SHORE

Exam Number: _____

2023

YEAR 11 YEARLY EXAMINATION

Chemistry

General instructions:

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black pen
- Draw diagrams using pencil
- Board approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper
- Write your Student Exam Number where required
- **Note:** Any time you have remaining should be spent revising your answers

Section 1

_____ of 20 marks

- Attempt Questions 1 - 20
- Allow about 35 minutes for this section

Section 2

_____of 47 marks

- Attempt Questions 21 - 27
- Allow about 1 hours and 25 minutes for this section

DO NOT REMOVE THIS PAPER FROM THE EXAMINATION ROOM.

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.

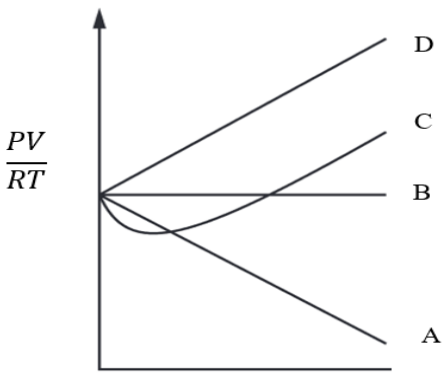
1 Electronegativity is a measure of an element's electron-attracting ability.

According to the trend on the periodic table, which of the following elements would have the highest electronegativity?

A. Sulfur
B. Silicon
C. Chlorine
D. Magnesium

2 A sample of an ideal gas is held at a constant temperature of 400 K in a gas syringe.

The pressure is increased and a graph of $\frac{PV}{RT}$ against the pressure is plotted.



ould best represent the results?

A. A
B. B
C. C
D. D

3 Which are non-polar molecules?

I NCl_3
II SCl_2
III CCl_4

A. I only
B. II only
C. III only
D. II and III only

4 The molar mass of a gas with a density of 5.8 g L^{-1} at 25°C and 100 kPa is closest to

A. 10 g mol^{-1}
B. 20 g mol^{-1}
C. 150 g mol^{-1}
D. 190 g mol^{-1}

5 How many moles of Na^+ ions are in 20 mL of 0.40 M Na_3PO_4?

A. 0.0080
B. 0.024
C. 0.050
D. 0.20

6 What is the oxidation number of manganese in the permanganate ion MnO_4^-?

A. -5

B. -1

C. +3

D. +7

7 The airbags in cars contain sodium azide (NaN_3) and an excess of potassium nitrate (KNO_3).

In a car accident, the reactions shown below occur, producing nitrogen. This causes the airbag to inflate rapidly.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

$$10Na + 2KNO_3 \rightarrow \ K_2O + \ 5Na_2O + N_2$$

How many moles of nitrogen gas are produced in total when 1 mol of sodium azide, decomposes in an airbag?

How many moles of nitrogen gas are produced in total when 1 mol of sodium azide, decomposes in an airbag?

A. 1.5

B. 1.6

C. 3.2

D. 4.0

8 How much heat is required to raise the temperature of 100.0 g of Fe_2O_3 from 5.0°C to 25.0°C? The specific heat capacity of Fe_2O_3 is 0.634 J g^{-1} K^{-1}.

A. 1.27 kJ

B. 1.58 kJ

C. 0.845 kJ

D. 0.0634 kJ

9 A homogeneous liquid reaction mixture is often heated to increase the rate of reaction.

This is best explained by the fact that raising the temperature

A. increases the heat of reaction.
B. decreases the energy of activation.
C. increases the vapour pressure of the liquid.
D. increases the average kinetic energy of the reactants.

10 The following is an excerpt from an interview where a researcher is explaining how Aboriginal and Torres Strait Islander Peoples detoxified poisonous food items.

> "Then the kernels are stored for months in a moist environment which allows microscopic organisms to break down some of the materials as a food source, generating alcohol. The kernels are no longer toxic after this process."

The process described in this excerpt is known as

A. Leaching
B. Oxidation
C. Precipitation
D. Fermentation

11 The lowest melting points overall occur for members of which class of solids?

A. Molecular
B. Ionic
C. Metallic
D. Network covalent

12 Hydrogen bonds exist between?

A. Two hydrogen atoms

B. Two hydrogen molecules

C. The Hydrogen and oxygen atom within a water molecule

D. The hydrogen and oxygen atom from two different water molecules.

13 A Year 11 chemistry student investigated the reactivity of four metals. The data gathered is shown in the table below.

Metal	Metal ion in solution			
	Mg^{2+}	Ag^{+}	Pb^{2+}	Sn^{2+}
Mg	✗	✓	✓	✓
Ag	✗	✗	✗	✗
Pb	✗	✓	✗	✗
Sn	✗	✓	✓	✗

Which of the following options lists the metals in order of decreasing reactivity?

A. Mg>Ag>Pb>Sn

B. Sn>Pb>Ag>Mg

C. Mg>Sn>Pb>Ag

D. Ag>Pb>Sn>Mg

14 What is the number of O_2 molecules in the 2.5 g of O_2 inhaled by the average person in one minute?

A. 1.9×10^{22}

B. 3.8×10^{22}

C. 4.7×10^{22}

D. 9.4×10^{22}

15 When 100 mL of 1.0 M HCl is added to a 2.0 g piece of $CaCO_3$, CO_2 is produced at a certain rate. Which of the changes below will NOT increase the rate of this reaction?

A. Adding 100 mL of 2.0 M HCl in place of 100 mL of 1.0 M HCl

B. Heating the 100 mL of 1.0 M HCl before adding it to the $CaCO_3$

C. Adding 100 mL of 1.0 M HCl to 2.0 g of powdered $CaCO_3$

D. Adding 150 mL of 1.0 M HCl in place of 100 mL of 1.0 M HCl

16 A phosphorus atom has the electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$. How many orbitals in this ground state atom are occupied by at least one electron?

