NCUK

THE NCUK INTERNATIONAL FOUNDATION YEAR

IFYCH002 Chemistry
End of Semester 1 Test

2016-17

Test Session
Semester One

Time Allowed
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.

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 †															

Key

relative atomic mass — 6.9 **Li** Lithium

atomic number — 3

* **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	247.1 **Cm** Curium 96	247.1 **Bk** Berkelium 97	252.1 **Cf** Californium 98	(252) **Es** Einsteinium 99	(257) **Fm** Fermium 100	(258) **Md** Mendelevium 101	(259) **No** Nobelium 102	(260) **Lr** Lawrencium 103

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

Question A1

An atom of ^{40}Ca has how many neutrons? **[1]**

a) 20

b) 21

c) 22

d) 23

Question A2

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

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

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

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 type of bonding exists between sodium and chlorine in NaCl? **[1]**

a) Hydrogen bonding

b) Metallic bonding

c) Coordinate bonding

d) Ionic bonding

Question A4

Which of the following compounds is the least soluble in water ? **[1]**

a) Barium sulphate

b) Calcium carbonate

c) Calcium sulphate

d) Barium hydroxide

Question A5

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

a) N

b) O

c) P

d) Br

Question A6

[1]

On the periodic table, atomic radius decreases:

a) Down a group, and left to right across a period.

b) Up a group, and left to right across a period.

c) Down a group, and right to left across a period.

d) Up a group, and right to left across a period.

Question A7

What is the correct name for $Na_2[NiCl_4]$? **[1]**

a) Sodium nickeltetrachlorate (II)

b) Nickel sodiumtetrachlorate (I)

c) Sodium tetrachloronickelate (II)

d) Sodium nickeltetrachlorate (I)

Question A8

Which of the following have the same number of particles as 12g of ^{12}C? **[1]**

a) 12g of H_2O

b) 12g of Mg

c) 14g of S

d) 44g of CO_2

Question A9

Which definition suits the following isotope: ^{15}N? **[1]**

a) An atom of 7 protons, 7 electrons and 8 neutrons

b) A cation of 7 protons, 6 electrons and 8 neutrons.

c) An anion of 7 protons, 8 electrons and 8 neutrons.

d) An atom of 7 protons, 7 electrons and 7 neutrons.

Question A10

What is the shape of the molecule ammonia, NH_3 ? **[1]**

a) Pyramidal

b) Square planar

c) Tetrahedral

d) Trigonal bipyramidal

Question A11

This question is about redox chemistry.

a) i. Define the term “reduction”. **[1]**

ii. State the oxidation number of the named element in each of the following compounds

I Manganese in $KMnO_4$ **[1]**

II Nitrogen in NO_2 **[1]**

III Nitrogen in HNO_3 **[1]**

IV Chlorine in HClO **[1]**

b) The following reaction can be described as a redox reaction:

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$$

i. Identify the element that has been oxidised. **[1]**

ii. Identify the element that has been reduced. **[1]**

c) The following reaction is an example of a disproportionation reaction: **[3]**

$$Cl_2 + 2NaOH \longrightarrow H_2O + NaCl + NaClO$$

Using this equation, describe what a disproportionation reaction is.

Question A12

This question is about atomic structure.

a) i. Explain why the nitrogen molecule is non polar. **[1]**

ii. What is the difference between ^{14}N and ^{16}N atoms ? **[1]**

iii. Explain why the two isotopes in a(ii) have identical chemical properties. **[1]**

b) Draw a fully labelled diagram showing a hydrogen bond between two water molecules. **[3]**

c) Complete the table below: **[4]**

Compound Formula	Number of Lone Pairs	Number of Bonded Pairs	Name of Shape
BF_3			
NH_3			
SF_6			
H_2O			

Question A13

The first ionisation energies of some of the elements in periods 2 and 3 are shown below. Some ionisation energies have been omitted. The units are $kJmol^{-1}$.

Period	Group						
	I	II	III	IV	V	VI	VII
2	**Li** 520	**Be**	**B** 801	**C** 1086	**N** 1402	**O** 1314	**F** 1681
3	**Na** 496	**Mg** 738	**Al** 578	**Si**	**P** 1012	**S** 1000	**Cl** 1251

a) Define the term “first ionisation energy”. **[2]**

b) i. Explain why there is a decrease in the value for the first ionisation energy from magnesium to aluminium. **[2]**

ii. Explain why there is a decrease in the value of the first ionisation energy from lithium to sodium. **[2]**

c) i. Predict the values for the first ionisation energies of beryllium and silicon. **[2]**

ii. Using your knowledge of the trend in first ionisation energies, arrange the following elements in order of increasing ionisation energy:
Ge, As, Se, Br. **[2]**

Question A14

This question is about molarity and reacting masses in reactions of group 2 and group 7 elements.

