# Laboratory Calculations

KSA 108/109
KSA 211/214

CA Lab Analyst

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# MISSION STATEMENT

Welcome to a rewarding career as a laboratory professional!

**You are making a difference in many people's lives; you are essential!**

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# WHO WE ARE

01 **Mollie Wooden**, Lab Supervisor at Monterey Bay Analytical Services: mwooden@mbasinc.com

02 **David Holland**, Lab Director at Monterey Bay Analytical Services: dholland@mbasinc.com

03 **Mindy Boele**, Water Quality Manager, City of Vacaville Utilities Department

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USE Q&A BOX

# Questions during?

David and Mindy will be monitoring the Q&A, if they can't answer we will review before moving on to the next section.

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TOOLS

- **Before you sign up for a test:**
  https://www.cwea.org/pdf/tcp/resources/hb_lab99.pdf
- **Study Guide:**

  G1: https://cert.cwea.org/wp-content/uploads/sites/3/2019/04/studyguide-lab1-ed2.pdf

  G2: https://cert.cwea.org/wp-content/uploads/sites/3/2019/04/studyguide-lab2-ed2.pdf
- Look online for references to things you don't know or have access to in your lab (**YouTube**!)

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# TOPICS

01 What to expect for the test – 5min

02 Grade 1 Practice

03 Grade 2 Practice

04 Questions and/or Mollie's Free time to talk about best lab practices

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FOCUS

- Computer based
- Multiple choice
- Choose best available answer
- Feedback section at the end of test
- No penalty for wrong answers

| KSA (Knowledge Skills and Abilities) | Weight | Total covered today |
|---|---|---|
| 108 | 5% | 10% |
| 109 | 5% | |
| 211 | 4% | |
| 214 | 5% | 9% |

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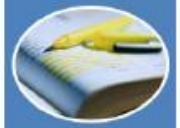
# Your Path to Certification

## Explore & Learn

Read Your Candidate Handbook & Study Guide, Begin gathering your documentation

## Assess Your Knowledge, Skills & Abilities

Review the KSAs and determine your areas of strength and weakness. Identify knowledge gaps you need to fill.

## Identify Resources to Fill Your KSA Gaps

Books, workshops, local sections training, CWEA state training, youtube, community colleges

## Attend a Cert Prep Session

Learn what to expect at the test site, resources to tap into and helpful hints/tools, take a sample test

## Apply for Certification

Get your documentation ready and apply. You'll have 3 months to take your test once you are approved.

## Continue Studying & Take Your Exam

Prepare, study, attend more trainings, read more books. Take the test.

***Steps to help you be successful in getting CWEA certification for competency in your field***

# HOW TO START STUDYING

## Take the practice exam

- Write down KSAs failed

## Read all sections of failed KSAs

- Focus on standard methods references

## Retake test

- Reread KSA sections failed
- Take a class or ask for help

## Right before test

- Write down all questions and correct answers
- Retake test until 100%
- Explain question and answer to someone else

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# Grade 1

## Preparation Calculations

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GRADE 1

# Calculate mean, median, mode, range

1. Know how to do this; it will be on the test

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GRADE 1

# Convert 121°C to °F

MEMORIZE: F=(C*1.8)+32
C=(F-32)*0.5556

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 1

# Convert 249.8°F to °C.

MEMORIZE: F=(C*1.8)+32
C=(F-32)*0.5556

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 1

# Memorize alkalinity formula

MEMORIZE:

$$\text{Alkalinity, mg/L } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{mL of sample}}$$

Where:

A = mL standard acid used

N = normality of standard acid

**Conversion Factors:**

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 1

MEMORIZE: BOD calculation

- Step 1

Seed Correction =

$$\frac{DO(in) - DO(out)}{mLs\ seed} * mLs\ seed\ in\ a\ seeded\ bottle$$

- Step 2
- BOD, mg/L=

$$\frac{[DO(in) - DO(out) - seed\ correction] * 300mLs}{mLs\ sample}$$

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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# More BOD

- GGA std – true value is 198, sd ± 30.5
- Blank must have < 0.2 mg/L depletion
- Must deplete at least 2 mg/L DO
- Must have at least 1 mg/L remaining
- DO uptake of seed control = 0.6-1.0 mg/L
- Dechlorinate chlorinated samples
- pH adjust to 6.5 – 7.5
- Set up w/in 6 hrs of collection or 48 hrs max
- Sample DO >9.0 – shake to reduce DO! Set up at 20 C

