

Name: \_\_\_\_\_

**CM1111 – Test 2 – 60 min**

Answer all questions.

<b>Q1</b>		<b>10</b>
<b>Q2</b>		<b>14</b>
<b>Q3</b>		<b>6</b>
<b>Q4</b>		<b>20</b>
<b>Total</b>		<b>50</b>

- Answers should be as precise and brief as possible.
- Please write your answers only in the space given after each question using a pen (no pencils are allowed).
- Answers written on the backsides of the test-paper won't be considered (however, you can of course use the backsides to "pre-design" your answers).
- This is a closed-book test.

**Question 1**

Fill in the blanks with the most appropriate terms (adjective, verb or noun). Note: Each of the correct terms can appear only once, and none of them has appeared in the rest of the sentences.

- a) According to the Brønsted-Lowry concept, an acid is a proton \_\_\_\_\_, while the base is a species that \_\_\_\_\_ a proton. Upon reaction, the initial acid becomes the \_\_\_\_\_ base and vice versa. This acid-base concept highlights the dynamic equilibrium of acid-base reactions.
- b) In the Lewis acid-base theory, a base must contain a \_\_\_\_\_ \_\_\_\_\_. Through donation to a Lewis acid, a Lewis acid-base \_\_\_\_\_ is formed as a new compound. In coordination chemistry, this product is called a complex.
- c) Redox reactions usually involve the full transfer of \_\_\_\_\_ through which the respective atoms receive a higher or lower \_\_\_\_\_. Increase of the latter is characteristic for the \_\_\_\_\_ half reaction.

(10 marks)

**Question 2**

Rank the following compounds in order of increasing acidity and briefly explain your order.

- a) HBr, HCl, HF and HI

(4 marks)

b) HOBr, HOCl and HOI

(4 marks)

c) HClO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub>, H<sub>2</sub>SO<sub>4</sub>

(4 marks)

d) What is the best term to describe all three compounds of Question 2c?

(2 marks)

**Question 3**

Complete and fully balance the following equation using the smallest set of integers. Show your working.



(6 marks)

**Question 4**

In the steam reforming process, methane is reacted with steam at high temperature ( $>1000$  °C) in the presence of a nickel catalyst to form dihydrogen gas.

- a) Give the fully balanced chemical equation for this simple reaction, and identify the general type of the reaction.

(4 marks)

- b) Briefly discuss if the reaction is driven by (i) enthalpy, (ii) entropy or (iii) both.

(4 marks)

- c)  $\text{BeH}_2$  and  $\text{NaH}$  are both solids at room temperature and atmospheric pressure. However,  $\text{BeH}_2$  is air and moisture stable, while  $\text{NaH}$  reacts violently with moisture.

- i) Briefly discuss the “bond character” of the two compounds in simple terms, *i.e.* covalent, ionic, etc. that is consistent with their reactivities. Note: Molecular orbital or valence bond theory are NOT required.

(4 marks)

- ii) Give the fully balanced chemical equation for this simple but violent reaction. Identify the general type of the reaction and indicate the role of all species.

(4 marks)

- iii)  $\text{BeH}_2$  reacts with trimethylamine to form a new compound. Give the fully balanced chemical equation for this reaction. Identify the general type of this reaction and indicate the role of each reactant.

(4 marks)

### Appendix: The Periodic Table of The Elements

	<b>1</b>																	<b>18</b>	
	1 H 1.008																		2 He 4.003
	3 Li 6.941	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	
	11 Na 22.99	12 Mg 24.31										13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95		
	19 K 39.10	20 Ca 40.08	21 Sc 49.96	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 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80	
	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	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	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	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 209.0	85 At 210.0	86 Rn 222.0	
	87 Fr 223	88 Ra 226.0	103 Lr 262.1	104 Rf 261.1	105 Db 262.1	106 Sg 263.1	107 Bh 264.1	108 Hs 265.1	109 Mt 268	110 Uun 269	111 Uuu 272	112 Uub 277	113 Uut 289	114 Uuq 289	115 Uup 289	116 Uuh 289	117 Uus 289	118 Uuo 293	
			57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 146.9	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			
			89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu 244.1	95 Am 243.1	96 Cm 247.1	97 Bk 247.1	98 Cf 251.1	99 Es 252.0	100 Fm 257.1	101 Md 258.1	102 No 259.1			