NCUK

THE NCUK INTERNATIONAL FOUNDATION YEAR

IFYCH002 Chemistry
End of Semester 1 Test

2016-17

Test Session	**Time Allowed**
Semester One	2 Hours 10 minutes
	(including 10 minutes reading time)

INSTRUCTIONS TO STUDENTS

SECTION A	**Answer ALL questions. This section carries 60 marks.**
SECTION B	**Answer TWO questions. This section carries 40 marks.**

The marks for each question are indicated in square brackets [ ].

- Answers must not be written during the first 10 minutes.
- A data sheet is included in the front of the test booklet.
- Graph paper will be provided.
- An approved calculator may be used in the test.
- Show **ALL** workings in your answer booklet.
- Test materials must not be removed from the room.

DO NOT OPEN THIS QUESTION PAPER UNTIL INSTRUCTED BY THE INVIGILATOR

The Periodic Table of the Elements

- The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

Key

6.9		
Li	relative atomic mass	
Lithium		
3	atomic number	

I	II												III	IV	V	VI	VII	0
1.0 **H** Hydrogen 1																		4.0 **He** Helium 2
6.9 **Li** Lithium 3	9.0 **Be** Beryllium 4												10.8 **B** Boron 5	12.0 **C** Carbon 6	14.0 **N** Nitrogen 7	16.0 **O** Oxygen 8	19.0 **F** Fluorine 9	20.2 **Ne** Neon 10
23.0 **Na** Sodium 11	24.3 **Mg** Magnesium 12												27.0 **Al** Aluminium 13	28.1 **Si** Silicon 14	31.0 **P** Phosphorus 15	32.1 **S** Sulphur 16	35.5 **Cl** Chlorine 17	39.9 **Ar** Argon 18
39.1 **K** Potassium 19	40.1 **Ca** Calcium 20	45.0 **Sc** Scandium 21	47.9 **Ti** Titanium 22	50.9 **V** Vanadium 23	52.0 **Cr** Chromium 24	54.9 **Mn** Manganese 25	55.8 **Fe** Iron 26	58.9 **Co** Cobalt 27	58.7 **Ni** Nickel 28	63.5 **Cu** Copper 29	65.4 **Zn** Zinc 30	69.7 **Ga** Gallium 31	72.6 **Ge** Germanium 32	74.9 **As** Arsenic 33	79.0 **Se** Selenium 34	79.9 **Br** Bromine 35	83.8 **Kr** Krypton 36
85.5 **Rb** Rubidium 37	87.6 **Sr** Strontium 38	88.9 **Y** Yttrium 39	91.2 **Zr** Zirconium 40	92.9 **Nb** Niobium 41	95.9 **Mo** Molybdenum 42	98.9 **Tc** Technetium 43	101.1 **Ru** Ruthenium 44	102.9 **Rh** Rhodium 45	106.4 **Pd** Palladium 46	107.9 **Ag** Silver 47	112.4 **Cd** Cadmium 48	114.8 **In** Indium 49	118.7 **Sn** Tin 50	121.8 **Sb** Antimony 51	127.6 **Te** Tellurium 52	126.9 **I** Iodine 53	131.3 **Xe** Xenon 54
132.9 **Cs** Caesium 55	137.3 **Ba** Barium 56	138.9 **La** Lanthanum 57 *	178.5 **Hf** Hafnium 72	180.9 **Ta** Tantalum 73	183.9 **W** Tungsten 74	186.2 **Re** Rhenium 75	190.2 **Os** Osmium 76	192.2 **Ir** Iridium 77	195.1 **Pt** Platinum 78	197.0 **Au** Gold 79	200.6 **Hg** Mercury 80	204.4 **Tl** Thallium 81	207.2 **Pb** Lead 82	209.0 **Bi** Bismuth 83	210.0 **Po** Polonium 84	210.0 **At** Astatine 85	222.0 **Rn** Radon 86
223.0 **Fr** Francium 87	226.0 **Ra** Radium 88	227 **Ac** Actinium 89 †															

* 58 – 71 Lanthanides

140.1 **Ce** Cerium 58	140.9 **Pr** Praseodymium 59	144.2 **Nd** Neodymium 60	144.9 **Pm** Promethium 61	150.4 **Sm** Samarium 62	152.0 **Eu** Europium 63	157.3 **Gd** Gadolinium 64	158.9 **Tb** Terbium 65	162.5 **Dy** Dysprosium 66	164.9 **Ho** Holmium 67	167.3 **Er** Erbium 68	168.9 **Tm** Thulium 69	173.0 **Yb** Ytterbium 70	175.0 **Lu** Lutetium 71

† 90 – 103 Actinides

232.0 **Th** Thorium 90	231.0 **Pa** Protactinium 91	238.0 **U** Uranium 92	237.0 **Np** Neptunium 93	239.1 **Pu** Plutonium 94	243.1 **Am** Americium 95	247.0 **Cm** Curium 96	247.1 **Bk** Berkelium 97	252.1 **Cf** Californium 98	252.0 **Es** Einsteinium 99	257.0 **Fm** Fermium 100	258.0 **Md** Mendelevium 101	259.0 **No** Nobelium 102	260.0 **Lr** Lawrencium 103

Section A
Answer ALL questions. This section carries 60 marks.

