Chemistry 2202 Final Examination – June 2009
Question Map and Answer Key

Part 1: Selected Response

Question	Unit	Level	SCO	Pg#
1	1	1	115-3	24
2	1	2	115-3	26
3	1	1	323-1	26
4	1	1	323-1	28
5	1	1	323-1	28
6	1	2	323-1	28
7	1	2	323-11	40
8	1	1	323-11	40
9	1	1	213-10	38
10	1	1	213-5	34
11	1	2	213-5	32
12	1	2	323-1	28
13	1	2	323-11	40
14	1	3	323-1	28
15	1	2	323-10	36
16	1	1	213-5	32
17	1	1	323-10	36
18	1	3	213-3 214-12	42
19	2	1	321-4	58
20	2	2	214-2	72
21	2	1	321-4	76
22	2	2	323-7	74
23	2	1	323-11	60
24	2	2	321-4	60
25	2	1	321-4	70
26	2	2	321-5	64
27	2	1	321-5	62
28	2	1	321-4	76
29	2	3	321-7	56
30	2	2	321-5	62
31	2	2	321-7	56
32	3	1	319-4	82
33	3	1	319-7	88
34	3	1	319-7	86
35	3	1	319-7	100
36	3	1	319-7	104
37	3	2	319-6	94
38	3	2	319-5	92
39	3	3	319-7	88
40	3	3	319-8	106

Part 2: Constructed Response

Question		Unit	Level	Marks	SCO	Page #
41	a	1	2	4	321-1	30
	b	1	2	5	323-1	30
	c	1	2	3	323-1	28
	d	1	2	4	213-5	34
	e	1	2	4	323-11	40
	f	1	3	4	213-5	32
	g	1	3	3	323-1	26
42	a	2	2	6	321-4 321-11 321-5	60 60 62
	b	2	2	3	321-8	66 & 76
	c	2	2	4	321-8	66 & 76
	d	2	3	4	321-4	58
43	a	3	2	6	319-5	92
	b	3	2	6	319-5	92
	c	3	3	4	319-8	96

Multiple Choice (PART I)

1.	C	21.	D
2.	B	22.	C
3.	C	23.	C
4.	D	24.	D
5.	B	25.	C
6.	C	26.	D
7.	B	27.	D
8.	B	28.	B
9.	C	29.	D
10.	C	30.	A
11.	B	31.	B
12.	B	32.	A
13.	B	33.	D
14.	D	34.	C
15.	A	35.	A
16.	B	36.	B
17.	D	37.	C
18.	A	38.	A
19.	C	39.	A
20.	A	40.	A

Part II- Constructed Response
Total Value : 60%

Answer ALL questions in the space provided. All necessary workings must be shown to receive full marks.

Value

4 41. a. Percent composition analysis reveals that a compound is 71.06% cobalt and 28.94% oxygen. Determine the empirical formula.

Assume 100 g.

$$n_{Co} = \frac{m}{M} = \frac{71.06\ g}{58.93\ g/mol} = 1.206\ mol$$ 1%

$$n_O = \frac{m}{M} = \frac{28.94\ g}{16.00\ g/mol} = 1.809\ mol$$ 1%

$$Co_{\frac{1.206}{1.206}}O_{\frac{1.809}{1.206}} = Co_1O_{1.5} \times 2 = Co_2O_3$$ 2%

3 b. A compound has a molar mass of 84.18 g/mol. Percent composition analysis revealed that the compound has an empirical formula of C_2H_4. Determine the molecular formula of the compound.

$$M_{C_2H_4} = 12.01\frac{g}{mol} \times 2 + 1.01\frac{g}{mol} \times 4 =$$

$$24.02\frac{g}{mol} + 4.04\frac{g}{mol} = 28.06\ g/mol$$ 1%

$$\frac{M_{molecular}}{M_{empirical}} = \frac{84.18\ g/mol}{28.06\ g/mol} = 3$$ 1%

$$3\times\ C_2H_4 = \boldsymbol{C_6H_{12}}$$ 1%

3 c. Calculate the volume of 10.0 g of nitrogen dioxide, $NO_{2(g)}$ at STP.

