CHEM-E4130: CHEMISTRY OF ELEMENTS

Exam 15.12.2016

Please answer to a minimum of five questions. You may also answer to all the six questions; in that case the five best answers will be taken into account.

1. Explain shortly the following terms/concepts/phenomena:
   a. disproportionation
   b. mixed valency
   c. rare earth element
   d. critical raw material

2. Describe shortly the crystal structures and/or chemical bonding of the following materials, and also the specific properties/application of these materials derived from the crystal structure/type of bonding.
   a. BN (high-pressure form)
   b. B_2H_6
   c. LaB_6
   d. TiH_x
   e. Li_xCoO_2

3. Give a good chemical reason/explanation for the following facts:
   a. Hafnium and zirconium mostly exist in nature in the same minerals.
   b. Transition metals have in general higher melting points than alkali and alkaline earth metals.
   c. For lanthanoids the melting point increases in a linear manner with increasing atomic number, but europium and ytterbium are exceptions. Why and to which direction?
   d. The luminescence emission of Eu^{3+} occurs in different compounds at the (essentially) same wavelength.

4. *a.* Give the electron configurations for the following elements and answer to the questions given below (with a short argument!): Sc, Ti, Cu, Y, La, Eu, Gd, Tb, Yb and Lu.
   *b*1. Which of the elements form(s) compounds with oxidation state +IV ?
   *b*2. Which of the elements form(s) compounds with oxidation state +II ?
   *b*3. Which of the elements form(s) compounds with oxidation state +I ?
   *b*4. Which of the elements has the largest metal radius?

5. *a.* Sketch the crystal field splitting of *d* orbitals in (*i*) octahedral and (*ii*) tetrahedral coordinations.

b. How many unpaired electrons the following ions have (assume high spin) in (*i*) octahedral, and (*ii*) tetrahedral crystal fields: Cr^{3+}, Mn^{2+}, Fe^{2+} and Co^{+2}

c. Which of the following ions is/are colourless and why: Cr^{3+}, CrO_4^{2-}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Co^{+2}

6. *a.* Shortly describe two macroscopically observable phenomena arising from relativistic effects in the case of heavy elements.

b. What major difference in the oxidation states of Au and Ag arises from relativistic effects.

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 to 71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 to 103	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt									

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr