# CLASS II WASTEWATER LABORATORY ANALYST EXAMINATION STUDY GUIDE 2008

**SPECIFIC WASTEWATER LABORATORY ANALYSES INCLUDED ON CLASS II EXAM**

ALL ANALYSES LISTED IN THE CLASS I EXAMINATION STUDY GUIDE
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Chemical Oxygen Demand
Conductivity
NITROGEN
- Ammonia-Nitrogen
- Total Kjeldahl Nitrogen
- Nitrate
- Nitrite

Oil and Grease
Ozone
PHOSPHORUS
- Total Phosphorus
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BIOLOGY

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RULES AND REGULATIONS

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**REFERENCES**
- 18th Edition of the Standard Methods for the Examination of Water and Wastewater
- 19th Edition of the Standard Methods for the Examination of Water and Wastewater
- 20th Edition of the Standard Methods for the Examination of Water and Wastewater
- U.S. EPA Approved Methods for Wastewater Analysis
- 40 CFR Part 136
- Water Environment Federation [WPCF] Manual of Practice No. 11
- Operation of Wastewater Treatment Plants, California State University Sacramento [Sacramento Manual]

**SPECIFIC WASTEWATER LABORATORY ANALYSES INCLUDED ON CLASS II EXAM**

**Biochemical Oxygen Demand (Advanced)**

Given appropriate data, be able to determine the appropriate BOD dilutions for a high strength industrial wastewater.

**Fecal Coliform (Advanced)**

Be familiar with the "confirmed phase" of the multiple-tube fermentation and membrane filtration methods for fecal coliform in cluding length of time and temperature requirements.

USING THE FECAL COLIFORM INFORMATION FROM THE CLASS I NTK, EXPAND IT TO INCLUDE TOTAL COLIFORMS.

What pore size membrane is used for fecal coliform determination in the membrane filter method?

Be familiar with testing procedures (and frequencies) for UV lamps used for sterilization of membrane filter apparatus

Describe the implications of the presence of *E.coli* in water samples

For NPDES purposes, how is a TNTC (Too Numerious to Count) result factored into the monthly average?

**Chemical Oxygen Demand**

Define Chemical Oxygen Demand including what the COD test determines.

Explain the following aspects of the procedure to determine COD:
a) EPA approved methods
b) Definition and purpose of test
c) List all reagents, their purpose and interferences
d) Digestion Time and specified test conditions
e) Low level COD procedure
f) Calculation
g) Required equipment
h) Endpoints and quality control tests [colorimetric and titrimetric]

What type of pretreatment is necessary for COD samples that contain suspended solids and what are the implications if the sample is not pretreated?

What are the advantages of the COD test over the BOD test? What are the disadvantages?

**Conductivity [Specific Conductance]**

Define conductivity.

What units are conductivity measured in?

What temperature is specified for the reporting of specific conductance?

Explain the conductivity measurement procedure.

What substance is generally used for conductivity standards?

What is a Wheatstone bridge?

What type of solids can be estimated by specific conductance results?

What solution is used to calibrate a conductivity meter?

**NITROGEN**

Describe the nitrogen cycle.

Describe how each of the following relate to the wastewater treatment process including the environmental impact of each on receiving waters:
a) Ammonia-nitrogen
b) Nitrate-nitrogen
c) Nitrite-nitrogen
d) Total Kjeldahl nitrogen

**Ammonia-Nitrogen**
Describe the Nesslerization test for ammonia nitrogen including equipment, test principles and required conditions

Describe the specific ion method for ammonia nitrogen including equipment, test principles and required conditions

Describe the manual distillation method for ammonia-nitrogen including equipment, test principles and required conditions.

Describe how to make ammonia-free water for use in the ammonia nitrogen test.

How are interferences removed in ammonia analysis?

**Total Kjeldahl Nitrogen**
What types of nitrogen are included in the TKN test?

List and describe EPA approved methods for TKN including test conditions, equipment used, safety precautions and calculations.

**Nitrate**

List and describe EPA approved methods for nitrate including test conditions, equipment used, interferences, safety precautions and calculations.

