

MARKER CODE				



STUDENT ENROLMENT NUMBER (SEN)									

TONGA FORM SIX CERTIFICATE 2020 CHEMISTRY

QUESTION AND ANSWER BOOKLET

Time allowed: 3 Hours

INSTRUCTIONS:

1. Write your **Student Enrolment Number (SEN)** on the top right-hand corner of this page.
2. This paper consists of **TEN QUESTIONS** and is out of 70 weighted scores.

QUESTION	STRANDS	TOTAL SKILL LEVEL
ONE	Atomic Trends	9
TWO	Shapes and Polarities	12
THREE	Solids and related properties	7
FOUR	Chemistry of oxides and chlorides	6
FIVE	Organic reactions	6
SIX	Isomerism	7
SEVEN	Unknown organic compounds and polymer	6
EIGHT	Rate of reactions	7
NINE	Equilibrium	6
TEN	Redox reactions and stoichiometry	4
TOTAL		70

3. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.
4. Use a **BLUE** or **BLACK** ball point pen only for writing. Use a pencil for drawing if required.
5. If you need more spaces for answers, ask the supervisor for extra paper. Write your **Student Enrolment Number (SEN)** on each additional sheet, number the questions clearly and insert them in the appropriate places in this booklet.

NOTE: There is a group of the **Periodic Table of the Elements** provided on page 19. The table gives the **Symbol**, **Atomic Number** and the **Relative Atomic Mass** of the elements. The Groups (columns) are numbered I, II, III, IV etc.

NOTE: The symbol M is used for molar mass. $M(\text{Na}) = \text{g mol}^{-1}$ and $M(\text{CO}_2) = 44 \text{ g mol}^{-1}$.

6. Check that this booklet contains pages 2-19 in the correct order and that none of the pages is blank.

**YOU MUST HAND IN THIS BOOKLET TO THE SUPERVISOR BEFORE YOU LEAVE
THE EXAMINATION ROOM.**

ATTEMPT ALL QUESTIONS IN THIS EXAMINATION PAPER.

Write the answer to each question in the correct spaces provided.

QUESTION ONE: Atomic Trends

- (a) (i) Define the term **electronegativity**.

Skill level 1	
1	
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NR	

- (ii) Explain why the electronegativity of chlorine is greater than that of phosphorus.

Skill level 3	
3	
2	
1	
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- (b) Write the electron arrangement using **s, p, d** configuration, for

Cl _____

Cl⁻ _____

Skill level 2	
2	
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- (c) Nitrogen and phosphorus can both form ions with a charge of -3 . Nitrogen forms the nitride ion, N^{3-} , and phosphorus forms the phosphide ion, P^{3-} .

Explain why both of these elements form ions with the same charge of -3 .

Skill level 3	
3	
2	
1	
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NR	

QUESTION TWO: Shapes and Polarities

- (a) (i) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecules	HOC1
Lewis structure	
Approximate bond angle around the central atom	109°

Skill level 3	
3	
2	
1	
0	
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- (ii) State the shape of HOCl molecule.

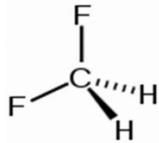
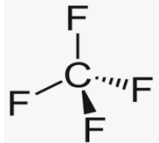
Skill level 1	
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0	
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- (iii) Explain why HOCl has the shape you have drawn in (a)(i) and bond angle of 109° :

[illegible]

Skill level 3	
3	
2	
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0	
NR	

(b) Three-dimensional diagrams for two molecules are shown below.

Molecule		
Name	<i>difluoromethane</i>	<i>tetrafluoromethane</i>
Polarity		

Skill level 1	
1	
0	
NR	

Skill level 1	
1	
0	
NR	

- (i) In the boxes above, identify the polarity of each molecule by writing either polar or non-polar.
- (ii) Justify your choices.

[illegible]

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION THREE: Solids and related properties

- (a) (i) For each substance below, classify the bonding type of each substance as either **ionic** or **covalent**.

Substance	Bonding
magnesium oxide, MgO	
carbon dioxide, CO ₂	

Skill level 2	
2	
1	
0	
NR	

- (ii) Using the above examples, describe the difference between an ionic and a covalent bond.

Skill level 2	
2	
1	
0	
NR	

- (b) Choose the substance below that would sublime. Circle the correct answer.

MgO**CO₂**

Justify your choice with reference to structure, particles and bonding of this substance.

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION FOUR: Chemistry of oxides and chlorides

(a) The oxides of the third period include the following.

