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Chapter test with answers

Chapter 9 Synthesis reactions

Time permitted: 50 minutes

	Section	Number of questions	Marks available
A	Multiple choice	15	15
B	Short answer	5	15
	Total	**20**	**30**

Scale:

A+	29–30	**A**	26–28	**B**	23–25	**C**	19–22	**D**	15–18	**E**	9–14	**UG**	0–8

Section A Multiple choice (15 marks)

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers. You are advised to spend no more than 15 minutes on this section.

1 Which of the following is not a synthetic material?
- **A** Nylon
- **B** Lycra
- **C** Teflon
- **D** *Silk*

2 Retrosynthetic analysis is:
- **A** a process developed back in time (retrospectively).
- **B** *a process used to determine how to make a compound.*
- **C** analysis of new materials.
- **D** a method of analysis.

3 Reaction mechanisms do not include:
- **A** multi-step reaction steps.
- **B** linear sequences of reactions.
- **C** *common pathways for different materials.*
- **D** convergent reaction steps.

4 What is Le Chatelier's principle important for?

A *Maximising yields*

B Improving purity of product

C Choosing reaction pathways

D Reducing waste products

5 A catalyst is important in producing new materials, because:

A it costs little to produce.

B is often a useful by-product.

C produces the same result by an alternative reaction.

D *provides an alternative and cheaper pathway for a reaction.*

6 A micelle is:

A *produced by soap action on grease.*

B a name of a detergent molecule.

C an important step in the saponification process.

D an organic molecule used to make soap.

7 Which of the following is not a biofuel made in Australia?

A Ethanol

B Bioethanol

C *Premium petrol*

D Biodiesel

8 Green chemistry is an initiative designed to:

A *prevent pollution, treat chemicals to make them safe and dispose of them safely.*

B reduce pollution, neutralise chemicals and dispose of them.

C treat pollution, reduce chemical waste, and produce disposal methods.

D prevent pollution, use safe solvents and dispose of them quickly.

9 Atom economy means:

A the amount of product atoms less the amount used as reactants.

B the percentage waste of atoms used to produce a product.

C the molar fraction of reactants to products used to produce a product.

D *the fraction of the mass atoms in reactants to products as a percentage.*

10 What process is commonly used to produce sulfuric acid?

A The Haber process

B The acid rain process

C The acid synthesis process

D *The Contact process*

11 What is the function of limiting reagents?

A To limit the effectiveness of catalysts in reactions

B *To limit how much product will be made in a reaction*

C To limit the amount of steps in a synthesis reaction

D To reduce the yield produced in a reaction

12 How does biodiesel differ from crude-based diesel?

A One has an oxygen molecule.

B *Biodiesel is an ester.*

C Diesel has up to 21 carbon atoms in a linear chain.

D Biodiesel is made from fossils.

13 The two main processes for producing ethanol exclude:

A fermentation.

B hydration of ethene.

C the reaction of water and ethene.

D *the Haber process.*

14 An excess reagent:

A is wasted in synthesis reactions.

B *is the other reactant that reacts with a limiting reagent.*

C is usually sent back to the manufacturer to reduce costs.

D has limited effectiveness, hence it is left over.

15 A successful product:

A is determined by the consumer response only.

B has successful reactants.

C *is determined by different factors and viewpoints.*

D has a low cost and high profit.

Section B Short answer (26 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 25 minutes on this section.

1 The synthesis of sulfuric acid involves several steps:

Step 1: The formation of SO_2

$$\text{either: } S + O_2 \rightarrow SO_2 \textit{ or } 2ZnS + 3O_2 \rightarrow 2SO_2 + 2ZnO$$

Step 2: The formation of SO_3

$$2SO_2(g) + O_2(g) \rightleftarrows 2SO_3(g)$$
$$\Delta H = -197 \text{ kJ mol}^{-1}$$

Step 3: Dissolving SO_3 in water to produce oleum

$$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$$

Step 4: Reaction of oleum and water to produce sulfuric acid

$$H_2O + H_2S_2O_7 \rightarrow 2H_2SO_4$$

The second step can be affected by a number of factors; comment on the following factors:

a proportion of reactants

Answer: The reaction shows ideal proportions of reactants; ideally you will buy the correct amounts to avoid any waste or excess. (1 mark)

b temperature

Answer: The reaction is endothermic; i.e. absorbs heat so adding heat will favour product formation. (1 mark)

c pressure.

Answer: Pressure will lead equilibrium to shift to the side with fewer gaseous species. Pressure will favour the formation of SO_3. (1 mark)

(= 3 marks total)

2 **a** Complete the following equation: a zinc chloride solution reacting with a sodium phosphate solution to form insoluble zinc phosphate and a soluble salt.

Answer:

$$ZnCl_2 + Na_2PO_4 \rightarrow ZnPO_4 + 2NaCl$$

(1 mark)

b If you had 4.32 g of $ZnCl_2$ and 222.0 mL of 0.100 M Na_3PO_4, identify the limiting reactant.

Answer: $ZnCl_2$ (n= m/M) has 0.0317 mol

Na_2PO_4 (n = CV) has 0.0222 mol and is the limiting reagent. (1 mark)

c What mass of precipitate would be recoverable?

Answer: 0.0222 mol ZnPO4 precipitates

m= n x M

m = 3.54 g (1 mark)

(= 4 marks total)

3 Describe and compare the cleaning action of soaps with detergents.

Answer: Soaps clean by having a polar head with a long hydrocarbon tail which dissolves in grease. Detergents are similar except their polar end will not react with magnesium or calcium ions found in hard water.

(= 2 marks total)

4 **a** Write out the formula for calculating atom economy.

Answer: $$\text{Atom economy } \% = \frac{\text{mass of atoms in the desired product}}{\text{mass of atoms in the reactants}} \times 100$$ (1 mark)

b Why is this an important consideration in chemical processes?

Answer: To help reduce waste when producing a desired product and decrease the number of steps in synthesising a desired product. This reduces waste atoms by increasing the atom economy. (1 mark)

(= 2 marks total)

5 **a** Calculate the atom economy of the following processes for producing ethanol: hydration of ethene, and fermentation of sugar.

Answer: Hydration of ethene:

$$C_2H_4 + H_2O \rightarrow CH_3CH_2OH$$

Atom economy is 100% because there are no other products. (2 marks)

Fermentation of sugar:

$$C_6H_{12}O_6 \rightarrow 2\ CH_3CH_2OH + 2CO_2$$

$$\text{Atom economy } \% = \frac{92.136}{180.156} \times 100$$

= 51% (1 mark)

b Compare these two processes and comment on their sustainability.

Answer: Ethanol by fermentation has a low atom economy, but the reactants are renewable. In contrast, the ethylene is from a non-renewable source (fossil fuels). Therefore, fermentation, with its poorer atom economy, is still better for the environment. (2 marks)

(= 5 marks total)