

MARKER CODE			



Student Personal Identification Number (SPIN)					

TONGA GOVERNMENT
MINISTRY OF EDUCATION AND TRAINING

Tonga National Form Seven Certificate

CHEMISTRY

2015

QUESTION and ANSWER BOOKLET

Time allowed: Three Hours

INSTRUCTIONS

1. Write your **Student Personal Identification Number (SPIN)** on the top right hand corner of this booklet.
2. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.
3. If you need more space for answers, ask the Supervisor for extra paper. Write your SPIN on all extra sheets used and clearly number the questions. Attach the extra sheets at the appropriate places in this booklet.
4. Show all working. Unless otherwise stated, numerical answers correct to three significant figures will be adequate.

QUESTION		Pages	Time (mins)	Total
QUESTION 1	Atomic structure, bonding & related properties	2-3	18	10
QUESTION 2	Organic chemistry	4-5	18	10
QUESTION 3	Energy changes in chemical and physical processes	6-7	18	10
QUESTION 4	Organic, oxidation and reduction reactions	8-9	18	10
QUESTION 5	Oxidation & reduction	10 -11	18	10
QUESTION 6	Equilibrium	12-14	18	10
QUESTION 7	Atomic structure and bonding	15-16	18	10
QUESTION 8	Organic chemistry	17-18	18	10
QUESTION 9	Atomic structure and bonding	19-20	18	10
QUESTION 10	Equilibrium	21-23	18	10
TOTAL		23 pages	180 mins	100 Marks

Check that this booklet contains pages 2-27 in the correct order. Pages 24 and 26 have been deliberately left blank.

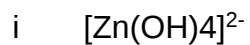
A periodic table has been provided at the end of this booklet (page 25).

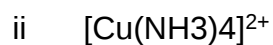
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Question 1: Atomic Structure, Bonding & Related properties

10 Marks

a) Name the following complex ions:





Skill level 1	
1	
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Skill level 1	
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b) i Write the balanced chemical equation for the formation of the complex ion:
 $[\text{Ag}(\text{NH}_3)_2]^+$

ii Name the complex ion $[\text{Ag}(\text{NH}_3)_2]^+$

Skill level 3	
3	
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Table 1: Trends in the sizes of some atoms and their ions.

Group 1	Group 2	Group 13	Group 16	Group 17
Li^+  90 Li 134	Be^{2+}  59 Be 90	B^{3+}  41 B 82	O^{2-}  126 O 73	F^-  119 F 71
Na^+  116 Na 154	Mg^{2+}  86 Mg 130	Al^{3+}  68 Al 118	S^{2-}  170 S 102	Cl^-  167 Cl 99
K^+  152 K 196	Ca^{2+}  114 Ca 174	Ga^{3+}  76 Ga 126	Se^{2-}  184 Se 116	Br^-  182 Br 114
Rb^+  166 Rb 211	Sr^{2+}  132 Sr 192	In^{3+}  94 In 144	Te^{2-}  207 Te 135	I^-  206 I 133

Sizes of atoms and their ions (in pm)

Use **Table 1** above to:

- i Explain the trend in size from Lithium atom (Li^+) to the Oxide ion (O^{2-}).

Skill level 2	
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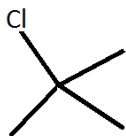
- ii State the trend in the sizes of the ions of aluminium and explain this trend.

Skill level 3	
3	
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Question 2: Organic Chemistry

10 Marks

- a) State the IUPAC name of the chloroalkane that has the following structural formula.



IUPAC name: _____

Skill level 1	
1	
0	
NR	

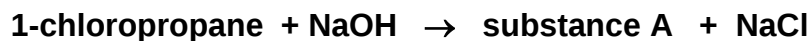
- b) **Propanone** is a ketone.

- i. Write down the structural formula of a *functional isomer* of **propanone**.

- ii. Explain your answer in i) above.

Skill level 2	
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- c) If a haloalkane such as 1-chloropropane is heated under reflux with a solution of sodium hydroxide, the chemical reaction shown below takes place:



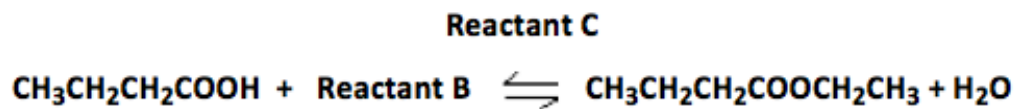
- i. What is the chemical formula for substance A?

- ii. What is the name given to the type of reaction happening above?

- iii. Describe how the reaction in (ii) takes place.

Skill level 3	
3	
2	
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- d) An important chemical reaction is shown below.



- i. Write the structural formula for Reactant B.

- ii. Name Reactant C.

- iii. What is the IUPAC name for the product $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3$?

- iv. Name the type of reaction that takes place here.