Question A1

How many neutrons does an atom of ^{23}Na have? **[1]**

a) 11

b) 12

c) 22

d) 23

Question A2

Which of the following is the correct electron configuration for sodium? **[1]**

a) $1s^2 2s^2 2p^6 3s^2$

b) $1s^2 2s^2 2p^6 3s^1$

c) $1s^2 2s^2 3s^2 3p^6 4s^2$

d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Question A3

What is the correct name for $K_2[CuCl_4(H_2O)_2]$? **[1]**

a) Potassium diaquatetrachlorocopper (IV)

b) Potassium diaquatetrachlorocopper (II)

c) Potassium diaquatetrachlorocuprate (IV)

d) Potassium diaquatetrachlorocuprate (II)

Question A4

What is the oxidation state of Cl in $HClO_4$? **[1]**

a) -1

b) +5

c) +7

d) -2

Question A5

Which of the following elements has the highest first ionisation energy?   **[1]**

a)   Be

b)   Sr

c)   O

d)   B

Question A6

What is the bond angle in the molecule CH_4 ?   **[1]**

a)   109.5⁰

b)   120⁰

c)   180⁰

d)   90⁰

Question A7

Which of the following has the highest electronegativity ?   **[1]**

a)   Carbon

b)   Bromine

c)   Oxygen

d)   Neon

Question A8

Which of the following is the correct formula for aluminium bromide?   **[1]**

a) Al_3Br

b) $AlBr_3$

c) $BrAl_2$

d) $AlBr_2$

Question A9

Which of the following compounds exhibits an ionic structure? **[1]**

a) Magnesium oxide

b) Diamond

c) Graphite

d) Carbon dioxide

Question A10

What is the molecular weight of NaClO ? **[1]**

a) 102.9 gmol^{-1}

b) 100 gmol^{-1}

c) 74.5 gmol^{-1}

d) 118.9 gmol^{-1}

Question A11

a) Chromium has the following isotopic masses and percentage abundances:

Isotopic Mass (a.m.u.)	Percentage Abundance
49.9	4.35%
51.9	83.79%
52.9	9.50%
53.9	2.35%

What is the relative atomic mass of chromium ? **[3]**

b) An analysis of sodium dichromate gives the following mass percentages: 17.5% Na, 39.7% Cr and 42.8% O.

What is the empirical formula of this compound? **[4]**

c) What colour is sodium dichromate ? **[1]**

d) The electronic configuration of chromium is [Ar]4s^{1}3d^5

Explain why chromium has this electron configuration. **[2]**

Question A12

a) Nitrogen is a diatomic molecule. Draw a dot and cross diagram to show the bonding in this molecule. **[2]**

b) What intermolecular forces exist between two molecules of nitrogen ? **[1]**

c) Write the electron configuration of an atom of nitrogen. **[1]**

d) The nitrogen atom has s and p orbitals only. Draw and label an s and a p orbital. **[2]**

e) In terms of electrons, explain why nitrogen is in group 5 of the periodic table. **[1]**

f) NH_3 can react with BF_3 to form BF_3NF_3. What type of bonding exists between nitrogen and boron ? Use a dot and cross diagram to display this. **[3]**

Question A13

This question is about group II.

a) Write a balanced equation for the reaction between magnesium and water. Include state symbols. **[3]**

b) i. Write a balanced equation for the reaction between barium chloride and sodium sulphate. Include state symbols. **[3]**

c) When calcium is burnt in oxygen what colour is the flame ? **[1]**

d) Which of the following has greater solubility in water ?

   i. Magnesium sulphate or strontium sulphate **[1]**

   ii. Magnesium hydroxide or strontium hydroxide **[1]**

e) Give a medical use for magnesium hydroxide. **[1]**

Question A14

a) Write the electronic configuration of the Mg^{2+} ion. **[1]**

b) Give the equation for the second ionisation energy of magnesium. **[2]**

c) Calculate the mass (to three significant figures) of silver chloride formed when 2.00g of magnesium chloride is reacted with excess silver nitrate according to the equation below: **[4]**

$$MgCl_2 \ + \ 2AgNO_3 \longrightarrow 2AgCl \ + \ Mg(NO_3)_2$$

d) The relative atomic mass of magnesium can be accurately obtained using a mass spectrometer.