**Nitrite**

List and describe EPA approved methods for nitrite including test conditions, equipment used, interferences, safety precautions and calculations.

**Oil and Grease**

List and describe the two EPA approved methods for Oil and Grease and be familiar with the differences.

List the reagents used in the two different methods and be familiar with the environmental pros and cons of the various reagents.

List the prescribed test conditions for each approved method for Oil and Grease.

Describe the approved sampling container and sampling method for the Oil and Grease test [including the proper way to determine actual sample volume used in the test].

What is the appropriate method for the determination of Oil and Grease on:
a) wastewater samples
b) sludge samples

Given appropriate data, be able to calculate an Oil and Grease.

**Ozone**
Describe the uses of ozone [O3] in a wastewater treatment facility.  Be familiar with the environmental and safety factors that should be considered before using ozone.

Describe the approved test procedure and the principle behind the procedure.

List the test conditions and equipment used in the procedure.

**PHOSPHORUS**
Define:
a) orthophosphate
b) condensed phosphates
c) organically bound phosphates

Describe how to properly clean glassware for use in phosphorus analyses?

Describe the differences between the total phosphorus test and the ortho-phosphorus test including sampling, preservation, holding times and the implications of the results.

Describe three methods [and the appropriate reagents and/or laboratory equipment] used for digestion of phosphorus samples and know the optimum use of each.

What is the purpose of digestion in the phosphorus test and what phosphorus form is left after digestion?

**Total Phosphorus**

List three colorimetric methods for the analysis of phosphorus including the endpoints and test conditions for each.

List the procedures, equipment and test conditions for the EPA approved methods for total phosphorus.

Describe interferences that would make one method preferable over another for the analysis of phosphorus.

**Orthophosphate**

List the procedures, equipment and test conditions for the EPA approved methods for ortho-phosphorus, including the filtering procedure and filtering equipment/supplies.

**SOUR [Specific Oxygen Uptake Rate]**

Describe the SOUR procedure and the implications of the results on the activated sludge process.

What are the units of measurement for the SOUR test results?

What is the most appropriate sampling location for the SOUR test?

**SAMPLING/PRESERVATION/HOLDING TIMES**

Be familiar with the sample types, container requirements, preservation requirements and holding times listed in 40 CFR Part 136 for the parameters listed in the Class II study material.

List several important factors in the sampling for bacteria analyses. What is the most important factor?

Be familiar with the appropriate cleaning procedures (including appropriate cleaning agents, etc.) for sampling containers to be used in: metals analyses, phosphorus analyses, nitrogen analyses)

## GENERAL LABORATORY INFORMATION AND PROCEDURES

Know the names of the instrumentation, major instrument components and/or apparatus and operational theory used to conduct analyses for the parameters listed in the Class II study material.

What is the purpose of using colored glassware for certain reagents?

What type of electrode is used in:[Also be familiar with filling solutions used for each]
- a) dissolved oxygen test
- b) ammonia-nitrogen test
- c) pH test

Define the following and list some specific tests that use the following:
- a) Gravimetric
- b) colorimetric
- c) Titrimetric

Define specific gravity and be able to use it in calculating concentrations.

Explain the reason for acidifying samples during volatile acid analyses.

Describe the method of standard addition.

Define the term "standard conditions" as used in a laboratory.

List the common sizes of stock reagent containers.

Be familiar with the different “grades” of chemical reagents and the appropriate uses of the grades.

List common indicator solutions, be familiar with the tests in which they are used and the ingredients common to indicator solutions.

What type of graph paper is used to generate a standard curve for Specific Ion Probe analysis for ammonia and fluoride?

Describe how to prepare the following types of laboratory water:
- organic free water
- Ammonia free water
- Carbon dioxide free water

Describe how a mixed bed deionizing column deionizes water.

Describe how activated carbon purifies water, including what contaminants it removes.

Describe the specifications (conductivity, resistivity and SiOs) for low, medium and high quality reagent water.

