CHEM 271 — TEST

Inorganic Chemistry

Tuesday 8 September 2009, Room Laws105

Time: 7:30 pm to 8:30 pm Time allowed: 60 minutes

Answer 4 out of 5 questions. There are 50 marks available.

Start each question on a new page. A periodic table is attached.

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1. (12.5 marks)

(a) Explain why defects are present in all materials.

(b) Explain why invention of technology to manufacture high purity single crystalline Si was a prerequisite to the development of semiconductors based on doped (extrinsic) Si?

(c) Sketch a diagram showing concentration of charge carriers in doped (extrinsic) Si semiconductor as a function of temperature. Referring to this diagram, explain why doped (extrinsic) semiconductors offer technological advantage over intrinsic semiconductors.

2. (12.5 marks)

(a) Give account on the trends in σ- and π- bond strengths on moving down the Periodic Table in Groups 14-16.

(b) Explain the trend in % of contraction for multiple bonds *vs.* single bonds (see table below) on moving down the Group 14 in light of efficiency of σ- and π- bonding and associated changes in angle □ (see scheme below right).

	d(X–X)/pm	% contraction
$H_3C–CH_3$	154	
$H_2C=CH_2$	133	13.6
$R_2HSi–SiHR_2$	235	(R = mesityl)
$R_2Si=SiR_2$	214	9.0
$R_3Ge–GeR_3$	245	(R = Me, $CH(SiMe_3)_2$)
$R_2Ge=GeR_2$	235	4.0
$R_3Sn–SnR_3$	282	(R = Me, $CH(SiMe_3)_2$)
$R_2Sn=SnR_2$	276	2.0

(c) Give an example of two technological applications which benefit from the strength of the multiple bond in N_2.

3. (12.5 marks)

(a) Define concepts of Polarizability and Polarizing Power and explain how they can be used to illustrate the transition from an ideal ionic bond to a mixed ionic-covalent bond.

(b) Order the compounds given in each list (i)-(iii) below in order of increasing covalent character:

i) LiF CsF KF RbF NaF

ii) NaI NaBr NaCl NaF

iii) Na^+Cl^- $Mg^{2+}O^{2-}$ $Al^{3+}N^{3-}$

4. (12.5 marks)

Below is a list of first and second ionisation energies (kJ/mole) for the Group 1 elements.

	Li	**Na**	**K**	**Rb**	**Cs**
1st IE	519	494	418	402	376
2nd IE	7300	4560	3070	2650	2420

IE = Ionisation energy

Explain, in terms of the electronic changes that occur:

(a) the trend in the values of first ionisation energies down the Group;

(b) the very high values of second ionization energies;

(c) the trend in the values of second ionisation energies down the Group. Make sure you address why Li has a particularly high second ionization energy.

(d) Which of the molecules N_2 or NO would you expect to have the larger first ionization energy? State your reasoning.

5. (12.5 marks)

(a) Discuss how you would expect the properties of BaH_2 and $HfH_{2.10}$ to differ.

(b) Explain why HI is a strong acid but KH is a strong base.

(c) List FOUR criteria for an ideal hydrogen storage medium.

Periodic Table

1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.8	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (99)	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
55 Cs 132.9	56 Ba 137.3	57-71 see below	72 Hf 178.5	73 Ta 181.0	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 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 see below	104 Rf (257)	105 Db (260)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110	111	112						

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	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

89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.1	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (245)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lr (257)