GK300

Ollscoil na hÉireann, Gaillimh

National University of Ireland, Galway

SUMMER EXAMINATIONS, 2000

SECOND SCIENCE CHEMISTRY

Third Paper ***CH-204***

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Time allowed: *Two* hours

(Answer *four* questions)

1. The calcium in a 1.5 g sample of powdered milk was released by ashing the sample. The calcium-containing residue when dissolved was titrated with EDTA (12.1 cm^3 of EDTA required for titration). The EDTA was standardised by titrating 10.0 cm^3 of a zinc solution prepared by dissolving 0.610 g of pure zinc metal in acid and diluting to 1000 cm^3 (10.8 cm^3 EDTA required for titration).

Calculate:

(a) The concentration of the zinc solution in moles dm^{-3}.

(b) The concentration of the EDTA solution in moles dm^{-3}

(c) The concentration of calcium in the powered milk in ppm.

Atomic weights: calcium, 40.0; zinc, 65.37

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2. Compare and contrast the chemistry of Groups 1 and 2. In your answer include a discussion of valence, ionic and covalent bonding and complex formation.

3. Describe the real nature of the so called "inert pair effect" in terms of the chemistry of Groups 13 and 14.

4. Answer **(a)** and **(b)**.

(a) Use the LCAO method to derive energy level diagrams for Be_2 and O_2. Using your diagrams predict some of the properties of Be_2 and O_2

(b) Use the valence shell electron pair repulsion theory to derive structures for the following; SF_4, XeO_3, BrF_2O^+, $BrFO_3$, IF_5 and $[ICl_4]^-$.

5. Answer **each** of the following.

(a) Distinguish between the terms, paramagnetism, diamagnetism and ferromagnetism

(b) Describe a method for the measurement of the magnetic moment of a solid.

(c) Distinguish between the terms; high field ligand and high spin coordination compound.

(d) Predict the magnetic moments of the following compounds.
$[TiCN_6]^{3-}$; $[Co(Cl)_6]^{3-}$; $[Cr(CN)_6]^{4-}$; $[Cu(H_20)_6]^{2+}$

6. Write balanced chemical equations to illustrate **one** example for **each** of the following and sketch the structures of all products.

(a) The reaction of a first row transition metal salt with a β-diketone ligand to give an octahedral coordination compound.

(b) The formation of a coordination compound that exhibits both optical and *cis-trans*-isomerism.

(c) The reaction of a non-transition metal salt with a hexadentate ligand.

(d) The reaction of a boron halide with a Lewis base.

(e) The formation of an octahedral coordination compound of a crown ether.

7. Answer all parts **(a – e)**

(a) With the aid of unit cell diagrams, describe the polymorphism exhibited by iron metal.

(b) On the assumption that a metal adopts the hexagonal close packed arrangement on formation of a carbide and that the carbon atoms fill all of the octahedral sites, provide a unit cell diagram of the carbide and clearly indicate why there are as many metal atoms as carbon atoms in this cell.

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(c) On the assumption that a metal adopts a cubic close packed structure on formation of a hydride of composition MH (M = metal) with the hydrogen atoms filling identical type tetrahedral sites, provide a unit cell diagram of the hydride. Clarify the fact that each metal atom is surrounded tetrahedrally by four hydrogen atoms.

(d) Describe in detail, with the aid of a diagram of the unit cell, the structure of MoS_2 and show why this structure accounts for an important physical characteristic of the material.

(e) Describe the structure of rutile (TiO_2).

8. Account for any **five** of the following (where appropriate provide chemical equations; these need not necessarily be balanced):

a. The concentration of Fe^{3+} in solution can be determined colorimetrically .
b. Hardness of water can be classified as either permanent or temporary.
c. It is possible to separate zinc and magnesium using an anion exchange resin.
d. When a basic aqueous solution of potassium chromate is acidified a colour change is observed.
e. When HCl is added to an aqueous potassium permanganate solution a colour change is observed but no such colour change is observed when sulphuric acid is employed.
f. Addition of potassium iodide to a basic aqueous permanganate solution results initially in the formation of a green colour which finally gives way to a black precipitate.
g. Addition of sodium hydroxide to an aqueous copper sulphate solution results in the formation of a bluish green precipitate whereas the addition of ammonium hydroxide results in the formation of a deep blue solution.
h. Addition of potassium iodide to an aqueous solution of $FeCl_3$ results in a reaction which does not take place if the $FeCl_3$ solution also contains dissolved phosphate.