NCUK

THE NCUK INTERNATIONAL FOUNDATION YEAR

IFYCH002 Chemistry
End of Semester 1 Test

2017-18

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

Which element has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$? **[1]**

a) Manganese

b) Chromium

c) Cobalt

d) Iron

Question A2

What is the oxidation number of S in Al_2S_3? **[1]**

a) +2

b) -2

c) +3

d) -3

Question A3

What is the bond angle in the molecule SF_6? **[1]**

a) 120^o

b) 109.5^o

c) 90^o

d) 180^o

Question A4

How many neutrons are present in an atom of ^{40}K? **[1]**

a) 19

b) 20

c) 21

d) 22

Question A5

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

a) Magnesium hydroxide

b) Barium carbonate

c) Magnesium sulphate

d) Barium sulphate

Question A6

Which statement below best describes the arrangement of electrons in the covalent bond in the hydrogen molecule H_2? **[1]**

a) One electron is positioned close to each of the two nuclei.

b) Two electrons are positioned halfway between the two nuclei.

c) Two electrons are in an orbital spread around the two nuclei.

d) Two electrons are positioned on opposite sides of the bond between the nuclei.

Question A7

In which compound will only covalent bonding be present? **[1]**

a) Magnesium sulphate

b) Calcium oxide

c) Sulphur dioxide

d) Magnesium carbonate

Question A8

What type(s) of bonding is/are present in ammonium chloride, NH_4Cl? **[1]**

a) Ionic

b) Covalent

c) Coordinate (dative covalent)

d) All of the above

Question A9

These elements are all covalent. Only one consists of small molecules. Which? **[1]**

a) Diamond

b) Graphite

c) Carbon dioxide

d) Silicon dioxide

Question A10

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

a) 23g of Na

b) 8g of O_2

c) 36g of H_2O

d) 35.5g of Cl_2

Question A11

a) 3.50g of barium hydroxide, $Ba(OH)_2$, is dissolved in water. A concentrated solution of sodium carbonate, Na_2CO_3, is slowly added, and a white precipitate appears.

i. Give the balanced equation, including state symbols, for the reaction producing this white precipitate. **[2]**

ii. When no more precipitate is produced, the addition of sodium carbonate is stopped, and the precipitate is washed, thoroughly dried, and weighed. What is its mass? **[4]**

b) The precipitate is transferred to a crucible, heated to a very high temperature, cooled and weighed. The process is repeated until the weight is constant.

i. Give the balanced equation of the reaction occurring during the heating. Include state symbols. **[2]**

ii. What will the mass of the solid residue be after the heating? **[2]**

Question A12

a) i. Define the term isotope. **[3]**

ii. Chlorine can exist as an element which is isotopic (^{35}Cl, ^{37}Cl). For each isotope give the number of protons, electron and neutrons. **[4]**

b) Describe the difference between atoms, compounds and mixtures. **[3]**

Question A13

a) i. Write the equation for the reaction between magnesium and cold water. **[1]**

ii. Use "dot and cross" diagrams to show how magnesium and chlorine atoms bond together. **[3]**

iii. Explain why molten magnesium chloride conducts electricity but solid magnesium chloride does not. **[2]**

b) Explain how a solution of barium chloride could be used to distinguish between solutions of sodium hydroxide and sodium sulphate. Describe all observations that take place and give an ionic equation for all reactions that occur. **[4]**

Question A14

a) Copy and complete the table below in your answer booklet:

Compound Formula	Number of Bonded Pairs	Number of Lone Pairs	Name of Shape
H_2O			
PCl_3			

[6]

b) i. Draw a "dot and cross" diagram to show the bonding in sulphur difluoride. **[2]**

ii. Sulphur difluoride contains polar bonds. Show the polarity of the S-F bond and briefly explain how this polarity arises. **[2]**

Question A15

a) Comment on the factors which favour a strong ionic bond in a crystal lattice. **[2]**

b) Write an equation for the formation of the ionic crystal potassium fluoride from its constituent gaseous species. **[2]**

c) Define the term "first ionisation energy" **[2]**

d) Write an equation for the first ionisation of one mole of potassium atoms in the gaseous state to form one mole of gaseous cations. **[2]**

e) Write an equation for the formation of one mole of gaseous fluoride anions from elemental fluorine in the gaseous state. **[2]**

