2.31 Life Cycle Assessment, Recycling and Corrosion: Test Pack

Total Marks

AQA 8464 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Life cycle assessments (LCAs) are used to evaluate the overall environmental impact of a product, from manufacture to disposal.

(a) Which of these is NOT normally considered one of the four main stages of a life cycle assessment? **(1)**

- ☐ A) Extracting and processing raw materials
- ☐ B) Manufacturing and packaging the product
- ☐ C) Advertising and marketing the product
- ☐ D) Using the product and disposing of it at the end of its life

(Total for Question 1 is 1 mark)

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2 Iron and steel objects, such as garden tools, can corrode (rust) over time.

(a) State the two substances that must both be present for iron to rust. **(2)**

(b) Name the substance produced when iron rusts. **(1)**

(Total for Question 2 is 3 marks)

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3 A locksmith makes a brass door handle with a total mass of 150 g. The handle contains 97.5 g of copper, and the rest of the mass is zinc.

(a) Calculate the mass of zinc in the door handle. **(1)**

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(b) Calculate the percentage by mass of zinc in the door handle. **(2)**

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(Total for Question 3 is 3 marks)

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4 Ammonia is manufactured industrially by the Haber process, in which nitrogen and hydrogen gases react together in a reversible reaction.

(a) Write the balanced symbol equation for the Haber process, including state symbols and the reversible reaction sign. **(2)**

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

(c) The forward reaction of the Haber process is exothermic, and the reaction reaches a dynamic equilibrium. Explain why a compromise temperature and pressure are used industrially, rather than the conditions that would give the maximum possible equilibrium yield of ammonia. **(3)**

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(Total for Question 4 is 8 marks)

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5 A seaside town council maintains a steel pier partly submerged in seawater. To prevent corrosion, magnesium sacrificial anode blocks are bolted to the steel legs of the pier. Each magnesium block protects 15 m^2 of steel surface and costs £85. The total steel surface area of the pier's legs that needs protection is 450 m^2.

(a) Calculate the minimum number of magnesium blocks needed to protect the whole pier. **(2)**

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(b) Calculate the total cost of the magnesium blocks needed. **(2)**

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(Total for Question 5 is 4 marks)

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6 Steel dustbins and farm gates are often galvanised - coated with a thin layer of zinc - to protect them from rusting.

(a) Explain how the zinc layer acts as a barrier to prevent rusting. **(2)**

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(b) Steel is still protected from rusting even where the zinc coating is scratched, exposing the iron underneath. Explain why, referring to the reactivity of zinc and iron. **(2)**

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(Total for Question 6 is 4 marks)

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Mark scheme · 2.31 Life Cycle Assessment, Recycling and Corrosion: Test Pack

Question 1

(a) C (Advertising and marketing the product) **B1**

(a) Answer: C (advertising and marketing is not one of the four stages assessed by an LCA)

Question 2

(a) oxygen cao **B1**

(a) water cao **B1**

(a) Answer: Oxygen and water

(b) hydrated iron oxide cao **B1**

(b) Answer: Hydrated iron oxide

Question 3

(a) 150 - 97.5 = 52.5 g cao **M1**

(a) Answer: 52.5 g

(b) 52.5 / 150 x 100 oe, ft from (a) **M1**

(b) 35% cao **A1**

(b) Answer: 35%

Question 4

(a) correct formulae, correctly balanced: $N_2 + 3H_2 \rightarrow 2NH_3$ (or using $\rightleftharpoons$) oe **M1**

(a) state symbols and reversible reaction sign both correct: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ cao **A1**

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

(b) temperature of about 450°C cao (accept 400-450°C) **B1**

(b) pressure of about 200 atmospheres cao (accept 200 atm, or a value in the range 150-250 atm) **B1**

(b) iron catalyst cao **B1**

(b) Answer: About 450°C, about 200 atmospheres pressure, using an iron catalyst

(c) a lower temperature increases the equilibrium yield of ammonia (since the forward reaction is exothermic), but also decreases the rate of reaction, so a very low temperature would be too slow to be economical oe **B1**

(c) a higher pressure increases both the equilibrium yield (there are fewer moles of gas on the product side) and the rate of reaction oe **B1**

(c) but very high pressures need expensive, strengthened equipment and are more hazardous, so the conditions used (about 450°C, 200 atm) are a compromise that balances rate, yield, cost and safety oe **B1**

(c) Answer: A lower temperature would increase the equilibrium yield but slow the reaction down too much; a higher pressure increases both yield and rate but needs costly, hazardous equipment; 450°C and 200 atm are chosen as a compromise between reaction rate, yield, cost and safety

Question 5

(a) 450 / 15 oe **M1**

(a) 30 (blocks) cao **A1**

(a) Answer: 30 blocks

(b) 30 x 85 oe, ft from (a) **M1**

(b) £2550 cao **A1**

(b) Answer: £2550

Question 6

(a) the zinc coats/covers the surface of the steel oe **B1**

(a) preventing oxygen and water from reaching the iron underneath oe **B1**

(a) Answer: The zinc coats the surface of the steel, preventing oxygen and water from reaching the iron underneath

(b) zinc is more reactive than iron, so the zinc corrodes/loses electrons in preference to the iron oe **B1**

(b) the zinc acts as a sacrificial metal, protecting the exposed iron from rusting even where the coating is scratched oe **B1**

(b) Answer: Zinc is more reactive than iron, so it corrodes in preference to the iron; the zinc acts as a sacrificial metal, protecting the exposed iron even where the coating is scratched

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