Chemistry 2202 Final Exam
June 2011

Part I- Selected Response
Total Value: 40 Marks

Multiple Choice (PART I)

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

Part II
Constructed Response
Total Value: 40 Marks

Answer ALL questions in the space provided. Show all workings and report all final answers with correct significant digits and units.

Value

3 41. (a) A compound contains 47.98 % C, 9.414 % H and 42.61 % O. What is the empirical formula of the compound?

Step 1: % to mass: Assuming a 100g sample, $m_c = 47.98g$, $m_H = 9.414g$, $m_O = 42.61g$

Step 2: Mass to moles: $n_C = \frac{m_C}{M_C} = \frac{47.98g}{12.01g/mol} = 3.995mol\ C$

$n_H = \frac{m_H}{M_H} = \frac{9.414g}{1.01g/mol} = 9.321mol\ H$

$n_O = \frac{m_O}{M_O} = \frac{42.61g}{16.00g/mol} = 2.663mol\ O$ (1 point)

Step 3: Divide by Lowest (moles): Write a temporary formula with the moles above; divide by lowest.

$C_{\frac{3.995}{2.663}}H_{\frac{9.321}{2.663}}O_{\frac{2.663}{2.663}} = C_{1.500}H_{3.500}O_1$ (1 point)

Step 4: Multiply until whole numbers: Have $C_{1.500}H_{3.500}O_1$; multiply by 2 to get $C_3H_7O_2$.

The empirical formula is $C_3H_7O_2$. (1 point)

2 (b) Which element would have 5.200×10^{22} atoms with a mass of 5.489 g?

Let "X" denote the unknown element

$n_X = \frac{N}{N_A} = \frac{5.200 \times 10^{22}\ atoms}{6.02 \times 10^{23}\ atoms/mol} = 0.0864mol\ X$ (1 point)

Rearranging the molar mass formula:

$M_X = \frac{m_X}{n_X} = \frac{5.489g}{0.0864mol} = 63.53g/mol$ (0.5 point)

Checking the periodic table, X = Cu, copper. (0.5 point)

Value

3 41. (c) Given the reaction:

$$4\ Al(s) + 3\ O_2(g) \rightarrow 2\ Al_2O_3(s)$$

Calculate the mass of aluminum needed to react completely with 325 mL of oxygen gas at STP.

Step 1: Get moles: $n_{O2} = \dfrac{V_{O2}}{MV} = \dfrac{0.325L}{22.4L/mol} = 0.0145mol\ O_2$ (1 point)

Step 2: Mole ratio: $n_{Al} = (0.0145\ \cancel{mol\ O_2})\left(\dfrac{4mol\ Al(s)}{3\ \cancel{mol\ O_2(g)}}\right) = 0.0193mol\ Al$ (1 point)

Step 3: Convert moles: Rearrange the molar mass formula to give:

$m_{Al} = n_{Al} \cdot M_{Al} = 0.0193mol\ Al \times 26.98g/mol = 0.522g\ Al$ (1 point)

4 (d) Calculate the theoretical yield of hydrogen gas, in grams, produced when 20.0 g of calcium metal, Ca(s), reacts with 1.50 L of 0.500 mol/L hydrochloric acid, HCl(aq), according to the reaction below.

$$Ca(s) + 2\ HCl(aq) \rightarrow H_2(g) + CaCl_2(aq)$$

Step 1: Get moles for each reactant:

$n_{Ca} = \dfrac{m_{Ca}}{M_{Ca}} = \dfrac{20.0g}{40.08g/mol} = 0.499mol\ Ca(s)$ (0.5 point)

$n_{HCl} = C_{HCl}V_{HCl} = (0.500mol/L)(1.50L) = 0.750mol\ HCl(aq)$ (0.5 point)

Step 2: Mole ratio for each reactant, to determine moles of hydrogen:

n_{H2} from Ca $= (0.499\ \cancel{mol\ Ca(s)})\left(\dfrac{1mol\ H_2(g)}{\cancel{1\ mol\ Ca(s)}}\right) = 0.499mol\ H_2(g)$ (0.5 point)

n_{H2} from HCl $= (0.750\ \cancel{mol\ HCl(aq)})\left(\dfrac{1mol\ H_2(g)}{\cancel{2\ mol\ HCl(aq)}}\right) = 0.375mol\ H_2(g)$ (0.5 point)

Step 3: Decide upon limiting reagent, and the theoretical yield (in moles)

The limiting reagent is HCl(aq), as it gives the maximum possible moles of $H_2(g)$ that can be produced; the theorectical yield is $n_{H2}= 0.375mol\ H_2(g)$. (1 point)

Step 4: Convert moles: Rearrange the molar mass formula to give:

$m_{H2} = n_{H2} \cdot M_{H2} = 0.375mol\ H_2(g) \times (2.02g/mol) = 0.757g\ H_2(g)$ (1 point)

(Aside: calculate $M_{H2} = 2 \times 1.01g/mol = 2.02g/mol$)

Value

3 41. (e) Calculate the volume of a 0.300 mol/L solution, $Mg(ClO_3)_2(aq)$, that contains 75.0 g of magnesium chlorate solute.

