NUI Galway
OÉ Gaillimh

Autumn Examinations 2010 / 2011

Exam Code(s)	2BS1, 2BY1, 2EH1, 2EV1, 2BPP1, 2BPC1
Exam(s)	
Module Code(s)	CH204 Inorganic Chemistry
Module(s)	
Paper No.	I
External Examiner(s)	Professor K. Molloy
Internal Examiner(s)	Dr. A. Erxleben, Dr. T. Higgins

Instructions:

Answer 4 questions.

Answer one question from each section.

All questions carry 25 marks distributed as shown. Leave the first page of the Answer Book blank and list on it clearly the numbers of the questions attempted.

Duration	2 hrs
No. of Pages	4 Following this page
Discipline(s)	Chemistry
Course Coordinator	Dr. A. Erxleben
Requirements	log tables with periodic table

Section A
Answer one question from this section

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

(a) Explain the principle of water softening by using an ion exchange resin. **[12 marks]**

(b) Explain how the iron:oxalate ratio in an iron:oxalate complex can be determined by redox titration. **[6 marks]**

(c) Explain the following observations and provide the relevant chemical equations:

(i) When dilute sulfuric acid is added to an aqueous solution of $[Cu(NH_3)_4]SO_4$ a colour change from deep blue to pale blue is observed.

(ii) When HCl and KI are added to a solution of $K_2Cr_2O_7$ in water, I_2 is liberated. Cl_2 is not formed.

					E° [V]
Cr^{3+}	+	e^-	=	Cr^{2+}	0.41
$1/2\ I_2$	+	e^-	=	I^-	0.536
$Cr_2O_7^{2-}$ +	$14H^+$	+ $6e^-$	=	$2Cr^{3+} + 7H_2O$	1.33
$1/2\ Cl_2$ +	e^-		=	Cl^-	1.36

[7 marks]

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

The following experiment has been carried out in order to determine the percentage calcium in powdered milk:
An EDTA solution was standardised by titrating it against 10.0 cm^3 of a zinc solution prepared by dissolving 0.620 g of pure zinc metal in acid and diluting to 1000 cm^3.10.6 cm^3 EDTA solution were required for the titration. A 1.60 g sample of powdered milk has been taken and the calcium was released by ashing the sample. The calcium-containing residue was dissolved in water and titrated with the standardised EDTA solution. 12.5 cm^3 of EDTA were required for the titration.

(a) Draw the structure of the Zn-EDTA complex. **[5 marks]**
(a) Calculate the concentration of the EDTA solution in mol dm^{-3}. **[10 marks]**
(b) Calculate the mass of calcium (g) in the powered milk sample. **[10 marks]**

Atomic weights: Zn 65
Ca 40

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Section B
Answer one question from this section

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

(a) Clearly distinguish between covalent and van der Waals radius.

[3 marks]

(b) Compare the MO and VB model with regard to explaining the magnetic properties of O_2.

[10 marks]

(c) Using the hybridization model, describe the bonding in CCl_4. **[6 marks]**

(d) Use the Valence Shell Electron Pair Repulsion Theory to derive the geometry of the following: **[6 marks]**

(i) N_3^-

(ii) ClF_5

(iii) ClO_3^-.

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

(a) What is the coordination number of

(i) a sphere in a hexagonal close-packed structure

(ii) Zn in the zinc blende lattice? **[4 marks]**

(b) With the aid of an appropriate diagram show the position of octahedral and tetrahedral sites in a cubic close-packed lattice. **[8 marks]**

(c) Vanadium dioxide, VO_2, crystallizes with the rutile lattice.

(i) Draw the unit cell of VO_2.

(ii) What is the coordination number of oxygen in VO_2?

(iii) Show that the structure of the unit cell is consistent with the formula VO_2.

[9 marks]

(d) Explain why the packing-of-hard-spheres models can be applied to the structure of solid F_2 but not to Cl_2. **[4 marks]**

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Section C
Answer one question from this section

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

(a) Distinguish between the terms, paramagnetism, diamagnetism and ferromagnetism. **[6 marks]**

(b) Describe how magnetic moments are measured. **[5 marks]**

(c) Describe the crystal field splitting pattern for an octahedral complex of a transition metal. **[6 marks]**

(d) Account for the magnetic moments of the following complex ions;

$[V(H_2O)_6]^{3+}$, $\mu = 2.83$BM
$[MnCl_6]^{3-}$, $\mu = 4.90$BM
$[Mn(NCS)_6]^{4-}$, $\mu = 6.06$ BM
$[Mn(CN)_6]^{4-}$, $\mu = 1.73$ BM **[8 marks]**

6. Answer **five** of the following:

(a) Give the valence shell electronic configuration of cobalt in the complex ions, $[Co(H_2O)_6]^{2+}$ and $[Co(H_2O)_4Cl_2]^{+}$.

(b) Give molecular formulae and draw structures for, (i) a hexa-aqua coordination compound of a transition metal with d^5 electronic configuration and (ii) a hexachloro coordination compound of a transition metal with a d^3 electronic configuration.

(c) Draw structures for all isomers of the complex cations, $[Fe(ox)_2(H_2O)_2]^{-}$ and $[Fe(ox)_3]^{3-}$: where ox is the bidentate oxalate anion.

(d) Draw structures for all isomers of the coordination compound $IrCl_3(CO)(PPh_3)_2$.

(e) Draw a structure for the molecule formed when the ligand dibenzo-14-crown-4 coordinates a magnesium cation.

(f) Give molecular formulae and draw structures for the products formed when an aqueous solution of copper sulphate is reacted with aqueous ammonia.

[5 marks each part]

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Section D
Answer one question from this section

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

(a) Discuss the chemistry of group 17 elements under the following headings:

(i) trend in X-X bond energies

(ii) stability of oxidation states

(iii) trends in boiling points and melting points of HX

(iv) trend in pK_a values of HX. **[17 marks]**

(b) Write balanced equations for the following reactions:

(i) $SnCl_4$ with H_2O

(ii) P_4O_{10} with H_2O

(iii) P_4O_6 with H_2O

(iv) $(CH_3)_3SiCl$ with H_2O **[8 marks]**

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

(a) Which Li salt do you expect to be more soluble in water, LiF or LiCl? Give a reason for your answer. **[6 marks]**

(b) Give an example for each of the following:

(i) an oxo acid of phosphorus

(ii) a nitrogen compound with nitrogen in the oxidation state I

(iii) a chlorine compound with chlorine in the oxidation state VII **[6 marks]**

(iv) a boron compound that is a Lewis acid.

(c) Which species do you expect to have the shorter B-F bonds, BF_3 or BF_4^-? Justify your answer. **[7 marks]**

(d) Write balanced equations for the following reactions:

(i) Li with O_2

(ii) KOH with CO_2

(iii) $NaHCO_3$ and heat. **[6 marks]**