GX370

Ollscoil na hÉireann, Gaillimh

National University of Ireland, Galway

AUTUMN EXAMINATIONS, 2002

SECOND SCIENCE CHEMISTRY

Inorganic Chemistry CH-204

Professor J. Evans
Professor R.N. Butler
Professor P. McArdle
Professor D. Cunningham
Professor M.J. Hynes
Dr. T. Higgins

Time allowed: *Two* hours

(Answer *four* questions)

1.

A sample of $MgSO_4.6H_2O$ was found to have been contaminated with sodium chloride. The sample was then analysed as follows. 0.31 g of the sample was dissolved in 500 cm^3 of distilled water (Solution A). 50 cm^3 of solution A were titrated with 0.012 mol dm^{-3} EDTA solution to an Erio-T endpoint (endpoint = 9.1 cm^3)

Answer each of the following:

(a) Draw the structure of EDTA. **[3 marks]**

(b) Calculate the number of moles of Mg in 50 cm^3 of solution A. **[5 marks]**

(c) Calculate the number of moles of Mg in 500 cm^3 of solution A. **[3 marks]**

(d) Calculate the weight of $MgSO_4.6H_2O$ in the sample. **[8 marks]**

(e) Calculate the percentage of $MgSO_4.6H_2O$ in the sample. **[3 marks]**

(f) Briefly describe using equations the mode of action of the indicator, Erio-T, in this titration. **[3 marks]**.

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2. Answer **(a)**, **(b)** and **(c)**.

(a) Provide unit cell diagrams for both cubic and hexagonal close packing, clearly indicating sphere (atom), octahedral and tetrahedral site positions. Deduce the number of each contributing to the unit cell. Show how the interstitial sites are occupied in the structures of zinc blende and wurtzite (the two crystal modifications of ZnS). **[13 marks]**

(b) Describe, with the aid of diagrams, the structures of copper metal and the alloy CuAu. **[6 marks]**

(c) Describe fully with the aid of a unit cell diagram, the structure of rutile TiO_2. **[6 marks]**

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

(a) Suggest reasons why carbon forms more stable compounds with bonds to itself than any other element. **[13 marks]**

(b) What are the stable oxidation states found for the Group 14 elements ? Give at least one example of a stable compound in each oxidation state. **[12 marks]**

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

(a) Explain the difference in the chemical properties of molecules of formula R_3NO and R_3PO. **[12 marks]**

(b) Describe the principal features of the oxides and oxyacids of phosphorus. **[13 marks]**

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

(a) Describe the advantages and disadvantages of Valence Bond Theory and Molecular Orbital Theory under each of the following headings;

(i) Ease of use, **[3 marks]**

(ii) Explanation of UV-visible spectra, **[4 marks]**

(iii) The bonding in O_2. **[6 marks]**

(b) Use the valence shell electron pair repulsion theory to derive structures for each of the following; $TeCl_4$, XeO_3, ClF_3 and $[ICl_4]^-$. **[12 marks]**

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6. Give **one** example for **each** of the following: **[2.5 marks each part]**

(a) A paramagnetic coordination compound.
(b) A diamagnetic coordination compound.
(c) A bidentate ligand that has tautomeric forms.
(d) *trans* and *cis* isomers of an octahedral Co^{2+} complex anion
(e) an optically active coordination compound involving bidentate ligands.
(f) a square planar complex of Pd^{2+}
(g) *mer* and *fac* isomers of a coordination compound.
(h) the ligand dibenzo-14-crown-4 coordinated to a transition metal ion.
(i) a coordination compound with 2 d electrons, i.e. a d^2 system.
(j) a hexadentate ligand complexed with a Mg^{2+} ion.

7. Answer **each** of the following:

(a) Briefly explain why compounds of first row transition metals are coloured. **[5 marks]**

(b) Describe the crystal field splitting pattern for octahedral complexes of transition metals. **[6 marks]**

(c) Identify factors that influence the magnitude of d-orbital splitting. **[6marks]**

(d) $[Ti(H_2O)_6]^{3+}$ has an absorption maximum at 498nm. Predict the colour and uv-visible spectrum of the following complex ions.
$[Ti\ (H_2O)_4Cl_2]^+$, $[Ti\ (H_2O)_4(NH_3)_2]^{3+}$,$[Ti\ (H_2O)_4\ en]^{3+}$, $[Ti\ (H_2O)_4CN_2]^+$, **[8 marks]**

8. Describe with the aid of chemical equations that need not necessarily be balanced what happens in each of the following instances: **[2.5 marks each]**

(a) A ferric chloride solution is made alkaline with NaOH
(b) A copper(II) sulphate solution is made alkaline with NaOH
(c) A copper(II) sulphate solution is made alkaline with NH_4OH
(d) A potassium permanganate solution is made alkaline with NaOH and the resulting solution exposed to the atmosphere.
(e) A potassium chromate solution is acidified with HCl.
(f) KI is added to an aqueous acidic solution of chromium(VI).
(g) KI is added to an aqueous acidic solution of $KMnO_4$.
(h) KI is added to an aqueous basic solution of $KMnO_4$.
(i) KI is added to an aqueous ferric chloride solution both in the absence and presence of phosphate in this solution.
(j) Zinc is added to an aqueous copper sulphate solution.