1.0g of calcium hydroxide $Ca(OH)_2$ is dissolved in water. A concentrated solution of sodium carbonate Na_2CO_3 is added and a white precipitate of calcium carbonate appears.

a) i. Give the balanced equation for the reaction producing this white precipitate. **[1]**

ii. When no more precipitate is produced the addition of sodium carbonate is stopped and the calcium carbonate is filtered off, thoroughly dried and weighed. What is its mass ? **[1]**

iii. How many molecules of calcium carbonate are there in the precipitate? (Avagadro's number is 6.02×10^{23}) **[1]**

b) One molar hydrochloric acid solution is slowly added to the precipitate until it is just completely dissolved. Carbon dioxide is given off.

i. What volume of hydrochloric acid solution has been added when this point is reached ? **[2]**

ii. How many grams of carbon dioxide are produced ? **[2]**

iii. Give another method by which carbon dioxide may be produced from calcium carbonate. **[1]**

c) What will happen if silver nitrate solution is added to the solution in b) after all the carbon dioxide has been given off ? Give an equation. **[2]**

Question A15

This question is about carbon and some of its compounds.

a) Using "box notation", draw the full electronic configuration of carbon labelling each set of orbitals. **[2]**

b) Naturally occurring carbon exists as two isotopes. The percentage abundances of these isotopes are 1.1% ^{13}C, 98.9% ^{12}C. Calculate the relative atomic mass of carbon to two decimal places. **[2]**

c) i. Briefly describe the processes that occur inside the mass spectrometer when measuring the relative atomic mass, taking the element carbon as an example. **[5]**

ii. Why is the mass spectrometer evacuated (emptied) of air before any sample is introduced into it ? **[1]**

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

Question B1

a) i. Which would you expect to have the larger radius, S or S^{2-}? Explain why. **[3]**

ii. Draw the dot and cross diagram for S^{2-}. **[1]**

b) Explain the following:

i. Why do most monatomic cations, such as Na^{+}, have a charge equal to the group number in the periodic table that they are in ? **[1]**

ii. Why do most monatomic anions, such as Cl^{-}, have a charge equal to their group number minus eight ? **[1]**

c) For the following pairs of elements state the type of bonding that is present between the atoms and give the molecular formula.

i. Sr and O **[2]**

ii. C and Br **[2]**

iii. Al and F **[2]**

iv. Ca and Cl **[2]**

d) Give an example of a compound that has coordinate covalent bonding. **[1]**

e) i. An ionic compound has the following percentage composition: **[4]**

23.3% Mg, 30.7% S, 46.0% O

Calculate the empirical formula of this compound.

ii. What is the name of the compound in e (i) ? **[1]**

Question B2

This question is about elements found in group II and group VII of the periodic table, and those in periods 2 and 3.

a) i. State the complete electronic structure of calcium. **[1]**

ii. Give an equation, including state symbols, for the reaction of calcium metal and hydrochloric acid. **[2]**

iii. Explain with reasons whether you would expect the first ionisation energy of calcium to be less than or greater than the first ionisation energy of strontium. **[3]**

b) i. Give the ionic equation for the reaction between aqueous solutions of barium ions and sulphate ions. **[2]**

ii. The hydrated form of sodium sulphate has the formula $Na_2SO_4.xH_2O$. 3.22g of this compound when added to an excess of barium chloride produced 2.33g of barium sulphate. Calculate the value of x in $Na_2SO_4.xH_2O$. **[4]**

c) i. Solid iodine consists of iodine molecules in a regular crystal lattice. What types of bonding are present in solid iodine? **[2]**

ii. How would you show that iodide ions were present in an aqueous solution ? **[2]**

iii. Give a common use for large scale amounts of chlorine. **[1]**

d) i. Give the name of an element in period 3 that forms a chloride with the formula XCl_5. **[1]**

ii. Give the formula of an oxide of an element in period 3 that will dissolve in water to form a strongly alkaline solution. **[1]**

iii. Give the name of an element in period 2 that exists in more than one form (allotrope), one of the forms being a non-metal that conducts electricity. **[1]**

Question B3

This question is about transition metal compounds.

a) Give the full electronic configuration of the Ni^{2+} ion. **[2]**

b) A compound of nickel has the composition 24.7% Ni, 40.4% O, 5.0% H, 29.9% Cl. Calculate its empirical formula. **[3]**

c) The empirical formula is found to be the same as the molecular formula. A solution in water conducts electricity. Suggest and draw the most likely three dimensional structure of the compound and explain the electrical conductivity. **[4]**

d) Name the type of bonding that takes place between the nickel in the compound and the atom(s) that nickel is bonded to. **[2]**

e) i. The compound gives a green solution in water. Explain this in terms of electronic energy levels. **[5]**

ii. Explain why adding ammonia to this solution turns it from green to blue. **[2]**

f) Give two other properties apart from colour that transition metal compounds show. **[2]**

This is the end of the test.