    i. Explain how the ions are formed in the spectrometer. **[1]**

    ii. Explain how the ions are separated in the spectrometer. **[2]**

Question A15

A chemist wishes to find out the amount of copper in a sample of bronze (an alloy of copper and zinc). To perform the analysis, the bronze is reacted with concentrated nitric acid. This process converts all the copper to Cu^{2+} ions. The resulting solution is then made up in a volumetric flask. Portions of this solution are reacted with a solution of potassium iodide and the iodine formed is titrated against a standardised solution of sodium thiosulphate. The equations for these reactions are given below:

$$2Cu^{2+} \ + \ 4I^- \longrightarrow Cu_2I_2 \ + \ I_2$$

$$2S_2O_3^{2-} \ + \ I_2 \longrightarrow S_4O_6^{2-} \ + \ 2I^-$$
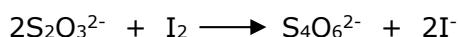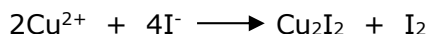
a)   i. What is the oxidation state of Cu in Cu_2I_2 ? **[1]**

    ii. What is the oxidation state of S in $S_2O_3^{2-}$? **[1]**

b) 1.05g of the alloy was treated in this way and the resulting solution was made up to $250cm^3$ in a volumetric flask. $25cm^3$ of this solution, when reacted with potassium iodide, needed $25.85cm^3$ of sodium thiosulphate solution of concentration $0.046moldm^{-3}$ for complete reaction.

    i. How many moles of $S_2O_3^{2-}$ are contained in $25.85cm^3$ of the solution? **[1]**

    ii. How many moles of copper ions, Cu^{2+}, is this equivalent to ? **[2]**

    iii. How many moles of Cu^{2+} are contained in the $250cm^3$ volumetric flask. **[1]**

    iv. What mass of Cu is this equal to ? **[2]**

    v. What is the percentage of copper in the sample of bronze ? Give your answer to 3 significant figures. **[2]**

Section B
Answer 2 questions ONLY.
This section carries 40 marks.

Question B1

a) What shape would you expect for the following molecules:

    i. CF_3 **[1]**

    ii. BrH_3 **[1]**

    iii. H_2O **[1]**

b) The main constituent of milk of magnesia is $Mg(OH)_2$. In order to neutralise the $Mg(OH)_2$ in a sample, $50.0cm^3$ of $0.500 moldm^{-3}$ HCl was added to a 5.44g sample of milk of magnesia.

    i.   Write a balanced equation for this reaction. **[2]**

    ii. Calculate the mass of $Mg(OH)_2$ in the milk of magnesia and quote your answer as a percentage of the total mass. **[3]**

c) State what would be observed, if anything, in the following reactions:

    i.   Chlorine gas added to potassium bromide solution. **[1]**

    ii. Bromine gas added to sodium chloride solution. **[1]**

    iii. Bromine gas added to sodium iodide solution. **[1]**

    iv. Silver nitrate solution added to sodium bromide solution. **[1]**

    v. Concentrated ammonia added to silver chloride. **[1]**

d) i.   List the intermolecular forces present in hydrogen halides. Explain why hydrogen fluoride has a higher boiling point than hydrogen chloride. **[2]**

    ii. Explain why chlorine is a gas, bromine is a liquid, and iodine is a solid. **[3]**

    iii. Explain why iodine is a weaker oxidising agent than fluorine. **[2]**

Question B2

Calculate the mass of the following to two decimal places. (Avagadro's number is 6.023×10^{23})

a) 0.6 moles of magnesium metal.   **[4]**

b) 0.135 moles of hydrogen chloride gas.   **[4]**

c) 6.023×10^{22} particles of sodium metal.   **[4]**

d) 6.023×10^{21} particles of sodium metal.   **[4]**

e) 11,000cm^3 of hydrogen gas at standard temperature and pressure. (Assume 1 mole of gas occupies 22.4dm^3 at standard temperature and pressure.)   **[4]**

Question B3 is on the next page

Question B3

This question is about transition metals and redox.

a) Scandium is a d block element but is not considered to be a transition metal. **[3]**

   Explain this statement. Your answer should include the electronic configuration of scandium in its ground state and in its main oxidation state.

b) Manganese has many oxidation states. What is the oxidation state of Mn in:

   i. $KMnO_4$? **[1]**

   ii.   MnO ? **[1]**

   iii. $MnCl_2$? **[1]**

   iv.   Mn metal ? **[1]**

c) Transition metal complexes are often coloured.

   i.   State what is meant by a "transition metal complex". **[2]**

   ii.   Name three factors that can determine the colour of a transition metal complex. **[3]**

   iii. Explain why an octahedral transition metal complex displays a characteristic colour. **[4]**

d) Hexaaquacopper ions undergo ligand exchange with chloride ions to form a tetrahedral complex.

   i.   Draw the complex ion formed. **[2]**

   ii.   What is the shape of this complex ? **[1]**

   iii. What would be observed during the formation of this complex ? **[1]**

This is the end of the Test.