Be familiar with appropriate labeling requirement for chemicals and standards

What is the most important aspect in determining how much buffer to purchase?

Be familiar with the glassware cleaning and prep requirements for all analyses listed for the Class II exam

What temperature is specified for drying reagents prior to weighing?

How quickly should an autoclave reach the required temperature?

Describe the proper use, care and restoration procedures for liquid in glass thermometers.

Be familiar with the following terms:

1) refluxing
2) distillation
3) liquid extraction
4) reverse osmosis
5) adsorption
6) absorption
7) autoclaving

Describe how a mistake in recording laboratory data on a bench sheet should be “corrected”.

**CHEMISTRY**

How does dissolved air affect the pH of water?

Describe the difference between strong and weak acids. Give specific examples of each. List unique characteristics of specific strong acids.

Describe major groups of acids and give specific examples of each.

Given the concentration of a specific ion, be able to calculate the concentration of its elements.

List common acids and bases by name and chemical formula.

Explain the effect of temperature on the solubility of gases in liquids.

Given appropriate date, know how to calculate % oxygen saturation of water.

**BIOLOGY**

List various types of media used for bacteriological analyses.

What test indicates dissolved oxygen uptake divided by time?

List the types of organisms predominantly found in:

a) anaerobic digesters
b) young sludge
c) old sludge
d) lagoons
e) "good" population of activated sludge

Describe the conditions necessary when viewing microorganisms (with a microscope) with a 100x objective

**SAFETY**

What is a TLV and how is it used?

Where would you find the TLV for a specific substance?

Explain proper storage practices for chemicals commonly used in wastewater laboratories [i.e. what should not be stored together?]

List the types of substances that should be handled under a fume hood and those that can be safely handled outside the fume hood.

Describe appropriate chemical waste disposal practices for chemicals commonly used in wastewater laboratories.

Describe the appropriate biological waste disposal practices for biological wastes that are generated in wastewater laboratories.

Be familiar with basic first aid procedures.

List the information found on a MSDS and know what the letters MSDS stand for.

What is the most important concern after chemical spill?

Be familiar with the appropriate type of gloves for various chemicals and conditions.

Be familiar with the source (certification for design, construction, testing, etc.) of eye and face protection standards and the appropriate testing of eye wash and safety showers.

Be familiar with confined space definition, confined space entry procedures and the agency which publishes the confined space regulations.

What is a Chemical Hygiene Plan and what regulation requires the development of such a plan?

In what part of the Code of Federal Regulations are the Occupational Safety and Health Standards (OSHA requirements) found?

Be familiar with waste minimization practices that can be used in the laboratory.

Describe the classes of fires and what materials are involved in each.

## QUALITY CONTROL/QUALITY ASSURANCE

Given appropriate data be able to calculate % recovery of a spiked sample.

What is Standard deviation?

What is % relative standard deviation and when and why might it be used?  How is it related to precision and differing concentrations?

Compare and contrast precision and accuracy.

What is the definition of Method Detection Limit (MDL), what is the MDL determination procedure and how many analyses are required to determine a MDL?

What is the purpose of an SOP in the laboratory?

Typically, how many standards are needed to prepare a linear calibration curve?

Describe the use and purpose of control charts (including warning limits, control limits, etc.)

## RULES AND REGULATIONS

Given appropriate data, be able to calculate a weekly average for NPDES reporting.

Describe the sampling procedures during a plant upset.

Be familiar with the procedure for obtaining alternate methodology variances [methods not listed or approved in 40 CFR part 136].

Describe the data reporting requirements for NPDES DMR reporting and other compliance monitoring.

## PLANT OPERATIONAL INFORMATION

Describe laboratory procedures that can be utilized to determine if significant numbers of filamentous bacteria are present in activated sludge.

Describe optimum conditions [pH, temperature, etc.] for the chlorination of wastewater.

What impact does heavy rainfall have on the influent concentrations of common wastewater parameters?

What analyses can be conducted to determine the fertilizer value of wastewater or sludge [biosolids].

