
Student Number

2022
YEAR 11 FINAL EXAMINATION

Saint Ignatius' College
RIVERVIEW

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
- Write your Student Number at the top of this page, on page 9 and on the Multiple-Choice Answer Sheet

Total marks – 70

This paper has two sections:

Section I – 15 marks

Attempt Questions 1-15
Allow about 25 minutes for this section

Section II – 55 marks

Attempt Questions 21-28
Allow about 1 hour and 35 minutes for this section

Section I – 15 marks
Attempt Questions 1-15
Allow about 25 minutes for this section

Use the multiple-choice answer sheet provided for Questions 1-15.

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 What is the molar mass of the compound $CuSO_4.5H_2O$?

A. 258.22 g mol^{-1}

B. 278.34 g mol^{-1}

C. 249.62 g mol^{-1}

D. 274.46 g mol^{-1}

2 Which of the following chemical equations is balanced?

A. $Fe(OH)_3(aq) + 2H_2SO_4(aq) \rightarrow Fe_2(SO_4)_3(aq) + 3H_2O(l)$

B. $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

C. $C_3H_7OH(l) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

D. $KNO_3(s) \rightarrow KNO_2(s) + O_2(g)$

3 Which of the following compounds have the same molecular geometry?

I – NH_3

II – BF_3

III – SCl_2

IV – H_2O

A. I and II

B. III and IV

C. II and III

D. II and IV

4 A student dissolves solid calcium carbonate in an excess of 0.01 mol L^{-1} nitric acid while stirring. He then investigates ways to make this reaction faster.
Which of the following actions would increase the rate of reaction?

I – Increasing the volume of nitric acid
II – Increasing the concentration of the nitric acid
III – Heating the nitric acid before adding the calcium carbonate

A. I and III only

B. I and II only

C. II and III only

D. I, II and III

5 Which statement below best explains why ethanol is difficult to separate from water using the process of distillation?

A. Ethanol is soluble in water in any proportion

B. The boiling points of the two liquids are very similar.

C. Ethanol and water form extensive hydrogen bonding to each other.

D. The dispersion forces between ethanol and water are similar in strength.

6 The molecular formula of glucose is $C_6H_{12}O_6$.
What is the empirical formula of glucose?

A. $C_3H_6O_3$

B. $C_2H_4O_2$

C. $C_6H_{12}O_6$.

D. CH_2O

7 Which of the following molecules would have the weakest intermolecular forces?

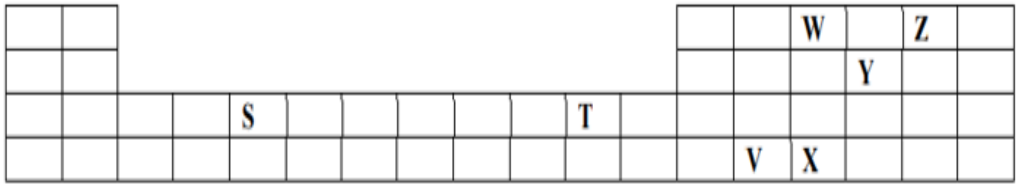
A. CO_2

B. H_2O

C. OF_2

D. CH_3Cl

8 In the part of the Periodic Table shown below, certain elements are indicated by letters which are not the usual symbols for the elements concerned.



Which one of the following sets of elements all exist as molecules at 25°C and atmospheric pressure?

A. S, W and Z

B. S, X and Y

C. T, X and Y

D. W, Y and Z

9 By referring to the standard reduction potentials below, which of the species listed is the best oxidising agent?

Cu^{2+} *(aq)* + $2e^-$ → Cu *(s)* E° = +0.34 V
Zn^{2+} *(aq)* + $2e^-$ → Zn *(s)* E° = –0.76 V

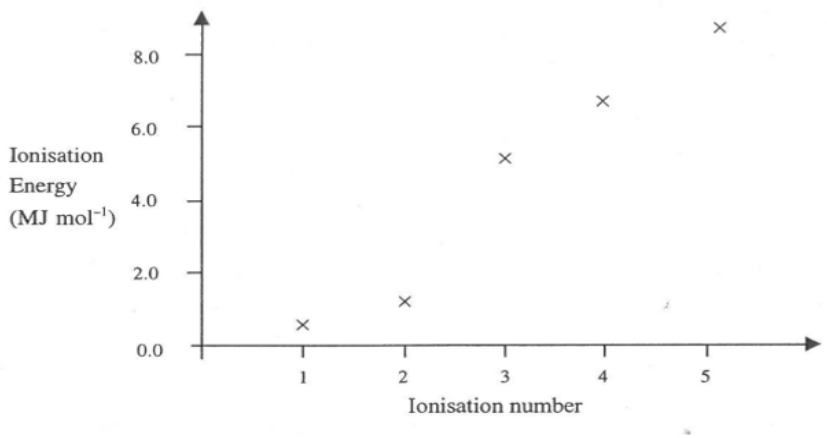
A. Cu^{2+} *(aq)*

B. Zn^{2+} *(aq)*

C. Cu *(s)*

D. Zn *(s)*

10 An element has the first five successive ionisation energies as on the graph below.



Which one of the following is most likely to be the element?