Na_2O	MgO	Al_2O_3	SO_2	SO_3
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From the list above, identify one oxide (in each case) which fits the description given.

(i) An oxide that reacts with water forming a strongly alkaline solution.

(ii) An oxide that is insoluble in water.

(iii) An oxide that has a simple molecular structure.

(b) Chlorine forms compounds with phosphorus and sodium.

Compound	melting point (°C)
sodium chloride	801
phosphorous (III) chloride	-93.6
chlorine	-101.5

Explain why chlorine gas has a lower melting point than sodium chloride.

Skill level 1	
1	
0	
NR	

Skill level 1	
1	
0	
NR	

Skill level 1	
1	
0	
NR	

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION FIVE: Organic reactions

- (a) 2-Methylpropan-1-ol can also be converted to produce diesel and jet fuel. The first step in the process is the production of 2-methylpropene.



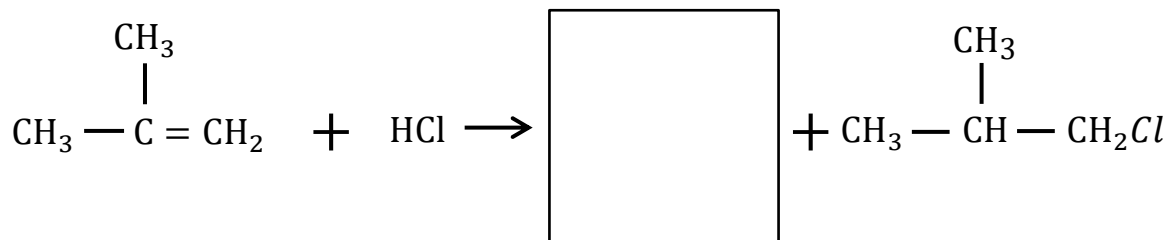
Using the data below, calculate the enthalpy change, ΔH° , in kJ mol^{-1} , for the production of 2-methylpropene from 2-methylpropan-1-ol.

- I. $4\text{C}(s) + 5\text{H}_2(g) + \frac{1}{2}\text{O}_2(g) \rightarrow \text{C}_4\text{H}_{10}\text{O}(l)$ $\Delta H = -335 \text{ kJ mol}^{-1}$
 II. $4\text{C}(s) + 4\text{H}_2(g) \rightarrow \text{C}_4\text{H}_8(g)$ $\Delta H = -17 \text{ kJ mol}^{-1}$
 III. $\text{H}_2(g) + \frac{1}{2}\text{O}_2(g) \rightarrow \text{H}_2\text{O}(g)$ $\Delta H = -242 \text{ kJ mol}^{-1}$

Skill level 3	
3	
2	
1	
0	
NR	

- (b) Methylpropene will react with HCl to give two different haloalkane products.

Draw the major products.



Skill level 2	
2	
1	
0	
NR	

(c) Methylpropan-2-ol is another isomer of 2-methylpropan-1-ol.

Which word below is used to classify this alcohol, methylpropan-2-ol.

