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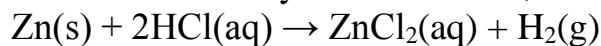
CHEMISTRY

PHYSICAL CHEMISTRY

LEVEL & BOARD:	OCR (A - LEVEL)
TOPIC:	AMOUNT OF SUBSTANCE
PAPER TYPE:	QUESTION PAPER 2
TOTAL QUESTIONS	10
TOTAL MARKS	50

Amount of Substance

1. Zinc reacts with hydrochloric acid, HCl(aq) , as shown in the following equation.

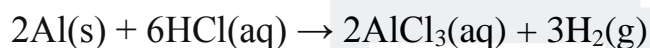


A student investigates the rate of this reaction. The student plans to react 50.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ HCl with 0.200 g of zinc (an excess).

Calculate the volume, in cm^3 , of hydrogen that should be produced at RTP. [3]

2. An aqueous solution of aluminium chloride can be prepared by the redox reaction between aluminium metal and dilute hydrochloric acid.

(a) A student reacts 0.0800 mol of aluminium completely with dilute hydrochloric acid to form an aqueous solution of aluminium chloride. The equation for this reaction is shown below.

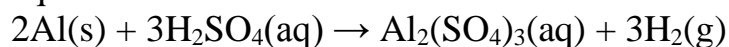


Calculate the volume of hydrogen gas formed, in dm^3 , at room temperature and pressure. [2]

(b) Calculate the mass of AlCl_3 formed. Give your answer to three significant figures. [2]

(c) Calculate the volume, in cm^3 , of 1.20 mol dm^{-3} hydrochloric acid needed to react completely with 0.0800 mol of aluminium. [2]

3. A student reacts 35.0 cm^3 of $3.00 \times 10^{-2} \text{ mol dm}^{-3}$ $\text{H}_2\text{SO}_4\text{(aq)}$ with an excess of Al. An equation for this reaction is shown.



Calculate the mass, in g, of $\text{Al}_2(\text{SO}_4)_3$ formed in solution. Give your answer to three significant figures. Show your working. [4]

4. Europium reacts with dilute sulfuric acid, forming a solution of europium sulfate and hydrogen gas.

(a) A chemist reacts 0.608 g of europium with an excess of $\text{H}_2\text{SO}_4(\text{aq})$ and collects 144 cm^3 of hydrogen gas at room temperature and pressure. Analyse the chemist's results to write the overall equation for the reaction between europium and sulfuric acid. Show all your working. Equation.[6]

(b) Calculate the number of europium atoms in 0.0019 g of europium. [2]

5. Alkenes can be prepared from alcohols. Cyclopentene can be prepared from cyclopentanol as shown in the equation below.



A student plans to prepare 5.00 g of cyclopentene from cyclopentanol. The percentage yield of this reaction is 45.0%.

(a) What is the name of this type of reaction? [1]

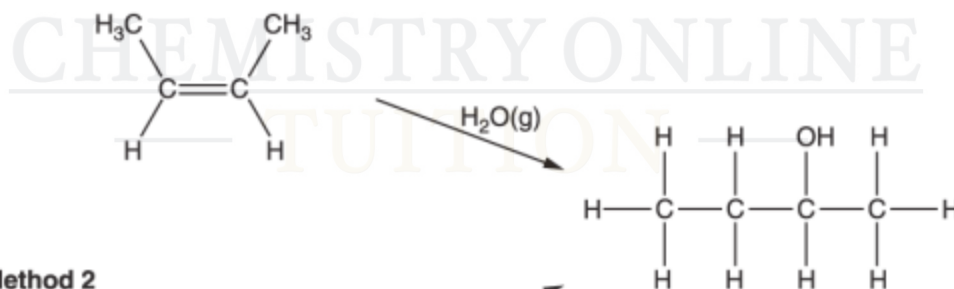
(b) Calculate the mass of cyclopentanol that the student should use. Show your working. [3]

6. 1.00 tonne of ammonia is reacted with carbon dioxide to prepare the fertiliser urea.
 $\text{NH}_2\text{CONH}_2 \cdot 2\text{NH}_3(\text{g}) + \text{CO}_2(\text{g}) \rightarrow \text{NH}_2\text{CONH}_2(\text{s}) + \text{H}_2\text{O}(\text{l})$
1.35 tonnes of urea are formed. Calculate the percentage yield of urea. Show all your working. [3]

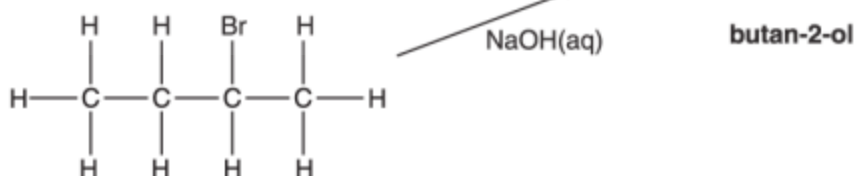
7. An alkene D is a liquid at room temperature and pressure but can easily be vaporised. When vaporised, 0.1881 g of D produces 82.5 cm^3 of gas at 101 kPa and 373 K. Determine the molar mass and molecular formula of alkene D. Show all your working. [5]

8. This question is about alcohols.
(a) Butan-2-ol can be prepared using two different methods.

Method 1



Method 2



Comment on the atom economy of each method, giving your reasons. [2]

(b) A student uses Method 2 to prepare 3.552 g of butan-2-ol from 2-bromobutane. The percentage yield of butan-2-ol is 80.0%. Calculate the mass of 2-bromobutane that the student uses. [3]

9. When magnesium nitrate, $\text{Mg}(\text{NO}_3)_2$, is heated, it decomposes as shown. $2\text{Mg}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{MgO}(\text{s}) + 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$
A student heats 2.966 g of $\text{Mg}(\text{NO}_3)_2$, which decomposes as above.
Calculate the total volume of gas formed, in cm^3 , at room temperature and pressure, RTP. [3]

10. Barium combines with oxygen, chlorine and nitrogen to form ionic compounds

(a) Barium oxide, BaO , has a giant ionic lattice structure.

- i. State what is meant by the term ionic bond. [1]

- ii. Draw a 'dot-and-cross' diagram to show the bonding in barium oxide. Show outer electrons only. [1]

- iii. Calculate the number of barium ions in 1.50 g of barium oxide. Give your answer in standard form and to three significant figures. [1]

(b) Barium chloride, BaCl_2 , is soluble in water.

- i. Compare the electrical conductivities of solid and aqueous barium chloride. Explain your answer in terms of the particles involved. [2]
- ii. Describe the use of aqueous barium chloride in qualitative analysis. [2]
- iii. Hydrated barium chloride can be crystallised from solution. Hydrated barium chloride has the formula $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$ and a molar mass of 244.3 g mol^{-1} . Determine the value of x in the formula of $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$. [2]

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