$$M = \frac{14.01g}{mol} + \frac{16.00g}{mol} \times 2 = 46.01\ g/mol$$ 1%

$$n = \frac{m}{M} = \frac{10.0\ g}{46.01\ g/mol} = 0.217\ mol$$ 1%

$$v = n \cdot V = 0.217\ mol \times 22.4\frac{L}{mol} = 4.87\ L$$ 1%

2 d. (i) Determine the volume of a 2.00 mol/L $KNO_{3(aq)}$ solution required to make 250.0 mL of a 0.200 mol/L $KNO_{3(aq)}$ solution.

$$C_IV_I = C_FV_F$$ 0.5%

$$V_I = \frac{C_FV_F}{C_I} =$$ 0.5%

$$\frac{\left(0.200\frac{mol}{L}\right)(0.250\ L)}{\left(2.00\frac{mol}{L}\right)} = 0.0250\ L$$ 1%

OR 25.0 mL

2 (ii) Outline the steps you would use to prepare this new solution.

1. With a pipette or graduated cylinder, obtain 25.0 mL of 2.00 mol/L $KNO_{3(aq)}$
2. Transfer to a 250 mL volumetric flask
3. Add water to bring the volume in the flask to the fill line on the flask
4. Stopper and invert

*Or other acceptable answer at teacher's discretion

4 e. (i) A student reacts 50.0 g of $SiO_{2(s)}$ with excess $HF_{(aq)}$. Calculate the theoretical yield of $H_2O_{(l)}$ in grams.

$$SiO_{2(s)} + 4HF_{(aq)} \rightarrow SiF_{4(g)} + 2H_2O_{(l)}$$

$M_{SiO_{2(s)}} = 28.09\frac{g}{mol} + 16.00\frac{g}{mol} \times 2 = 60.09\frac{g}{mol}$ 1%

$n_{SiO_{2(s)}} = \frac{50.0\ g}{60.09\ g/mol} = 0.832$ mol 1%

$n_{H_2O} = 0.832\ mol\ SiO_{2(s)} \times \frac{2\ mol\ H_2O}{1\ mol\ SiO_{2(s)}} = 1.66$ mol H_2O 1%

$m_{H_2O} = n \times M = 1.66\ mol\ H_2O \times 18.02\frac{g}{mol} = 30.0g$ 1%

2 (ii) If the actual yield of $H_2O_{(l)}$ produced in part (i) was 24.6 g, determine the percent yield.

* Please note: If students do not get part (i) correct, mark part (ii) for procedure (i.e. they can still get full marks for part (ii))

$\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100\%$ 0.5%

$\%\ yield = \frac{24.6g}{30.0g} \times 100\%$ 0.5%

$\%\ yield = 0.820 \times 100\%$ 0.5%

$\%\ yield = 82.0\%$ 0.5%

4 f. A student discovered a bottle which contains a clear colorless solution. The label on the bottle, which was partially removed, read "_____ nitrate". The student tested two samples of the solution to determine the compound.

In test tube A the student added a few drops of $NaCl_{(aq)}$ and a precipitate formed.

In test tube B the student added a few drops of $Na_2SO_{4(aq)}$ and a precipitate formed.

What are 2 possible names for the solution in the bottle? Explain.

Cations that form insoluble compounds with chloride:

$Ag^+,\ Tl^+,\ Hg^{2+},\ Hg^+,\ Cu^+,\ Pb^{2+}$ 1%

Cations that form insoluble compounds with sulfate:

$Ca^{2+},\ Sr^{2+},\ Ba^{2+},\ Ra^+,\ Ag^+,\ Pb^{2+}$ 1%

Both lead(II) and silver ions form precipitates with chloride and sulfate, therefore the 2 possible names for the solution in the bottle are: 1%

		Also Accept	
1. Silver nitrate	OR	$AgNO_3$	0.5%
2. Lead (II) nitrate	OR	$Pb(NO_3)_2$	0.5%

3 g. Naturally occurring magnesium exists as a mixture of three isotopes. Mg-24 has an atomic mass of 23.985 amu and a relative abundance of 78.70 %. Mg-25 has an atomic mass of 24.985 amu and a relative abundance of 10.13%. The average atomic mass of magnesium is 24.31 amu. Calculate the atomic mass of the remaining isotope.

(23.985)(0.7870) + (24.985)(0.1013) + (Mg-26)(0.1117) = 24.31 1%

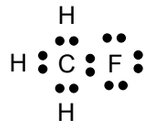
18.876 + 2.531 + (Mg-26)(0.1117) = 24.31

(Mg-26)(0.1117) = 2.903 1%

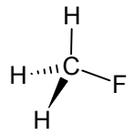
Mg-26 = 25.989 μ 1%

42. a. For the molecule CH_3F:

2 (i) Draw the Lewis dot diagram.



2 (ii) **Draw and name** the VSEPR shape diagram.

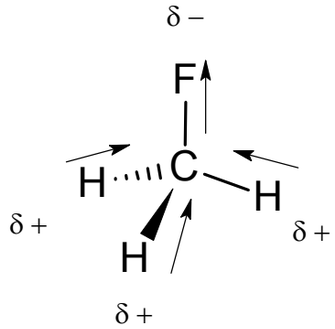


Tetrahedral Shape

2 (iii) Is CH_3F a polar molecule? Explain.

* No marks for simply saying yes. Must explain why and/or use a diagram.

Answer: Yes. All bonds are polar and the vectors don't cancel each other, therefore there is a negative dipole at fluorine and positive dipoles at the hydrogens.



b. For each pair of compounds, predict which substance will have the higher boiling point. **Justify your answer.**

2 (i) CF_4 or CBr_4

Only significant force in either compound is LDF. CBr_4 would have a higher boiling point because its LDF are stronger due to larger number of electrons per molecule (CBr_4 has 146 electrons compared to 42 electrons for CF_4)

2 (ii) SiO_2 or Pb

SiO_2 has a higher boiling point because it is a network solid and has network covalent bonding. Network covalent bonding is a stronger force than metallic bonding.

2 (iii) CH_4 or NaCl

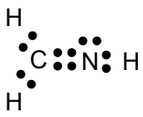
NaCl has a higher boiling point because ionic bonding is a stronger force than the London dispersion forces present amongst the CH_4 molecules.

1 c. Which of the 6 substances in (b) has the lowest boiling point? CH_4

d. A molecule consists of carbon, nitrogen, and hydrogen. This molecule has one multiple bond, one carbon atom and one nitrogen atom.

4

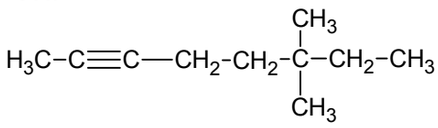
Draw the 2 Lewis diagrams for this compound.

Structure 1  2%

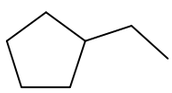
Structure 2  2%

43. a. **Name** each compound using the IUPAC naming rules.

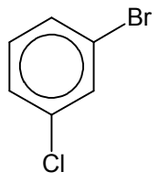
*** While teachers should use their own discretion when marking the naming questions, it is suggested that students get partial marks for getting the parent chain correct.**

2 (i) 

Name: 6,6-dimethyl-2-octyne

2 (ii) 

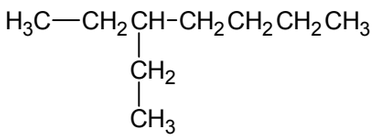
Name: ethylcyclopentane

2 (iii) 

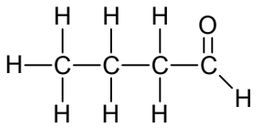
Name: 1-bromo-3-chlorobenzene

b. Draw a structural diagram for each compound.

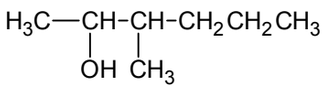
2 (i) 3-ethylheptane



2 (ii) butanal



2 (iii) 3-methyl-2-hexanol



4 c. Ethene reacts with hydrogen gas to produce Compound A. Compound A reacts with fluorine gas to produce Compound B and Compound C. Use structural diagrams to identify Compounds A, B, and C.