**Take 2; Leave 1**

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GRADE 1

Given the following data, calculate the BOD for the sample if the initial DO is 8.5 mg/L.

| Sample size, mL | DO Final, mg/L |
|---|---|
| Blank | 8.5 |
| 3.0 | 7.0 |
| 5.0 | 5.8 |
| 7.0 | 4.8 |
| 9.0 | 3.4 |
| 11 | 2.7 |
| 15 | 0.5 |

1. Look what's given (does it meet BOD criteria?)
2. What do we want? (average BOD)
3. Calculate using BOD equation

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GRADE 1

# Memorize COD formula

MEMORIZE:

$$\text{Molarity of FAS solution} = \frac{\text{Volume } 0.04167M\ K_2Cr_2O_7 \text{ solution titrated, mL}}{\text{Volume FAS used in titration, mL}} \times 0.2500$$

$$\text{COD as mg } O_2\text{/L} = \frac{(B - A) \times M \times 8000}{\text{mL sample}}$$

where:

$B$ = mL FAS used for sample,
$A$ = mL FAS used for blank,
$M$ = molarity of FAS, and
8000 = milliequivalent weight of oxygen × 1000 mL/L.

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GRADE 1

Given the following data, calculate the COD for the sample.

- mL of FAS to titrate 10 mL of 0.25 N dichromate = 10.7
- mL of FAS to titrate reagent blank = 10.6
- mL of FAS to titrate sample = 7.5
- sample size = 20 mL

1. Look what's given (Volume FAS)
2. What do we want? (Molarity of FAS and COD)
3. First calculate molarity of FAS
4. Now calculate COD

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GRADE 1

Given the following data, calculate the COD for the sample:

- mL of FAS to titrate 10 mL of 0.25 N dichromate = 10.7
- mL of FAS to titrate reagent blank = 10.6
- mL of FAS to titrate sample = 7.5
- sample size = 20 mL

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GRADE 1

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- mL of FAS to titrate sample = 7.5
- sample size = 20 mL

$$\text{COD as mg } O_2\text{/L} = \frac{(B - A) \times M \times 8000}{\text{mL sample}}$$

where:

$B$ = mL FAS used for sample,
$A$ = mL FAS used for blank,
$M$ = molarity of FAS, and
8000 = milliequivalent weight of oxygen × 1000 mL/L.

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# Memorize Chloride formula

GRADE 1

MEMORIZE:

$$\text{mg } Cl^{-}/L = \frac{(A - B) \times N \times 35\,450}{\text{mL sample}}$$

where:

$A$ = mL titration for sample,
$B$ = mL titration for blank, and
$N$ = normality of $Hg(NO_3)_2$.

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GRADE 1

## Calculate the following Chloride given that:

- mL of titrant needed for sample = 55 mL
- mL of titrant needed for blank = 1.05mL
- N = 0.0141N
- mL of sample = 100 mL

1. Look what's given (mL titrant for sample and blank!)
2. Plug and Chug

$$\text{mg } Cl^-/L = \frac{(A - B) \times N \times 35\,450}{\text{mL sample}}$$

where:

$A$ = mL titration for sample,
$B$ = mL titration for blank, and
$N$ = normality of $Hg(NO_3)_2$.

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GRADE 1

# How many gallons of water will it take to fill a 3 cubic foot container?

1. Look what's given (3cu ft)
2. What do we want? (gal)
3. Use given conversions

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 1

# If a gallon of gasoline weighs 7.0 pounds, what would be the weight of a 350-gallon tank full of gasoline?

1. Look what's given (gas weighs 7lbs/gal)
2. What do we want? (350gal gas total weight)

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 1

# The rated capacity of a pump is 500 gallons per minute (GPM). Convert this capacity to million gallons per day (MGD).

1. Look what's given (500 gal/min)
2. What do we want? (x Mgal/day)
3. Convert min to day
4. Convert gal to Mgal

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 1

# A chemical feed pump delivers 50 mL per minute (mL/min). Determine the chemical feed in gallons per day (gpd).

1. Look what's given (50 mL/min)
2. What do we want? (x gal/day)
3. Convert 50mL/min to x mL/day
4. Convert x mL/day (from #3) to x gal/day

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

MEMORIZE: 1 gal = 3.785 Liters

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GRADE 1

If a company runs a discharge pump rated at 50 gallons per minute all day, every day for a year, what is the discharge for the year in millions of gallons per year (MGY)?

