
Student Number

2024
YEAR 11 PRELIMINARY EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- NESA-approved calculators may be used
- Use the Data Sheet and Periodic Table provided
- Use the Multiple-Choice Answer Sheet provided

Total marks – 67

This paper has two sections:

Section I – 20 marks
- Attempt Questions 1-20
- Allow about 35 minutes for this section

Section II – 47 marks
- Attempt Questions 21-25
- Allow about 1 hour and 25 minutes for this section

Section I – 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet provided for Questions 1-20.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = A. 2 B. 6 C. 8 D. 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you have changed your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

correct ←

A ⊗ B ⊗ C ○ D ○

1 Some carbon dioxide is to be generated by reacting 50 g of calcium carbonate with a solution of hydrochloric acid. Which of the following actions is LEAST likely to lead to an increase in the rate of formation of carbon dioxide?

A. Grinding the calcium carbonate to a fine powder

B. Raising the temperature

C. Raising the atmospheric pressure

D. Raising the concentration of hydrochloric acid

2 Which technique would most easily be used to separate a mixture of partly crushed rock particles and sand?

A. Filtration

B. Separating funnel

C. Sieving

D. Sedimentation and decanting

3 What is the formula of aluminium phosphide?

A. AlP

B. Al_2P_3

C. $AlPO_4$

D. Al_3P_3

4 A 1.00 kilogram packet of sodium hydrogen carbonate ($NaHCO_3$) is added to the water in a swimming pool to balance the pH of the system.

What is the number of moles of this compound in the 1.00kg packet?

A. 0.80

B. 1.20

C. 8.40

D. 11.9

5 The decomposition of water can be represented by the chemical equation:

$2H_2O\ (l) \rightarrow 2H_2\ (g) + O_2\ (g) \qquad \Delta H = +\ 571.8\ kJ\ mol^{-1}$

From this equation, it can be concluded that the formation of two moles of liquid water from gaseous hydrogen and oxygen is an

A. exothermic process releasing 571.8 kJ of heat energy.

B. exothermic process releasing 1143.6 kJ of heat energy.

C. endothermic process absorbing 571.8 kJ of heat energy.

D. endothermic process absorbing 1143.6 kJ of heat energy.

6 The maximum number of electrons that can occupy a 4*p* sub-shell is

A. 2

B. 6

C. 10

D. 14

7 As you move down the elements of Group 3 of the Periodic Table, the first ionisation energy

A. decreases and the electronegativity decreases.

B. decreases and the electronegativity increases.

C. increases and the electronegativity decreases.

D. increases and the electronegativity increases.

8 An ion with a charge of +2 and the same electron configuration as the chloride ion is the

A. phosphide ion.

B. sulfide ion.

C. magnesium ion.

D. calcium ion.

9 A compound was created from a reaction between elements P and Q. The atoms of element P contain 20 protons whereas those of element Q contained 9 protons. Which of the following gives the correct chemical structure and identification for the type of bonding present?

A. P_2Q with ionic bonds

B. P_2Q with covalent bonds

C. PQ_2 with covalent bonds

D. PQ_2 with ionic bonds

10 How much water needs to be added to 200.00 mL of 0.75 mol L^{-1} zinc chloride solution to change its concentration to 0.500 mol L^{-1}?

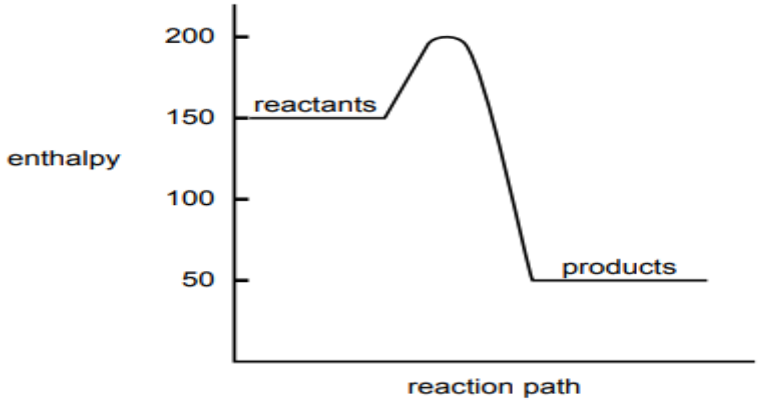
A. 100.00mL

B. 133.00mL

C. 150.00mL

D. 300.00mL

11 The relative enthalpies, on an arbitrary scale, of the reactants and products of a chemical reaction are represented on the following diagram:



The numerical value of enthalpy change, ΔH, for the forward reaction is

A. +150

B. +50

C. –50

D. –100

12 Which of the following statements best describes a comparison of the reactants and products in any chemical reaction?

A. There are always as many molecules before the reaction as after the reaction.

B. The total number of moles is always the same

C. The total mass is always the same.

D. The amount of energy in the products and reactants is always the same.

13 A 100 mL sample of helium exerts a pressure of 1 atm at 10°C. The volume of the container is reduced to 50 mL and then the temperature is increased to 20°C. The pressure now exerted by the helium, in atmospheres, is closest to