A. 12

B. 9

C. 8

D. 5

17 Given these reactions:

$A \rightarrow 2B$ $\quad \Delta H = +40$ kJ

$B \rightarrow C$ $\quad \Delta H = -50$ kJ

$2C \rightarrow D$ $\quad \Delta H = -20$ kJ

calculate ΔH for the reaction:

$D + A \rightarrow 4C$

A. +100 kJ

B. –100 kJ

C. –60 kJ

D. –40 kJ

18 Hydrazine, N_2H_4, contains a N–N single bond and 4 N–H bonds.

Use bond energies below to calculate ΔH in kJ for the reaction:

$N_2 + 2H_2 \rightarrow N_2H_4$

Bond Energies (kJ mol^{-1})	
H–H	436
N–H	389
N–N	159
N=N	418
N≡N	941

A. 98 kJ

B. –98 kJ

C. –425 kJ

D. 425 kJ

19 The bromide impurity in a 2.00 g sample of a metal nitrate is precipitated as silver bromide. If 6.40 mL of 0.200 M $AgNO_3$ solution is required, what is the mass percentage of bromide in the sample?

A. 1.28 %

B. 2.56 %

C. 5.11 %

D. 9.15 %

20 Given the thermochemical equations:

$Br_2\ (l) + F_2\ (g) \rightarrow 2BrF\ (g)$ $\quad \Delta H^\circ = -188$ kJ
$Br_2\ (l) + 3F_2\ (g) \rightarrow 2BrF_3\ (g)$ $\quad \Delta H^\circ = -768$ kJ

determine ΔH° for the reaction

$BrF\ (g) + F_2\ (g) \rightarrow BrF_3\ (g)$

A. –956 kJ

B. –580 kJ

C. –478 kJ

D. –290 kJ

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Chemistry

Section II – 47 marks
Attempt Questions 21-27
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.
Extra writing space is provided on pages 19 and 20. If you use this space, clearly indicate which question you are answering.

Question 21 (13 marks)

In an experiment, 5.85 g of liquid ethanol (C_2H_6O) was ignited with 14.2 g of oxygen. Assume that the reaction was initially carried out at room temperature.

(a) Write an equation for the complete combustion of ethanol. Explain how the product(s) of this reaction might differ if the reaction had been carried out in a limited supply of oxygen. **2**

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(b) Which reagent is in excess? Show your calculation and hence determine the amount, in moles, of the reagent identified as being in excess. **2**

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Question 21 continues on the next page

Question 21 (continued)

(c) Draw an electron-dot formula for carbon dioxide. **1**

(d) Explain why the molecule's shape is linear, not V-shaped. **2**

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(e) Identify a compound of carbon which is molecular and has a tetrahedral shape. Draw an electron-dot formula for this compound. **2**

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Question 21 continues on the next page

Question 21 (continued)

(f) Boiling point and solubility in water are physical properties of compounds. Relate the physical properties of the compound you have chosen in part (e) to the structure and bonding of the compound. **4**

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Question 22 (3 marks)

(a) Write a balanced nuclear reaction for $^{239}_{94}$Pu undergoing alpha decay. **1**

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(b) Identify a natural radioisotope and its usage in industry. **2**

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Question 23 (8 marks)

A pair of students conduct an investigation to measure the reduction potential of a galvanic half-cell.

They construct a cell by placing a zinc electrode in a beaker of zinc sulfate and a copper electrode in a solution of copper(II) nitrate.

(a) Sketch and label the galvanic cell. **3**

(b) Determine which element is oxidised and which is reduced. **1**

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Question 23 continues on the next page

Question 23 (continued)

(c) Write half equations for both half cells and use these to construct a balanced overall ionic equation to represent the reaction taking place in the cell. **3**

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(d) Calculate the cell potential of the galvanic cell **1**

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Question 24 (8 marks)

The following is a student's summary of catalysts. It contains some correct and incorrect statements.

I	A catalyst increases the rate of a reaction.
II	All catalysts are solids.
III	The mass of a catalyst is the same before and after the reaction.
IV	A catalyst lowers the enthalpy change of a reaction, enabling more particles to have sufficient energy to successfully react.
V	All catalysts align the reactant particles in an orientation that is favourable for a reaction to occur.
VI	The effectiveness of a metal catalyst is not dependent upon its surface area.
VII	Enzymes are biological catalysts that catalyse a specific biochemical reaction once only.

(a) Identify TWO correct statements (list by numeral: e.g. I, IV). **2**

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(b) Evaluate the student's summary by identifying THREE incorrect statements. In each case, explain why it is incorrect. **6**

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Question 25 (7 marks)

In order to carry out an investigation, a student obtains a 2.5 mol L^{-1} standard solution of sodium carbonate.

(a) 20 mL of the standard solution is diluted to 100 mL in a volumetric flask. **2**

Calculate the concentration of the diluted solution.

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(b) The diluted solution is reacted with sulfuric acid to form sodium sulfate. **2**

Write a balanced chemical equation for this reaction.

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(c) Determine the mass of sodium sulfate that can be produced from the 20 mL of sodium carbonate used in this reaction. **3**

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Question 26 (3 marks)

Ammonium nitrate is a white solid with a heat of solution of + 25.7 $kJmol^{-1}$.
The incomplete data table below shows results of adding some of this solid to a mass of water in an insulating cup.

