Electrons, bonding and structure – 2021/20 GCE AS Chemistry A

1. Nov/2021/Paper_H032/01/No.1

Which compound has the highest boiling point?

A ethanol

B heptane

C sodium chloride

D water

Your answer ☐ **[1]**

2. Nov/2021/Paper_H032/01/No.2

Pauling electronegativity values for the halogens F to I and some elements in period 2 of the periodic table are shown below.

B 2.04	C 2.55	N 3.04	O 3.44	F 3.98
				Cl 3.16
				Br 2.96
				I 2.66

Which bond has the correct polarity?

A	B	C	D
$^{\delta-}$N—I$^{\delta+}$	$^{\delta-}$C—F$^{\delta+}$	$^{\delta-}$B—Cl$^{\delta+}$	$^{\delta-}$Br—Cl$^{\delta+}$

Your answer ☐ **[1]**

3. Nov/2021/Paper_H032/01/No.3

Which compound releases hydroxide ions when it dissolves in water?

A CH_3COOH

B HNO_3

C H_2SO_4

D NH_3

Your answer ☐ **[1]**

4. Nov/2020/Paper_H032/01/No.1

Which substance contains polar molecules?

A C_2H_4

B CO_2

C NCl_3

D SF_6

Your answer ☐ **[1]**

5. Nov/2020/Paper_H032/01/No.3

Which statement explains why ice is less dense than water?

A Hydrogen bonds are stronger in ice than in water.

B Hydrogen bonds hold H_2O molecules apart in ice.

C Ice is a solid but water is a liquid.

D Ice contains hydrogen bonds, but water does not contain hydrogen bonds.

Your answer ☐ **[1]**

6. Nov/2020/Paper_H032/01/No.5

Which p-block element contains atoms with one unpaired electron?

A Al

B Si

C P

D S

Your answer ☐ **[1]**

7. Nov/2020/Paper_H032/01/No.21(a)

This question is about atoms, isotopes and mass spectrometry.

(a) Complete the table to show the number of electrons that can fill the first four shells.

Shell	1st shell	2nd shell	3rd shell	4th shell
Number of electrons				

[1]

8. Nov/2021/Paper_H032/02/No.1

This question is about compounds of sulfur.

(a) Potassium sulfide, K_2S, shows ionic bonding.

(i) Explain what is meant by **ionic bonding**.

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..... **[1]**

(ii) Draw a 'dot-and-cross' diagram to show the bonding in K_2S.

Show outer electrons only.

[2]

(b) Sulfur difluoride, SF_2, shows covalent bonding.

Draw a 'dot-and-cross' diagram to show the bonding in SF_2.

Show outer electrons only.

[2]

(c) At room temperature, K_2S is a solid, but SF_2 is a gas.

Use ideas about structure and bonding to explain this difference.

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..... **[3]**

(d) Sulfur hexafluoride, SF_6, is used in medical ultrasound imaging because SF_6 is unreactive.

(i) State the shape of, and F—S—F bond angle in, an SF_6 molecule.

Shape .....

Bond angle .....

[2]

(ii) Suggest why SF_6 is unreactive.

.....

..... **[1]**

9. Nov/2020/Paper_H032/02/No.(4(a)

A student carries out an investigation to find the enthalpy change for the decomposition of magnesium carbonate, ΔH_1 (**Reaction 1**).

Reaction 1 $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$ ΔH_1

This enthalpy change cannot be found directly. It can be determined indirectly from the enthalpy changes for the reactions below, which can be found by experiment.

Reaction 2 $MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$ ΔH_2

Reaction 3 $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$ ΔH_3

The enthalpy cycle is shown in **Fig. 4.1**.

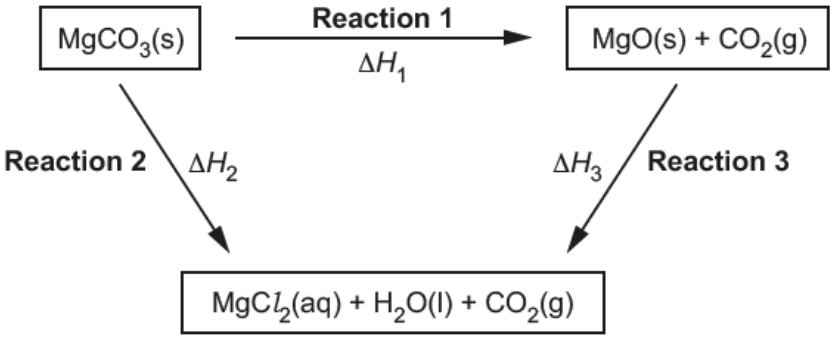

Fig. 4.1

Determination of ΔH_2 for Reaction 2

Student's method

- Weigh a 250 cm^3 polystyrene cup.
- Add about 100 cm^3 of 2.00 mol dm^{-3} hydrochloric acid (an excess) to the polystyrene cup and record the initial temperature of the $HCl(aq)$.
- Add 4.215 g $MgCO_3$, stir the mixture, and record the final temperature.
- Weigh the polystyrene cup containing the final solution.

Results

Mass of polystyrene cup / g	21.415
Mass of polystyrene cup + final solution / g	124.425
Initial temperature of $HCl(aq)$ / °C	20.40
Final temperature of solution / °C	25.40

Determination of ΔH_3 for Reaction 3

The student uses the same method as for **Reaction 2** but with MgO in place of $MgCO_3$.

The student calculates ΔH_3 for **Reaction 3** as $-136.1\ kJ\ mol^{-1}$.

(a)* Use the student's results to calculate ΔH_2 for **Reaction 2** and determine the enthalpy change ΔH_1, in $kJ\,mol^{-1}$, for the decomposition of magnesium carbonate (**Reaction 1**), using the energy cycle in **Fig. 4.1**.

Assume the specific heat capacity, *c*, of the reaction mixture is the same as for water.

Additional answer space if required.

[6]