A. 0.5

B. 1

C. 2

D. 4

14 Equal masses of the two gases, oxygen (O_2) and sulfur dioxide (SO_2), are placed in separate vessels. Both vessels have the same volume and are at the same temperature. The pressure exerted by the oxygen is 100 kPa. The pressure, in kPa, exerted by the SO_2 is closest to

A. 25

B. 50

C. 100

D. 200

15 In the following four substances, $H_2S_2O_7$, N_2O_5, HIO_3, Cl_2O_7, the atom with the highest oxidation number is

A. I

B. S

C. N

D. Cl

16 Potassium has a radioactive isotope, ^{40}K. One of the ways this isotope disintegrates leads to the emission of a beta particle by the ^{40}K nucleus. The new nucleus produced by this disintegration is

A. $^{40}K^{+}$

B. ^{41}K

C. ^{40}Ar

D. ^{40}Ca

17 When concentrated sulfuric acid is poured onto solid sodium bromide, the liquid turns brown as bromine is produced. In this reaction the sulfuric acid is acting as

A. an oxidant.

B. a reductant.

C. a dehydrating agent.

D. a strong acid.

18 Consider the following two reactions:

$2Cu\ (s) + O_2\ (g) \rightarrow 2CuO\ (s) \quad \Delta H = -312\ kJ\ mol^{-1}$

$2Cu\ (s) + \frac{1}{2}O_2\ (g) \rightarrow Cu_2O\ (s) \quad \Delta H = -170\ kJ\ mol^{-1}$

What is the value of ΔH, in kJ mol^{-1}, for the reaction:

$4CuO\ (s) \rightarrow 2Cu_2O\ (s) + O_2\ (g)$

A. +284

B. +142

C. –142

D. –284

19 When 1.0 mole of Cu_3FeS_3 and 1.0 mole of O_2 are mixed and allowed to react according to the equation:

$2Cu_3FeS_3\ (s) + 7O_2\ (g) \rightarrow 6Cu\ (s) + 2FeO\ (s) + 6SO_2\ (g)$

A. no reagent is in excess.

B. 5 mole of O_2 is in excess.

C. $^5/_7$ mole of Cu_3FeS_3 is in excess.

D. $^2/_7$ mole of Cu_3FeS_3 is in excess.

20 For an endothermic reaction to be spontaneous under standard conditions at constant pressure at some temperature T, which must be true?

A. The entropy change ΔS^o must be positive and greater than $\Delta H^o/T$.

B. The entropy change ΔS^o must be positive and less than $\Delta H^o/T$.

C. The entropy change ΔS^o must be negative and greater than $-\Delta H^o/T$.

D. The entropy change ΔS^o must be negative and less than $-\Delta H^o/T$.

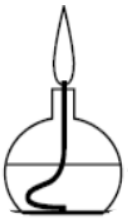
Student Number

Section II – 47 marks
Attempt Questions 21-25
Allow about 1 hour and 25 minutes for this section

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 21 (16 marks)

(a) Draw a labelled diagram showing how this spirit burner and other apparatus could be used to measure the heat of combustion of ethanol (C_2H_6O). 2



Question 21 continues on the next page

Question 21 (continued)

(b) What measurements must be taken to determine the experimental value for the heat of combustion of ethanol? 2

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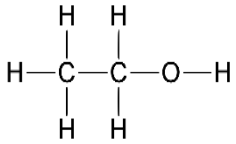
(c) Write the equation for the complete combustion of ethanol (g). The structure of ethanol is shown below. 1



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(d) Use the bond energies in the table to determine a value for the heat of complete combustion of ethanol. Show all working and reasoning. Assume all reactants and products are in the gaseous state. 4

Bond	*Bond dissociation energy* (kJ mol^{-1})
C—C	346
C═C	614
C≡C	839
H—H	436
O═O	498
C—H	414
C—O	358
C═O	804
H—O	463

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Question 21 continues on the next page

Question 21 (continued)

(e) The theoretical value for the heat of combustion of ethanol may differ from the values determined by experiment in part (a) and that calculated from the bond energies in part (d). Explain fully why these differences might occur. 2

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(f) Ethanol boils at about 80°C, while water boils at 100°C and methane boils at –162°C. 5

Using appropriate diagrams, explain fully the differences in the boiling points of these 3 compounds.

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Question 22 (10 marks)

Elements in Group 1 of the Periodic Table have a major similarity in their electron configuration.

(a) State this similarity. 1

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(b) Name the element in Group 1 of Period 4 and give its ground-state electron configuration (s, p, d, f notation). 2

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(c) Sodium metal reacts with water to form sodium hydroxide solution & hydrogen gas. Write a balanced chemical equation (including subscripts) for this reaction. 1

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(d) Explain how the atomic radius and electron configuration of the Group I elements affects their reactivity and explain the reactivity of the element named in part (b) compared to sodium. 3

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Question 22 (continued)

(d) For the following two reactions: 3

- the dissolution of sodium chloride in water
- the melting of sodium chloride

Classify each reaction as spontaneous or non-spontaneous.