Mass of polystyrene cup (g)	**54.55**
Mass of cup with water (g)	**155.1**
Initial temperature of water (^oC)	**20.5**
Mass of NH_4NO_3 added (g)	**8.0**
Final theoretical temperature of water reached (^oC)	**?**

Ignoring any heat exchange between the cup or air, calculate the final theoretical temperature that the water could reach (in ^oC). (Show your working) **3**

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Question 27 (5 marks)

A compound contains only C, H and N.

Combustion of 0.125 g of this compound produces 0.172 g of H_2O and 0.279 g of CO_2.

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

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(b) Find the mass percentages of C, H and N and hence the empirical formula of this compound. **3**

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End of Examination

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Chemistry

FORMULAE SHEET

$$n = \frac{m}{MM} \qquad c = \frac{n}{V} \qquad PV = nRT$$

$$q = mc\Delta T \qquad \Delta G^\circ = \Delta H^\circ - T\Delta S^\circ \qquad \text{pH} = -\log_{10}[H^+]$$

$$pK_a = -\log_{10}[K_a] \qquad A = \varepsilon lc = \log_{10}\frac{I_o}{I}$$

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Gas constant ..... 8.314 J mol^{-1} K^{-1}

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

DATA SHEET

Solubility constants at 25°C

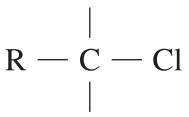
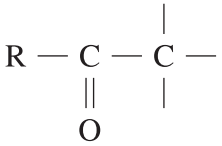
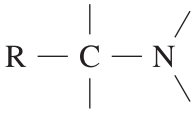
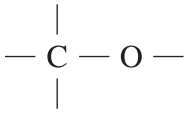
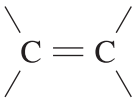
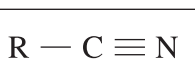
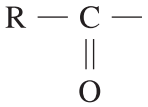
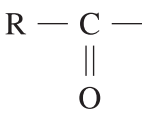
Compound	K_{sp}
Barium carbonate	2.58×10^{-9}
Barium hydroxide	2.55×10^{-4}
Barium phosphate	1.3×10^{-29}
Barium sulfate	1.08×10^{-10}
Calcium carbonate	3.36×10^{-9}
Calcium hydroxide	5.02×10^{-6}
Calcium phosphate	2.07×10^{-29}
Calcium sulfate	4.93×10^{-5}
Copper(II) carbonate	1.4×10^{-10}
Copper(II) hydroxide	2.2×10^{-20}
Copper(II) phosphate	1.40×10^{-37}
Iron(II) carbonate	3.13×10^{-11}
Iron(II) hydroxide	4.87×10^{-17}
Iron(III) hydroxide	2.79×10^{-39}
Iron(III) phosphate	9.91×10^{-16}

Compound	K_{sp}
Lead(II) bromide	6.60×10^{-6}
Lead(II) chloride	1.70×10^{-5}
Lead(II) iodide	9.8×10^{-9}
Lead(II) carbonate	7.40×10^{-14}
Lead(II) hydroxide	1.43×10^{-15}
Lead(II) phosphate	8.0×10^{-43}
Lead(II) sulfate	2.53×10^{-8}
Magnesium carbonate	6.82×10^{-6}
Magnesium hydroxide	5.61×10^{-12}
Magnesium phosphate	1.04×10^{-24}
Silver bromide	5.35×10^{-13}
Silver chloride	1.77×10^{-10}
Silver carbonate	8.46×10^{-12}
Silver hydroxide	2.0×10^{-8}
Silver iodide	8.52×10^{-17}
Silver phosphate	8.89×10^{-17}
Silver sulfate	1.20×10^{-5}

Infrared absorption data

Bond	Wavenumber/cm^{-1}
N—H (amines)	3300–3500
O—H (alcohols)	3230–3550 (broad)
C—H	2850–3300
O—H (acids)	2500–3000 (very broad)
C≡N	2220–2260
C=O	1680–1750
C=C	1620–1680
C—O	1000–1300
C—C	750–1100

^{13}C NMR chemical shift data

Type of carbon		δ/ppm
		5–40
		10–70
		20–50
		25–60
	alcohols, ethers or esters	50–90
		90–150
		110–125
		110–160
	esters or acids	160–185
	aldehydes or ketones	190–220

UV absorption

(This is not a definitive list and is approximate.)

Chromophore	λ_{max} (nm)
C—H	122
C—C	135
C=C	162

Chromophore	λ_{max} (nm)
C≡C	173 178 196 222
C—Cl	173
C—Br	208

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for the standard potentials. Some data may have been modified for examination purposes.

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79
Symbol	Au
Standard Atomic Weight	197.0
Name	Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Standard atomic weights are abridged to four significant figures.

Elements with no reported values in the table have no stable nuclides.

Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of all other data. Some data may have been modified.

SHORE

Student exam number:			

Year 11 Chemistry
Yearly Examination

Section 1 – Multiple Choice Answer Sheet

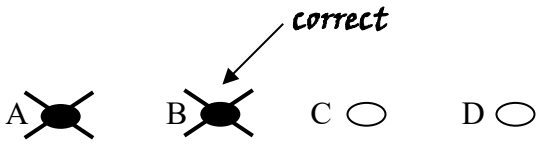
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

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.

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



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

SHORE

Exam Number: _____

2023

YEAR 11 YEARLY EXAMINATION

Chemistry

General instructions:

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black pen
- Draw diagrams using pencil
- Board approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper
- Write your Student Exam Number where required
- **Note:** Any time you have remaining should be spent revising your answers

Section

_____ of 20 marks

- Attempt Questions 1 - 20
- Allow about 35 minutes for this section

Section

_____of 47 marks

- Attempt Questions 21 - 27
- Allow about 1 hours and 25 minutes for this section

DO NOT REMOVE THIS PAPER FROM THE EXAMINATION ROOM.

