

Suggested answers to 2015 O level Combine Science Chemistry Paper 3 5076/5078

Section A

1 (a) To distinguish

(i) a substance with pH 1 and another with pH 14

Perform a litmus test on the two substances. The one with a pH value of 1 will turn damp blue litmus red and the other with a pH value of 14 would turn damp red litmus blue.

OR

Add Universal Indicator solution onto the two substances. It will turn red on contact with the substance with a pH value of 1 and purple/violet with the substance with a pH value of 14.

(ii) ethane and ethene

Add aqueous bromine into solutions of both ethane and ethene. Only ethene will decolourise brown aqueous bromine; ethane would not.

Teacher's Comments: Alkenes react readily with aqueous bromine through an addition reaction. Alkanes can only react with aqueous bromine in the presence of UV light.

(iii) an endothermic reaction from an exothermic reaction

Measure the temperature of both reactions before and after reaction. The endothermic reaction will register a decrease in temperature after the reaction while the exothermic reaction will register an increase in temperature instead.

Teacher's Comments: Exothermic reactions release heat energy, which causes the temperature of the surroundings to increase. Conversely, endothermic reactions absorb heat energy from the surroundings, causing the temperature of the surroundings to decrease.

(iv) NaCl & Na₂SO₄

Add acidified aqueous AgNO₃ to both solutions. Only NaCl will form a white precipitate with acidified aqueous AgNO₃.

OR

Add acidified aqueous Ba(NO₃)₂ to both solutions. Only Na₂SO₄ will form a white precipitate with acidified aqueous Ba(NO₃)₂.

Teacher's Comments:



OR



Both AgCl and BaSO₄ are insoluble in aqueous solution.

2

- (a) Air Mixture of elements & compounds
- (b) Brass Mixture of elements
- (c) Hydrogen Element
- (d) Sodium carbonate Compound

3

(a)

	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	$\frac{1}{1840}$	-1

(b) An ionic equation for the formation of beryllium ions from beryllium atoms is



4 (a)

- (i) Ammonia is a covalent compound with very strong covalent bonds between atoms but weak intermolecular forces of attraction between molecules.

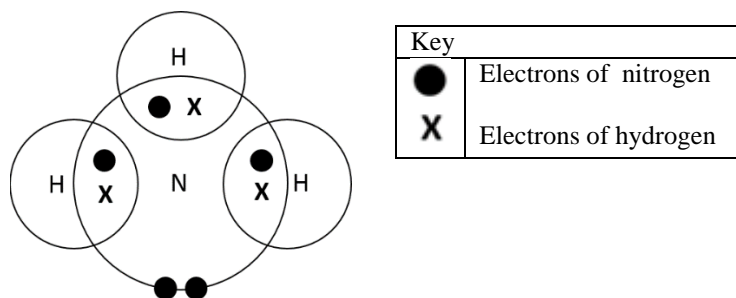
Teacher's Comments: Ammonia is a compound formed between N and H, both of which are non-metals, which is why it is a covalent compound.

- (ii) Magnesium chloride is an ionic compound with strong electrostatic forces of attraction between oppositely charged ions.

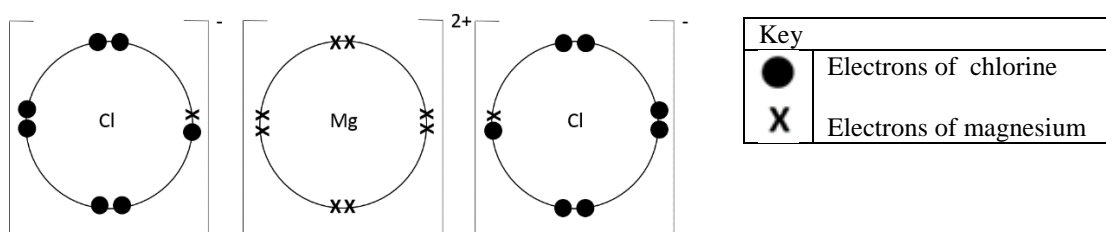
Teacher's Comments: Magnesium chloride is a compound formed between Mg, a metal, and Cl, a non-metal, which is why it is an ionic compound.