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

Question B1

a) i. Define the term "oxidation number" with an appropriate example. **[2]**

ii. Define the term "reducing agent" with an appropriate example. **[2]**

b) i. In your answer booklet, state the oxidation number of sulphur in each of these species: H_2S, S, SO_3^{2-}, SO_2, SO_4^{2-}, SO_3. **[6]**

Species	Oxidation Number
H_2S	
S	
SO_3^{2-}	
SO_2	
SO_4^{2-}	
SO_3	

ii. Which of the species listed above would be the best oxidising agent? Explain why. **[2]**

iii. Which of the species listed above would be the best reducing agent? Explain why. **[2]**

c) i. Write a half equation for the reduction of chlorine to chloride ions. **[2]**

ii. Write a half equation for the oxidation of iron(II) ions to iron (III) ions. **[2]**

iii. Combine the half equations to show the overall redox reaction between chlorine and iron (II) ions. **[2]**

Question B2

Both aluminium and chromium form the M^{3+} ion in solution. There are some similarities and several differences between the two metals.

Both metals react with sulphuric acid to form a salt solution and a gas.

a) i. Name the gas given off and the salt formed when sulphuric acid reacts with aluminium. **[2]**

ii. What differences would you expect in the solutions formed when Al and Cr react with H_2SO_4? **[2]**

b) Solutions of chromium metal salts such as chromium sulphate form complex ions with different ligands.

i. Explain what is meant by the terms "ligand" and "complex ion". **[2]**

ii. Explain why NH_4^+ cannot act as a ligand but NH_3 can. **[1]**

iii. Draw a diagram to show the crystal field splitting in d orbitals. **[2]**

iv. Use your diagram to explain why solid transition metal compounds are usually coloured. **[3]**

v. If concentrated hydrochloric acid is added to an aqueous solution of copper (II) sulphate there is a colour change. Give two reasons why this is the case. **[2]**

c) Give the name of:

i. $[Cr(H_2O)_6]^{3+}$ **[2]**

ii. $[CuCl_4]^{2-}$ **[2]**

d) State the colour of the following solutions:

i. Potassium dichromate (VI) **[1]**

ii. Sodium manganate (VII) **[1]**

Question B3

a) A common test for halogen ions is the reaction with silver nitrate solution. Complete the the table below by writing the missing observations in your answer booklet marking them **i)**, **ii)** and **iii)**:

Halide Ion	Observation of Reaction with Silver Nitrate Solution	Observation of Reaction with Ammonia Solution
F-	***i)***	
Cl-	White precipitate	Dissolves in dilute ammonia
Br-	***ii)***	Dissolves in concentrated ammonia
I-	Yellow precipitate	***iii)***

[3]

b) Chlorine is a gas at room temperature, whilst bromine is a liquid and iodine is a solid. Explain these differences in physical state. **[3]**

c) When chlorine water ($Cl_{2(aq)}$) is added to aqueous KI the solution becomes brown. Write a balanced equation for this reaction and explain this observation using your knowledge of the relative oxidising properties of the halogens. **[5]**

d) The amount of sodium sulphite (Na_2SO_3) in a sample can be found by reaction with hydrochloric acid as shown below:

$$Na_2SO_3 + 2HCl \longrightarrow SO_2 + 2NaCl + H_2O$$

The amount of SO_2 produced is found by titration with iodine:

$$SO_2 + I_2 + 2H_2O \longrightarrow SO_4^{2-} + 2I^- + 4H^+$$

i. An excess of HCl was reacted with 0.700g of an impure sample of Na_2SO_3. 15.0cm^3 of 0.300$moldm^{-3}$ iodine solution was required to react completely with the SO_2 produced. Calculate the percentage purity of the sample of Na_2SO_3. **[5]**

ii. State what would be observed when $BaCl_2$ is added to the products of the titration. Give a balanced ionic equation for this reaction.
Calculate the mass of the precipitate formed in this reaction. **[4]**

This is the end of the test.

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