Overall Average = 38.4/67 (STD=13.8) – 57%
Class Averages all the same ~38
This was a hard test, with not many easy questions.

If you got below ~45% you should be having a conversation with your teacher. If you had lots of silly mistakes and enjoy the subject, stay on. If you are leaving most questions blank and don't understand/enjoy, consider your choices or make a concerted effort to turn things around.

Content/skills you need for Year 12:

- balancing chemical equations
- mole and enthalpy calculations
- IMFs

Sect B combustion, bonding and structure (relevant to 12)
Sect C galvanic cells, evaluation of catalyst (not relevant to 12 besides knowing what a catalyst is)
Sect D dilution involving acids, enthalpy of dissolution (relevant to 12)

Average Mark = 12.0/20 (STD = 4.0) – 60%

Quick check: **CBCCB DBADD ADCCD BDACD**

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	2	7	7	3	9	5	26	45	1	6	30	1	2	3	0	4	5	16	11	7
A%	3.4	12	12	5.2	16	8.6	45	78	1.7	10	52	1.7	3.4	5.2	0	6.9	8.6	28	19	12
B	1	21	10	14	34	5	19	5	3	0	6	6	0	8	3	16	12	14	12	12
B%	1.7	36	17	24	59	8.6	33	8.6	5.2	0	10	10	0	14	5.2	28	21	24	21	21
C	46	3	22	34	6	2	6	2	0	1	5	14	40	34	6	5	11	11	20	14
C%	79	5.2	38	59	10	3.4	10	3.4	0	1.7	8.6	24	69	59	10	8.6	19	19	34	24
D	3	21	13	1	2	39	1	0	48	45	11	31	10	6	42	27	24	11	9	19
D%	5.2	36	22	1.7	3.4	67	1.7	0	83	78	19	53	17	10	72	47	41	19	16	33

Blue = hard questions (less than 50%)

1 Electronegativity is a measure of an element's electron-attracting ability.

According to the trend on the periodic table, which of the following elements would have the highest electronegativity?

A. Sulfur

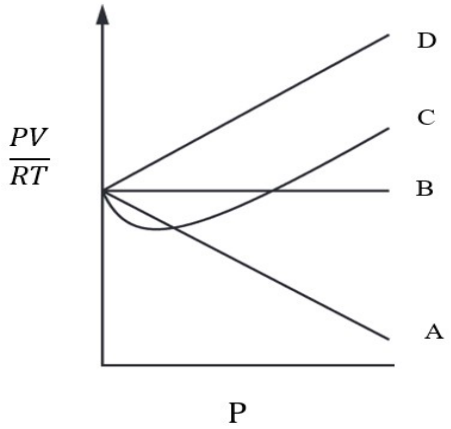
B. Silicon

C. Chlorine

D. Magnesium

2 A sample of an ideal gas is held at a constant temperature of 400 K in a gas syringe.

The pressure is increased and a graph of $\frac{PV}{RT}$ against the pressure is plotted.



Which ... sent the results?

A. A

B. B

C. C

D. D

3 Which are non-polar molecules?

I NCl_3
II SCl_2
III CCl_4

A. I only
B. II only
C. III only
D. II and III only

4 The molar mass of a gas with a density of 5.8 g L^{-1} at 25°C and 100 kPa is closest to

A. 10 g mol^{-1}
B. 20 g mol^{-1}
C. 150 g mol^{-1}
D. 190 g mol^{-1}

5 How many moles of Na^+ ions are in 20 mL of 0.40 M Na_3PO_4?

A. 0.0080
B. 0.024
C. 0.050
D. 0.20

6 What is the oxidation number of manganese in the permanganate ion MnO_4^-?

A. -5

B. -1

C. +3

D. +7

7 The airbags in cars contain sodium azide (NaN_3) and an excess of potassium nitrate (KNO_3).

In a car accident, the reactions shown below occur, producing nitrogen. This causes the airbag to inflate rapidly.

$$2\,NaN_3 \rightarrow 2\,Na + 3\,N_2$$

$$10\,Na + 2\,KNO_3 \rightarrow K_2O + 5\,Na_2O + N_2$$

How many moles of nitrogen gas are produced in total when 1 mol of sodium azide, decomposes in an airbag?

How many moles of nitrogen gas are produced in total when 1 mol of sodium azide, decomposes in an airbag?

A. 1.5

B. 1.6

C. 3.2

D. 4.0

8 How much heat is required to raise the temperature of 100.0 g of Fe_2O_3 from 5.0°C to 25.0°C? The specific heat capacity of Fe_2O_3 is 0.634 J g^{-1} K^{-1}.

A. 1.27 kJ

B. 1.58 kJ

C. 0.845 kJ

D. 0.0634 kJ

9 A homogeneous liquid reaction mixture is often heated to increase the rate of reaction.

This is best explained by the fact that raising the temperature

A. increases the heat of reaction.
B. decreases the energy of activation.
C. increases the vapour pressure of the liquid.
D. increases the average kinetic energy of the reactants.

10 The following is an excerpt from an interview where a researcher is explaining how Aboriginal and Torres Strait Islander Peoples detoxified poisonous food items.

> "Then the kernels are stored for months in a moist environment which allows microscopic organisms to break down some of the materials as a food source, generating alcohol. The kernels are no longer toxic after this process."

