FI AL EXAMI ATIO
CHEMISTRY 202- YA-05
Monday, December 13, 2010
9:30 AM-12:30 PM

Print your ame:_____ Student umber:_____ VERSIO 2

Final Examination Rules

Q1. a) Name the following compounds.

i. $Mg(ClO_4)_2$

Q3. Classify each of the reactions given below as: precipitation ***and/or*** acid-base ***and/or*** oxidation-reduction.

Q6. a) Write the complete molecular, complete ionic, and net ionic equations for the

Q8. a) Determine the empirical formula of the compound that has the following mass percentage: C = 40.0%, H = 7.00%, O = 53.0% . (***3 marks***)

In 100 g, we have 40.0 g of C, 7.00 g of H and 53.0 g of O.

The molar mass of C is 12.01g/mol, the molar mass of H is 1.008 g/mol and the
molar mass of O is 15.99 g/mol.

Thus, the number of moles of C is 3.33 mol, the number of moles of H is 6.94 mol and the number of moles of O is 3.31 mol.

The ratio of each element is :

C: 3.33/3.31 = 1

H: 6.94/3.31 = 2.09 = 2

0: 3.33/3.31 = 1

Empirical formula = CH_2O

b) Determine the molecular formula of the acid produced if the molar mass of the compound is between 58 – 66 g/mol. ***(1 mark)***

Molar mass of CH_2O = 12.0 + 2x1.0 + 16.0 = 30.0 g/mol
Molecular formula = $C_2H_40_2$ = 60.0 g/mol

Q9. a) The total energy of a nitrogen gas laser pulse with a wavelength of 337 nm is 3.87 millijoules. ***(3 marks)***

i. How many photons does the laser pulse contain?

$E_{photon} = hc/\lambda = 6.626 \times 10^{-34}$ J.s $\times$ 2.998×10^{8} m/s $= 5.89(5) \times 10^{-19}$ J

337×10^{-9} m

Number of photons = $E_{pulse}/E_{photon} = 3.87 \times 10^{-3}$ J / $5.89(5) \times 10^{-19}$ J = **6.56×10^{15} photons**

ii. In which region of the electromagnetic spectrum is the radiation found?

Answer: ***The laser pulse is in the _____ part of the spectrum.***

b) An electron in the n = 6 level of a hydrogen atom falls to a lower energy level emitting light of wavelength 93.8 nm. Find the principal energy level to which the electron falls. ***(2 marks)***

$1/\lambda = R_H (1/n_{in}^2 - 1/n_{out}^2)$

$1/n_{in}^2 = 1/(\lambda R_H) +$

c) What is the de Broglie wavelength (in nm) associated with a 2.5 g Ping-pong ball travelling at a speed of 20. m/s? ***(2 marks)***

Q10. a) Which of the four quantum numbers (***n***, ***l***, m_l and m_s) determine . . .

i. . . . .the energy level of an orbital in a hydrogen atom. Answer:___

ii. . . . . the shape of an orbital. Answer:____

iii. . . . . the size of an orbital Answer:____

iv. . . . . the spatial orientation of an orbital. Answer:____

b) Draw the orbital (box) diagram for the atom with the following electron configuration. Name the element represented by the electron configuration. ***(2 marks)***

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$ Element:_____

c) Which of the following sets of quantum numbers are allowed and which are not allowed to specify an electron? For the set of quantum numbers that are incorrect, state what is wrong in each set. ***(1 mark)***

i. $n = 1, l = 1, m_s = -\frac{1}{2}$ . . . . . Not allowed, max for l is n-1 . . . . . .

ii. $n = 4, l = 3, m_l = -2, m_s = +\frac{1}{2}$ . . . . . Allowed . . . . . .

d) Answer the following questions (i. to iii.) for an atom of gallium, Ga.

i. Write the complete ground state electron configuration.

Answer:_____

ii. How many valence electrons does Ga have? Answer:_3 valence electrons_

iii. How many ***s*** electrons does Ga have ***with a spin of*** **+ ½** ? Answer:_4, s electrons_

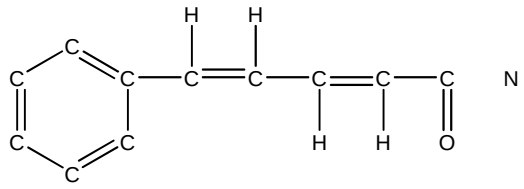
Q11. a) Explain why Se^{2-} has a larger atomic radius than Sr^{2+}.

b) Answer the following questions (i. – iii.) for the set of atoms B, Al and O:

Q12. Use the molecular orbital diagram (right) to answer the following questions.

Q13. Piperine, below, is the compound responsible for the spiciness of black pepper.

a) Complete the Lewis structure of piperine below by adding lone-pairs wherever required.



