RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES
B.Sc. Second year Semester I Examination – June / July 2018
CHE 2105 – Inorganic Chemistry - I

Answer both questions. Time: 1 hour

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) Write down the primary and secondary reforming reactions with conditions in the production of hydrogen.

(b) What conditions of temperature and pressure would favour the formation of products in both the primary and the secondary stage in the production of hydrogen?

(c) Explain the following observations;
   (i) $BeCl_2$ is linear molecule whereas H_2O is bent.
   (ii) Bond angle in NH_3 is less than that in CH_4.

(d) Write down the balanced chemical equations of Boron with conc. H_2SO_4 and N_2 at high temperature.

(e) Draw the structures of F_2O and Cl_2O and give a reason why the bond angle in F_2O is different than in Cl_2O.

(f) List three industrial processes which used transition metals or their compounds as catalyst. Name the catalyst in each case.

(g) The mass defect for an isotope was found to be 0.1587 amu/atom. Calculate the binding energy in kJ/mol.

(h) Complete the following nuclear reactions and identify X in each case;

(i) $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{94}_{36}Kr + {}^{139}_{56} + 3X$

(ii) $^{59}_{27}Co + {}^{1}_{0}n \rightarrow {}^{56}_{25}Mn + X$

(10 x 12 marks = 120 marks)

2). Answer either Part A or Part B

Part A

(a) Write down the reaction with conditions involving in the shift reaction to converts CO to CO_2 in the steam reforming process in the production of hydrogen. Above what temperature will the shift reaction begin to favour the reactants?
(the ΔH^o and ΔS^o values of the shift reactions are - 41.2 kJ mol^{-1} and - 42.0 J K^{-1} mol^{-1} respectively.)

(26 marks)

(b) Calculate the spin only magnetic moment, μ_s of the following species;
(i) $[Zn(NH_3)_4]^{2+}$
(ii) $[Co(NH_3)_6]^{3+}$
(iii) $[Cr(NH_3)_6]^{3+}$

(24 marks)

(c) Explain the following observations;
(i) The conductivity measurements in aqueous solution of alkali metal ions are $Cs^+ > Rb^+ > K^+ > Na^+ > Li^+$
(ii) The solubility of the sulphates of alkaline earth elements in water decreases and the thermal decomposition of their carbonates increases down the group.

(30 marks)

Part B

(a) Explain the following terms;
(i) Nuclear binding energy.
(ii) Half life.

(20 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.

(25 marks)

-END-

hydrogen 1 H 1.0079																	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 [265]	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]