The process described in this excerpt is known as

A. Leaching
B. Oxidation
C. Precipitation
D. Fermentation

11 The lowest melting points overall occur for members of which class of solids?

A. Molecular
B. Ionic
C. Metallic
D. Network covalent

12 Hydrogen bonds exist between?

A. Two hydrogen atoms

B. Two hydrogen molecules

C. The Hydrogen and oxygen atom within a water molecule

D. The hydrogen and oxygen atom from two different water molecules.

13 A Year 11 chemistry student investigated the reactivity of four metals. The data gathered is shown in the table below.

Metal	Metal ion in solution			
	Mg^{2+}	Ag^{+}	Pb^{2+}	Sn^{2+}
Mg	✗	✓	✓	✓
Ag	✗	✗	✗	✗
Pb	✗	✓	✗	✗
Sn	✗	✓	✓	✗

Which of the following options lists the metals in order of decreasing reactivity?

A. Mg>Ag>Pb>Sn

B. Sn>Pb>Ag>Mg

C. Mg>Sn>Pb>Ag

D. Ag>Pb>Sn>Mg

14 What is the number of O_2 molecules in the 2.5 g of O_2 inhaled by the average person in one minute?

A. 1.9×10^{22}

B. 3.8×10^{22}

C. 4.7×10^{22}

D. 9.4×10^{22}

15 When 100 mL of 1.0 M HCl is added to a 2.0 g piece of $CaCO_3$, CO_2 is produced at a certain rate. Which of the changes below will NOT increase the rate of this reaction?

A. Adding 100 mL of 2.0 M HCl in place of 100 mL of 1.0 M HCl

B. Heating the 100 mL of 1.0 M HCl before adding it to the $CaCO_3$

C. Adding 100 mL of 1.0 M HCl to 2.0 g of powdered $CaCO_3$

D. Adding 150 mL of 1.0 M HCl in place of 100 mL of 1.0 M HCl

16 A phosphorus atom has the electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$. How many orbitals in this ground state atom are occupied by at least one electron?

A. 12

B. 9

C. 8

D. 5

17 Given these reactions:

$A \rightarrow 2B$ $\quad \Delta H = +40$ kJ

$B \rightarrow C$ $\quad \Delta H = -50$ kJ

$2C \rightarrow D$ $\quad \Delta H = -20$ kJ

calculate ΔH for the reaction:

$D + A \rightarrow 4C$

A. +100 kJ

B. –100 kJ

C. –60 kJ

D. –40 kJ

18 Hydrazine, N_2H_4, contains a N–N single bond and 4 N–H bonds.

Use bond energies below to calculate ΔH in kJ for the reaction:

$N_2 + 2H_2 \rightarrow N_2H_4$

Bond Energies (kJ mol^{-1})	
H–H	436
N–H	389
N–N	159
N=N	418
N≡N	941

A. 98 kJ

B. –98 kJ

C. –425 kJ

D. 425 kJ

19 The bromide impurity in a 2.00 g sample of a metal nitrate is precipitated as silver bromide. If 6.40 mL of 0.200 M $AgNO_3$ solution is required, what is the mass percentage of bromide in the sample?

A. 1.28 %

B. 2.56 %

C. 5.11 %

D. 9.15 %

20 Given the thermochemical equations:

$Br_2\,(l) + F_2\,(g) \rightarrow 2BrF\,(g)$ $\quad \Delta H^\circ = -188$ kJ

$Br_2\,(l) + 3F_2\,(g) \rightarrow 2BrF_3\,(g)$ $\quad \Delta H^\circ = -768$ kJ

determine ΔH° for the reaction

$BrF\,(g) + F_2\,(g) \rightarrow BrF_3\,(g)$

A. –956 kJ

B. –580 kJ

C. –478 kJ

D. –290 kJ

Section II – 47 marks
Attempt Questions 21-27
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.
Extra writing space is provided on pages 19 and 20. If you use this space, clearly indicate which question you are answering.

Question 21 (13 marks)

In an experiment, 5.85 g of liquid ethanol (C_2H_6O) was ignited with 14.2 g of oxygen. Assume that the reaction was initially carried out at room temperature.

(a) Write an equation for the complete combustion of ethanol. Explain how the product(s) of this reaction might differ if the reaction had been carried out in a limited supply of oxygen. **2**

Criteria
• Writes a correct equation for complete combustion of ethanol forming carbon dioxide and liquid water • Explains that carbon monoxide or carbon might form if in a limited oxygen supply
• ONE of the above

Sample answer

$C_2H_6O\ (l) + 3O_2\ (g) \rightarrow 2CO_2\ (g) + 3H_2O\ (l)$

If the reaction is carried out above 100°C and all reactants and products are in the gaseous state, $H_2O(g)$ rather than $H_2O(l)$ will form.

If the reaction is carried out in a limited supply of oxygen, carbon monoxide or carbon might form instead of carbon dioxide (incomplete combustion will occur).

Generally answered well- watch out for balancing equations, lots had 2 o2 molecules, which isn't balanced. Average 1.1

Some students don't know basic equation for combustion so didn't get correct products.

(b) Which reagent is in excess? Show your calculation and hence determine the amount, in moles, of the reagent identified as being in excess. **2**

Criteria	Marks
• Determines that oxygen is in excess (showing correct calculation of the amount of oxygen required for complete reaction) • Calculates the no. of moles of excess $O_2(g)$	2
• Determines that oxygen is in excess (showing correct calculation of the amount of oxygen required for complete reaction)	1

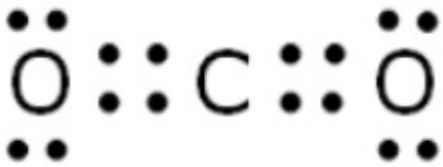
Sample answer
1 mole ethanol reacts completely with 3 moles of oxygen
46.07 g ethanol reacts with 3 moles of oxygen, i.e. with 96.00 g oxygen
Hence 5.85 g ethanol reacts completely with 12.2 g oxygen
Hence oxygen is in excess by (14.2 – 12.2) g which is 2.0/32 = 0.063 mol of oxygen (O_2).

Nicely marked this one- if correct equation had been used to work out moles and then used to work out excess reactant then largely 2 marks was awarded. Not balancing equation above led to lost marks here. Average- 1.1.

(c) Draw an electron-dot formula for carbon dioxide. **1**

Criteria
• Draws a correct electron-dot formula for carbon dioxide (dots only, no crosses, no lines to represent bonds)

Sample answer



Lots of easy mistakes here- no double bond between C and O drawn or electrons draw as crosses. Some lines to represent bonds, always read question. Average- 0.3

(d) Explain why the molecule's shape is linear, not V-shaped. **2**

Criteria
• Explains that the structure is linear in shape because of the bonding about the carbon central atom, i.e. the bonding electrons align at 180° to allow the least repulsion between the negative charges AND • Explains that V-shaped bonding occurs when there are 3 or 4 pairs of electrons around the central atom
• Explains that the structure is linear in shape because of the bonding about the carbon central atom, i.e. the bonding electrons align at 180° to allow the least repulsion between the electron pairs OR • Explains that V-shaped bonding occurs when there are 3 or 4 pairs of electrons around the central atom

Sample answer
Carbon dioxide is a linear molecule because there are double bonds on each side of the central carbon atom. These electron pairs align at 180° to allow the least repulsion between the electron pairs.

V-shaped molecules result when there are 3 or 4 charged regions around the central atom, so bond angles of approx. 108° or 120° result. This gives the most stable geometry with the smallest repulsion between electron pairs. Examples of these situations occur in water (4 pairs, 2 bonds from oxygen to hydrogen) and SO_3 (3 bonds in a planar structure at 120°).

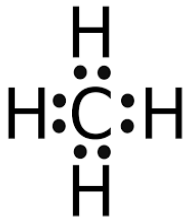
Difficult question, but poorly answered (0.6/2) - as long as lone pairs and 180° mentioned I normally gave full marks.

(e) Identify a compound of carbon which is molecular and has a tetrahedral shape. **2**
Draw an electron-dot formula for this compound.

……..

Criteria
• Identifies a carbon compound which is molecular and tetrahedral in shape (note doesn't have to name as methane, as not in year 11 course) AND • Draws a correct electron-dot formula for this compound
• Identifies a carbon compound which is molecular and tetrahedral in shape

Sample answer
Methane (CH_4) is the simplest example.
It has non-metal atoms covalently bonded into a molecule, with tetrahedral angles at 109° between the 4 C–H bonds.



Poorly answered- 0.8/2
Difficult question, but some compounds given didn't even contain carbon…
Some students don't understand molecular shape and gave a molecule that wasn't tetrahedral (ammonia or co2 being some that came up a few times)

Question 21 (continued)

(f) Boiling point and solubility in water are physical properties of compounds. Relate the physical properties of the compound you have chosen in part (e) to the structure and bonding of the compound. **4**

Criteria
• Thoroughly relates both the boiling point and solubility in water of the carbon compound in part (e) above to its structure and bonding
• States some correct information linking both the boiling point and solubility of the chosen compound to its structure and bonding
• Thoroughly relates ONE of the boiling point OR solubility of the carbon compound in part (e) above to its structure and bonding
• States some correct information linking ONE of the boiling point OR solubility of the chosen compound to its structure and bonding

Sample answer

Methane is a molecular compound, with strong covalent C–H bonds within the molecule but only weak dispersion intermolecular forces. The molecule as a whole is non-polar. As a result, neighbouring molecules are only weakly attracted to each other as colliding particles cause temporary dipole-dipole forces when the electron clouds are temporarily distorted on collision. This means little energy is needed to separate neighbouring molecules so the liquid changes state at a very low temperature (i.e. methane has a low boiling point).

Methane will not dissolve in water. Water is polar and has strong hydrogen bonds between the adjacent molecules. Methane is non-polar and does not form strong attractions to polar molecules. As a result, methane cannot get between the water molecules and does not mix with water. Hence it is classified as insoluble in water. The C–H bonds are strong and are not broken in water. So there is no chemical reaction to break the methane or water into other particles.

Really poorly scored (1.3). lots of students missed marks for talking too generally about structure and properties rather than referring specifically to the molecular compound. I was nice and if you got part e wrong, which lots did, but your structures and properties generally linked to a molecule you had named then I allowed 1 or 2 marks.

Question 22 (3 marks)

(a) Write a balanced nuclear reaction for $^{239}_{94}Pu$ undergoing alpha decay. **1**

Criteria	Marks
Provides correct answer	1

Sample answer:

$^{239}_{94}\text{Pu} \rightarrow {}^{235}_{92}\text{U} + {}^{4}_{2}\text{He}$

Generally scored well (average- 0.6).

(b) Identify a natural radioisotope and its usage in industry. **2**

Criteria	Marks
Identifies a natural radioisotope and Provides a usage of the isotope. (NB be generous in the marking here)	2
Any one of the above	1

Sample answer:
Carbon-14 is a natural radioisotope that is used by archaeologists to provide accurate dating of archaeologist artifacts.

Generally scored well (Average- 1.6) , I was generous and if AM of a specific isotope wasn't mentioned but a clear use and name of element was given- two marks still awarded. E.g. Uranium for nuclear power, rather than Uranium-235.