primary

secondary

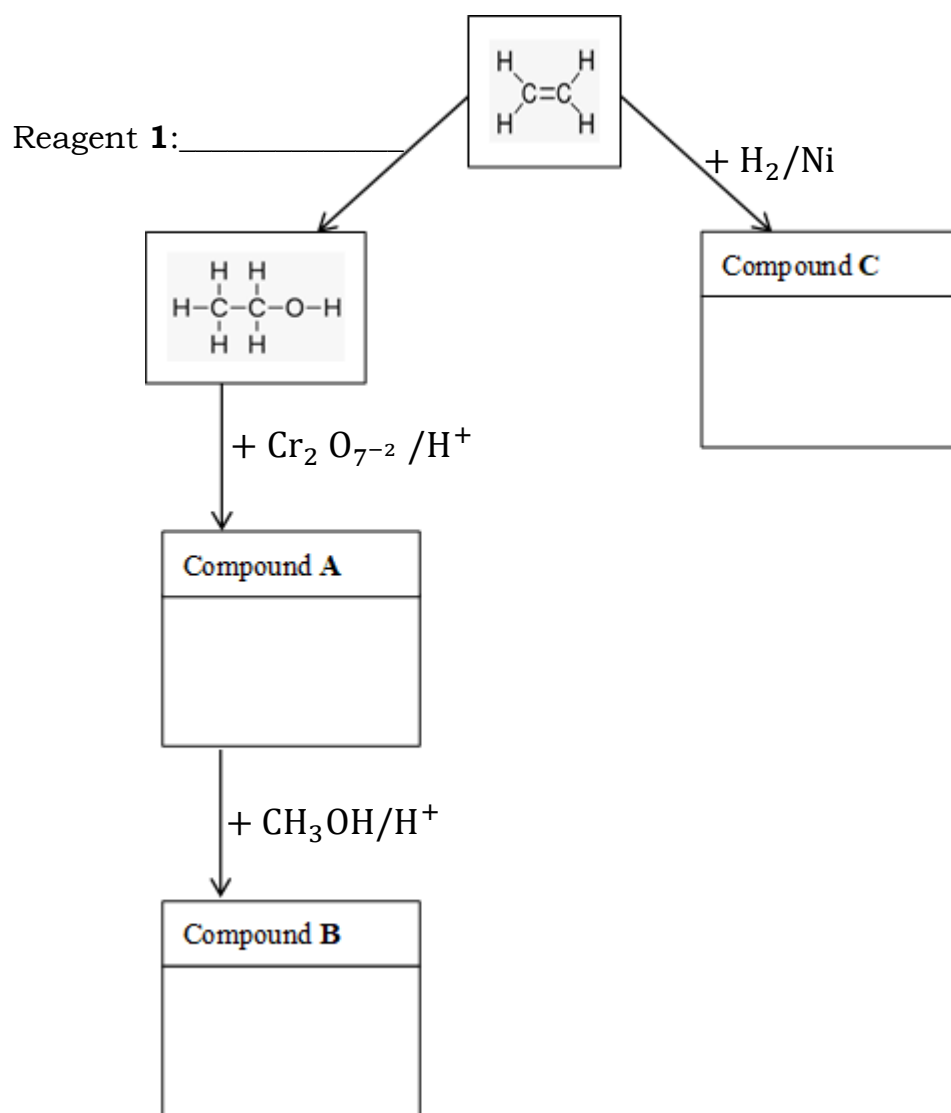
tertiary

(Circle **ONE**)

Skill level 1	
1	
0	
NR	

QUESTION SEVEN: Unknown organic compounds and polymer

- (a) Complete the following reaction scheme by drawing the structural formulae for the organic Compounds **A**, **B**, and **C**, and identifying Reagent **1**.



Skill level 4	
4	
3	
2	
1	
0	
NR	

- (b) Vinyl chloride, $\text{H}_2\text{C}=\text{CHCl}$ is a toxic chlorinated hydrocarbon. It is the monomer from which the widely used polymer polyvinyl chloride (PVC) is made.

(i) Give the systematic name (IUPAC) for vinyl chloride.

Skill level 1	
1	
0	
NR	

(ii) Draw the repeating of this polymer, PVC.

Skill level 1	
1	
0	
NR	

QUESTION EIGHT: Rate of reactions

The same volume and concentration of hydrochloric acid, $\text{HCl}(aq)$, was added to each of three test tubes. Metal samples were added, according to the table and diagram below.

test tube **1**
iron and acid



test tube **2**
copper and acid



test tube **3**
iron, copper and acid



Test tube	Contents	Observations
1	20 mL hydrochloric acid, $\text{HCl}(aq)$, and 1 g iron granules, $\text{Fe}(s)$	<i>slow rate of bubbles</i>
2	20 mL hydrochloric acid, $\text{HCl}(aq)$, and 1 g copper granules, $\text{Cu}(s)$	<i>no reaction</i>
3	20 mL hydrochloric acid, $\text{HCl}(aq)$, 1 g iron granules, $\text{Fe}(s)$, and 1 g copper granules, $\text{Cu}(s)$	<i>fast rate of bubbles</i>

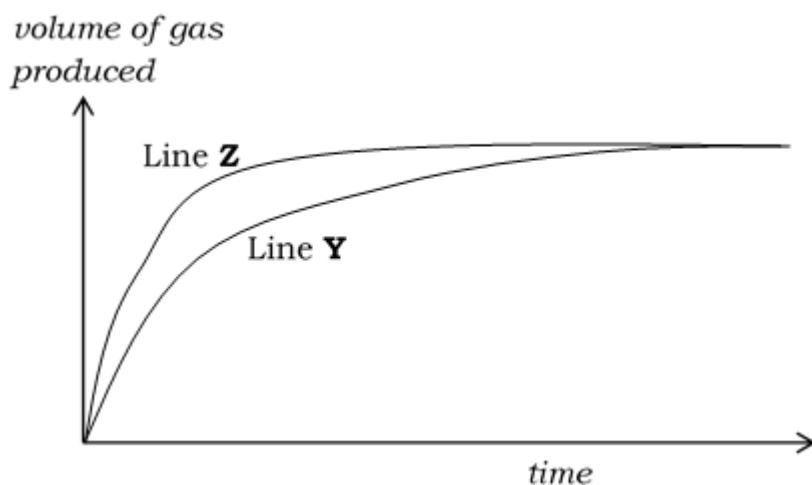
- (a) (i) Identify the role of the copper granules, $\text{Cu}(s)$, in test tube **3**.