What does the predominance of the following indicate in an activated sludge process:
- a) rotifers
- b) filamentous bacteria
- c) stalked ciliates
- d) nematodes

Given appropriate data, be able to calculate % reduction in volatile solids in digesters.

Describe various "tertiary" treatment processes in wastewater.

Describe the biological nitrification process.

Describe the use of “jar testing” and given appropriate data be able to calculate a chemical dosing based on the results of a jar test.

## MATH

Define and have a working knowledge of the following:
- a) mean
- b) median
- c) mode
- d) range
- e) significant figures

Have a working knowledge of the following:
- a) chemical feed calculations
- b) chemical dose calculations

## DEFINITIONS

Define and have a working knowledge of the following:
- a) gram equivalent weight
- b) molecular weight
- c) specific gravity
- d) density
- e) conductivity
- f) solvent
- g) solute
- h) titrant/titration
- i) standard solution
- j) significant figures
- k) catalyst
- l) MPN
- m) TLV
- n) colloids

o) facultative bacteria
p) aerobic bacteria
q) anaerobic bacteria
r) cation
s) anion
t) normality
u) molarity
v) NPDES
w) compound
x) element
y) atom
z) coagulant
aa) surfactant
bb) CFR
cc) pH
dd) disinfection
ee) sterilization
ff) duplicate sample
gg) spike sample
hh) atomic weight
ii) alkalinity
jj) hardness
ll) buffer
mm) chemical equilibrium
nn) oxidant
oo) reducer
pp) pathogenic
qq) Gravimetric
rr) colorimetric
ss) Titrimetric
tt) relative standard deviation
uu) replicate sample

# Calculations Study Guide for Class II Wastewater Analyst "Needs to Know"

**Acidity:**

$$\text{Acidity (mg CaCO3/L)} = \frac{[(A)(B)-(C)(D)](50000)}{\text{ml Sample}}$$

Where A = ml NaOH titrant
B = Normality of NaOH
C = ml of H2SO4 used
D = Normality of H2SO4

Note Report the final pH with result

**Alkalinity:**

$$\text{Alkalinity (mg CaCO3/L)} = \frac{(A)(N)(50000)}{\text{ml Sample}}$$

Where A = ml Standard Acid used
N = Normality of Standard Acid

for low Alkalinities -

$$\text{Total Alkalinity (mg CaCO3/L)} = \frac{[(2)(B)-(C)](N)(50000)}{\text{ml Sample}}$$

Where B = ml titrant to reach first endpoint
C = ml titrant to reach pH 0.3 below endpoint for B
N = Normality of Standard Acid

**Biochemical Oxygen Demand (BOD/CBOD) :**

Unseeded -

$$\text{BOD5 (mg/L)} = \frac{(D1-D2)}{P}$$

Seeded -

$$\text{BOD5 (mg/L)} = \frac{(D1-D2)-(B1-B2)(F)}{P}$$

Where B1 = initial DO of seed control (Blank)
B2 = final DO of seed control (Blank)
D1 = initial DO of prepped sample
D2 = final DO of prepped sample
F = Ratio of seed in prepped sample to seed in blank (% seed in sample / % seed in Blank)
P = Decimal volume fraction of sample used (1% = 0.01, 10% = 0.10, 50% = 0.50, etc.)

Note If a Nitrification inhibitor is used, report the result as CBOD.

**Residual Chlorine :**

Iodometric Method I -

$$\text{mg } Cl_2/L = \frac{(A+B)(N)(35450)}{\text{ml Sample}}$$

Where A = ml titrant used for sample
B = ml titrant (positive or negative) used for Blank
N = Normality of Thiosulfate ($Na_2S_2O_3$)

Iodometric Method II -

with Iodine titrant -

$$\text{mg } Cl_2/L = \frac{[A-(5)(B)](200)}{\text{ml Sample}}$$

Where A = ml of .000564 reductant
B = ml of .0282 N Iodine

with Iodate titrant -

$$\text{mg } Cl_2/L = \frac{(A-B)(200)}{\text{ml Sample}}$$

Where A = ml of Thiosulfate ($Na_2S_2O_3$)
B = ml of Iodate titrant used

Amperometric Titration -

$$\text{mg } Cl_2/L = \frac{(\text{ml .000564 N phenylarsine})(200)}{\text{ml Sample}}$$