Explain your reasoning in terms of enthalpy and entropy.

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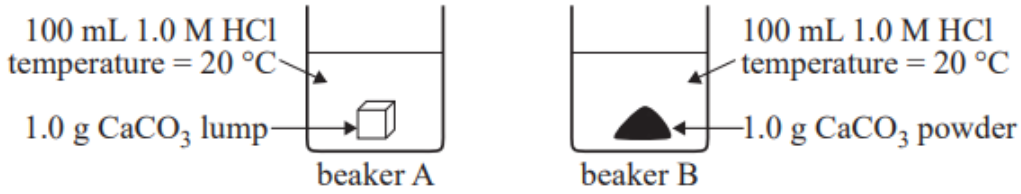
Question 23 (8 marks)

Two experiments were conducted to investigate various factors that affect the rate of reaction between calcium carbonate and dilute hydrochloric acid.

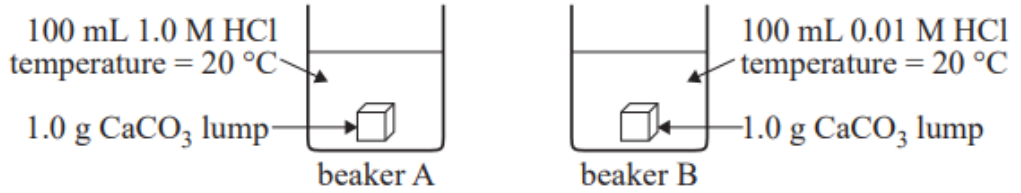
$CaCO_{3\,(s)} + 2HCl_{\,(aq)} \rightarrow CO_{2\,(g)} + CaCl_{2\,(aq)} + H_2O_{\,(l)}$

The two experiments are summarised in the diagrams below.

Experiment 1.



Experiment 2.



(a) How could the rate of this reaction be measured in these experiments? 1

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(b) Identify the rate determining factor that is investigated in Experiment 1. 1

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(c) In Experiment 2, will the rate of reaction be faster in beaker A or beaker B? Explain your selection in terms of collision theory. 2

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Question 23 continues on the next page

Question 23 (continued)

(d) Why is the following statement incorrect? 2

"Collision theory states that all collisions between reactant particles will result in a chemical reaction."

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(e) How does the presence of a catalyst increase the rate of reaction according to collision theory? Explain, using an example. 2

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Question 24 (7 marks)

(a) 947 J of energy is required to raise the temperature of 125 g of stainless steel by 15.7°C. Calculate the specific heat capacity of the stainless steel, in J g^{-1} $°C^{-1}$. (Show all working.) **2**

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(b) Calculate the concentration of K^+ ions in 100 mL of 0.0500 M K_2CO_3 solution, in g L^{-1}. Show all working. **2**

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(c) 8.30 grams of solid calcium carbonate ($CaCO_3$) was mixed with 100.0 mL of 1.00 M hydrochloric acid and allowed to react according to the following equation:

$$2\ HCl_{(aq)} + CaCO_{3\,(s)} \rightarrow CaCl_{2\,(aq)} + CO_{2\,(g)} + H_2O_{(l)}$$

(i) Determine the limiting reagent showing all working. **2**

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(ii) Determine the volume of carbon dioxide gas produced at 25˚C and 100 kPa. **1**

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Question 25 starts on the next page

Question 25 (6 marks)

A compound contains only C, H and N.
Combustion of 0.125 g of this compound produces 0.279 g of CO_2 and 0.172 g of H_2O.

(a) Calculate the number of moles of CO_2 and H_2O. **2**

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(b) Find the mass percentages of C, H and N and hence the empirical formula of this compound. **4**

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End of Examination

Section II - Extra writing space

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Section II - Extra writing space

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2024 YEAR 11 FINAL EXAMINATION

CHEMISTRY – MARKING GUIDELINES

Section I

Question	Answer
1	C
2	C
3	A
4	D
5	A
6	B
7	A
8	D
9	D
10	A
11	D
12	C
13	C
14	B
15	D
16	D
17	A
18	A
19	C
20	A

Explanations for Multiple-Choice	
1	**C 100%** Since the reaction occurs in solution, increasing the atmospheric pressure will not impact on the rate of combination of particles within the solution unless an equilibrium system existed. There is no evidence of that in the question. Grinding the solid to a powder, raising the temperature and increasing the concentration of the solution will all increase the rate of reaction, and hence formation of carbon dioxide.
2	**C 64%** Sieving will catch the rock particles and allow the sand to fall through the sieve
3	**A 85%** Al^{3+} combines with P^{3-} to produce AlP
4	**D 90%** Moles = Mass/MM = 1000g/84 = 11.9
5	**A 46%** The reaction is reversed. Hence 571.8 kJ is released. Thus the reaction is exothermic.
6	**B 90%** All *p* sub-shells have a maximum occupancy of 6 electrons (in 3 orbitals with 2 electrons in each).
7	**A 74%** As you move down Group 3, the atoms increase in size. This means the first ionisation energy decreases (easier to remove an electron) and the atoms become less electronegative.
8	**D 54%** Ca^{2+} has electron configuration of 2,8,8.

