the sample is pure water. **(3)**

**(e)** Evaluate the evaporation method used in part (b) to measure dissolved solids, suggesting one improvement to make the result more reliable. **(2)**

**(f)** Give one advantage and one disadvantage of using reverse osmosis, rather than distillation, to produce potable water on a large scale. **(2)**

**(Total for Question 4 is 15 marks)**

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**5** A company carries out an LCA to compare a plastic shopping bag with a paper shopping bag. The table below shows some data from the LCA.

Plastic bag: energy to make one bag = 2.0 MJ; can be reused 20 times before disposal.
Paper bag: energy to make one bag = 4.5 MJ; can be reused 4 times before disposal.

(a) Calculate the energy used per use of the plastic bag.
(b) Calculate the energy used per use of the paper bag.
(c) State which bag has the lower energy cost per use.

**(Total for Question 5 is 5 marks)**


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**6** Explain why an LCA is described as being difficult to carry out with complete objectivity (some parts rely on estimates or judgements).

**(Total for Question 6 is 2 marks)**

**7** A jeweller makes a bronze ornament with a total mass of 50 g, containing 44 g of copper and 6 g of tin.

**(a)** Calculate the percentage of copper and the percentage of tin in this sample of bronze. **(4)**

**(Total for Question 7 is 4 marks)**


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**8** A supermarket is deciding whether to switch from single-use plastic carrier bags to paper carrier bags. Simplified life cycle assessment data for the two types of bag are given below.

Plastic bag: raw material is crude oil; low energy to manufacture; very light and compact to transport; not biodegradable, but can be recycled; often reused as bin liners before disposal.
Paper bag: raw material is wood pulp from trees; higher energy and water use to manufacture; bulkier and heavier to transport; biodegradable and can be recycled, but is rarely reused before disposal.

Evaluate whether switching from plastic to paper carrier bags would reduce the supermarket's overall environmental impact. In your answer, you should refer to: raw materials, energy and water use in manufacture, transport, and disposal/end of life.

**(Total for Question 8 is 6 marks)**

**9** The forward reaction in the Haber process is exothermic, and the reaction reaches a dynamic equilibrium. Lower temperatures and higher pressures both increase the equilibrium yield of ammonia, yet the industrial conditions used (about 450C and 200 atmospheres) are a compromise rather than the conditions that would give the maximum possible yield. Explain why these compromise conditions are used, referring to reaction rate, equilibrium yield, and cost/safety.

**(Total for Question 9 is 6 marks)**


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# Mark scheme · 2.5 Using Resources: 1-hour Pack

## Question 1

(a) the scrap metal is sorted/separated from other waste (oe) **B1**

(a) it is then melted down and cast/re-formed into new products (oe) **B1**

**(a) Answer: Scrap metal is sorted from other waste, then melted down and recast into new products.**

(b) recycled glass melts at a lower temperature than the raw materials used to make new glass, so less energy is needed (oe; accept raw materials do not need to be extracted/quarried, saving energy) **B1**

**(b) Answer: Recycled glass melts at a lower temperature than the raw materials needed to make new glass, so less energy is used.**

## Question 2

(a) water desalination cao **B1**

(a) by distillation (or reverse osmosis) cao **B1**

**(a) Answer: Water desalination, using distillation (or reverse osmosis).**

(b) electroplating (coats the steel with an unreactive/protective metal layer to keep out air and water) cao **B1**

**(b) Answer: Electroplating.**

## Question 3

(a) correct formulae $N_2$, $H_2$ and $NH_3$ used, with a reversible arrow **M1**

(a) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, fully balanced with correct state symbols cao **A1**

**(a) Answer: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$**

(b) temperature of about 450C **B1**

(b) pressure of about 200 atmospheres **B1**

(b) iron catalyst **B1**

**(b) Answer: A temperature of about 450C, a pressure of about 200 atmospheres, and an iron catalyst.**

## Question 4

(a) pond water may contain microorganisms/pathogens that are invisible to the eye (oe) **B1**

(a) it may also contain dissolved substances (e.g. from run-off) at levels unsafe to drink, even though it appears clear (oe) **B1**

**(a) Answer: Even if it looks clear, pond water can contain harmful microorganisms and dissolved substances (for example from agricultural or animal run-off) at levels that are unsafe to drink.**

(b) weigh a clean, dry evaporating basin, then add a measured volume of the water sample and weigh again (oe) **B1**

(b) gently heat the basin (e.g. on a water bath or over a low flame) until all the water has evaporated, leaving a solid residue (oe) **B1**

(b) allow the basin to cool, then reweigh it; the mass of dissolved solids is found by subtracting the mass of the basin from the mass of basin plus residue (oe) **B1**

**(b) Answer: Weigh a dry evaporating basin, add a known volume of the sample and reweigh. Gently heat until all the water has evaporated, leaving a solid residue. Cool and reweigh the basin; the mass of dissolved solids is the mass of basin plus residue minus the mass of the empty basin.**

(c) recognises 1 dm3 = 1000 $cm^3$, so a scaling factor of 1000/100 = 10 is needed **M1**

(c) 0.45 x 10 (method seen, dependent on first mark) **M1**

(c) 4.5 g/dm3 (accept awrt 4.5 g/dm3) cao **A1**

**(c) Answer: 4.5 g/dm3**

(d) set up distillation apparatus (e.g. flask, thermometer, condenser, collecting vessel) and heat the water sample so that it boils (oe) **B1**

(d) record the temperature at which the water boils, once it is steady, using the thermometer (oe) **B1**

(d) if the sample is pure water, it should boil at exactly 100C at standard atmospheric pressure; any dissolved substances would raise the boiling point above 100C (oe) **B1**