Low Level Amperometric Titration -

$$\text{mg } Cl_2/L = \frac{(A)(N)(200)}{(B)(.000564)}$$

Where A = ml titrant at equivalence point
B = ml Sample
N = Normality of phenylarsine

**Coliforms :**

$$\text{MPN/100 ml} = \frac{(\text{MPN value from table})(10)}{\text{largest sample vol. in ml}}$$

By Multiple tube

$$\text{Coliform colonies/100ml} = \frac{(\text{Coliform colonies counted})(100)}{\text{ml Sample filtered}}$$

By Membrane Filter

**Sludge Volume Index** = $\frac{(\text{Settled Sludge Volume in ml/L})(1000)}{(\text{Mixed Liquor Suspended Solids in mg/L})}$

**Sludge Density Index** = $\frac{\text{TSS in mg/L}}{(\text{Settled Sludge Volume in ml/L})(10)} = \frac{100}{\text{SVI}}$

**Specific Oxygen Uptake** (mg/g/hr) = $\frac{(O_2 \text{ consumption rate in mg/L/min})(60 \text{ min/hr})}{\text{VSS in g/L}}$

**Solids :**

$$\text{MLSS in ppM} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Wt. of filter + Residue in mg
B = Wt. of filter in mg (tare wt.)

$$\text{TSS in ppM} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Wt. of filter + Residue in mg
B = Wt. of filter in mg (tare wt.)

$$\text{TDS in ppM} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Wt. of dish + Residue in mg
B = Wt. of dish in mg (tare wt.)

$$\text{TS in ppM} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Wt. of dish + Residue in mg
B = Wt. of dish in mg (tare wt.)

$$\text{VS in ppM} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Wt. of dish + Residue in mg before ignition
B = Wt. of dish + Residue in mg after ignition

$$\text{VSS in ppM} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Wt. of filter + Residue in mg before ignition
B = Wt. of filter + Residue in mg after ignition

**COD:**

open reflux method -

$$\text{COD (mg/L)} = \frac{(A-B)(M)(8000)}{\text{ml Sample}}$$

Where: A = ml FAS used to titrate the blank
B = ml FAS used to titrate the Sample
M = Molarity of FAS titrant

COD by closed reflux / titration method -

$$\text{COD (mg/L)} = \frac{(A-B)(M)(8000)}{\text{ml Sample}}$$

Where: A = ml FAS used to titrate the blank
B = ml FAS used to titrate the Sample
M = Molarity of FAS titrant

COD by closed reflux / colorimetric method -

$$\text{COD (mg/L)} = \frac{(\text{mg O2 in final sample volume})(1000)}{\text{ml Sample}}$$

$$\text{mg Oil \& Grease/L} = \frac{(A-B)(1000)}{\text{ml Sample}}$$

Where: A = Total gain in wt. of tarred flask in mg
B = Wt. of residue in solvent blank in mg

**Phosphorous:**

Vanadomolybdophosphoric Acid colorimetric method

$$\text{mg P/L} = \frac{\text{(mg P in 50 ml final volume)(1000)}}{\text{ml Sample}}$$

Stannous Chloride direct method

$$\text{mg P/L} = \frac{\text{(mg P in 104.5 ml final volume)(1000)}}{\text{ml Sample}}$$

Stannous Chloride Extraction method

$$\text{mg P/L} = \frac{\text{(mg P in 50 ml final volume)(1000)}}{\text{ml Sample}}$$

Ascorbic Acid method

$$\text{mg P/L} = \frac{\text{(mg P in 58 ml final volume)(1000)}}{\text{ml Sample}}$$

**Ammonia Nitrogen:**

Nesslerization -

$$\text{mg NH3-N/L} = \frac{\text{(A) (B)}}{\text{(ml sample) (C)}}$$

Where: A = ug NH3-N in tested solution
B = Total volume distillate collected in ml, including acid absorbent
C = Volume of distillate used in Nesslerization in ml

Phenate method -

$$\text{mg NH3-N/L} = \frac{\text{(A) (B) (D)}}{\text{(C) (S) (E)}}$$

Where: A = Absorbance of sample
B = ug NH3-N in standard
C = Absorbance of standard
S = Volume of sample used in ml
D = Total volume distillate collected in ml, including acid absorbent, neutralizing agent, and NH3 free water added.
E = Volume of distillate used in color development, in ml.