Calculate $M_{Mg(ClO3)2}$ = 1 x 24.31g/mol Mg = 24.31g/mol
2 x 35.45g/mol Cl = 70.90g/mol
6 x 16.00g/mol O = 96.00g/mol
191.21g/mol (1 point)

Get moles: $n_{Mg(ClO3)2} = \frac{m_{Mg(ClO3)2}}{M_{Mg(ClO3)2}} = \frac{75.0g}{191.21g/mol}$ = 0.392mol $Mg(ClO_3)_2$ (1 point)

Rearranging the molar concentration formula for volume:

V = n / C = 0.392 mol / 0.300mol/L = 1.31L (1 point)

3 (f) Three beakers are labeled A, B, and C. Each beaker contains one of the solutions below:

$CaI_2(aq)$, $NH_3(aq)$, $NaClO_4(aq)$

Each beaker's solution is tested for electrical conductivity and reaction with a solution of silver ions. The results are tabulated below:

	Electrical Conductivity	Reaction with $Ag^+(aq)$
Beaker A	No	No precipitate
Beaker B	Yes	Precipitate forms
Beaker C	Yes	No precipitate

Identify the chemical formula of the solution in each beaker. Briefly explain your choices.

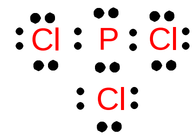
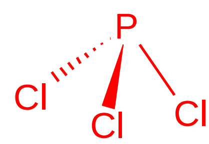
Beaker A is $NH_3(aq)$ (0.5 point)
Since $NH_3(aq)$ is molecular, it will neither conduct electricity nor form an ionic precipitate. (0.5 point)

Beaker B is $CaI_2(aq)$ (0.5 point)
Since $CaI_2(aq)$ is ionic, it will conduct electricity. According to our solubility table, AgI(s) **will** precipitate when $Ag^+(aq)$ is added. (0.5 point)

Beaker C is $NaClO_4(aq)$ (0.5 point)
Since $NaClO_4(aq)$ is ionic, it will conduct electricity. According to our solubility table, **no** $ClO_4^-(aq)$ precipitate when $Ag^+(aq)$ is added. (0.5 point)

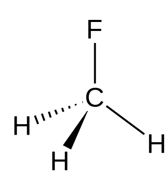
Value

3 42. (a) Complete the table for the molecule, PCl_3.

Lewis diagram	
VSEPR shape diagram	
Shape Name	pyramidal
Polarity: (polar/non-polar)	polar

2 (b) For the molecules given;

(i) List the intermolecular forces present.

Molecule		H—C≡C—H
Forces present	LDF (18 e-) and D-D	LDF (14e-)

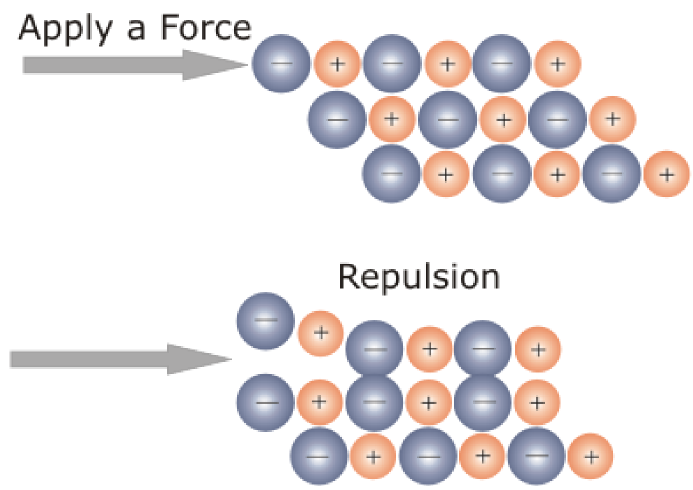
1 (ii) Explain, using intermolecular forces, which molecule in (i) above has the highest boiling point.

CH_3F has the higher boiling point since both molecules have similar LDF but CH_3F has the added force of D-D to be broken during the boiling process.

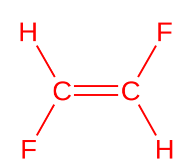
Value

2 42. (c) Explain, using principles of bonding and a diagram, why ionic compounds are brittle.

Ionic compounds are composed of a rigid network of oppositely charged ions in fixed positions. When struck with sufficient force, ions of the same charge are forced toward each other resulting in repulsion and the crystal shatters.