Skill level 4	
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Question 3: Energy Changes in chemical and Physical processes 10 Marks

a) Define the following terms:

i Heat of fusion

Skill level 1	
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NR	

ii Standard heat of reaction

Skill level 1	
1	
0	
NR	

b) In terms of a chemical reaction being endothermic or exothermic, which one occurs during the process of bond formation?

Skill level 1	
1	
0	
NR	

- c) Use the bond enthalpies in **Table 2** to calculate the enthalpy change of the following reaction:

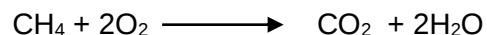
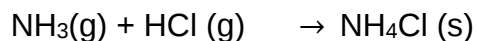


Table 2: Bond Enthalpies

Table of bond enthalpies / kJ mol ⁻¹	
C-C	348
C-H	412
C-O	360
C=C	612
C=O	743
Cl-Cl	242
O-H	463
Cl-H	431
C-Cl	338
O=O	496
Ref: CRC Handbook of chemistry and physics - Edition 44	

Skill level 3	
3	
2	
1	
0	
NR	

- d) Use the given values for standard enthalpy of formation to calculate the standard enthalpy change for the reaction:



$$\Delta H_f(\text{NH}_3(\text{g})) = -46.1 \text{ kJ mol}^{-1}$$

$$\Delta H_f(\text{HCl}(\text{g})) = -92.3 \text{ kJ mol}^{-1}$$

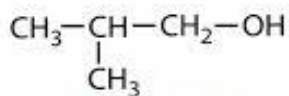
$$\Delta H_f(\text{NH}_4\text{Cl}(\text{s})) = -314.4 \text{ kJ mol}^{-1}$$

Skill level 4	
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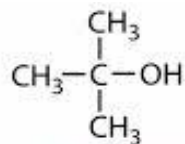
Question 4: Organic, Oxidation and Reduction Reactions

10 Marks

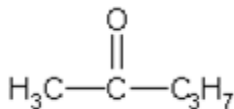
- a) Use the IUPAC naming system to name the following organic isomers.



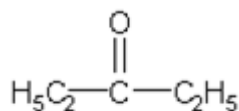
i _____



ii _____



iii _____



iv _____

Skill level 1	
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Skill level 1	
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Skill level 1	
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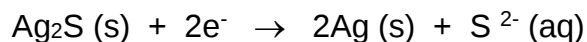
Skill level 1	
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- b) Polyethylene is a rubber-like substance, which is stretchable under force but returns to its original state upon release. Relate the structure and bonding of polyethylene to this property.

Skill level 3	
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2	
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c) The diagram below demonstrates black tarnish on silver metal. It is known that the black tarnish is primarily Ag_2S .

By using the right reducing agent, the black tarnish (Ag_2S) can be removed as shown in the half-equation below:



The standard reduction potentials for Zn and Ag₂S are shown below:

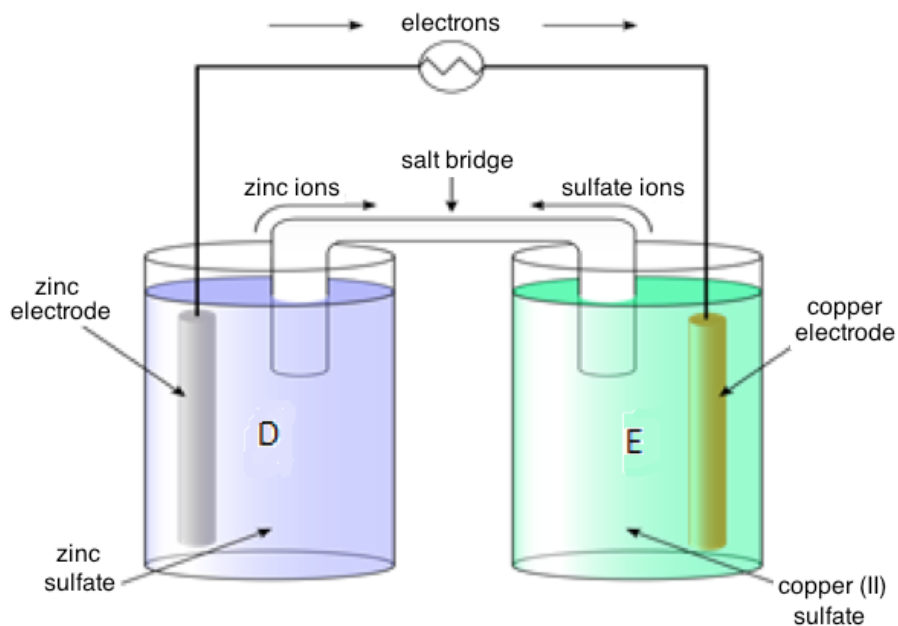
Half reaction	E° (V)
$\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^- \rightleftharpoons \text{Zn (s)}$	- 0.7681
$\text{Ag}_2\text{S (s)} + 2 \text{e}^- \rightleftharpoons 2\text{Ag (s)} + \text{S}^{2-} (\text{aq})$	- 0.71

- i. Determine the overall redox reaction for the possible reduction of Ag_2S by Zn metal.
- ii. Use the E° cell value to predict whether the above reaction is possible.