Question 23 (8 marks)

Exam Number: _____

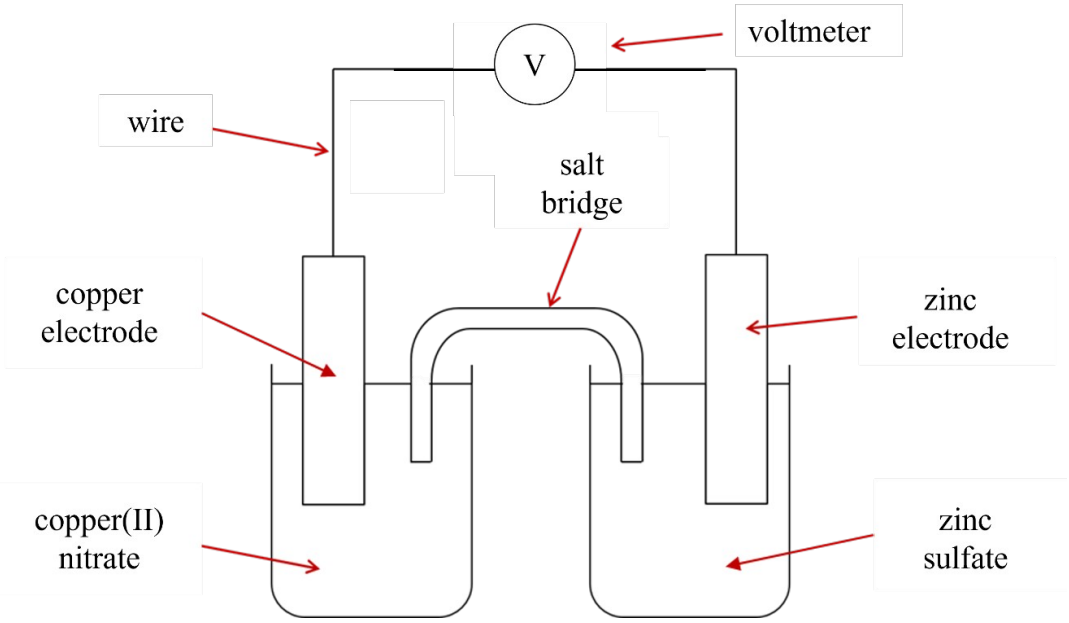
A pair of students conduct an investigation to measure the reduction potential of a galvanic half-cell.

They construct a cell by placing a zinc electrode in a beaker of zinc sulfate and a copper electrode in a solution of copper(II) nitrate.

(a) Sketch and label the galvanic cell. **3**

Criteria
• Draws an accurate diagram with the key features labelled: includes correct set up, salt bridge with electrolyte, voltmeter
• Draws a diagram which would work, or all correct but missing voltmeter
• Draws a diagram with some key features

Sample answer:



(b) Determine which element is oxidised and which is reduced. **1**

Criteria
• Correctly identifies which element is oxidised and which is reduced

Sample answer:

Zinc is oxidised. Copper is reduced.

(c) Write half equations for both half cells and use these to construct a balanced overall ionic equation to represent the reaction taking place in the cell. **3**

Criteria
• Provides correct oxidation half equation • Provides correct reduction half equation • Provides correct balanced overall chemical equation
• Provides correct oxidation half equation • Provides correct reduction half equation
• Provides correct oxidation half equation OR • Provides correct reduction half equation

Sample answer:

oxidation: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
reduction: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
overall: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

NB maximum of 1 mark deducted for no or incorrect states

(d) Calculate the cell potential of the galvanic cell **1**

Criteria
• Calculates EMF° of cell

Sample answer:

$EMF°_{(total)} = EMF°_{(red)} + EMF°_{(oxid)}$
$EMF°_{(total)} = 0.34 + 0.76$
$EMF°_{(total)} = 1.10\ V$

Exam Number: _____

Question 24 (8 marks)

The following is a student's summary of catalysts. It contains some correct and incorrect statements.

I	A catalyst increases the rate of a reaction.
II	All catalysts are solids.
III	The mass of a catalyst is the same before and after the reaction.
IV	A catalyst lowers the enthalpy change of a reaction, enabling more particles to have sufficient energy to successfully react.
V	All catalysts align the reactant particles in an orientation that is favourable for a reaction to occur.
VI	The effectiveness of a metal catalyst is not dependent upon its surface area.
VII	Enzymes are biological catalysts that catalyse a specific biochemical reaction once only.

(a) Identify TWO correct statements (list by numeral: e.g. I, IV). **2**

Criteria	
• Identifies TWO statements as correct	
• Identifies ONE statement as correct	

Sample answer
(Note: Marks should be deducted if incorrect statements are included)
Correct statements are: I and III only.

(b) Evaluate the student's summary by identifying THREE incorrect statements. In each case, explain why it is incorrect. **6**

Criteria	Marks
• Identifies THREE incorrect statements and explains thoroughly why each is incorrect	6
• Identifies THREE incorrect statements and explains thoroughly why 2 of these are incorrect	5
• Identifies THREE incorrect statements and explains thoroughly why 1 of these is incorrect OR • Identifies TWO incorrect statements and explains why these are incorrect	4
• Identifies TWO incorrect statements and explains why ONE of these is incorrect	3
• Identifies TWO incorrect statements OR • Identifies ONE incorrect statement and explains why it is incorrect	2
• Identifies ONE incorrect statement	1

Sample answer – There are FIVE incorrect statements (only 3 need to be discussed):

Statement II is False.
Catalysts can also exist as liquids, gases and in aqueous solutions. Catalysts can be heterogeneous or homogeneous.

Statement IV is False.
Catalysts lower the activation energy of a given reaction, not the enthalpy change, which remains constant.