- (ii) Describe the role of copper, $\text{Cu}(s)$, in this reaction. You should refer to activation energy and collision theory in your answer.

Skill level 1	
1	
0	
NR	

Skill level 2	
2	
1	
0	
NR	

- (b) In a second investigation, two 20 mL samples of 0.2 mol L⁻¹ sulfuric acid, H₂SO₄(aq), were placed in separate conical flasks. One of the flasks was placed in a water bath at 40°C and the other was placed in a water bath at 20°C. To each conical flask, 5.0 g of iron granules, Fe(s), were added. The gas produced was collected and measured over time and the following graph was produced



- (i) Identify which line on the graph represents the reaction at 40°C, and describe why the two lines still finish in the same position.

Line: _____

Skill level 2	
2	
1	
0	
NR	

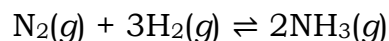
- (ii) Describe the effect of increasing temperature on the rate of reaction. Refer to collision theory and activation energy in your answer.

Skill level 2	
2	
1	
0	
NR	

QUESTION NINE: Equilibrium

- (a) The Haber process combines nitrogen, $\text{N}_2(g)$, from the air with hydrogen, $\text{H}_2(g)$, to form ammonia, $\text{NH}_3(g)$, which is then used in the manufacture of fertiliser.

The equation for this process is:



- (i) Using equilibrium and the Le Chateliers' principle, explain why carrying out the Haber process at high pressure is an advantage to the manufacturer.

[illegible]

Skill level 3	
3	
2	
1	
0	
NR	

- (ii) In another part of the process, the ammonia, $\text{NH}_3(g)$, is removed as it is produced.

Explain using equilibrium and the Le Chateliers' principle why this would be an advantage to a manufacturer.

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION TEN: Redox reactions and stoichiometry

- (a) An experiment was conducted to determine the concentration of specific types of sugar called reducing sugars. This was carried out by titration with Fehling's solution.

Reducing sugars contain an aldehyde functional group.

Determine:

- (i) the **empirical formula** of reducing sugars, $C_6H_{12}O_6$;

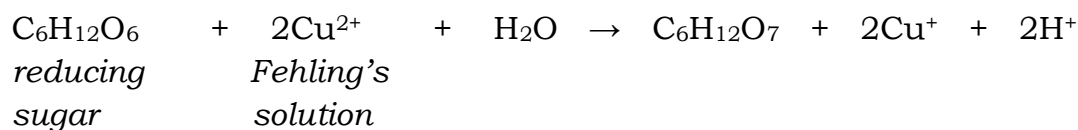
Empirical Formula: _____

- (ii) the **oxidation number** of carbon (C) in reducing sugars, $C_6H_{12}O_6$.

$C_6H_{12}O_6$ _____

Skill level 1	
1	
0	
NR	

- (b) The overall reaction that occurs with Fehling's solution and a reducing sugar is shown.



- (i) Write the ion-electron equation for the **oxidation reaction**.

Skill level 1	
1	
0	
NR	

- (ii) State the colour change that would be observed when reducing sugars are reacted with Fehling's solution.

Skill level 1	
1	
0	
NR	

(c) Complete the sentence:

In its reaction with reducing sugar ($\text{C}_6\text{H}_{12}\text{O}_6$), Fehling's solution (Cu^{2+}) is acting as an

oxidant / reductant (Circle **ONE**)

Justify your answer.

Skill level 1	
1	
0	
NR	

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I																	
1	VIII																
H 1.008																	
II																	
3 Li 6.94	4 Be 9.01																
11 Na 22.99	12 Mg 24.31																
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po 210	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226.03	103 Lr 257	Unq	Unp	Unh	Uns	Uno	Umn									
		57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	102 No 255	
		89 Ac 227.03	90 Th 232.04	91 Pa 231.04	92 U 238.08	93 Np 237.05	94 Pu 239.05	95 Am 241.06	96 Cm 247.07	97 Bk 249.08	98 Cf 251.08	99 Es 254.09	100 Fm 257.10	101 Md 258.10			