Skill level 3	
3	
2	
1	
0	
NR	

Question 5: Oxidation & Reduction

10 Marks

 a) **Figure 2: Redox**

 i. At which half-cell (D or E) does the **oxidation** reaction take place?

 ii. At which half-cell (D or E) does the **reduction** reaction take place?

 b) Write the **balanced half-equation** for the reaction in half-cell E.

 c) Describe the difference between an **electrochemical** and an **electrolytic cell**.

Skill level 1	
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Skill level 1	
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Skill level 2	
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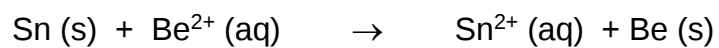
Skill level 2	
2	
1	
0	
NR	

d)

The standard reduction potentials for selected half reactions are shown below:

Half reaction	E° (V)
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Sn (s)}$	- 0.14
$\text{Be}^{2+} + 2\text{e}^- \rightleftharpoons \text{Be (s)}$	- 1.99

Predict whether the reaction below will occur spontaneously:



Skill level 4	
4	
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Question 6: Equilibrium**10 Marks**

- a) What happens to the equilibrium constant (K_c) of a system when the pressure is increased?

Skill level 1	
1	
0	
NR	

- b) Explain how a buffer solution of $\text{CH}_3\text{COONH}_4$ works when a small amount of a strong acid is added to it.

Skill level 2	
2	
1	
0	
NR	

d) What is the concentration of silver ions in 1 L of solution containing 0.02 mol of AgCl and 0.02 mol of Cl⁻ ions in the following equilibrium?



The equilibrium constant is 1.5×10^{-10}

[illegible]

Skill level 4	
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Question 7: Atomic Structure and Bonding**10 Marks**

- a) What does the high melting point of Ni suggests?

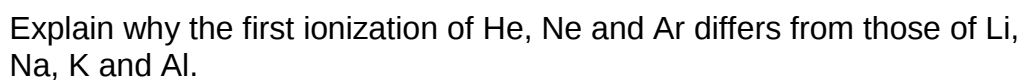
Skill level 1	
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- b) Describe the differences between nuclear fusion and nuclear fission.

Skill level 2	
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- c) Determine the shape of BF_3 showing how you arrive at your answer.

Skill level 3	
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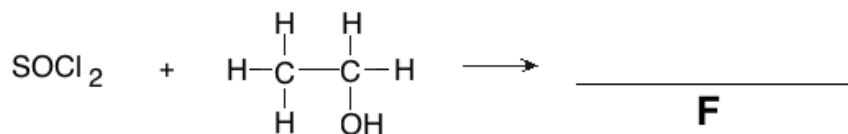
[illegible]

Skill level 4	
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Question 8: Organic Chemistry

10 Marks

- a) i Write down the structural formula of the missing product (F) of the following reaction.



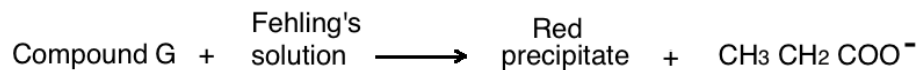
Skill level 2	
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- ii What precaution that needs to be taken during this reaction?

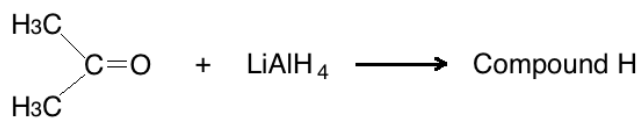
Skill level 1	
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- b) Use the following reactions to identify the unknown compounds **G** and **H**.

Reaction 1:



Reaction 2:



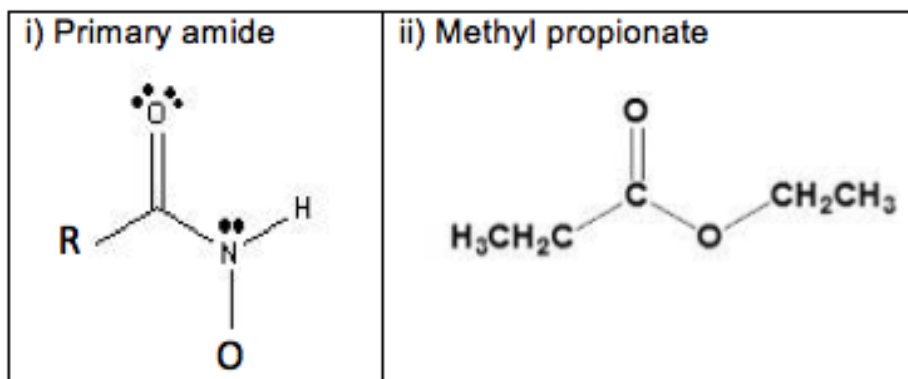
Write the structural formulae of **G** and **H**.