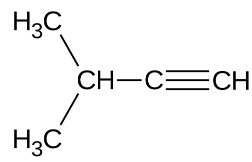
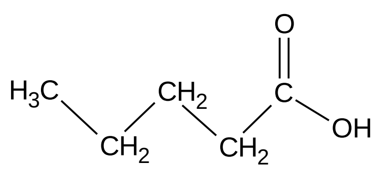
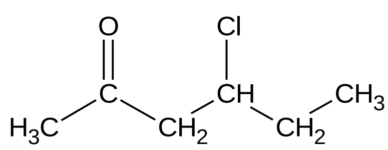
4 (d) Draw and name two shape diagrams, one that is polar and one that is non-polar for a molecule composed of C, H, and F atoms.

	polar	Non-polar
Shape diagram	Multiple examples.	 One possible example
Name	multiple	trans-difluoroethene

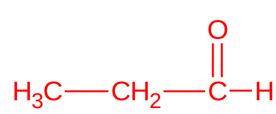
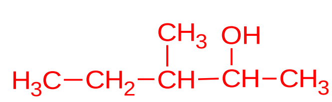
Note: 1 C compounds will all be polar. Therefore, non-polar structures must have a minimum of 2 C's.

Value

3 43. (a) Name each compound using IUPAC rules.

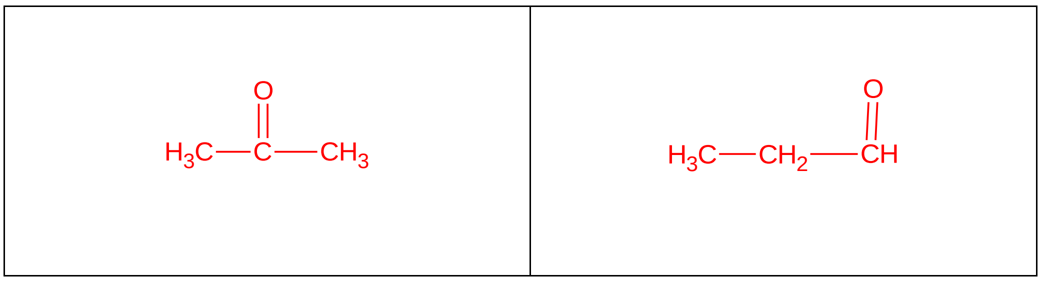
Structure	Name
	3-methyl-1-butyne
	pentanoic acid
	4-chloro-2-hexanone

2 (b) Draw a structural diagram for each compound.

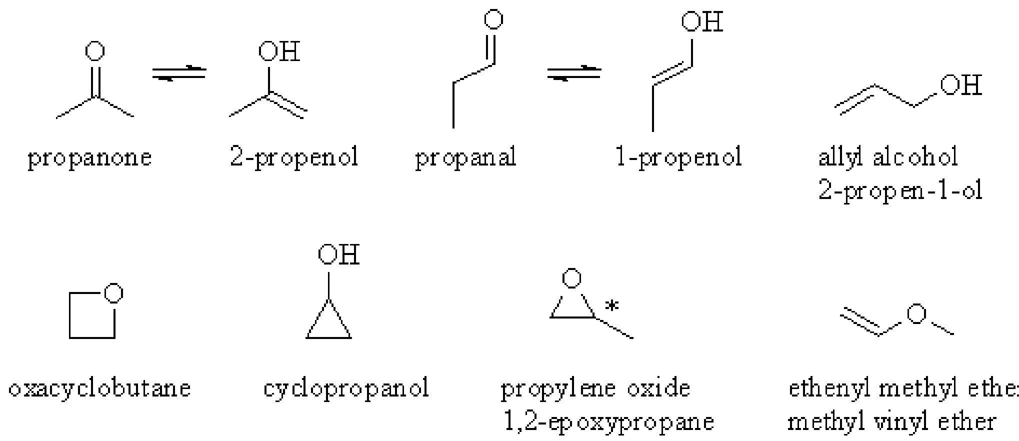
Name	Structure
propanal	
3-methyl-2-pentanol	

Value

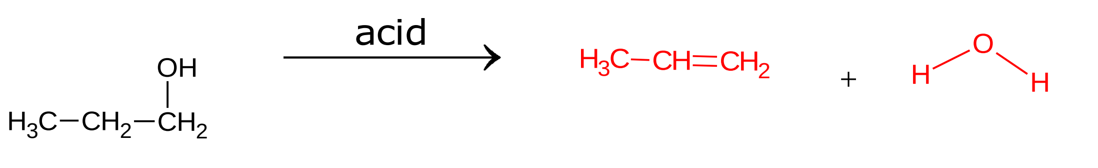
2 (c) Draw two isomers of C_3H_6O.



Other possible answers are shown below.



3 43. (d) In the lab, 1-propanol can be used to produce 1,2-dibromopropane in a two step process. Using structural diagrams, write the two reactions necessary for this process.



ii) step 2: