RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES
B.Sc. Second year Semester I Examination – June/July 2018
CHE 2205 – Inorganic Chemistry

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

Mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
Mass of proton	$m_p = 1.672 \times 10^{-27}$ kg
Mass of neutron	$m_n = 1.675 \times 10^{-27}$ kg
Avogadro number	$N_A = 6.022 \times 10^{23}$ per mole
Universal gas constant	$R = 8.314$ J mol^{-1} K^{-1}
Planck constant	$h = 6.63 \times 10^{-34}$ J s
Speed of light	$c = 3.00 \times 10^{8}$ m s^{-1}
1 atomic mass unit (amu)	1 amu $= 1.66 \times 10^{-27}$ kg
	1MeV $= 9.648 \times 10^{7}$ kJ mol^{-1}

The use of a non-programmable calculator is permitted.

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1). (a) Give the IUPAC name for the following compounds:

(i) $[Co(NH_3)_4Cl_2]Cl$

(ii) $[Cr(en)_3]Cl_3$

(b) Write the formula for the following compounds;

(i) pentaamminechlorocobolt(III) chloride.

(ii) dichlorobis(ethylenediamine)platinum(IV) nitrate.

(c) What is the respective central-metal oxidation state, coordination number, and the overall charge on the complex ion in $NH_4[Cr(NH_3)_2(NCS)_4]$ and $[Ru(NH_3)_5(H_2O)]Cl_2$?

(d) What is meant by ligands. Name and draw the structures of one bidentate and one hexadentate ligands.

(e) Compounds containing the Sc^{3+} ions are colouless, whereas those containing the
Ti^{3+} are coloured. Explain.

(f) The absorption maximum for the complex ion $[Co(NH_3)_6]^{3+}$ occurs at 470 nm. Calculate the crystal field splitting in kJ mol^{-1}.

(g) Give two differences between amorphous and crystalline solids, name one example for each type of solid.

(h) Calculate the binding energy (in MeV) per nucleon for the isotope $^{56}_{26}Fe$.
(the mass of $^{56}_{26}Fe$ = 55.9349 amu).

(130 marks)

2). (a) List four properties with one reason of transition elements.

(30 marks)

(b) Write equations for the formation of the complex ions between;

(i) Hydrated nickel ions and ammonia molecules.

(ii) Hydrated nickel ions and ethylene diamine.

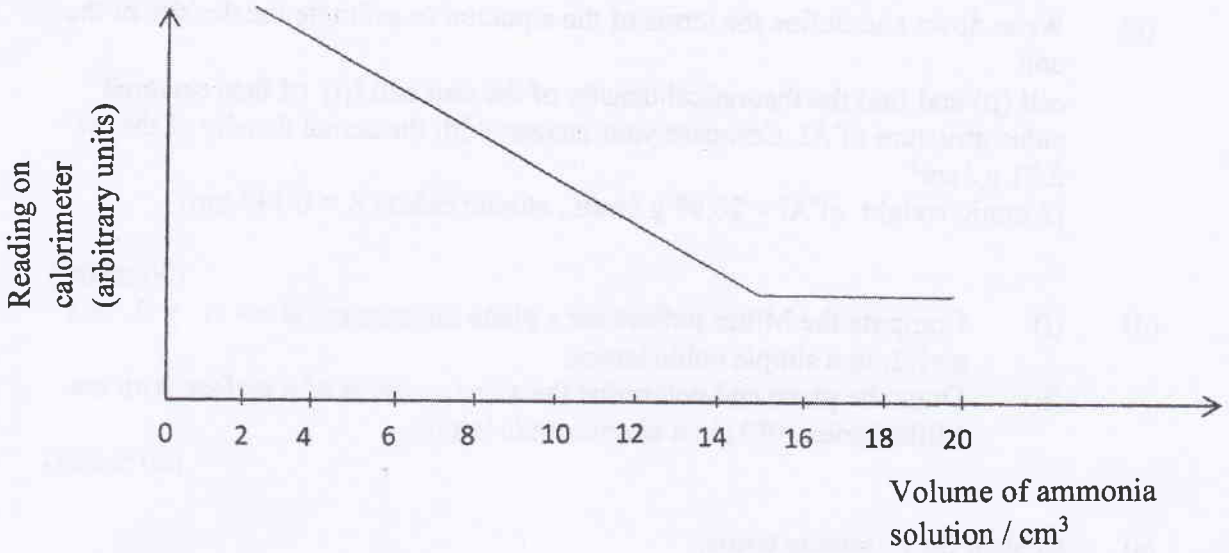
Draw the structures of (b) (i) and (ii) above and state, giving one reason which has The higher stability constant among them.