G:

H:

Skill level 3	
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You have been asked to review a chapter of an organic textbook. A sample of the structural formulae and names of the chemicals is presented below.



Would you approve for the chapter to be printed? Justify your decision. Write your answer in the space below.

[illegible]

Skill level 4	
4	
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Question 9: Atomic Structure and Bonding**10 Marks**

a) There are 6 fundamental nuclear decay reactions.

i) Name the nuclear decay that results in the emission of a helium atom.

Skill level 1	
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ii) Name the nuclear decay that results in the conversion of a neutron to a proton and a high energy electron is emitted.

Skill level 1	
1	
0	
NR	

iii) Define enthalpy change.

Skill level 1	
1	
0	
NR	

b) One of the characteristic properties of transition metals are the differences in colour of their compounds.
Describe the colour differences of the following compounds of transition metals:

K₂Cr₂O₇, NiCl₂ and CuSO₄

Skill level 2	
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c) Describe the relationship between a polar molecule such as water and hydrogen bonding.

Skill level 2	
2	
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NR	

d) Radioactive Iodine-131 is used in the Hospitals in the treatment of cancerous thyroid tissues. Iodine-131 has a half-life of 8 days. If 20 mg of Iodine-131 is given to a patient how much of it is left after 32 days?

[illegible]

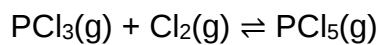
Skill level 3	
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1	
0	
NR	

Question 10: Equilibrium**10 Marks**

- a) Define buffer solution.

Skill level 1	
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0	
NR	

- b) Consider the following reaction:



Describe how the equilibrium position will be affected by an increase in the PCl_3 concentration.

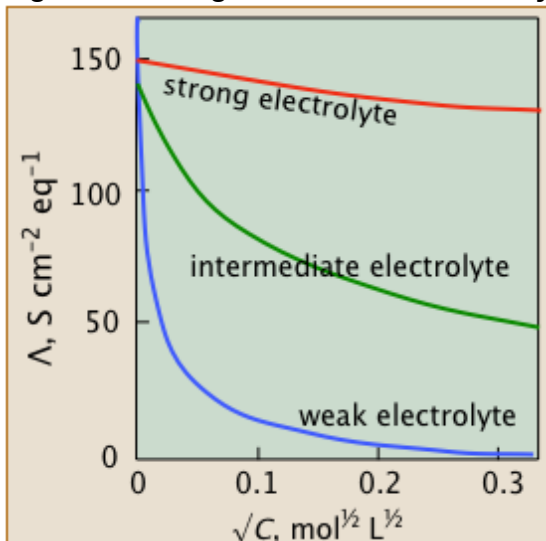
Skill level 2	
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[illegible]

Skill level 3	
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Compare the conductance and pH of KCl, NH₃, and CH₃COONa to those of the strong, intermediate and weak ones shown in **Figure 4** below. In your answer, explain why KCl, NH₃, and CH₃COONa are considered as either a strong, intermediate or weak electrolyte.

Figure 4: Strength of Different Electrolytes.

[illegible]

Skill level 4	
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The periodic table:

hydrogen 1 H 1.0079																	helium 2 He 4.0026	
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	
sodium 11 Na 22.990	magnesium 12 Mg 24.305																	
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80	
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29	
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 ★	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 ★ ★	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununilium 110 Uun [271]	ununium 111 Uuu [272]	unubium 112 Uub [277]	ununquadium 114 Uuq [289]					

*Lanthanide series

* * Actinide series

lanthanum 57	cerium 58	praseodymium 59	neodymium 60	promethium 61	samarium 62	euporium 63	gadolinium 64	terbium 65	dysprosium 66	holmium 67	erbium 68	thulium 69	ytterbium 70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
138.91	140.12	140.91	144.24	[145]	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04
actinium 89	thorium 90	protactinium 91	uranium 92	neptunium 93	plutonium 94	americium 95	curium 96	berkelium 97	californium 98	einsteinium 99	fermium 100	mendelevium 101	nobelium 102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
[227]	232.04	231.04	238.03	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]

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Student Personal Identification Number (SPIN)

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Tonga National Form Seven Certificate 2015

CHEMISTRY

(For Markers Use Only)

QUESTIONS	MARK	CHECK MARKER	TOTAL
1			10
2			10
3			10
4			10
5			10
6			10
7			10
8			10
9			10
10			10
TOTAL MARKS			100