(b) A dot-and-cross diagram for

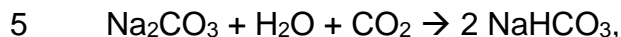
- (i) ammonia



- (ii) magnesium chloride



Teacher's Comments: A key/legend and ionic charges must be included in students' answers.



- (a) The volume of $2 \text{ mol/dm}^3 \text{ Na}_2\text{CO}_3$ containing 500g of Na_2CO_3 .

$$M_r(\text{Na}_2\text{CO}_3) = 2(23) + 12 + 3(16) = 106$$

$$n(\text{Na}_2\text{CO}_3) = \frac{500}{106} = 4.716 \text{ mol}$$

$$\begin{aligned} \therefore v(\text{Na}_2\text{CO}_3) &= \frac{4.716}{2} = 2.358 \text{ dm}^3 \\ &\approx 2.36 \text{ dm}^3 \text{ (3 sig. fig.)} \end{aligned}$$

The maximum mass of NaHCO_3 obtained from 500g of Na_2CO_3

$$\begin{array}{ccc} n(\text{Na}_2\text{CO}_3) & : & n(\text{NaHCO}_3) \\ 1 & : & 2 \\ 4.716 & : & 9.433 \end{array}$$

$$M_r(\text{NaHCO}_3) = 23 + 1 + 12 + 3(16) = 84$$

$$\begin{aligned} \therefore \text{maximum } m(\text{NaHCO}_3) \text{ obtained} &= 9.433 \times 84 = 792.4\text{g} \\ &\approx 792 \text{ g (3 sig. fig.)} \end{aligned}$$

- (b) All acids dissociate to give H^+ in water. This also happens with the weak acid in moist dough, which then reacts with NaHCO_3 to liberate CO_2 gas, which makes the dough rise as it bakes in the oven.

Teacher's Comments: Two concepts are required to answer this question.

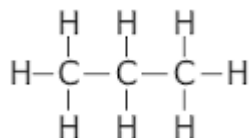
- 1) Acid + Metal carbonate \rightarrow Salt + Water + Carbon dioxide gas
- 2) Acids release H^+ (source of acidity) in the presence of water.

6 Our students could not remember this question.

Section B

7. (a) (i) The structural/chemical formula of propane is

Structural formula:



Chemical formula:



- (ii) The relative molecular mass of propane.

$$M_r(\text{propane}) = 3(12) + 8(1) = 44$$

- (b) (i) 10 g of ethane will occupy a volume of

$$M_r(\text{ethane}) = 2(12) + 6(1) = 30$$

$$\therefore v(\text{ethane}) = n(\text{ethane}) \times 24 \text{ dm}^3 = \frac{1}{3} \times 24 = 8 \text{ dm}^3$$

- (ii) The volume of O_2 that is required to burn 10 g of ethane is



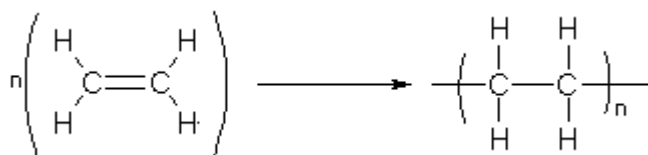
$$\begin{array}{ccc} n(\text{ethane}) & : & n(\text{O}_2) \\ 2 & : & 7 \end{array}$$

$$\therefore v(\text{O}_2) \text{ required} = \frac{7}{2} \times 8 = 28 \text{ dm}^3$$

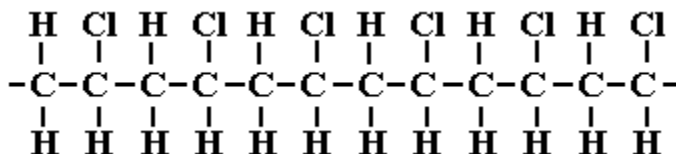
- (iii) The volume of air that is required to burn 10g of ethane if 21% of air is O_2 is

$$v(\text{air}) \text{ containing } 28 \text{ dm}^3 \text{ of } \text{O}_2 = \frac{28}{21\%} \times 100\% = 133.3 \text{ dm}^3 \\ \approx 133 \text{ dm}^3 \text{ (3 sig. fig.)}$$

