

APOLLO

How much? The amount of chemical
change

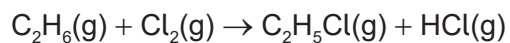
HL

Chemistry

First assessment 2025

11 questions | questions

26. Chloroethane is produced by the reaction of ethane with chlorine.



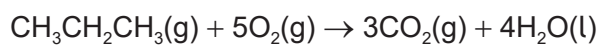
($\text{C}_2\text{H}_6 = 30.08 \text{ g mol}^{-1}$, $\text{Cl}_2 = 70.90 \text{ g mol}^{-1}$, $\text{C}_2\text{H}_5\text{Cl} = 64.52 \text{ g mol}^{-1}$, $\text{HCl} = 36.46 \text{ g mol}^{-1}$)

$$\% \text{ atom economy} = \frac{\text{molar mass of desired product}}{\text{molar mass of all reactants}} \times 100$$

What is the atom economy for this reaction?

- A. 15.7 %
- B. 46.6 %
- C. 63.9 %
- D. 99.9 %

27. 75 cm³ of propane was completely combusted in 400 cm³ of oxygen according to the following equation.



What is the volume of unreacted oxygen remaining at the original conditions?

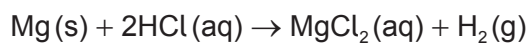
- A. 25 cm³.
- B. 50 cm³.
- C. 75 cm³.
- D. 150 cm³.

— 17 —

Turn over

2220-0201

23. What are the limiting reactant and theoretical yield of hydrogen when 0.20 mol of magnesium reacts with 0.20 mol of hydrochloric acid?



	Limiting reactant	Theoretical yield of H ₂ / mol
A.	Mg	0.10
B.	Mg	0.20
C.	HCl	0.05
D.	HCl	0.10

25. Which process to produce ethanol has an atom economy of 100?

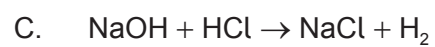
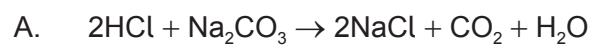
- A. $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH}$
- B. $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$
- C. $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{NaOH} \rightarrow \text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COONa}$
- D. $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O} \rightleftharpoons \text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COOH}$

30. How many moles of oxygen are needed for the complete combustion of 11.5 g of $\text{C}_3\text{H}_8(\text{g})$?

M_r propane = 44.1 g mol^{-1}

- A. 10.4
- B. 5.20
- C. 2.60
- D. 1.30

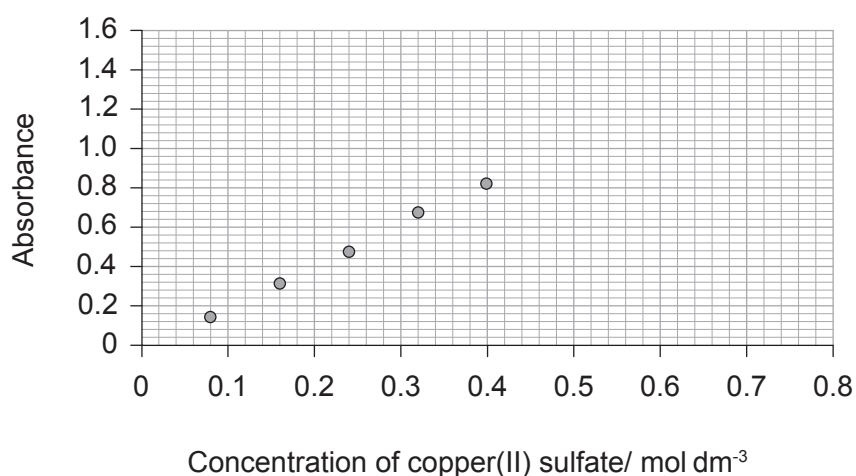
33. Which equation correctly describes a chemical reaction?



3. A colorimetry experiment was conducted on a series of solutions of copper(II) sulfate, CuSO_4 . The absorbance versus concentration data were graphed.

(a) Draw a best fit line in the graph below, extrapolating beyond the data given.

[2]



(b) State the mathematical relationship between absorbance and concentration.

[1]

.....

(c) The instrument used can collect absorbance or percent transmittance at a specific wavelength. Outline why a specific wavelength must be selected.

[1]

.....

(This question continues on the following page)



(Question 3 continued)

- (d) Deduce the equation that relates the absorbance to concentration including the value of the constant. [2]

.....
.....
.....
.....

- (e) Estimate the absorbance value of a $0.600 \text{ mol dm}^{-3}$ CuSO_4 solution. [1]

.....
.....

- (f) Predict the difference, if any, between reading the absorbance value for the $0.600 \text{ mol dm}^{-3}$ CuSO_4 solution from the graph and calculating it using the equation in (d). [1]

.....
.....

- (g) The copper(II) sulfate solution is blue. Deduce the optimum wavelength to use for colorimetry, using section 15 of the data booklet. [1]

.....



Please **do not** write on this page.

Answers written on this page
will not be marked.



Please **do not** write on this page.

Answers written on this page
will not be marked.



Please **do not** write on this page.

Answers written on this page
will not be marked.



Section B

Answer **all** questions. Answers must be written within the answer boxes provided.

2. In a separate experiment, the rate of a reaction was studied using colorimetry. During the reaction, the mixture changed colour from orange to green.

Before the investigation could be carried out, it was necessary to construct a calibration curve for the colorimeter.

- (a) Describe how a standard aqueous solution can be prepared.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Describe how this solution can be used to construct a calibration curve.

[3]

.....

.....

.....

.....

.....

.....

- (c) Explain how this curve can be used to determine the unknown concentration.

[1]

.....

.....

.....

.....



Turn over

— 0 —

4440-0440

4. 3.162 g of calcium carbonate, $\text{CaCO}_3(\text{s})$, is reacted with 20.0 cm^3 of 4.00 mol dm^{-3} hydrochloric acid, $\text{HCl}(\text{aq})$.

(a) (i) Write an equation for the reaction, including all state symbols. [2]

.....
.....

(ii) Deduce which reactant is limiting. Use sections 1, 4 and 7 of the data booklet. [2]

.....
.....
.....
.....
.....

(iii) Calculate the volume, in dm^3 at STP, of the gas produced. Use section 2 of the data booklet. [1]

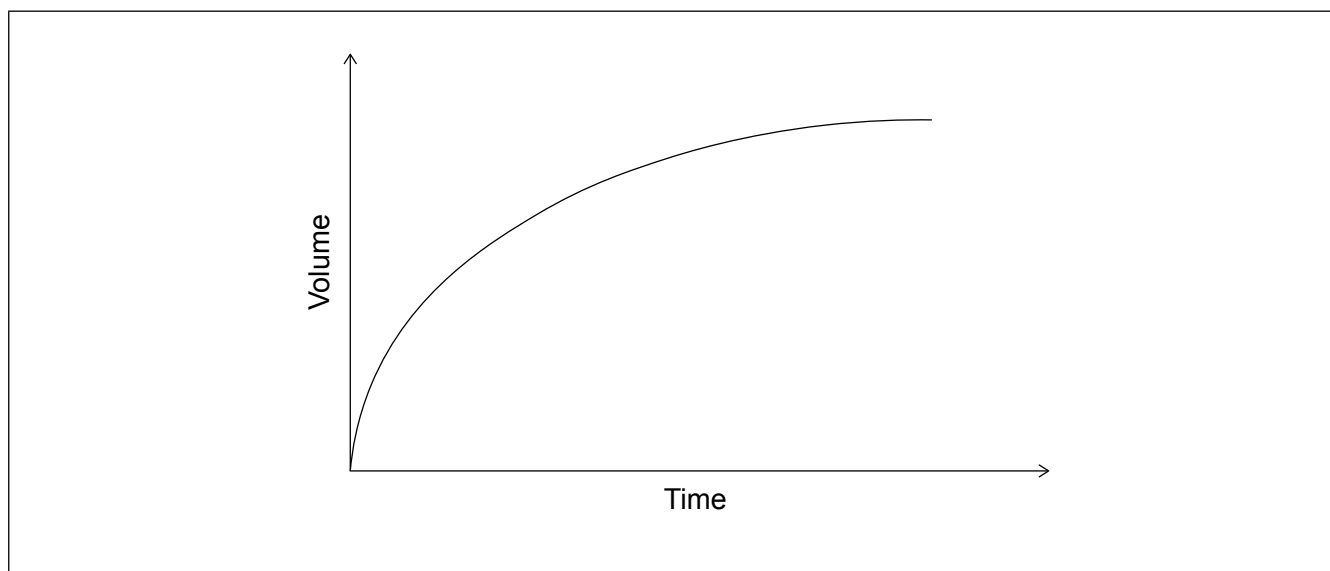
.....
.....
.....

(This question continues on the following page)



(Question 4 continued)

- (b) The rate of this reaction can be experimentally determined by measuring the volume of gas produced as time progresses.
- (i) Sketch another curve for the reaction taking place with the acid at a higher temperature and all other conditions unchanged. [1]



- (ii) Outline why the reaction rate would be lower if ethanoic acid, CH_3COOH , were used instead of hydrochloric acid. [1]

.....

.....

.....

.....