(30 marks)

(c) Draw all possible three isomers of $Co(NH_2CH_2CH_2CH_2NH_2)_2Cl_2$ and find the optically active and optically inactive isomers of them.

(30 marks)

3). (a) In the colorimetric experiment ten tubes were taken and labeled them as A, B, C, D, E, F, G, H, I, and K and each tube containing 20 cm^3 of 0.05 mol dm^{-3} solution of $NiSO_4$. Then 2, 4, 6, 8, 10, 12, 14, 16, 18, 20 cm^3 of 0.4 mol dm^{-3} of ammonia solutions were added to the tube of A, B, C, D, E, F, G, H, I, and K respectively. Distilled water was added to bring the total volume of the tube to 50 cm^3. The plot based on the calorimetric results as follows;
(Hint: - A solution of $NiSO_4$ (green) changes it colour to blue when ammonia is added to it.)



(i) What colour filter should be used in the colorimeter?
(ii) Why does the reading of the colorimeter go down?
(iii) Explain why the graph comes to a minimum and then plateau.
(iv) What is the formula of the complex?
(v) Why the total volume of each tube kept constant?

(30 marks)

(b) Find the spin only magnetic momentum of the octahedral complex ions of $[Fe(H_2O)_6]^{2+}$, $[Fe(CN)_6]^{4-}$ and $[Ni(NH_3)_6]^{2+}$ and deduce the magnetic properties of each of the above ions.

(30 marks)

(c) Draw the crystal field splitting diagram to explain the following observations:

(i) $[Ni(CN)_6]^{2-}$, which has square planar geometry is diamagnetic.

(ii) $[NiCl_4]^{2-}$, which has tetrahedral geometry is paramagnetic.

(30 marks)

4). (a) Describe and explain the Jahn-Teller effect in octahedral complexes of Cr^{2+} and Cu^{2+}.

(25 marks)

(b) Describe the following terms:
(i) Unit cell.
(ii) Molecular crystals.
(iii) Ionic crystals.

(15 marks)

(c) Write down and define the terms of the equation to estimate the density of the unit
cell (ρ) and find the theoretical density of the unit cell (ρ) of face centered cubic structure of Al. Compare your answer with the actual density of the Al = 2.71 g / cm^3.
(Atomic weight of Al = 26.98 g / mol , atomic radius R = 0.143 nm)

(30 marks)

(d) (i) Compute the Miller indices for a plane intersecting at x= ¼ , y=1, and x=1/2, in a simple cubic lattice.

(ii) Draw the plane and determine the axis intersects of a surface with the Miller index (013) in a simple cubic lattice.

(20 marks)

5). (a) Explain the following terms;

(i) Nuclear binding energy.

(ii) Nuclear fusion.

(14 marks)

(b) Describe the term nuclear fission and state which isotopes can undergo nuclear fission. The following reaction in one of the processes which occurs during fission:

$$^{235}_{92}U \rightarrow ^{140}_{58}Ce + ^{94}_{40}Zr + ^{1}_{0}n + 6\,^{0}_{-1}e$$

Calculate how much energy is released for one mole $^{235}_{92}U$. If one ton of TNT releases about 4 x 10^9 J of energy, estimate how many grams of $^{235}_{92}U$ required to produce the energy which is equal to 20,000 tons of TNT produces. (one ton = 1000 kg)
(the masses are:U = 235.0439 amu, Ce = 139.9054 amu and Zr = 93.9063 amu).

(35 marks)

(c) $^{24}_{11}Na$ is an unstable isotope of sodium with a half-life of 15 hours. Calculate the radioactive decay constant. State any assumption/s you have made in this calculation.

(21 marks)

(d) Briefly describe the use of radionuclides in agriculture and medicine.

(20 marks)

- END -

hydrogen 1 H 1.0079																	helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]	nihonium 113 Nh [284]	flerovium 114 Fl [289]	moscovium 115 Mc [288]	livermorium 116 Lv [293]	tennessine 117 Ts [294]	oganesson 118 Og [294]

*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
**Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]