A. Sodium
B. Calcium
C. Aluminium
D. Phosphorus

11 Which pair of substances is listed in increasing order of the property given?

A. First ionisation energy: O, S
B. Radius: Mg, Mg^{2+}
C. Electronegativity: O, F
D. Boiling point: Br_2, Cl_2

12 Which of the following gases will occupy 22.71 L at 100 kPa and 0°C (273.15 K)?

A. 5.0 g of H_2
B. 20 g of O_2
C. 50 g of NO_2
D. 64 g of SO_2

13 Elements X and Y are in the same period of the Periodic Table and have 2 and 5 electrons respectively in the outer shell. What is the likely formula of the compound they form together?

A. X_2Y_3

B. X_3Y_2

C. X_2Y_5

D. X_5Y_2

14 Which one of the following is NOT assumed by the collision theory as it relates to ideal gases?

A. Gases are composed of particles in random motion.

B. Gas particles do not attract or repel each other.

C. The size of gas particles is negligible compared to the size of the container.

D. When gas particles collide, kinetic energy is lost.

15 How can the reaction of calcium carbonate to form carbon dioxide and calcium oxide be described?

I – endothermic
II – combustion
III – synthesis
IV – decomposition

A. I and III only

B. I and IV only

C. II and IV only

D. IV only

Chemistry

Student Number

Section II – 55 marks
Attempt Questions 21-28
Allow about 1 hour and 35 minutes for this section

Answer the questions in the spaces provided. Show all relevant working in questions involving calculations. Extra writing space is provided.
If you use this space, clearly indicate which question you are answering.

Question 21 (10 marks)

Compare the intramolecular forces present in solid sodium chloride (NaCl) and a water (H_2O) molecules **2**

(a) ……..

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(b) Explain the forces present when NaCl dissolves in water. Use a diagram to illustrate your answer **2**

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Question 21 continues on the next page

Question 21 (continued)

(c) The nuclear equation below, involving uranium-238, is incomplete, using letters including a-e and X, Y and Z to represent particles (atoms or sub-atomic particles) or numbers to balance the equation. **3**

$$^{238}_{a}U + {}^{b}_{c}X \rightarrow {}^{239}_{92}U \rightarrow {}^{239}_{94}Y + 2{}^{d}_{e}Z$$

Complete the table below to identify the correct particle or number represented by each letter.

a	b	c	d	e	X	Y	Z

(d) Hydrogen can form both ionic and covalent compounds. Explain this statement, identifying examples of ionic and covalent bonding in compounds of hydrogen. **3**

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Question 22 (4 marks)

Experiment	Mass of $CaCO_3$ powder (*g*)	Conc. of HCl (aq) (mol L^{-1})	Initial temperature (^oC)	Final temperature (^oC)	Initial rate of CO_2 (g) (mL min^{-1})
1	2.0	0.1	20	25	5
2	2.0	0.1	30	35	50
3	4.0	0.1	20	30	10
4	2.0	0.2	20	25	20
5	4.0	0.2	30	40	100
6	2.0	0.3	20	25	15

Calcium carbonate reacts with hydrochloric acid according to the equation:

$$\mathbf{CaCO_3(}s\mathbf{) + 2HCl(}aq\mathbf{) \rightarrow CaCl_2(}aq\mathbf{) + CO_2(}g\mathbf{) + H_2O(}l\mathbf{)}$$

A series of experiments were conducted to investigate reaction conditions that may affect the rate of this reaction. The initial rate of the reaction under each set of conditions was estimated by measuring the rate of formation of carbon dioxide gas using a gas syringe.

The data table above shows the results of the experiments.

The volume of HCl(*aq*) used in each experiment was the same.

(a) Describe three relationships between the reaction conditions tested and the initial rate of reaction and apply the collision theory to account for each relationship. **4**

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Question 22 continues on the next page

(Question 22 continued)

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Question 23 (9 marks)

Ethylene glycol is a chemical used to depress the freezing point of water in products marketed as 'antifreeze'. It is a compound composed of C, H and O only.

A 44.80 g sample of this chemical was completely oxidised to form 61.6 g of carbon dioxide and 37.8 g of water.

(a) Calculate the mass of carbon and hydrogen in this sample. **2**

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(b) Determine the mass of oxygen in antifreeze and hence the empirical formula of the compound. **2**

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(c) If the molar mass of the compound is approximately 62 g mol^{-1}, determine the molecular formula of antifreeze. **1**

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(d) **Methane** is another compound containing carbon and hydrogen.
The molecular formula for methane is CH_4.

(i) Write a balanced chemical equation for the complete combustion of gaseous methane. **1**

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ii) Identify the type of intermolecular forces that exist between methane molecules and explain how these forces effect the size of its boiling point. **2**

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iii) Draw an electron dot diagram for a methane molecule which is consistent with details provided in questions above. **1**

Question 24 (7 marks)

(a) A balloon was filled with helium at 0°C and 1.00 x 10^5 Pa pressure. **2**
By what factor will its volume have changed when it passes through a region where the temperature is –50°C and the pressure is 1.00 x 10^2 Pa?

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(b) What assumptions have you made in determining your answer to part (a) above? **2**
Are these assumptions valid?

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(c) If 42 g of Fe powder and 8 g of S powder are mixed and heated, what mass of FeS will be produced? Name the limiting reagent. **3**

$$Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)}$$

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Question 25 (10 marks)

(a) Write **net** equations for each of the reactions below. Use appropriate ionic and molecular formulae and omit formulae for all ions or molecules that do not take part in a reaction (spectators). **4**

(I) Solid calcium carbonate decomposes when strongly heated.