(This question continues on the following page)

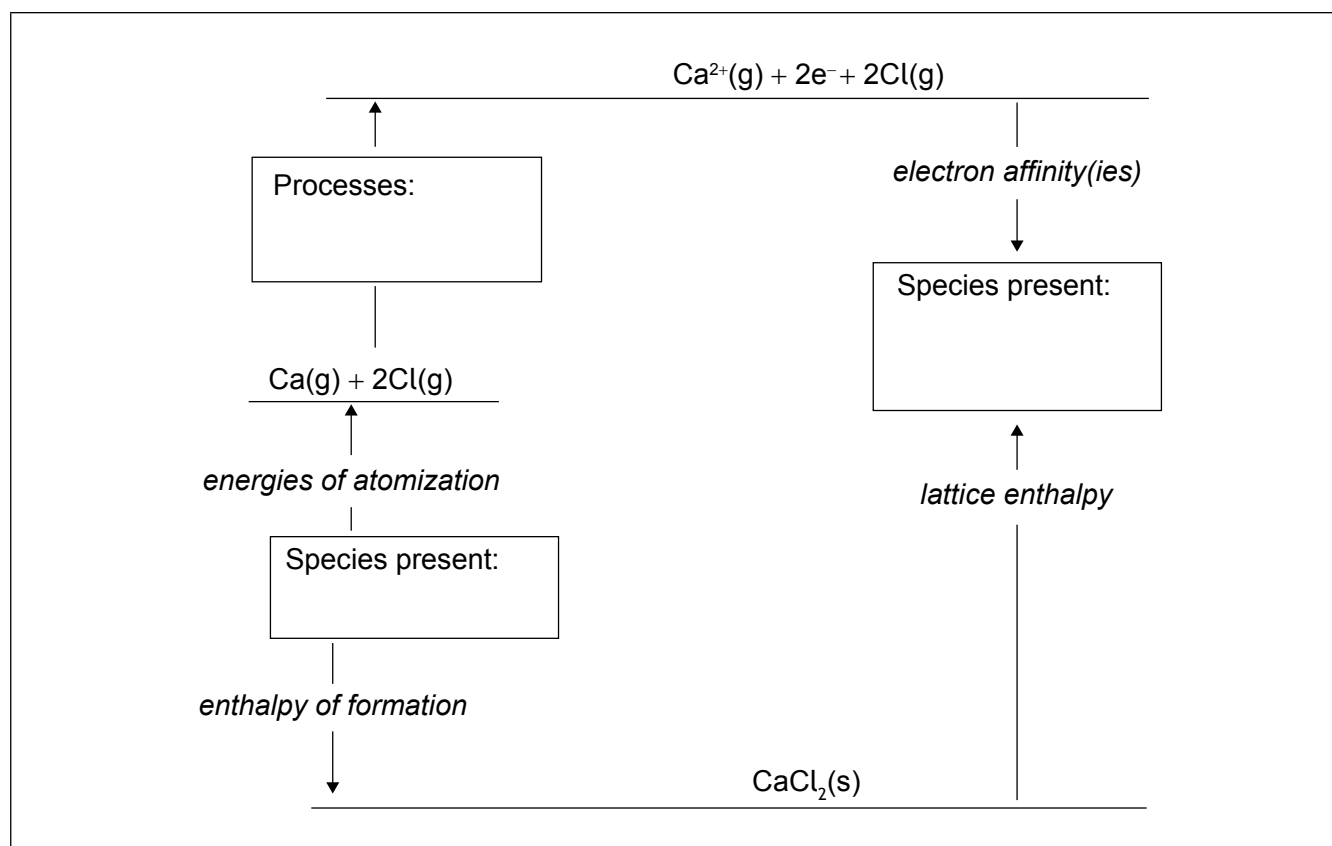


Turn over

(Question 4 continued)

(c) Calcium carbonate and calcium chloride are ionic compounds.

- (i) Annotate the Born–Haber cycle for calcium chloride, CaCl_2 , by filling the names of processes and formulas of species, including state symbols, in the boxes. [3]



- (ii) Outline why the lattice enthalpy of calcium chloride is lower than the lattice enthalpy of magnesium chloride. [1]

.....

.....

.....

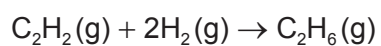


— 5 —

4420-0209

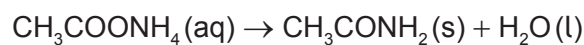
4. What is the volume, in dm^3 , of ethane gas, $\text{C}_2\text{H}_6(\text{g})$, produced when 0.25 dm^3 of ethyne, $\text{C}_2\text{H}_2(\text{g})$, reacts with 0.40 dm^3 of hydrogen gas, $\text{H}_2(\text{g})$?

All volumes are measured under the same conditions.



- A. 0.20
- B. 0.25
- C. 0.40
- D. 0.45

24. What is the theoretical yield, in g, of ethanamide, CH_3CONH_2 , that can be produced from the reaction of 4.00 g of ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$, with excess ethanoic acid, CH_3COOH ?



$$M_{\text{r}}(\text{NH}_4)_2\text{CO}_3 = 96.11$$

$$M_{\text{r}}\text{CH}_3\text{CONH}_2 = 59.08$$

- A. 1.23
- B. 2.46
- C. 4.92
- D. 6.51