**Ammonia Nitrogen: (cont.)**

Titrimetric method -

For liquid samples, $\text{mg } NH_3\text{-N/L} = \frac{(A - B)(280)}{\text{ml sample}}$

For sludge or sediment samples, $\text{mg } NH_3\text{-N/L} = \frac{(A - B)(280)}{\text{grams dry wt. sample}}$

Where: A = ml $H_2SO_4$ titrated for sample
B = ml $H_2SO_4$ titrated for blank

Ammonia Selective Electrode -

$\text{mg } NH_3\text{-N/L} = (A)(B)[(101 + C)/101]$

Where: A = dilution factor
B = mg $NH_3$-N/L from calibration curve
C = ml of 10N NaOH added past 1 ml.

**Nitrite Nitrogen:**

Colorimetric method -

Prepare a standard curve by plotting Absorbance of standards vs. concentration of $NO_2$-N. Compute sample concentration directly from curve.

**Nitrate Nitrogen:**

Cadmium reduction method -

Prepare a standard curve by plotting Absorbance of standards vs. concentration of $NO_3$-N. Compute sample concentration directly from curve.

**Definitions:**

Anion - A negatively charged ion

Atom - The smallest possible unit of an element.

Aerobic - Needs Oxygen to live, uses air.

Anaerobic - Lives without Oxygen.

Catalyst - Effects the rate of a chemical reaction but is not itself consumed by the reaction.

Cation - A positively charged ion.

Colloid - A material that when mixed with a liquid solvent, forms a system that is between a true solution and a suspension. The particles are held in suspension by virtue of their size and/or their charge.

Colorimetric Procedure - A procedure that uses the law that intensity of color in certain solutions is proportional to the amount of substance in the solution.

Compound - A substance composed of atoms or ions from two or more elements in chemical combination.

Coagulant - A substance that induces precipitation of solids or semi-solids from solution, to coagulate.

Element - A material that is made up of only one type of atom.

Equivalent - The amount of a material that can accept or donate one mole of electrons.

Facultative - Bacteria that can live either with or without Oxygen.

Gram Atomic Weight - The weight in grams of one mole of a given element.

Gram Equivalent Weight - The weight in grams of one equivalent of a given substance. The Gram Molecular Wt. (also Formula Wt.) divided by the number of charge changes in the reaction.

Gram Molecular Weight - The weight in grams of one mole of a compound. The sum of all the atomic weights represented by the chemical formula.

Gravimetric - Using mass (weight) to determine analytical results.

Molar Solution - A solution containing one mole solute per Liter solution.

MPN - Most Probable Number. Used to report statistical prediction of bacterial densities in Multiple Tube methodologies.

Normal Solution - A solution containing one Equivalent solute per Liter solution.

pH - The log of the reciprocal of the Hydrogen ion concentration. This value is taken to represent the acidity or alkalinity of an aqueous solution.

Solute - In a solution, the substance(s) uniformly dispersed in the solvent.

Solvent - A substance capable of dissolving another substance.

Titration - The measured addition of a standard solution of known strength until the reaction is complete to measure the concentration of a substance.

