

Past-paper walk-through

Formulas ■ 2.3

eXercise

Questions in this set

- 9701/11 N25 Q17 ■ 1 mark
- 9701/21 N25 Q3 ■ 13 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 17

9701/11 N25 ■ Q17 ■ 1 mark

17 Three equations are listed. x , y and z are all whole numbers.



Which equations can be balanced if $x = 4$ and $z = 2$?

A 1 and 3

B 1 only

C 2 only

D 3 only

Solution 17

Answer: **A**

Why

- Equation 1 balances as $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$ with whole numbers.
- Equation 3 balances as $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$.
- Equation 2 fails on magnesium: 4Mg cannot give only 2MgO .

Question 3

9701/21 N25 ■ Q3 ■ 13 marks

- 3** Cycloalkanes show similar chemical properties to alkanes but have the same empirical formula as alkenes.
- (a)** Define empirical formula.

Question 3

- (b) Cyclopentane, C_5H_{10} , has four cyclic structural isomers. One of these isomers is **C**, shown in Fig. 3.1.

Complete Fig. 3.1 to show two other cyclic structural isomers of C_5H_{10} .

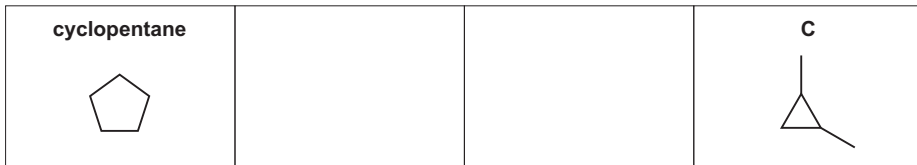


Fig. 3.1

[2]

- (c) Cyclopentane reacts with Cl_2 in the presence of ultraviolet light to form C_5H_9Cl .

(i) The reaction is initiated by the bond fission of Cl

Question 3

- ✓ The reaction is initiated by the bond fission of Cl_2 .

State the type of bond fission shown in the initiation step.

Question 3

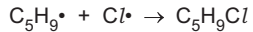
- (ii) Complete the equations to show the two propagation steps that follow the initiation step.

Question 3

Question 3

[2]

(iii) The final step is shown.



Give the name for this step in the reaction.

Question 3

(d) Fig. 3.2 shows a reaction cycle involving cyclopentane, cyclopentene and $\text{C}_5\text{H}_9\text{Cl}$.

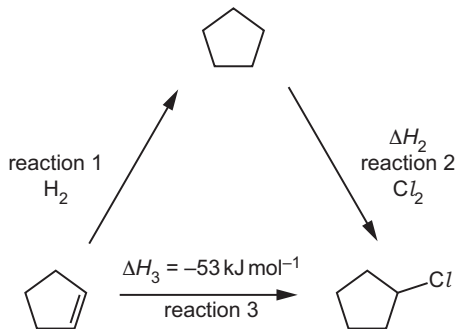


Fig. 3.2

Question 3

- (i) Identify a suitable reagent for reaction 3

Question 3

- (v) Identify a suitable reagent for reaction 3.

Question 3

- (ii) Use the data in Fig. 3.2 and in Table 3.1 to calculate the enthalpy change of reaction 2, ΔH_2 .

Table 3.1

compound	enthalpy change of combustion, $\Delta H_c / \text{kJ mol}^{-1}$
	-3292
	-3115

Question 3

|

|

|

Question 3

H_2	-286
--------------	------

Question 3

- (e) Cyclopentene, C_5H_8 , reacts with hot concentrated acidified KMnO_4 to form compound **W**, $\text{C}_5\text{H}_8\text{O}_4$.
- (i) Draw the structure of **W**.

Question 3

[1]

- (ii) The infrared spectrum of **W** is shown in Fig. 3.3.

100_____

Question 3

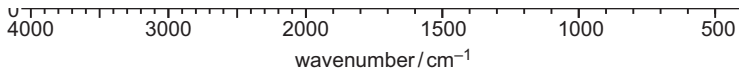


Fig. 3.3

Identify **two** absorptions in the infrared spectrum of **W** that would **not** be present in the infrared spectrum of cyclopentene.

- Write **1** or **2** on Fig. 3.3 against each of these two absorptions.
- Complete Table 3.2 to show which bond is responsible for each absorption that you have identified in Fig. 3.3.

Table 3.2

absorption	1	2
bond responsible		

Question 3

Table 3.3

bond	functional groups containing the bond	characteristic infrared absorption range (in wavenumbers)/ cm^{-1}
C–O	hydroxy, ester	1040–1300
C=C	aromatic compound, alkene	1500–1680
C=O	amide carbonyl, carboxyl ester	1640–1690 1670–1740 1710–1750
C≡N	nitrile	2200–2250
C–H	alkane	2850–2950
N–H	amine, amide	3300–3500
O–H	carboxyl hydroxy	2500–3000 3200–3650

Question 3



[Total: 13]

Solution 3

(a)

Mark scheme

- simplest /lowest (whole number / integer) ratio of atoms (of each element) in a compound / molecule
- 1

Solution 3

(b)

Mark scheme

- two of:
- OR
- OR
- 2

Solution 3

(c)(i)

Mark scheme

- homolytic
- 1

Solution 3

(c)(ii)

Mark scheme

- M1 $\text{C}_5\text{H}_{10} + \text{Cl} \rightarrow \text{C}_5\text{H}_9 + \text{HCl}$ (M2)
- $\text{C}_5\text{H}_9 + \text{Cl}_2 \rightarrow \text{C}_5\text{H}_9\text{Cl} + \text{Cl}$
- 2

Solution 3

(c)(iii)

Mark scheme

- termination
- 1

Solution 3

(d)(i)

Mark scheme

- HCl (g)
- 1

Solution 3

(d)(ii)

Mark scheme

- M1 (reaction 1): $-3115 - 286 + 3292 = -109$ (kJ mol⁻¹) M2
- H2 = $-53 - (-109) = (+)56$ (kJ mol⁻¹)
- 2

Solution 3

(e)(i)

Mark scheme

■ 1

Solution 3

(e)(ii)

Mark scheme

- M1 absorption labelled at approx. 3000 cm^{-1} identified as O—H **M2**
- absorption labelled at approx. 1720 cm^{-1} identified as C=O
- 2
- 9701/21
- October/November 2025