**(d) Answer: Set up distillation apparatus and heat the sample until it boils, recording the steady boiling temperature on the thermometer. Pure water boils at exactly 100C at standard atmospheric pressure; a boiling point above 100C would show the sample still contains dissolved substances.**

(e) identifies a limitation, e.g. heating too strongly could spit/lose some solid, or some solid could remain stuck to the basin, giving an inaccurate mass (oe) **B1**

(e) suggests a suitable improvement, e.g. repeat the test and calculate a mean, or heat gently/use a water bath to avoid spitting (oe) **B1**

**(e) Answer: Heating too quickly can cause spitting, losing some solid and giving a mass that is too low. Repeating the test to obtain a mean, and heating gently (e.g. using a water bath), would make the result more reliable.**

(f) advantage: reverse osmosis generally uses less energy than distillation (oe) **B1**

(f) disadvantage: the membranes used in reverse osmosis are expensive and need regular replacement/cleaning (oe; accept other valid advantage/disadvantage pair) **B1**

**(f) Answer: Advantage: reverse osmosis generally uses less energy than distillation. Disadvantage: the membranes are expensive and need regular replacement or cleaning.**

## Question 5

(a) substitutes: 2.0 / 20 **M1**

(a) 0.10 MJ per use cao **A1**

(b) substitutes: 4.5 / 4 **M1**

(b) 1.125 MJ per use (accept 1.1 MJ) cao **A1**

(c) the plastic bag has the lower energy cost per use **B1**

**Answer: (a) 0.10 MJ per use. (b) 1.125 MJ per use. (c) The plastic bag.**


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## Question 6

some factors, such as the environmental effect of water use, or the impact of noise or visual pollution, are hard to measure precisely and give a numerical value to, oe — **B1**

so different companies or assessors may make different judgements/estimates for these factors, which can allow selective (biased) LCAs to be produced, oe — **B1**

**Answer: Some environmental impacts (e.g. pollution or water use) are hard to measure precisely, so assessors must estimate or judge their size, which means different LCAs for the same product can reach different conclusions.**

## Question 7

(a) percentage copper = (44 / 50) x 100 (method seen) — **M1**

(a) 88% copper cao — **A1**

(a) percentage tin = (6 / 50) x 100 (method seen; ft their total mass if consistent) — **M1**

(a) 12% tin cao — **A1**

**(a) Answer: 88% copper, 12% tin**

## Question 8

**Level 1** Simple, isolated comments are made about plastic and/or paper bags, with little or no comparison between the stages of their life cycles. No overall conclusion is reached. — **1-2**

**Level 2** Some relevant points are compared across the two bags (for example raw materials or manufacturing), but the comparison is not applied consistently across all stages of the life cycle. A conclusion is attempted but only partly supported by the evidence. — **3-4**

**Level 3** A detailed, logically structured comparison is made across raw materials, manufacture, transport and disposal for both bags, leading to a well-reasoned conclusion about which bag has the lower overall environmental impact, recognising that the answer depends on how the bags are used and disposed of. — **5-6**

**Indicative content:**

- Plastic bags are made from crude oil, a finite resource, while paper bags are made from wood pulp, a renewable resource if trees are replanted sustainably.
- Paper bag manufacture typically uses more energy and water than plastic bag manufacture, which increases the environmental impact of this stage for paper.
- Paper bags are bulkier and heavier than plastic bags, so transporting the same number of bags uses more fuel and releases more emissions for paper than for plastic.
- Plastic bags are not biodegradable and can persist in the environment or oceans for a very long time if not disposed of properly, whereas paper bags will biodegrade.
- However, plastic bags are often reused (e.g. as bin liners) before disposal, extending their useful life, whereas paper bags are less commonly reused.
- Both types of bag can be recycled, but recycling rates and processes differ, and paper recycling itself uses energy and water.
- Overall, no single life cycle stage makes one bag clearly better than the other; a full comparison across all stages is needed, and the environmental impact strongly depends on how many times each bag is reused and how it is disposed of at the end of its life.

## Question 9

**Level 1** Isolated statements are made about temperature and/or pressure, with little or no reference to the trade-off between rate, yield and cost/safety. No clear conclusion is reached. — **1-2**

**Level 2** The effect of either temperature or pressure on rate and yield is explained reasonably well, with some reference to cost or safety, but the answer does not fully link both variables to the idea of a compromise. — **3-4**

**Level 3** A detailed, logically structured explanation covers both temperature and pressure, correctly linking their effects on reaction rate, equilibrium yield, and cost/safety, to explain clearly why a compromise is chosen rather than the conditions that maximise yield alone. — **5-6**

**Indicative content:**

- A lower temperature would increase the equilibrium yield of ammonia, because the forward reaction is exothermic and equilibrium shifts to favour the exothermic direction as temperature decreases.
- However, a much lower temperature would make the reaction rate far too slow, so it would take too long to reach equilibrium and would not be economically viable.
- A higher pressure would also increase the equilibrium yield, because there are fewer moles of gas on the product side (4 moles of reactant gas forming 2 moles of product gas), so increasing pressure shifts equilibrium towards the side with fewer gas molecules.
- However, much higher pressures than 200 atmospheres would require very strong, expensive reaction vessels and pipework, increasing capital cost, and would raise safety risks.
- 450C is a compromise: it is high enough to give a reasonably fast rate of reaction (so ammonia is produced quickly enough to be profitable), even though it gives a lower equilibrium yield than a lower temperature would.
- 200 atmospheres is also a compromise: it increases the yield without needing excessively expensive, high-pressure equipment.
- Any unreacted nitrogen and hydrogen are recycled back into the reactor, so even though the percentage yield at equilibrium is not maximised, the overall process still produces ammonia efficiently and profitably.


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