Statement V is False.
Whilst enzymes and solid catalysts do align particles in favourable orientations, liquid and gaseous catalysts do not.

Statement VI is False.
The reaction involving a metal catalyst will occur at its surface. Hence, a larger surface area provides more catalyst area for reaction to occur, increasing 'effectiveness' of the catalyst.

Statement VII is False.
Enzymes can be used multiple times; they are not permanently altered during the reaction.

Question 25 (7 marks)
In order to carry out an investigation, a student obtains a 2.5 mol L^{-1} standard solution of sodium carbonate.

(a) 20 mL of the standard solution is diluted to 100 mL in a volumetric flask. **2**

Calculate the concentration of the diluted solution.

Criteria
• Correctly calculates the concentration of the diluted solution including units
• Provides some relevant information

Sample answer:

$c_1V_1 = c_2V_2$

$2.5 \times 20 = c_2 \times 100$

$$c_2 = \frac{2.5 \times 20}{100}$$

$$c_2 = \frac{50}{100} = 0.5 \text{ mol } L^{-1}$$

Avg = 1.48 out of 2
Common marks lost for total volume (this is dilution) and no units.

Students that did dilution factor (i.e., divide by 5) should show working

(b) The diluted solution is reacted with sulfuric acid to form sodium sulfate. **2**

Write a balanced chemical equation for this reaction.

Criteria
• Provides a balanced chemical equation
• Provides a chemical equation that is partially correct Eg. It may be ○ incomplete ○ incorrectly balanced ○ missing states ○ contains incorrect formulae

Sample answer:

$$Na_2CO_{3(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Avg = 0.82 out of 2
Marks lost for minor errors very common

Some students need to revise chemical formula and types of chemical reactions

(c) Determine the mass of sodium sulfate that can be produced from the 20 mL of sodium carbonate used in this reaction. **3**

Criteria
• Calculates moles of sodium carbonate • Calculates moles of sodium sulfate • Calculates mass of sodium sulfate
• Calculates moles of sodium carbonate • Calculates moles of sodium sulfate
• Provides some relevant information

Sample answer:

$Na_2CO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l) + CO_2(g)$

molar ratio 1:1:1:1:1

$$c = \frac{n}{V}$$

$$2.5 = \frac{n}{0.02}$$

n = 2.5 x 0.02

$n(Na_2CO_3) = 0.05$ mol

$n(Na_2SO_4) = 0.05$ mol

$$n = \frac{m}{MM}$$

m = n x MM

$MM(Na_2SO_4) = (2 \times 22.99) + 32.07 = (4 \times 16.00)$

$MM(Na_2SO_4) = 142.05$ g mol^{-1}

m = 0.05 x 142.05

$m(Na_2SO_4) = 7.1$ g

Avg = 1.8 out of 3

Many errors carried on. Lots of students using dilution concentration of 0.5 M instead of the original conc of 2.5 M

Question 26 (3 marks)

Ammonium nitrate is a white solid with a heat of solution of + 25.7 $kJmol^{-1}$.
The incomplete data table below shows results of adding some of this solid to a mass of water in an insulating cup.

Mass of polystyrene cup (g)	**54.55**
Mass of cup with water (g)	**155.1**
Initial temperature of water (°C)	**20.5**
Mass of NH_4NO_3 added (g)	**8.0**
Final theoretical temperature of water reached (°C)	**?**

Ignoring any heat exchange between the cup or air, calculate the final theoretical temperature that the water could reach (in °C). (Show your working) **3**

Marking Criteria	Marks
• Calculates the lowest theoretical temperature reached by the water.	**3**
• Completes the calculation with one error.	**2**
• Completes one step of the calculation.	**1**

Sample answer:

Mass (H_2O) in cup = 100.55 g or 0.010055 kg

***Note total mass should be 108.55 but wasn't marked**

q absorbed by dissolving = ΔH x n (NH_4NO_3)
= 25.7 x (8 /80.052)
= 2.568 kJ = 2568.3J

$q=mC\Delta T$
$\Delta T = q/mC$
$\Delta T = 2568.3/(100.55 \times 4.18) = 6.11$ °C
Final temp = 20.5 – 6.11 = 14.4 °C.

Avg = 1.11 out of 3 (HARD - 3 people got full marks)

So many tricks
– many students not working in correct units
- many thought +25.7 was q rather than ΔH
- few realised this process was endothermic and thus the final temp was lower than initial

Question 27 (5 marks)

A compound contains only C, H and N.

Combustion of 0.125 g of this compound produces 0.172 g of H_2O and 0.279 g of CO_2.

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

Criteria	Mark
• Both equations correctly written OR both values correctly calculated	2
• One value correctly calculated	1

Sample answer

Moles H_2O = 0.172/18.0 = 9.56 x 10^{-3}
Moles CO_2 = 0.279/44.0 = 6.34 x 10^{-3}

Avg = 1.76 out of 2

Calc errors and silly mistakes still prevalent

(b) Find the mass percentages of C, H and N and hence f
compound.

Criteria	Marks
• Determines correct empirical formula.	3
• Determines the correct percentages of C, H and N.	2
• Determines the correct masses of C, H and N.	1

Sample answer

Mol CO_2 = 6.34 x 10^{-3} Hence mass C = 12
Mol H_2O = 9.56 x 10^{-3} Hence mass H = 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

% 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%

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
% mass of C in CO_2 =

% mass of H in H_2O =

Avg = 0.87 out of 3 (Hardest question)

Very difficult to mark as a few different methods, such as:
% mass of C in CO_2 and % mass of H in H_2O

Was holistically marked – sensible steps that eventually allowed for mole comparisons and the deduction of Nitrogen based on the others.

End of Examination