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(II) Zinc metal reacts with a solution of dilute sulfuric acid.

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(III) Potassium hydroxide solution reacts with dilute hydrochloric acid.

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(IV) Solid sodium*(s)* reacts with oxygen.

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(b) Using the symbols I, II, III and/or IV, which of the above reactions are classified as **3**

(i) a redox reaction ……

(ii) a synthesis reaction ……

(iii) an acid-base reaction …….

(c) Using your knowledge of the solubility rules, outline a procedure which would allow you to distinguish between solutions of nitric acid (HNO_3) and hydrochloric acid (HCl). Use an equation in your response. **3**

Soluble Ionic Compounds		**Important Exceptions**
Compounds containing	NO_3^-	None
	$C_2H_3O_2^-$	None
	Cl^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	Br^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	I^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+}, Ba^{2+}, Hg_2^{2+}, and Pb^{2+}
Insoluble Ionic Compounds		**Important Exceptions**
Compounds containing	S^{2-}	Compounds of NH_4^+, the alkali metal cations, and Ca^{2+}, Sr^{2+}, and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of the alkali metal cations, and Ca^{2+}, Sr^{2+}, and Ba^{2+}

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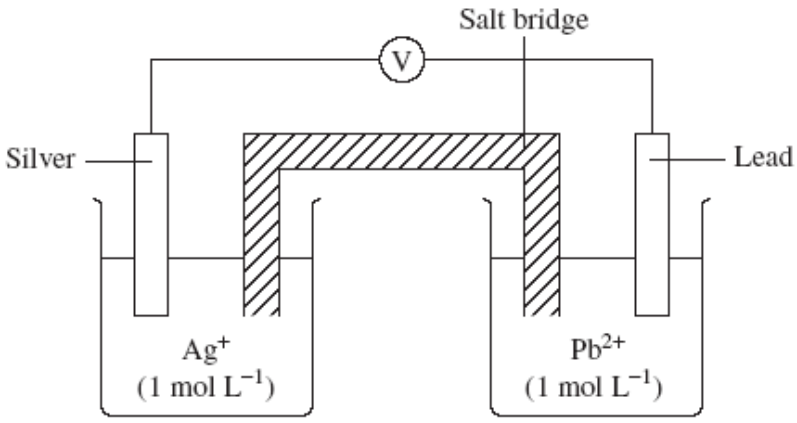
Question 26 (8 marks)



(a) Identify the Anode and Cathode in the Galvanic cell above. **2**

ANODE ……

CATHODE ……

(b) Write the oxidation and reduction half equations for the Galvanic cell. **3**
Calculate the Cell Potential E^o

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(c) Calculate the concentration of sulfate ions (SO_4^{2-}) present in solution resulting when solutions of 300mL of 0.25mol L^{-1} Na_2SO_4 and 200mL of 0.08mol L^{-1} $Al_2(SO_4)_3$ are mixed. **3**

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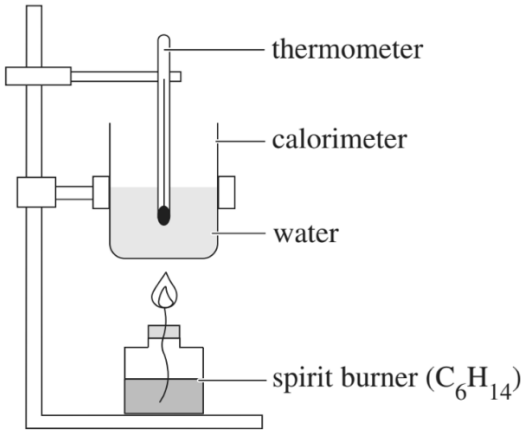
Question 27 (4 marks)

A student sets up the following experiment to determine the amount of energy that would be released by the combustion of a sample of hexane (C_6H_{14}).



The following data was recorded at the start of the experiment

Mass of Hexane burned	2.38 g
Mass of water heated	600 mL
Initial Temperature of water	23.0 °C

If the heat of combustion of hexane is – 4163 kJ mol^{-1}, calculate the final temperature of the water. **4**

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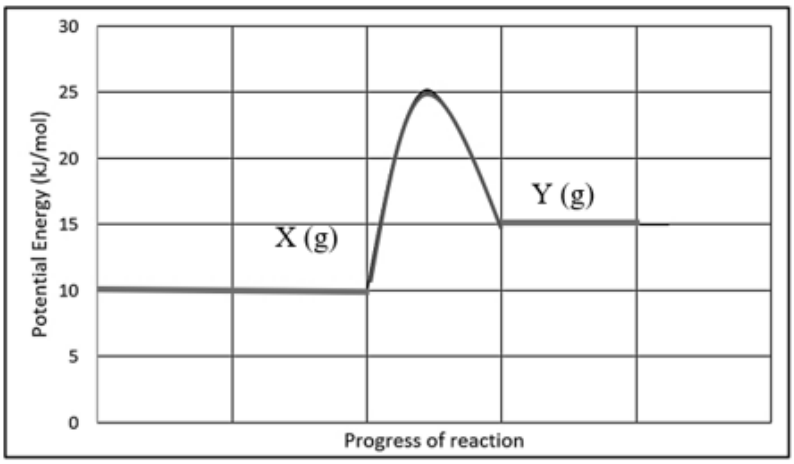
Question 28 (3 marks)



(a) What is the activation energy for the conversion of one mole of X(g) into Y(g)? **1**

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(b) What is the enthalpy change for the conversion of 49.6L of Y(g) into X(g) at 298K and 100 kPa pressure? **1**

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(c) Is the conversion of X(g) into Y(g) Exothermic or Endothermic? **1**

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End of Paper

Student Number

CHEMISTRY – MULTIPLE-CHOICE ANSWER SHEET

ATTEMPT ALL QUESTIONS

Question	**1**	A ⬭	B ⬭	C ⬭	D ⬭
	2	A ⬭	B ⬭	C ⬭	D ⬭
	3	A ⬭	B ⬭	C ⬭	D ⬭
	4	A ⬭	B ⬭	C ⬭	D ⬭
	5	A ⬭	B ⬭	C ⬭	D ⬭
	6	A ⬭	B ⬭	C ⬭	D ⬭
	7	A ⬭	B ⬭	C ⬭	D ⬭
	8	A ⬭	B ⬭	C ⬭	D ⬭
	9	A ⬭	B ⬭	C ⬭	D ⬭
	10	A ⬭	B ⬭	C ⬭	D ⬭
	11	A ⬭	B ⬭	C ⬭	D ⬭
	12	A ⬭	B ⬭	C ⬭	D ⬭
	13	A ⬭	B ⬭	C ⬭	D ⬭
	14	A ⬭	B ⬭	C ⬭	D ⬭
	15	A ⬭	B ⬭	C ⬭	D ⬭

2022 YEAR 11 FINAL EXAMINATION

CHEMISTRY – MARKING GUIDELINES

2022 Year 11 Final Examination
Chemistry
Marking Guidelines

Section I

Question	Answer
1	C
2	B
3	B
4	C
5	C
6	D
7	A and C
8	D
9	A
10	B
11	C
12	D
13	B
14	D
15	B

Explanations for Multiple-Choice

1	**C** **63.5+32.07+64+ (5x18) = 249.62**
2	**B**
3	**B** I – NH_3 is pyramidal in shape II – BF_3 is triangular planar III – SCl_2 is angular, as is IV – H_2O. Hence B (III and IV) have the same shape, based on the tetrahedral arrangement of electrons, with 2 pairs of non-bonding electrons.
4	**C** I – is incorrect, as increasing the volume of nitric acid (which is already in excess) will not change the rate. II and III – increasing the concentration of the acid and heating the nitric acid will both increase the rate of reaction as collisions will occur more frequently between the calcium carbonate and acid. Hence C is correct.
5	**C –** extensive Hydrogen bonding the reason BP are 76 &100 so not too close
6	**D** Empirical formula is the simplest whole number ratio
7	**A and C** Weakest IM forces lead to the lowest BP Most molecules are polar (dipoles) OF_2 has the lowest BP due to smallest difference in electronegativity, so weakest dipole.

8	**D** W, Y and Z are all non-metals in Groups 5, 6 and 7. Only non-metals can form molecules. X is a metalloid; V, S and T are metals.
9	**A** An oxidising agent is itself reduced; it gains electrons. Cu^{2+} and Zn^{2+} are oxidising agents. Of these, Cu^{2+} has the greater tendency to gain electrons, as seen by the greater E° value.
10	**B** Calcium has 2 valency electrons which require less energy to remove during ionisation than the inner shell electrons. Here, a discontinuity is seen in the graph after 2 electrons have been removed. This indicates that there are 2 electrons in the outer valency shell.
11	**C** Fluorine is more electronegative than oxygen. So C is correct. The larger sulfur atom requires less energy to remove the first electron than oxygen. A positive ion is smaller than its neutral atom, as the outer electron shell has been removed, and there is a net 2+ charge on the nucleus which draws the electrons to the centre and fewer electrons to repel each other. At room temperature, Br_2 is a liquid and Cl_2 is a gas, so the boiling point of bromine is higher than of chlorine.
12	**D** Molar volume says 1 mole occupies 22.71L at 100kPa and 273K A,B,C molar masses differ from 1 mole. SO_2 molar mass = 64g

13	**B** The metal, X, forms a X^{2+} ion and the non-metal, Y, forms a Y^{3-} ion. Hence the formula is X_3Y_2 e.g. Mg_3P_2
14	**D** The kinetic theory assumes no energy is lost during collisions. A, B and C are all correct assumptions when gases are ideal.
15	**B** The calcium carbonate is heated strongly to decompose into carbon dioxide and calcium oxide. Hence the reaction is endothermic. I and IV both apply.

2022 YEAR 11 FINAL EXAMINATION

CHEMISTRY – MARKING GUIDELINES

Section II – 55 marks
Question 21 (11 marks)
21 (a) (2 marks)

Criteria	Marks
● Explains the difference in intramolecular present in both NaCl/H_2O	2
● Explains intramolecular present in NaCl OR ● Explains intramolecular present in H_2O OR ● compares strength of the intramolecular forces	1

Sample answer
NaCl is an ionic compound. Its intramolecular forces are strong IONIC (electrostatic forces of attraction between positive Na^+ ion and negatively charged Cl^- ion.
H_2O is a covalent molecule. Outer shell electrons from both H and O share to complete their outer shell in covalent bonds

