LEAVING CERTIFICATE EXAMINATION, 1970

CHEMISTRY – HONOURS

FRIDAY, 19th JUNE – AFTERNOON, 2.00 to 4.30

<u>Six</u> questions to be answered.

Atomic weights: $H = 1$, $O = 16$, $S = 32$, $K = 39$, $Mn = 55$, $Fe = 56$.
Periodic Table may be obtained from the Superintendent.

1. With regard to the electronic structure of atoms, state what you understand by quantum numbers, energy levels, sub-levels, orbitals.
Show the building up of the first twenty-one elements of the periodic table, and refer in your answer to Pauli's exclusion principle.

(66 marks)

2. The following elements are placed in this order in the activity ('electrochemical') series:
K   Na   Ca   Mg   Al   Zn   Fe   Sn   Pb   H   Cu   Ag   Au   I   Br   Cl   F
Describe and discuss each of the following items:

(i) the displacement of metals from solutions of their salts,
(ii) the displacement of halogens from solutions of their salts,
(iii) the displacement of hydrogen from water and non-oxidising acids,
(iv) the reduction of oxides by hydrogen,
(v) the occurrence of metals.

(66 marks)

3. Discuss the valence of carbon.
Describe the hybridisation of orbitals, referring in your answer to sp^3, sp^2 and sp hybrids.

(66 marks)

4. Given a supply of ethyl alcohol and concentrated sulphuric acid, describe with the aid of labelled diagrams how you would prepare <u>two</u> different organic compounds.
Name the compounds, list their principal chemical properties and indicate their structures.

(66 marks)

5. What do you understand by a functional group in organic chemistry ?
In the case of each of the following types of compound – alcohol, aldehyde, amino, carboxylic acid, ester, ether, ketone – (i) indicate by means of a diagram the functional group involved, (ii) name a compound containing that group, (iii) list the principal reactions associated with that group.

(66 marks)

6. Give an account of the Brønsted concept of acids and bases. Comment on the significance of the general equation
$$acid_1 + base_2 \rightleftharpoons acid_2 + base_1$$
Complete the following "equations" and comment on each of them

$$H_2O + NH_2^- \rightleftharpoons$$
$$H_3O^+ + OH^- \rightleftharpoons$$
$$HCl + H_2O \rightleftharpoons$$
$$HF + H_2SO_4 \rightleftharpoons$$
$$H_3O^+ + NH_3 \rightleftharpoons$$

"The stronger an acid is, the weaker must be its conjugate base". Discuss this statement in the light of the Brønsted acid/base reaction
$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$

(66 marks)

7. State clearly what you understand by (i) electron affinity, (ii) ionization potential, (iii) electronegativity, and discuss the relation between them.
The following table gives the first ionization potential (in electron-volts) of a number of elements:

H							He
13·6							24·6
Li	Be	B	C	N	O	F	Ne
5·4	9·3	8·3	11·3	14·5	13·6	17·4	21·6
Na	Mg	Al	Si	P	S	Cl	Ar
5·1	7·6	6·0	8·1	11·0	10·4	13·0	15·8
K	Ca	Ga	Ge	As	Se	Br	Kr
4·3	6·1	6·0	8·1	10·0	9·8	11·8	14·0
Rb	Sr	In	Sn	Sb	Te	I	Xe
4·2	5·7	5·8	7·3	8·6	9·0	10·4	12·1
Cs	Ba						
3·9	5·2						

Comment on the trends in this table (left to right, top to bottom) and explain them with reference to nuclear charge, quantum levels, shielding effect of inner electrons.

(67 marks)

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8. (a) Balance the following equation:

$$KMnO_4 + FeSO_4 + H_2SO_4 = K_2SO_4 + MnSO_4 + Fe_2(SO_4)_3 + H_2O$$

What is a normal solution of potassium permanganate ?
In order to oxidise 25 c.c. of a given ferrous sulphate solution, which had been acidified with sulphuric acid, 22 c.c. of decinormal potassium permanganate were required. Find the concentration of the ferrous sulphate solution (i) in terms of normality, (ii) in grams of crystalline ferrous sulphate ($FeSO_4 \cdot 7H_2O$) per litre.

(b) Select any <u>four</u> of the following ions and show how you would identify and confirm the presence of the ion in a given salt:

carbonate, chloride, nitrate, sulphate, sulphide, sulphite.

(67 marks)

9. (a) What is (i) heat of formation, (ii) heat of combustion, (iii) heat of neutralisation? Find the heat of formation of sulphur trioxide given

$$S + O_2 = SO_2 + 71 \text{ kcal.}$$
$$2SO_2 + O_2 = 2SO_3 + 46 \cdot 7 \text{ kcal.}$$
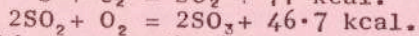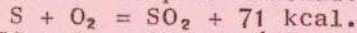
Describe how you would measure the heat of neutralisation of a strong acid and a strong base.

(b) Write a short account of catalysis. In your answer refer to homogeneous catalysis, heterogeneous catalysis and autocatalysis.

(67 marks)

10. Answer any <u>two</u> of the following:-

(i) What is geometrical isomerism? Explain, with the aid of examples, how it occurs.
(ii) Explain what an indicator is and how it works. Mention any <u>two</u> indicators and explain when and why you would use each of them.
(iii) Discuss a possible mechanism for the reaction between bromine and ethylene.

(67 marks)