Q16. ***continued***

Q17. a.) Explain in terms of intermolecular forces why . . . ***(2 marks)***

i. NH_3 has a higher boiling point than CH_4.

Ammonia has H-bonding and methane only vdW forces.

ii. KCl has a higher melting point than I_2.

KCl has ionic bond and iodine is covalent and non-polar.

b) The binary hydrogen compounds of Group 4A elements have the following boiling points:

Compound:	Boiling point:(°C)
CH_4	– 162
SiH_4	– 112
GeH_4	– 88
SnH_4	– 52

Fully explain the increase in boiling points from CH_4 to SnH_4.

The higher the atomic mass of the central atom the greater its polarisability leading

c) List the most significant intermolecular force that exists between molecules in each of the following species:

i. HF……

ii. CH_3Cl……

iii. benzene, C_6H_6 ……

iv. CS_2……

Q18. a) Complete the phase diagram of H_2O below.

i. Label the axes.

ii. Label the physical state that corresponds to each region.

iii. Circle the triple point.

Q19. The following information describes the procedure and results for the reaction of calcium chloride with sodium carbonate to produce calcium carbonate. Answer the following questions based on the data supplied.

PROCEDURE

i. Weigh the $CaCl_2 \cdot 2H_2O$ and record the mass on the data sheet
ii. Transfer the solid $CaCl_2 \cdot 2H_2O$ into a volumetric flask, dissolve the solid with distilled water and fill the flask to the 100.0 mL mark.
iii. Pipette 10.00 mL of this solution into a 150 mL beaker
iv. Record the concentration of the Na_2CO_3 solution and add, to the same 150 mL beaker a precise volume of Na_2CO_3 solution. Record this volume on your datasheet.
v. On a clean and dry watch glass, put a filter paper and weigh both of them together.
vi. Use this filter paper to filter the solid $CaCO_3$ obtained, dry your filter paper containing the final product in an oven at 110°C for 20 min and weigh on the watch glass.

DATA SHEET

1. Mass of $CaCl_2 \cdot 2H_2O$ ***4.0122 g***
2. $[Na_2CO_3]$, $mol \cdot L^{-1}$ ***0.3330 M***
3. Volume of the Na_2CO_3 solution added ***11.03 mL***
4. Mass of filter paper + watch glass ***46.8778 g***
5. Mass of filter paper + watch glass + dry product (final) ***47.1001 g***

Molar masses: Na_2CO_3 : 105.99 g/mol , $CaCO_3$: 100.09 g/mol , $CaCl_2$: 110.98 g/mol

a) Write the balanced molecular equation of this reaction.

b) Calculate the concentration of the initial $CaCl_2$

Q19. ***continued.***

c) Identify the limiting reactant. ***(2 marks)***

Mole of $CaCl_2$·in the beaker:
0.2729 M x 0.01000 L = 2.729×10^{-3} mole

Mole of Na_2CO_3·in the beaker:
0.3330 M x 0.01103 L = 3.673×10^{-3} mole

Since the stoichiometric ratio is 1 $CaCl_2$ for 1 Na_2CO_3 then **$CaCl_2$·is the limiting reactant**.

d) Calculate the theoretical yield (in grams). ***(2 marks)***

From the previous calculation:

$CaCl_2$·= 2.729×10^{-3} mole (limiting reactant)

Since the stoichiometric ratio is 1 $CaCl_2$ for 1 $CaCO_3$ then the number of moles of $CaCO_3$ obtained will be the same as the one of the limiting reactant (assuming 100% yield).

Theoretical yield:

2.729×10^{-3} mole $CaCl_2$ x (1 $CaCO_3$ / 1 $CaCl_2$·) x (100.09 g / mol) = **0.2731 g $CaCO_3$**

e) Calculate the actual yield and the % yield of the reaction. ***(2 marks)***

Actual yield:

47.1001 g – 46.8778 g = **0.2223 g $CaCO_3$**

%Yield:

(0.2223 g / 0.2731 g) x 100% = **81.40 %**

USEFUL DATA:

Bohr constant $B = 2.178 \times 10^{-18}$ J

Rydberg constant $R_H = 1.0974 \times 10^{7}$ m^{-1}

Gas constant $R = 0.08206$ $L \cdot atm \cdot mol^{-1} \cdot K^{-1} = 8.314$ $L \cdot kPa \cdot mol^{-1} \cdot K^{-1}$

Avogadro's number $N_A = 6.0221 \times 10^{23}$ mol^{-1}

Planck's constant $h = 6.626 \times 10^{-34}$ $J \cdot s$

Speed of light $c = 2.998 \times 10^{8}$ $m \cdot s^{-1}$