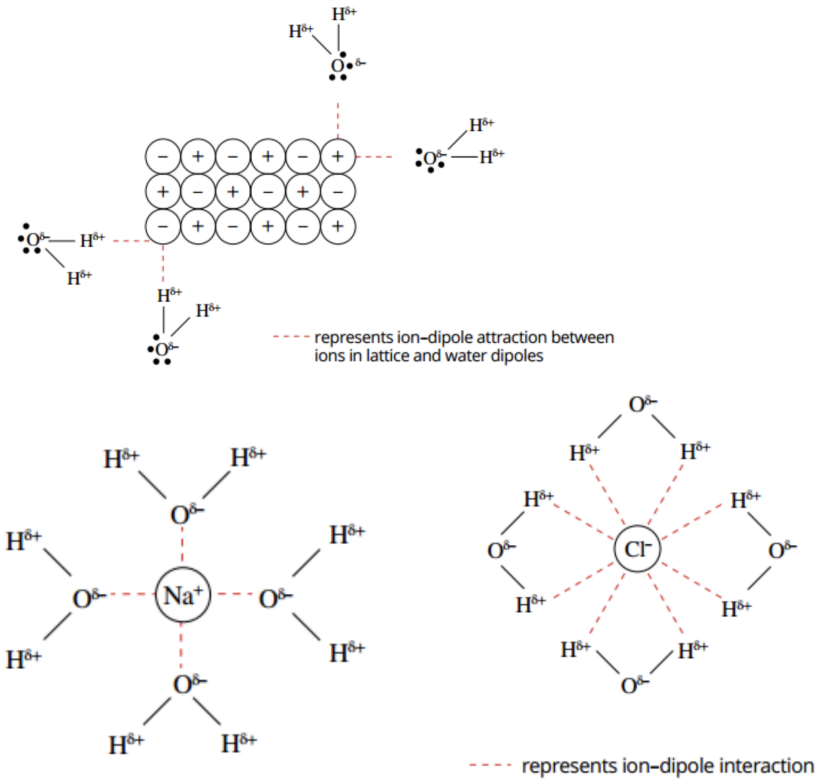
Marks	2	1	0
Student	30	13	12

Comment: Many students did not understand the difference between Intramolecular and intermolecular forces and confused their responses talking about intermolecular forces (dispersion, dipole H bonding) which aren't relevant to this question.

21 (b) (3 marks)

Criteria	Marks
● Includes relevant diagram and explains the process of dissolution	2
● Relevant diagram OR explains to a reasonable level	1

Sample answer



Ion-dipole attractions between water and ionic lattice pull ions from the lattice.

Ions are then surrounded by water molecules and unable to reform.

Marks	2	1	0
Student	13	12	30

Comment: Many students didn't understand the question, therefore didn't use terms like ion-dipole and lattice in their answer which is the essence of this question

21 (c) (2 marks)

Criteria	Marks
● Correctly fills in the complete table	3
● Correctly fills in 4 boxes	2
● Correctly fills in 2 boxes	1

Sample answer

a	b	c	d	e	X	Y	Z
92	1	0	0	-1	n (Neutron)	Pu	e^- Beta particle

Marks	**2.5-3**	2	1	0.5-0
Student	**28**	16	6	5

Comment:
Nuclear equations like ordinary equations is balancing numbers (to obey the law of the conservation of matter)

21 (d) (2 marks)

Criteria	Marks
• Explains the statement AND • Identifies examples of hydrogen forming ionic and covalent bonds	3
• Explains the statement OR • Identifies examples of hydrogen forming ionic and covalent bonds	2
• provides some relevant information	1

Sample answer

Hydrogen has unique properties. It has only 1 electron.
It can share that electron and form a covalent bond. Compounds include H_2O HCl, NH_3.
Electrons are shared whenever the electronegativity of hydrogen and the non-metal atom attached to it are fairly similar.
When the electronegativities of hydrogen and another element differ greatly, electrons can be donated rather than shared. When hydrogen and a metal react, they form ions. The hydrogen will gain an electron and form a negative ion, called the hydride ion. Sodium hydride, NaH, and lithium hydride are ionic compounds, consisting of positive lithium or sodium ions and a negative hydride ion.

Marks	**3**	**2**	**1**	**0**
Student	**9**	17	23	5

Comment: The answer to this revolved around the different types of bonding due to difference in electronegativity. Most students understood an example of covalent but mixed up ionic and used an example involving OH ions - in this case the H is covalently bonded to oxygen in the polyatomic ion, rather than use hydrides as an example where H ions are negatively charged.

Question 22 (4 marks)

Marking Criteria	Marks
• Describes three relationships which can be drawn from the data, identifying which trials should be compared to draw the relationship AND • Outlines the main features of the collision theory and applies the correct feature/s to explain each relationship.	**4**
• Describes two relationships which can be drawn from the data, identifying which trials should be compared to draw the relationship AND • Outlines the main features of the collision theory and applies the correct feature/s to explain each relationship.	**3**
• Describes three relationships which can be drawn from the data OR • Outlines the main features of the collision theory OR • Describes at least ONE relationship which can be drawn from the data AND • Accounts for the relationship in reference to features of the collision theory	**2**
• Provides some relevant information	**1**

Sample answer

The data from experiment 1 and 2 shows that **increasing the temperature of the HCl** increases the rate of production of CO_2. This can be explained using the *collision theory, which states that in order for a reaction to occur, the molecules of the reactants must collide at the correct orientation and with sufficient energy (equal or above the reaction's activation energy E_A).* Increasing the temperature of the acid increases the rate of collisions and increases the proportion of the molecules which possess the E_A. Thus, the initial reaction rate increases as reactants convert into products more quickly.