9	**D 92%** P has 2,8,8,2 electron configuration becomes a P^{2+} ion when loses 2 e^- Q has 2,7 electron configuration becomes Q^- ion when gains 1 e^- PQ_2 is the correct combination of these 2 ions
10	**A 82%** $C_1V_1=C_2V_2$ V_2= 0.2x0.75/0.5= 0.3L = 300mL Therefore 100mL needs to be added
11	**D 95%** The forward reaction is exothermic with $\Delta H = (50 - 150) = -100$
12	**C 85%** The total mass is the same obeys the Law of the conservation of mass A&B are incorrect as molecule and moles numbers can vary according to balancing
13	**C 64%** The temperature increase is small, when measured in Kelvin (from 283 K to 299 K). Hence the pressure will approximately double (from 1 atm to 2 atm) due to the reduction in volume from 100 mL to 50 mL. (Actually 2.07 atm)
14	**B 41%** *MM* O_2 = 32 *MM* SO_2 = 64 Hence, there are twice the no. of particles of oxygen in the same volume of gas at the same temperature and pressure. Hence the pressure of SO_2 is ½ x 100 = 50 kPa
15	**D 85%** Applying an oxidation number of -2 for O and +1 for H: $H_2S_2O_7$: 2(+1) + 2x + 7(-2) = 0 2x = 12 x = +6 The oxidation number of S is +6. N_2O_5: 2x + 5(-2) = 0 2x = 10 x = +5 The oxidation number of N is +5. HIO_3: +1 + x + 3(-2) = 0 x = +5 The oxidation number of I is +5. Cl_2O_7: 2x + 7(-2) = 0 2x = 14 x = +7 The oxidation number of Cl is +7. Hence Cl in Cl_2O_7 has the highest oxidation number.

16	**D 44%** $^{40}_{19}K \rightarrow {}^{40}_{20}Ca + {}^{0}_{-1}e^{-}$
17	**A 51%** Concentrated sulfuric acid is a strong oxidant (oxidising agent), so will oxidise bromide ion to bromine. Bromine solution is brown. The bromide ion loses electrons (is oxidised) and molecular Br_2 forms.
18	**A 87%** Reverse equation 1 and double it. Double equation 2. $4CuO\ (s) \rightarrow 4Cu\ (s) + 2O_2\ (g)$ $\quad \Delta H = +624$ kJ mol^{-1} $4Cu\ (s) + O_2\ (g) \rightarrow 2Cu_2O\ (s)$ $\quad \Delta H = -340$ kJ mol^{-1} Add the 2 equations. $4CuO\ (s) \rightarrow 2Cu_2O\ (s) + O_2\ (g)$ $\quad \Delta H = +284$ kJ mol^{-1}
19	**C 64%** Since 2.0 mole Cu_3FeS_3 requires 7.0 mole O_2, then oxygen is the limiting reagent when equal moles of Cu_3FeS_3 and O_2 are mixed. Divide the whole equation by 7 so that only 1.0 mole of oxygen is reacting. $\frac{2}{7}Cu_3FeS_3\ (s) + O_2\ (g) \rightarrow \frac{6}{7}Cu\ (s) + \frac{2}{7}FeO\ (s) + \frac{6}{7}SO_2\ (g)$ Hence only $\frac{2}{7}$ mole Cu_3FeS_3 reacts. Hence $\frac{5}{7}$ mole Cu_3FeS_3 is in excess.
20	**A 79%** $\Delta G = \Delta H - T\Delta S$ If a reaction is spontaneous, ΔG must be negative. $\Delta H - T\Delta S < 0$ Since the reaction is endothermic, then ΔH is positive. The entropy change (ΔS) must be positive and $T\Delta S > \Delta H$ $\Delta S > \Delta H / T$

2024 YEAR 11 FINAL EXAMINATION

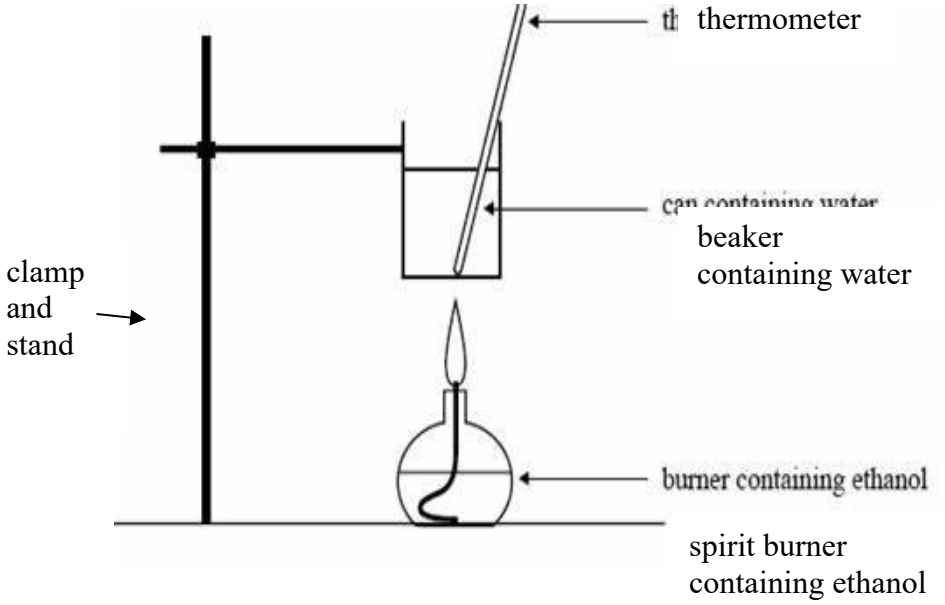
CHEMISTRY – MARKING GUIDELINES

Section II – 47 marks

Question 21 (17 marks)
21 (a) (2 marks)

Criteria	Marks
• Draws a labelled diagram showing spirit burner, beaker of water and thermometer	2
• Draws a partially correct or partially labelled diagram	1

Sample answer



Markers Comments:
PLEASE USE PENCIL - the diagrams were rough and lacked accuracy. \
Labels must touch the piece of equipment
Test tubes wouldn't be used to hold the water, the volume is too small - we used conical flasks or beakers

MARKS DISTRIBUTION

0	1	2
0	15	24

21 (b) (2 marks)

Criteria	Marks
● 5 measurements correctly stated	2
● Fewer than 5 correctly stated measurements	1

Sample answer

The initial and final masses of the spirit burner
The initial and final temperatures of the water
The volume of water in the beaker
(Note: for teachers: calculations based on measurements (such as change in temperature or change in mass should not be accepted – based on past HSC marking schemes).

Markers Comments:

Students lacked specificity in responses. For example you were asked for measurements - and students wrote a change in temperature, when you measured the initial and final temperature then were able to calculate the change in Temp.

MARKS DISTRIBUTION

0	1	2
7	28	4

21 (c) (1 mark)

Criteria	Mark
● Correct equation, balancing and states	1

Sample answer

C_2H_6O *(l)* + $3O_2$ *(g)* → $2CO_2$ *(g)* + $3H_2O$ *(l)*

Markers Comments:

A few students left equations balanced with multiples eg. 2:6:4:6 (instead of 1:3:2:3)

MARKS DISTRIBUTION

0	1
8	31

21 (d) (4 marks)

Criteria	Marks
● Correct answer	4
● Correct method and reasoning, with mathematical error	3
● Correct understanding of endothermic process when breaking bonds and correct understanding of exothermic process when making bonds AND ● Some correct steps in interpreting the bond dissociation data	2
● Correct understanding of endothermic process when breaking bonds and correct understanding of exothermic process when making bonds OR ● Some correct steps in interpreting the bond dissociation data	1

Sample answer

When combustion of ethanol occurs, the bonds within ethanol and the bonds between oxygen atoms in O_2 molecules must be broken.

Bonds in carbon dioxide and within water must be formed.

To break bonds in ethanol, the energy required is:

1 C–C bond: 1 x 346 kJ = 346 kJ

5 C–H bonds: 5 x 414 kJ = 2070 kJ

1 C–O bond: 1 x 358 kJ = 358 kJ

1 O–H bond: 1 x 463 kJ = 463 kJ

To break bonds in oxygen, the energy required is:

3 O=O bonds: 3 x 498 kJ = 1494 kJ

Total energy required = 4731 kJ

To make bonds in carbon dioxide and water, the energy given out is:

4 C=O bonds: 4 x 804 kJ = 3216 kJ

6 O–H bonds: 6 x 463 kJ = 2778 kJ

Total energy given out = 5994 kJ

Hence net energy change = 1263 kJ released

i.e. ΔH = –1263 kJ mol^{-1} of ethanol

Markers Comments:

Most students did not read the question where it was asked to **show ALL working and reasoning.** Too many questions were a blob of numbers with no idea what they were or where they came from and lost easy marks.

A BLOB OF NUMBERS ON A PAGE WILL NEVER EARN YOU 4 MARKS

Most students did not state anywhere the concept of breaking and making bonds and the energy required or made.

MARKS DISTRIBUTION

0	1	2	3	4
3	16	12	6	2

21 (e) (3 marks)

Criteria	Marks
● Explains why the laboratory experimental value may differ from the theoretical value for the heat of combustion because of heat loss to the surroundings AND/OR ● Explains that combustion may not be complete because of insufficient oxygen available AND/OR ● Explains that heats of combustion calculated from bond energies are based on average bond energies which may not apply precisely for a particular species undergoing combustion	2
● ONE of the above	1

Sample answer

Experiments such as those depicted in part (a) usually give a lower than theoretical value for heat of combustion because:

(i) heat losses which are not accounted for in the calculated value for heat of combustion often occur because of minimal insulation of the water being heated

(ii) incomplete combustion may occur due to insufficient oxygen being available Incomplete combustion results in a lower value for the heat of combustion than for complete combustion.

(iii) calculations based on average bond energies rather than specific bond energies for the bonds in the fuel being combusted may result in the heat of combustion being higher or lower than the theoretical value for a specific reaction.

Markers Comments:

Most student included heat loss but very few they other reasons

MARKS DISTRIBUTION

0	1	2
4	26	9

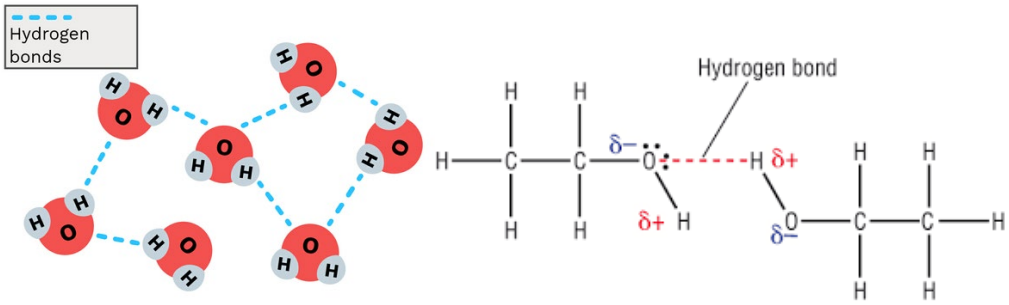
21 (f) (5 marks)

Criteria	Marks
• Explains fully, using appropriate diagrams, how the different structures and intermolecular forces determine the different boiling points of ethanol, water and methane	5
• Satisfactory explanation, using correct and appropriate diagrams and correct discussion of specified intermolecular forces to explain the differences in boiling points of the 3 compounds	4
• Gives a satisfactory explanation for the difference in boiling points of the 3 compounds OR 2 of 3 and 1 appropriate diagram	3
• Gives a satisfactory explanation for the difference in boiling points of 2 of the 3 compounds OR 1 satisfactory explanation and draws each molecule correctly	2
• Provide some relevant information	1

Sample answer

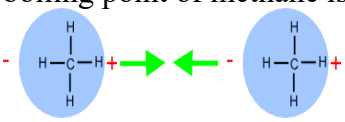
Boiling point is determined by the strength of intermolecular forces and by the relative masses of the molecules involved.

Water has the highest boiling point because of the strong hydrogen bonding between adjacent water molecules in. Ethanol has a higher molecular mass than water but only forms 1 hydrogen bond with an adjacent ethanol molecule, whereas water can form hydrogen bonds in 3D with multiple water molecules.



Ethanol can only form 1 hydrogen bond on collision with another ethanol molecule. Hence the hydrogen bonding is not as strong as in water.

Methane forms a non-polar structure. Only weak intermolecular forces link neighbouring molecules. Hence the boiling point is lower than that of ethanol and water. These intermolecular forces, called dispersion forces are weak and short-lived and result when electrons are temporarily moved during collision of non-polar molecules. As a result, the boiling point of methane is the lowest of the 3 compounds.



Markers Comments:
This questions was about intermolecular forces. The difference between ethanol and water was about number of Hydrogen bond possibilities in water being greater. Many students just drew diagrams of the molecules and not the reactions between the molecules which is the essence of the question

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0	1	2	3	4	5
0	7	10	12	8	2

Question 22 (10 marks)
22 (a) (1 mark)

Criteria	Mark
• States that all Group 1 elements have 1 electron in their outer electron shell, in an *s* orbital	1

Sample answer
All Group 1 elements have 1 electron in their outer electron shell, in an *s* orbital.
Markers Comments:
Well done

0	1
3	36

22 (b) (2 marks)

Criteria	Marks
• Identifies potassium AND • Gives the correct ground state electron configuration, including sub-shells	2
• Identifies potassium	1

Sample answer
Potassium is in Group 1 of Period 4. Its electron configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$.
Markers Comments:
Must be aware that 4s orbital is filled before 3d

0	1	2
0	13	26

22 (c) (1 mark)

Criteria	Marks
• Writes a correct equation for this reaction including subscripts	1

$$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2(g)}$$

Markers Comments:
Make sure you know states

0	½	1
10	2	27

22 (d) (3 marks)

Criteria	Marks
• Identifies that the reactivity of Group 1 elements is determined by their large atomic radii and only 1 valence shell electron • Explains how the atomic size of Group 1 elements results in low first ionisation energy, metallic properties, low electronegativity and tendency to form positive ions • Describes a reaction of Group 1 elements that is related to their ability to lose an electron	3
• TWO of the above	2
• ONE of the above	1

Sample answer

The atomic radius decreases from left to right across all periods, so the Group 1 atoms are the largest in each period. This large size means a smaller force of attraction of the valency shell electron to the positive nucleus than for smaller atoms. Group 1 elements all have low first ionisation energy. This decreases down Group 1. Potassium is larger than sodium and lithium, has lower first ionisation energy and more readily loses its valency electron. All Group 1 elements have a single electron in their outside shell. Group 1 elements are electropositive and have low tendency to attract electrons. Large atoms easily lose electrons in reactions with non-metals. These reactions result in positive ions and all Group 1 elements show metallic properties.

All group 1 metals will react with a non-metal such as chlorine. One valency electron is transferred from the metal to the valency shell of the halogen and a negative ion is formed.

Potassium and chlorine form the ionic solid, potassium chloride.

$K\ (s) + \frac{1}{2}Cl_2\ (g) \rightarrow KCl\ (s)$

Markers Comments:

Most marks lost by not using correct scientific terms especially Ionisation Energy

0	1	2	3
1	14	14	20

22 (d) (3 marks)

Criteria	Marks
• Explains why dissolution of sodium chloride is classified as spontaneous AND why the decomposition of sodium chloride is classified as non-spontaneous AND • Identifies the driving force of the dissolution of sodium chloride as the increase in entropy	3
• Identifies the dissolution of sodium chloride as spontaneous AND identifies the decomposition of sodium chloride as non-spontaneous	2

AND ● Identifies the driving force of the dissolution of sodium chloride as the increase in entropy	
● Identifies the dissolution of sodium chloride as spontaneous AND identifies the decomposition of sodium chloride as non-spontaneous OR ● Identifies the driving force of the dissolution of sodium chloride as the increase in entropy	1

Sample answer

A spontaneous reaction is one that will occur without being driven by an external force. The dissolution of sodium chloride in water at room temperature occurs without input of heat energy. Even though the enthalpy change for the dissolution is slightly endothermic, there is an increase in entropy as the ions which were in a fixed position move into random positions in the aqueous state. The increase in entropy is the driving force in the dissolution. Overall, the Gibbs free energy is negative – an indication of a spontaneous reaction.

Solid sodium chloride cannot be heated to form sodium and chorine. However, electrolysis of molten sodium chloride will produce sodium and chlorine. The reaction will not occur without the constant input of electrical energy and is very endothermic, despite the increase in entropy. The overall Gibbs free energy change is positive. This means the reaction is classified as non-spontaneous.

Markers Comments:
Most marks lost by not correctly identifying and relating the effect of entropy and enthalpy on reactions you should be aware of.

0	1	2	3
6	18	15	1

Question 23 (8 marks)
23 (a) (1 mark)

Criteria	Mark
● Identifies a correct method of measuring the rate of reaction	1

Sample answer
Measure the loss of mass of the beaker and contents over a time interval OR measure the mass/volume of CO_2 produced over a time interval.

Markers Comments:
Correct answers identified a specific measurable observation.

0	½	1
15	3	21

23 (b) (1 mark)

Criteria	Mark
● Correct answer	1

Sample answer
The size of the particles OR the surface area of the particles

Markers Comments:
Very straightforward. Use the correct term "surface area".

0	1
1	38

23 (c) (2 marks)

Criteria	Marks
● Explains why the rate of reaction is faster in beaker A, in terms of collision theory	2

• Identifies that the rate of reaction is faster in beaker A	1

Sample answer

The reaction rate is faster in beaker A because of the higher concentration of HCl. This will increase the frequency (number) of collisions between reactant particles and hence increase the frequency of successful collisions (with energy greater than the activation energy).

Markers Comments:

Reaction rate increases if there are more SUCCESSFUL collisions.

0	1	1½	2
1	2	20	16

23 (d) (2 marks)

Criteria	Marks
• Explains that particles need to have energy equal to or greater than the activation energy AND be correctly orientated for a successful collision to occur and hence a reaction to occur	2
• Explains that particles need to have energy equal to or greater than the activation energy OR be correctly orientated for a successful collision to occur and hence a reaction to occur	1

Sample answer

Only collisions with energy equal to or greater than the activation energy for the reaction can result in reaction. Chemical reaction requires breaking of bonds in the reactant particles; this requires collisions to have energy greater than or equal to the activation energy. Even if the particles have sufficient energy to react, the reactant particles must collide with the correct orientation.

Markers Comments:

Must clearly state the effect of energy and orientation.

0	½	1	1½	2
1	6	1	29	1

23 (e) (2 marks)

Criteria	Marks
● Explains that a catalyst lowers the activation energy for a reaction by providing a new lower energy pathway for the reaction to occur, using an appropriate example	2
● Explains that a catalyst lowers the activation energy for a reaction by providing a new lower energy pathway for the reaction to occur	1

Sample answer

A catalyst lowers the activation energy for a reaction by providing a new lower energy pathway for the reaction to occur. In the reaction:

$$CH_4\,(g) + O_2\,(g) \xrightarrow{Pt} CO_2\,(g) + 2H_2O\,(g)$$

the catalyst is platinum metal.

The platinum wire acts as an inert catalyst. It does not change as the reaction proceeds. The gas molecules are adsorbed onto its surface; their covalent bonds are weakened and the neighbouring molecules are held in position in this unstable state for long enough for new bonds to form and the reaction to proceed. The rate of reaction is higher than the same reaction without a catalyst. An increase in the proportion of successful collisions occurs if there is a decrease in activation energy.

Markers Comments:
Most marks lost through not giving a real example.

0	1	2	3
5	8	10	16

Question 24 (6 marks)
24 (a) (2 marks)

Criteria	Mark
● Correctly calculates the specific heat capacity of the stainless steel	2
● Makes one error	1

Sample answer

$\Delta H = mc\Delta T = 947$ J = 125 x 15.7 x c
Hence c = 947/(125 x 15.7) = 0.483

Markers Comments:
Most students knew what they were doing here.

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0	1	2
2	3	34

24 (b) (2 marks)

Criteria	Marks
● Correctly calculates the concentration of K^+ ions in g L^{-1}	2
● Correctly calculates the concentration of K^+ ions in mol L^{-1}	1

Sample answer

$[K^+]$ in 0.0500 M K_2CO_3 = 2 x 0.0500 = 0.100 mol L^{-1} = 0.100 x 39.1 g L^{-1}
= 3.91 g L^{-1}

Markers Comments:
Many students over complicated this question. As seen in the sample answer all that was required was to double the moles of K and multiply by molar mass to convert to g/L

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0	1	2
23	6	10

24 (c) (i) (2 marks)

Criteria	Mark
● Correctly identifies HCl as limiting reagent showing appropriate working	2
● Correctly identifies number of moles of each reagent	1

Sample answer

n(HCl) = c x V = 1.00 x 0.100 = 0.100 mol
$n(CaCO_3)$ = m/MM = 8.30/100.09 = 0.0829 . . mol

Since reaction ratio is 2:1
Would require 0.0829 x 2 = 0.166 moles of HCl
Therefore, HCl is the limiting reagent.

Markers Comments:
Reasonably well done/ Needed a logical explanation backed up with molar ratios to reach 2 marks.

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0	1	2
1	19	19

24 (c) (ii) (1 mark)

Criteria	Mark
● Correctly converts no. moles CO_2 to gas volume at 25˚C and 100 kPa	1

Sample answer

Since $n(CO_2)$ = 0.5 x n(HCl) = 0.5 x 0.100 = 0.0500 mol

$V(CO_2)$ = n x Molar Volume = 0.0500 x 24.79 = 1.24 L

Markers Comments:

Disappointing response to a molar volume question. Find moles and multiply by molar volume was all that was required.

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0	1
27	12

Question 25 (6 marks)
25 (a) (2 marks)

Criteria	Marks
● Calculates the correct no. of moles of CO_2 AND H_2O	2
● Calculates the correct no. of moles of CO_2 OR H_2O	1

Sample answer
Moles $H_2O = 0.172/18.0 = 9.56 \times 10^{-3}$
Moles $CO_2 = 0.279/44.0 = 6.34 \times 10^{-3}$

Markers Comments:
Most students knew what they were doing here:)

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0	1	2
3	1	34

25 (b) (4 marks)

Criteria	Marks
• Correctly determines the empirical formula	4
• Correctly determines the mole percentages/ratios of C, H and N	3
• Correctly determines the mass percentages/ratios of C, H and N	2
• includes some relevant information	1

Sample answer

1) Find mass of carbon and hydrogen using moles from part a)

Mol $CO_2 = 6.34 \times 10^{-3}$ **Hence mass C** $= 12.01 \times 6.34 \times 10^{-3} = 0.0761$ g

Mol $H_2O = 9.56 \times 10^{-3}$ **Hence mass H** $= 2.016 \times 9.56 \times 10^{-3} = 0.0193$ g

2) Combined mass C and H in the compound = 0.0761 + 0.0193 = 0.0954 g

The remainder must be nitrogen. **Mass of nitrogen** = 0.125 – 0.0954 = 0.0296 g

3) Convert masses to percentages to use for empirical formula calculation

% C = 0.0761/0.125 x 100 = 60.9%

% H = 0.0193/0.125 x 100 = 15.4%

% N = 0.0296/0.125 x 100 = 23.7%

4) Empirical Formula calculation

Mole ratios	C	H	N
	60.9/12	15.4/1	23.7/14
	5.08	15.4	1.70
Simplifying	5.08/1.70	15.4/1.70	1.70/1.70
	3	9	1

Hence empirical formula = C_3H_9N

Markers Comments:

The question gave you a lead to find the %composition of each of the elements. To do this you needed to use the moles to find the mass of the elements in CO2 and H2O. Most students were awarded a mark for some relevant steps. On the whole our work is messy and needs some logical thinking to map out a neat answer. You will get better at this in the HSC year.9

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0	1	2	3	4
11	14	7	3	4

END OF MARKING GUIDELINES