AP Chemistry

Lecture Guide

Queen Anne School 2009–2010

Student Name _____

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Mole & Reaction Computations

1 Equation balancing – supplemental package

a) Molecular equation on Complex REDOX
b) BNIE on Complex REDOX

2 Significant figures (sigfigs) – Chapter 1.8

a) Thumb of rules
b) Addition and subtraction
c) Multiplication and division
d) Combined operations
e) In APFRQ

3 Goals to strive in math computation

a) Reducing using calculator
b) Reducing inter-medium steps

Requirements for presentation in Chemistry test

a) Key verbal statements
b) Explain shorthand and self-created notations
c) Square answer with enough sig fig and a unit
d) Presentation Trilogy: gas density
    i. Theoretical expression or deduction
    ii. Value plug-in to auto unit conversion
    iii. Final answer with enough sig fig and a proper unit

4 Common units and conversions

Measurement	SI	USCS	Mr. D's lab
Mass			
Volume			
Temperature			
Pressure			
Time			
Counts			

Computations

1 Mole computation is central

Conversions: mass↔mole ↔numbers

mole↔numbers (Avogadro number)

mole↔mass (molar mass)

a) Name and compute the molar mass of compound $CaCl_2 \bullet 2H_2O$

b) Compute the number of moles of $CaCl_2 \bullet 2H_2O$ contained in a 1.25g sample.

c) Compute the number of this hydrated compound contained in this sample.

2 **Mole ratios are vitally central and reflected in a chemical compound**
Solid: sequential imbed-ment of atoms and ions in a compound

d) Compute the number of moles of water moles of water molecules contain in a 1.25g $CaCl_2 \bullet 2H_2O$ sample.
e) Compute the mass of hydrogen atoms contained in a 1.25g $CaCl_2 \bullet 2H_2O$ sample.
f) Compute the number of atoms contained in 1.25g $CaCl_2 \bullet 2H_2O$ sample.

3 **% by mass of each atoms/ions in a compound is also central**

g) Compute the % by mass of water in a 1.25g $CaCl_2 \bullet 2H_2O$ sample.
h) Compute the % by mass of Ca in a 1.25g $CaCl_2 \bullet 2H_2O$ sample.
i) Does the mass of the sample matter in determining the % by mass for the 2 questions above? Explain.

4 Chemical reactions follow mole ratios in disappearing and producing

5 Reaction I: solid with some reactant(s) explicitly limited

Rules: set-up three lines – coefficient, mass and mole

A piece of 0.235g magnesium strip is burned in by Mr. Duan,

a) Present BNIE
b) Determined the species reduced
c) Identify the limited reactant
d) Compute the mass of the product
e) Compute the % change of mass after burning

6 Reaction II: solid with some reactant(s) implicitly limited

Determine the limited reactant

Rule: cross multiplication between moles and coefficients, the smaller value reveals the limited

2.00g CaO solid is mixed with 2.00g of P_2O_3 solid, and then heated strongly till the reaction to completion

a) Present BNIE
b) Is this reaction a REDOX? Explain.
c) Compute and identify the limited reactant
d) Compute the mass of the product

7 Mole TRIOLOGY ICE is a vital technique to master in answering various questions

2.00g CaO solid is mixed with 2.00g of P_2O_3 solid, and then heated strong till the reaction to completion

e) Present mole ICE
f) Compute the leftover in mass of the reactant
g) Confirm: conservation of mass in this particular chemical reaction

8 Molar concentration of a solution can be computed in molarity

Formula:

To make 100ml of 0.250M $KMnO_4$ solution

a) Name the glassware to be use to make this solution
b) Compute the mass of $KMnO_4$ needed
c) State a detailed stepwise procedure to make this solution

9 Reaction III: solid with aqueous

A sample of 0.66g of MgO resulted from the burning of a magnesium strip is put in a beaker containing 10.0mL of 0.250M HCl, which is heated till the reaction is complete

a) Present the BNIE
b) Is this a REDOX reaction? Explain.
c) SET up mole ICE
d) Formulate 3 questions that can be answered through the mole ICE

10 Solution: dilution

Rule: the total amount of moles in solute remains the same (in moles) before and after the dilute

Formula:

You need to make 100mL of 1.25M HCl,

a) How much 3.0M of HCl stock solution do you need?
b) State a detailed stepwise procedure to carry-out this dilution

11 Solution: mixture

Rule: both the moles and volume will reconstitute

Formula:

If 20.0mL of 0.10M of $AlCl_3$ solution is mixed with 15.0mL of 0.50M of $AlCl_3$ solution

a) Compute molar concentration of this solution mixture
b) Compute the concentration of chloride ions $[Cl^-]$in the mixture
c) If 20.0mL of 0.10M of $AlCl_3$ solution is mixed with 0.50M of $AlCl_3$ solution to make a mixture with a concentration of 0.30M, compute the amount of 0.50M $AlCl_3$ solution that is needed.

12 Reaction IV: solution with solution

Ppt & Ion ranking: milli-mole ICE

If 20.0mL of 0.25M calcium nitrate solution is mixed with 30.0mL of 0.10M of sodium phosphate solution

a) Present the BNIE
b) State a technique that can be used to fully collect the ppt
c) Present milli-mole ICE
d) Compute the molar concentrations, and then rank all the ions in the final solution

Titration: aq/aq & aq/solid

Formulas

The concentration of an unknown $Ba(OH)_2$ is determined through titration, consuming 20.00mL of 0.125M of HCl and 36.80mL of $Ba(OH)_2$

a) List 5 central devices and/other chemicals needed for this titration
b) Present BNIE
c) Explain how the equivalent point is determined
d) Compute the molar concentration of the unknown $Ba(OH)_2$

26.5mL of KOH with unknown concentration is needed to neutralize 0.66g of KHP in a titration trail

a) What is KHP?
b) What is a primary standard?
c) Compute the concentration of the unknown base.

Complex REDOX titration:

Lab 8 bleach titration: % by mass determination

13 Gaseous

The Ideal Gas Law integrates 4 variables: volume, pressure, amount, and temperature

Rule: 1 mole of any gas occupies 22.4L of volume under STP

a) Present the Ideal Gas Law
b) Define each variable and its unit in the ideal gas law
c) Present 3 different units of pressures and show their inter-conversions
d) Derived the density formula of a gas from the Ideal Gas Law. What is its unit?
e) Define STP
f) Prove: 1 mole of any gas occupies 22.2L of volume under STP

14 Reaction V: a reaction containing a mixture of solid, aqueous and gas

22.0mL of gas is collected under STP by dissolving a piece of Mg metal with excess HCl

a) Present the BNIE
b) State the method to test the identity of the gas
c) Name a glassware suited to collect the gas
d) Compute the mass of magnesium
e) Compute the total number of electrons transferred in this reaction

15 Empirical formula

(Empirical formula)n = molecules formula

16 Empirical formula determination I: from direct % by mass

Steps

a) Set-up mass line for each element, assume 100g sample
b) Set-up the computed mole line
c) Compute mole ratio line by dividing the smallest mole from last line
d) Rearrange ratio line into simplest whole numbers by proportion

A hydrocarbon compound contains 20.0% hydrogen atoms by mass

a) Determine the empirical formula of this compound
b) Using your knowledge in Organic chemistry, propose a plausible molecular formula for this compound through drawing the structural formula
c) Name this compound

17 Empirical formula determination II: from indirect % by mass – combustion analysis

Steps: use mole ratios (but not use the coefficients)

a) Tease the mass of carbon out from carbon dioxide, using % by mass
b) Tease the mass of hydrogen out from water, using % by mass
c) Get the mass oxygen from last two step, to obtain the complete mass line
d) Back to steps in the 'old fashion' stated in 15

A sample of 1.15g organic liquid containing C, H, O is fully combusted to produce 2.20g of CO2 and 1.35g of H2O

a) Determine the empirical formula of this compound
b) Referring to Figure 3.6 in your textbook on H_2O and CO_2 absorbers, given they are $CaCl_2$, and CaO, present the BNIE for both (absorption) reactions
c) Draw 2 plausible structural formulas for this compound
d) To which larger groups of organic compound does it belong to?