Data from experiments 4 and 6 shows that **increasing the concentration of the HCl** increases the rate of production of CO_2. Increasing the concentration of the HCl results in a greater frequency of collisions between the acid and calcium carbonate, thus the initial reaction rate increases as reactants convert into products more quickly.

Data from experiments 1 and 3 shows that **increasing the mass of calcium carbonate powder** increases the rate of production of CO_2. Increasing the mass of powder added results in a greater frequency of collisions between the acid and calcium carbonate because there is a greater surface area of powder exposed to the acid, thus the initial reaction rate increases as reactants convert into products more quickly.

Marks	**4**	**3**	2	1	0
Student	**10**	**13**	17	11	3

Comment:

This question asked to convey a knowledge of Collision theory and relate to a data set. A good way to do this is to outline the main points of the theory early in your answer. Many students did not do this - the better responses did!

Also asked for 3 relationships from the experimental data. In this context it is best to talk about ways reactions are sped up, and then relate to Collision theory.

23 (a) (2 marks)

Marking Criteria	Marks
• Calculates the mass of C and H which must be present in ethylene glycol.	**2**
• Completes one correct step in the calculation.	**1**

Sample answer

$n(CO_2) = m/MM = 61.6g / 44.01 = 1.40$ mol
n(C) from compound = 1.40 mol
mass(C) = n x MM = 1.4 x 12.01 = 16.8g

$n(H_2O) = 37.8g/ 18.016 = 2.098$ mol
n(H) = 2.098 x 2 = 4.19
Mass (H) = 4.19 x 1.008 = 4.16g

Marks	2	1-1.5	0
Student	24	15	16

Comment: SZABO TIP: if given masses in a chemical calculation ALWAYS CONVERT THEM TO MOLES. If you have no idea what to do next - at least you will get a mark or 2!!! In this case once you had moles then you use your knowledge of stoichiometry to find an new moles and convert back to mass by multiplying by MM

23 (b) (2 marks)

Marking Criteria	Marks
• Determines through calculation the empirical formula of ethylene glycol.	2
• As above with one error or omission.	1

Sample answer

mass (O) in compound = 44.80 – (mass of C and H (16.8 + 4.16) = 23.8g
n(O) = m/MM = 23.8 / 16 = 1.5 mol

C	H	O
n=1.40	n=4.2	n=1.5
Simplest ratio: 1.4/1.4 = 1	Simplest ratio: 4.2/1.4 =3	Simplest ratio: 1.5/1.4 =1

Hence empirical formula = CH_3O

Marks	2	1	0
Student	8	7	39

Comment: Empirical formula calculations are about molar ratios (in whole numbers) - if you converted to moles in the (a) then all you needed to do was deduce the moles of oxygen and find the simplest whole number ratio.

23 (c) (1 marks)

Marking Criteria	Marks
• Determines the molecular formula of ethylene glycol	1

Sample answer

Number of 'empirical units' in a molecule = 62 / 31 = 2
Hence molecular formula is $C_2H_6O_2$

Marks	1	0
Student	10	45

Comment: tough to get this one without the previous - many of you used the mass and found by trial and error a formula

23 (d)i) (1 marks)

Marking Criteria	Marks
• Writes a correctly balanced formula for the combustion of methane.	**1**

Sample answer

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

Marks	1	0.5	0
Student	28	6	21

Comment: subscripts are always needed. You must always balance equations.

23 (d)ii) (2 marks)

Marking Criteria	Marks
• Identifies dispersion forces and explains how they affect BP	2
• Identifies dispersion forces as the major type of intermolecular force in methane	**1**

Sample answer

Weak dispersion forces means that the attraction force between the molecules is very low. Therefore Boiling point is also very low as not much energy is required to separate the molecules apart into the gas phase.

Marks	**2**	1	0.5	0
Student	**27**	7	2	19

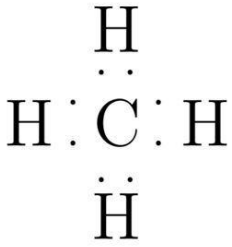
Comment:

You should know the different intermolecular forces. Dispersion is the weakest so BP is very low.

23 (d)iii) (1 marks)

Marking Criteria	Marks
• draws a correct electron dot diagram for methane	1

Sample answer



Marks	1	0.5	0
Student	42	2	12

Comment:

Electron dot formulae show the outer shell electrons.

Question 24 (7 marks)
24 (a) (2 marks)

Criteria	Marks
• Correct answer, with correct working	2
• Correct method with mathematical error Or • any qualitative data that would lead to understanding and correct answer	1

Sample answer

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$T_1 = 0°C = 273$ K
$T_2 = -50°C = 223$ K
$P_1 = 1.00 \times 10^5$ Pa
$P_2 = 1.00 \times 10^2$ Pa

$$\frac{V_2}{V_1} = \frac{P_1T_2}{P_2T_1} = \frac{1.00 \times 10^5 \times 223}{1.00 \times 10^2 \times 273} = 0.817 \times 10^3 = 817$$

Hence the balloon will get much bigger, in that its volume has increased by a factor of 817.

Marks	**2**	1	0
Student	**19**	18	18

Comment:
This was a difficult question and marks were given if you showed working and used the formula.