## Let's look at what is involved in moving from one concentration type to another.

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{Liters solution}}$$

To determine the number of moles solute,

$$\text{moles} = \frac{\text{Wt. in grams of solute}}{\text{gram molecular wt. of solute}}$$

$$\text{Normality (N)} = \frac{\text{Equivalents of solute}}{\text{Liters of solution}}$$

To determine the number of Equivalents solute,

$$\text{Equivalents} = \frac{\text{Wt. in grams of solute}}{\text{gram Equivalent wt. of solute}}$$

To determine the number of gram Equivalent wt. of solute,

$$\text{gram Equivalent wt.} = \frac{\text{gram molecular wt. of solute}}{\text{\# of charge changes in solute's reaction}}$$

Example: H2SO4 (Sulfuric Acid) is the solute, its gram molecular wt. is 98.
It gives two (2) H+ ions for a total charge change of 2.

$$\text{gram Equivalent wt.} = \frac{\text{gram molecular wt.}}{\text{charge change}} = \frac{98}{2} = 49$$

Now let's try converting from a Molarity concentration to Normality. Again let's use H2SO4 as the solute. The solution is 0.5 M, what is its Normality ?

$$0.5\text{ M} = \frac{\text{0.5 moles H2SO4}}{\text{Liter solution}}$$

$$\frac{\text{(0.5 moles H2SO4) (98 grams H2SO4)}}{\text{(Liter solution) (1 mole H2SO4)}} = \frac{\text{49 gram H2SO4}}{\text{Liter solution}}$$

$$\frac{\text{(49 gram H2SO4) (1 Equivalent H2SO4)}}{\text{(Liter solution)(49 grams H2SO4/Equivalent)}} = \frac{\text{1 Equivalent H2SO4}}{\text{Liter solution}} = \text{1.0 Normal H2SO4}$$

Let's try just calculating a Normality. The solute will be NaOH, which has a gram molecular wt. of 40. It will accept one H+ ion for a total charge change of 1. That means the gram equivalent wt. is the same as the gram molecular wt.

What would the normality be of a solution containing 10.0 grams NaOH per 250ml?

$$\text{Normality} = N = \frac{\text{\# of Equivalents}}{\text{Liters solution}}$$

$$\text{\# of Equivalents} = \frac{\text{Wt. in grams of solute}}{\text{gram Equivalent wt. of solute}}$$

In our case the gram Equivalent wt. of solute is equal to the gram Molecular wt. of solute.

Therefore ...

$$\frac{10\text{g}}{40\text{g}} = 0.25\text{ Equivalents}$$

and

$$\frac{0.25\text{ Equivalents}}{0.25\text{ Liters}} = 1.0\text{ N}$$

**Practice Problems**

1) To prepare the titrant for Ammonia-Nitrogen analysis, an analyst weighs out 1.20 grams of concentrated (98%) Sulfuric Acid ($H_2SO_4$), and brings it to 1000ml in lab pure water. If the molecular weight of this diprotic acid is 98, calculate the Normality of the solution this analyst has prepared.
ANSWER: 0.024N $H_2SO_4$

2) To standardize the acid prepared in problem #1, the analyst weighs out 0.0550 grams of previously dried Sodium Carbonate ($Na_2CO_3$), molecular weight = 106. This was mixed with water and titrated to endpoint using 46.50ml of the prepared acid. Calculate the standardized Normality of this acid.
ANSWER: 0.022N $H_2SO_4$

3) a. An analyst has a 2.00N Sodium Hydroxide (NaOH) solution. She transfers 50.0ml of this solution to a 1000ml volumetric flask and brings it to volume with lab pure water. Calculate the Normality of the new NaOH solution.
ANSWER: 0.1N NaOH

b. An analyst has a 1000-mg Cu/L solution. She transfers 1.5ml of this solution to a 250ml volumetric flask and brings it to volume with lab pure water. Calculate the Copper concentration of the new solution.
ANSWER: 6.0 mg Cu/L

4) If a Nitrate + Nitrite-Nitrogen sample has between 9.0 and 14.5 mg N/L, which of the following would be the best dilution to use in the analytical run if the calibration standards are 0.05, 0.50, 1.00, and 1.50 mg N/L.

a. 5ml sample brought to 2000ml
b. 50ml sample brought to 100ml
c. 20ml sample brought to 250ml     Correct Answer = c
d. 10ml sample brought to 50ml