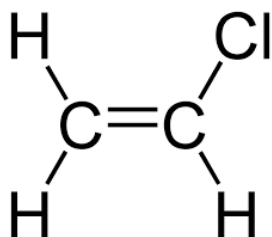
- (c) Ethene undergoes an addition polymerisation process at high temperatures and pressures, and in the presence of a catalyst, to form polyethene. This process requires the addition of ethene molecules, to each other, over their C=C double bond, and in so doing, breaking it and forming a saturated molecule and two new C–C bonds per monomer. The chemical equation for this reaction is as follows:



- (d) The monomer from the polymer shown below.



Monomer structure:



Teacher's Comments: Students should look out for a repeating unit with a two-carbon-long chain and identify that as the monomer.

8. (a) An element from Period 2 is oxygen. Elements in Period 2 have two valence electrons.
- (b) Explain the changes in the character of the elements from Group I to VII.

Across a period, the character of the elements changes from metallic to non-metallic as the number of valence electrons increase with each element.

Teacher's Comments: Moving from Group I to Group VII means moving across the periods. Metals are on the left of the Periodic Table, while non-metals are on the right. The number of valence electrons increase as the proton number of the elements increase. This also decreases the tendency of elements to form cations as non-metals form anions instead.

- (c) A physical property of the element with an atomic number of 85 is that the element would be very intensely coloured/have low melting and boiling points/be a poor conductor of electricity/have low density/be a solid.

A chemical property of the element with an atomic number of 85 is that the element and can form an acidic oxide/be displaced by all the other halogens.

Teacher's Comments: Element 85 is Astatine, the last member of the halogens.

9. (a) When pressure increases, the number of reactant particles per unit volume of a gas increases. This leads to an increase in the number of collisions, and thus effective/activated collisions, which results in a faster speed of reaction.

When concentration decreases, there are a lesser number of reactant particles per unit volume of a solution. This leads to a decrease in the number of collisions, and thus effective/activated collisions, which results in a slower speed of reaction.

- (b) The greater a particles' reactivity, the faster the speed of the reaction, as particles with a greater reactivity will have a higher likelihood of undergoing an effective/activated collision every time it collides with other reactant particles.

Teacher's Comments: Link the question back to the concept of Collision Theory. Since we know that the more reactive a substance is, the greater the speed of reaction, its reactivity must necessarily also cause an increase in the number of effective/activated collisions.

- (c) The speed of reaction of a gaseous reaction can be measured by measuring the change in the pressure of the reaction. The faster the initial change in the pressure of the reaction, the faster the speed of reaction.

Teacher's Comments: Link the question back to the concept of Collision Theory. Since the only factor we know that affects the speed of a gaseous reaction is pressure, it must be the only measurable factor to indicate speed of reactions for gaseous reactions.



10. (a) Other than heating, metals can also be extracted from their metal oxides by electrolysis.
- (b) Extraction of a metal with carbon depends on the reactivity of the metal with respect to carbon. Only metals that are less reactive than carbon, located below carbon in the reactivity series, can be extracted by heating with carbon. The Group I and II metals are located above carbon in the reactivity series, and thus cannot be extracted by heating with carbon.
- (c) The position of the following elements in the reactivity series:
- (i) Iron
- Fe is a moderately reactive metal which can be reduced from its oxide by heating with C but not with H.
- (ii) Calcium
- Ca is a reactive metal and cannot be reduced from its oxide by heating with C.
- (d) $\text{Fe} + \text{H}_2\text{O} \rightarrow$ no reaction
- $\text{Ca} + 2 \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$

Teacher's Comments: Iron is not reactive enough to react with cold water. Calcium is reactive enough to form its hydroxide and hydrogen gas in cold water.