24 (b) (2 marks)

Criteria	Marks
• Lists 2 assumptions associated with the properties of ideal gases AND • States evidence why the assumptions would be valid (or not valid)	2
• Lists 2 assumptions associated with the properties of ideal gases OR • States evidence why the assumptions would be valid (or not valid)	1

Sample answer

The equation used in the calculation (the combined gas equation) assumes the gas, helium, is behaving ideally.

Ideal gases have the following properties:

- Gas particles are in constant, random, straight-line motion.
- Collisions of the particles with other particles and with the walls of the container are perfectly elastic (no energy is lost as collisions occur).
- There is no attraction or repulsion between particles.

The ideal gas model applies well for gases at low pressure and high temperature. Helium is a noble gas and has minimal attraction between molecules (single atoms). The pressure in this question is initially at 1 atmosphere and falls to 1 x 10^{-3} atmospheres. Helium should behave ideally at these conditions. The temperature is initially at 273 K and falls to 223 K. Particles move more slowly at low temperatures, but these temperatures are not low enough to allow significant interaction between atoms of helium, so they would still be behaving ideally.

Marks	**2**	1	0
Student	**5**	8	41

Comment: Ideal gases **have** the following properties:

- Gas particles are in constant, random, straight-line motion.
- Collisions of the particles with other particles and with the walls of the container are perfectly elastic (no energy is lost as collisions occur).
- There is no attraction or repulsion between particles.

24(c)

Criteria	Marks
• Calculates moles for Fe and S AND • names the limiting reagent	3
• Calculate moles for Fe and S	2
• Calculates moles for Fe OR S	1

Sample Answer:

Fe + S → FeS

n(Fe) =42/55.85 = 0.7520 mol

n(S) = 8/32.07 = 0.2495 mol

1: 1 ratio

0.75 : 0.25

Therefore limiting reagent is S

Comment: need to do step by step calculations to work this out. Those that did got it correct.

Question 25 (10 marks)
25 (a) (4 marks)

Criteria	Marks
• Writes 4 correct equations	4
• Writes 3 correct equations	3
• Writes 2 correct equations	2
• Writes1 correct equation	1

Sample answer

I	$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$
II	$Zn\ (s) + 2H^+\ (aq) \rightarrow Zn^{2+}\ (aq) + H_2\ (g)$
III	$OH^-\ (aq) + H^+\ (aq) \rightarrow H_2O\ (l)$

IV	$4Na\ (s) + O_2\ (g) \rightarrow 2Na_2O\ (s)$

Marks	**4**	**3-3.5**	**2-2.5**	0.5- 1.5	0
Student	**3**	**4**	**12**	20	14

Comment:
Half marks were given in this question if a minor mistake was seen. This is not usual practice : -½ for each mistake

25 (b) (3 marks)

Criteria	Marks
● Classifies reactions II and IV as redox reactions AND ● Classifies reaction III as an acid-base reaction AND ● Classifies reaction IV as a synthesis reaction	3
● Classifies TWO reactions correctly	2
● Classifies ONE reaction correctly	1

Sample answer
Reactions II and IV are redox (reduction-oxidation) reactions.
Reaction IV is a synthesis reaction.
Reaction III is an acid-base reaction.

Marks	**2.5-3**	**2**	1	0
Student	**19**	**24**	8	4

Comment:

25 (c) (3 marks)

Criteria	Marks
• Outlines a procedure which would distinguish between nitric acid and hydrochloric acid and the results of the procedure AND • Writes an appropriate equation	3
• Outlines a procedure which would distinguish between nitric acid and hydrochloric acid	2
• Provides some relevant information	1

Sample answer (several possible answers)

A solution of silver nitrate could be added to samples of the 2 acids.
No reaction occurs with nitric acid.
A white precipitate of silver chloride occurs with hydrochloric acid.

$Ag^{+}\ (aq) + Cl^{-}\ (aq) \rightarrow AgCl\ (s)$

Marks	**3**	**2**	1	0
Student	**18**	**20**	5	12

Comment:

Read the question: Need to provide an appropriate equation,

Q 26 to Q 28 UMS

Question 26 (8 marks)

26 (a) (2 mark)

Criteria	Mark
● Identifies the Anode and Cathode correctly	2
● Identifies the Anode OR Cathode correctly	1

Sample answer

Anode- Lead Electrode

Cathode – Silver electrode

Marks	2	1	0
Student	32	0	15

Many careless mistakes - in recognising the anode where oxidation occurs

AN OX

RED CAT

26 (b) (3 marks)

Criteria	Marks
● Writes 2 correct half equations and calculates cell voltage, with working	3
● Any 2 of the above	2
● Any 1 of the above	1

Sample answer

$Pb_{(s)} \rightarrow Pb^{2+} + 2e^-$

$Ag^+ + e^- \rightarrow Ag_{(s)}$

$E = 0.13 + 0.8 = 0.93V$

Marks	3	2.5	2	1	0
Student	22	5	4	10	6

Error in recognising oxidation and reduction led to incorrect equations

Some doubled the Ag voltage to get a wrong answer

26 (c) (1 mark)

Criteria	Mark
● Correct calculation with all 3 steps	3
● Contains 2 correct steps	2
● Contains 1 correct step	1

Sample answer
Moles (n) = Conc (c) x Volume (V) n= cv
Remember to convert ml to L by dividing by 1000

300 mL of 0.25 mol/L Na_2SO_4 contains (300/1000) x 0.25 mol SO_4^{2-} = 0.075 mol
200 mL of 0.08 mol/L $Al_2(SO_4)_3$ contains (200/1000) x 0.08 x 3 mol of SO_4^{2-} = 0.048 mol
(If you calculated this as 0.016 and did the rest of the calculations correctly you got 2.5 marks)

Total moles of SO_4^{2-} = 0.123 in 500 mL

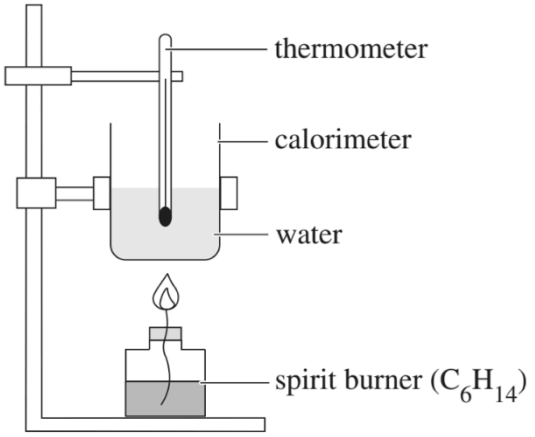
c=n/V
Conc = moles/volume = 0.123/0.5L
Hence concentration SO_4^{2-} = 0.246 mol/L

Marks	3	2.5	2	1.5	1	0
Student	6	3	6	3	7	21

Comment: Done poorly. Students did not know how to approach this question.
Errors in calculating the correct sulfate ions in aluminium sulfate

Molar ratio of sulfate was inaccurate

Question 27 (4 marks)



The following data was recorded at the start of the experiment

Mass of Hexane burned	2.38 g
Mass of water heated	600 mL
Initial Temperature of water	23.0 ºC

Criteria	Mark
● Calculates moles of Hexane, calculate energy released (q), calculates change in Temp and calculates the final temp of water	**4**
● Any 3 of the above	**3**
● Any 2 of the above	2
● Provides some relevant information	1

Sample answer

Method: n= m/MM
q=deltaH x n
q=mcat
Final temp= temp increase - initial temp

$$n(\text{hexane}) = \frac{m}{MM}$$
$$= \frac{2.38}{86.172}$$
$$= 0.0276 \text{ mol}$$

$$\Delta H = \frac{q}{n}$$
$$q = \Delta H \times n$$
$$= 4163 \times 0.0276$$
$$= 114.9786 \text{ kJ}$$
$$= 114\,978.6474 \text{ J}$$
$$q = mc\Delta T$$
$$114\,978.6474 = 600 \times 4.18 \times \Delta T$$
$$\Delta T = 45.8448°$$
$$\Delta T = T_2 - T_1$$
$$T_2 = \Delta T + T_1$$
$$= 45.8448 + 23.0$$
$$= 68.9°C$$

Marks	4	3	2.5	2	1	0
Student	10	2	1	3	15	13

Poorly done.
Students did not convert g to moles
Heat of combustion of hexane was taken as q
Many put 2.3g as mass of water in mCAT equation

28 (a) (1 marks)

Criteria	Marks
• Provides the correct answer	1

Sample answer
15 KJ/mol

Marks	1	0
Student	26	18

Good

28 (b) (1 marks)

Criteria	Marks
• Provides the correct answer	1

Sample answer
49.6L / 24.79L = 2 moles of Y
Enthalpy change 10-15 = -5KJ/mol
Therefore: = -10KJ (2 moles)

Marks	1	1.5	0
Student	2	15	27

Students did not convert 49.6L by dividing by 24.79 to get moles

28 (c) (1 marks)

Criteria	**Marks**
• Provides the correct answer	1

Sample answer
Endothermic.
(products have a higher energy than the reactants – therefore net input of energy)

Marks	1	0
Student	34	10

Marks Analysis and HSC Chemistry

Year 11 Preliminary Average **37/70 (53%) (56 students)**

Minus Outliers **43/70 (62%) (42 students)**

Year 12 Chemistry HSC trial Average **60-63%(2018-2021)**

Year 12 Chemistry HSC Mark Mean

2018	**SIC 82**	**STATE 74**
2019	**SIC 85**	**STATE 75**
2020	**SIC 83**	**STATE 75**
2021	**SIC 81**	**STATE 74**

Be careful when choosing what subjects you keep for the HSC and what you drop.

A few questions/ideas to ponder:

- Did you enjoy Chemistry classes and the content (regardless of exam marks)?
- You are very inexperienced in attempting Chem exams and these types of questions - you will get better the more Chemistry you do!
- Chemistry marks and scaling???
- Don't forget - various courses at University - you get bonus points for doing difficult subjects like Chemistry (sciences in general).

Report by CSNSW

- It is possible for high performing students to attain an ATAR over 95 and not receive a single Band 6/E4. This means that such a student would not be recognised in NESA's Merit Lists. Given that ATARs and scaled marks are not made available to schools (nor CSNSW) it is also possible that a high achieving student is not recognised by their school. Currently, schools rely on students voluntarily sharing their ATAR ranking.
- It is also possible to be an *All Rounder* (10 units at Band 6/E4) and yet have an ATAR of only 85. Anecdotal evidence suggests that failure to recognise high performing students in subjects that "scale well" is influencing student choice and impacting on enrolments in the sciences, economics, and other subjects.[1]

Figure 1: *Course Ranked by minimum scaled marked required to achieve Band 6/E4*[1]