RAJARATA UNIVERSITY OF SRI LANKA

FCULTY OF APPLIED SCIENCES

B.Sc. First year Semester I Examination – May 2015

CHE 1201 - General and Inorganic Chemistry

Answer question No. 1 (compulsory) and any other three questions. Time: 2 hours

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Electronic rest mass	m_e	=	9.11×10^{-31} kg
Proton rest mass	m_p	=	1.672×10^{27} kg
Neutron rest mass	m_n	=	1.675×10^{-27} kg
Magnitude of the electron charge	e	=	1.60×10^{-19} C
Universal gas constant	R	=	8.314 J mol^{-1} K^{-1}
Planck constant	h	=	6.626×10^{-34} J s
Avogadro number	N_A	=	6.022×10^{23} mol^{-1}
Speed of light	c	=	3.0×10^{8} ms^{-1}
Rydberg constant,	R	=	1.097×10^{7} m^{-1}
Permittivity of vacuum	ε_o	=	8.85×10^{-12} kg^{-1} m^{-3} A^2
1 atomic mass unit (amu)	1amu	=	1.66×10^{-27} kg
1 eV	1eV	=	1.602×10^{-19} J

Use of non-programmable calculator is permitted

Q1). (a) Using the de Broglie's relationship determine the wavelength in nm, associated with an electron whose velocity is 3×10^{7} m s^{-1}.

(b) What is the wavenumber and wavelength (in Å), of the first transition in the Lyman series in the atomic spectra of hydrogen?

(c) (i) Write down the general form of the Schrödinger equation and define each of terms in it.

(ii) How many possible values for the magnetic quantum number of an electron in a 5f subshell.

(d) Deduce the molecular geometries of the central atom of the following molecules using the VSEPR model?

(i) PF_5

(ii) NCl_3

(e) Determine the bond order of C_2 molecule based on molecular orbital theory.

(f) Give the Lewis structure of carbon dioxide and state the hybridization of the carbon atom in it.

(g) Write down the Born-Lande equation to calculate the lattice energy of the ionic compound. The experimental and calculated values of lattice energy for CdI_2 are – 2435 J $mol^{-1}$and - 1986 J mol^{-1} respectively. Explain the discrepancy in these values.

(h) What is the respective central-metal oxidation state, coordination number, and the overall charge on the complex ion in $NH_4[Cr(NH_3)_2(NCS)_4]$?

(i) (a) (i) Write down the formula of
lithium chloridotris(trifluorophosphine)nickelate(0)

(ii) Give the IUPAC name of $K_2[CrCO(CN)_5]$.

(j) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic. Explain.

(10 x 13 marks = 130 marks)

2). (a) Write down the equation which explains the different series of lines in the atomic spectrum of hydrogen. Explain the terms in it.

(13 marks)

(b) An electron and a photon have the same wavelength of 2.0×10^{-10} m. Determine:

(i) their momentum,

(ii) the kinetic energy of the electron, and

(iii) the energy of the photon.

(27 marks)

(c) A hydrogen atom is in the ground state. It absorbs energy and makes a transition to the n = 3 excited state. The atom returns to the ground state by emitting two photons. What are their wavelengths?

(24 marks)

(d) A hydrogen atom emits a photon that has momentum with a magnitude of 5.452×10^{-27} kg m s^{-1}. This photon is emitted because the electron in the atom falls from a higher energy level into the n = 1. What is the quantum number of the level from which the electron falls?

(26 marks)

3). (a) Calculate the lattice energy (in units of kJ mol^{-1}) for ZnO in the wurtzite structure using the Born-Landé equation and using a Born-Haber cycle. Compare the two answers and comment on any differences.

Hint: $r_0 = 1.99 \times 10^{-10}$ m, the Born exponent, n = 8, and A = 1.641 for the wurtzite structure,

	ΔH^0 / kJ mol^{-1}
Energy of sublimation for Zn(s):	130.4
1st ionization energy for Zn(g)	418.6 l
2nd ionization energy for Zn(g)	1733
Bond dissociation energy for O_2(g)	497
Electron affinity values of oxygen:	
$O(g) \rightarrow O^-(g)$	141
$O^-(g) \rightarrow O^{2-}(g)$	-780
Heat of formation for ZnO(s)	-350.5 l

(45 marks)

(b) Explain the following observations:

(i) lattice energy for LiF (-1047 kJ)is much less than for MgO (-3916 kJ) ?

(ii) lattice energy of Na_2S is -2203 kJ and Cs_2S is -1850 kJ?

(20 marks)

(c) In terms of molecular geometry, account the fact that the CF_4 molecule is non polar and SF_4 molecule is polar. Discuss the type of hybridization in CF_4 and SF_4.

(25 marks)

4. (a) (i) Draw the most acceptable Lewis structure and resonance structures for peroxonitrite ion, $(OONO)^-$.

(ii) State the hybridization of the atoms and sketch the shape of the Lewis structure with approximate bond angles.

(25 marks)

(b) Draw the molecular orbital diagram for the OF^+ ion. Calculate the bond order and predict the magnetic properties of OF^+ ion.

(40 marks)

(c) A coordination compound is composed of one Co(III), one chloride, one sulfate and four molecules of ammonia. The aqueous solution of the compound gives no precipitate with aqueous $BaCl_2$, while a white precipitate is formed with aqueous $AgNO_3$ solution. Draw its structure and give the name of the compound.

(25 marks)

5). (a) Indicate the types of isomerism exhibited by the following complexes and draw the structures for these isomers:

(i) $K[Cr(H_2O)_2(C_2O_4)_2$

(ii) $[Pt(NH_3)(H_2O)Cl_2]$

(30 marks)

(b) Calculate the oxidation state of the metal and the number of d electrons in the following coordination complexes:

(i) $[CoCl_4]^{2-}$

(ii) $[Fe(bpy)_3]^{3+}$

(iii) $[Cu(ox)_2]^{2-}$

(iv) $[Cr(CO)_6]$

[Hint:- bpy (2,2'-Bipirydyl) and ox (oxalate, $C_2O_4^{2-}$)]

(28 marks)

(c) Predict the number of unpaired electrons, the magnetic moments at 25° C for each of the following

(a) $[Fe(CN)_6]^{4-}$

(b) $[Ru(NH_3)_6]^{3+}$

(c) $[Cr(NH_3)_6]^{2+}$

(d) $[EuCl_6]^{4-}$

(32 marks)

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																		
1	1 H 1.008																	2 He 4.003
2	3 Li 6.94	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.79
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.92	40 Zr 91.22	41 Nb 92.91	42 Mo 95.96	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	*	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.5	81 Tl 204.38	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	**	104 Rf (265)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

	Lanthanide Series*	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3			69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
	Aclinide Series**	89 Ac (227)	90 Th 232	91 Pa 231	92 U 238	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)			101 Md (258)	102 No (259)	103 Lr (262