1. Look what's given (50gal/min)
2. What do we want? (MGY)
3. Convert gal to MG
4. Convert min to hr to day to year

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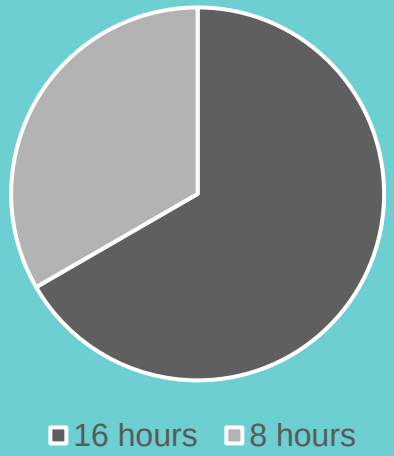
GRADE 1

# Pounds of Cyanide Destroyed




A cyanide destruction process is designed to treat 30 pounds of cyanide per 24-hour operational day. How many pounds of cyanide can be treated during an 8- hour shift?

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

1. Look what's given (30 lbs destroyed/day)
2. What do we want? (x lbs destroyed/8 hr)
3. Find factor of 8 in 24
4. Multiply by total

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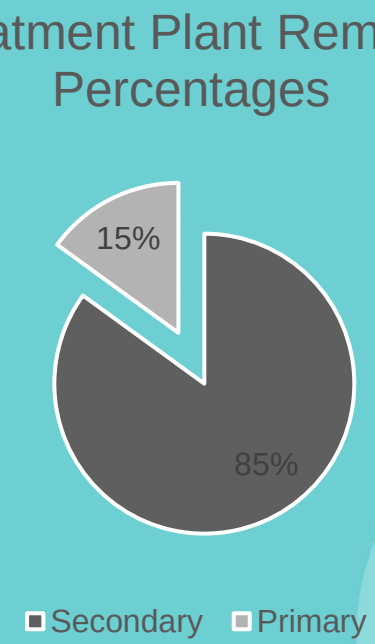
GRADE 1

A treatment plant removes 85% of the suspended solids in the secondary clarifier. If the effluent suspended solids are 22 mg/L, the secondary influent suspended solids are ____mg/L.

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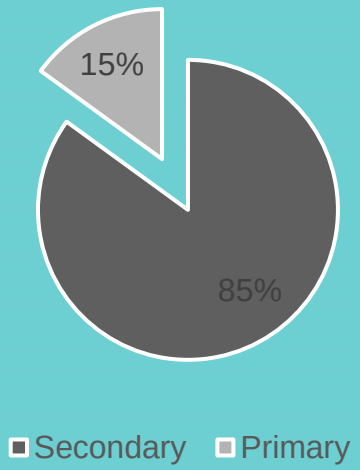
GRADE 1

# Treatment Plant Removal Percentages




**Example**

A treatment plant removes 85% of the suspended solids in the secondary clarifier. If the effluent suspended solids are 22 mg/L, the secondary influent suspended solids are ____mg/L.

**Solution**

This problem can be done using ratios:

$$\frac{\%\ \text{SS effluent}}{\%\ \text{SS influent}} = \frac{\text{mg/L SS effluent}}{\text{mg/L SS influent}}$$

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GRADE 1

# How many grams of silver nitrate ($AgNO_3$) are needed to prepare one liter of 1,000 mg/L Ag standard (Ag=108, N=14, O=16)?

1. Find molecular weight of $AgNO_3$ (g/gmole)
2. Find weight of $AgNO_3$ per Ag (g)
3. Convert final concentration to g (from mg)
4. Multiply final concentration by weight of $AgNO_3$/Ag

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GRADE 1

An analyst filters 50 mL of raw domestic wastewater through a tared glass fiber filter, dries the filter at 103 degrees to 105 degrees C and weighs it again. Given the following weights, what is the total suspended solids of the sample in mg/L?

- Tare weight:0.4158 g
- Dry weight: 0.4285 g

1. Look what's given (50mL sample)
2. What do we want? (TSS mg/L)
3. Subtract dry weight from tare for net weight

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GRADE 1

Given the following, find the percent solids and the percent volatile solids of the sample:

- Dish tare weight = 1.38 g
- Dish and wet sample weight = 32.40
- Dish and dry sample weight = 1.86 g
- Dish and ashed weight = 1.56 g

1. Look what's given (a buncha weights)
2. What do we want? (%Solids and %VS)
3. Calculate wet, dry and ashed net weight

$$\%\ \text{solids} = \frac{\text{dry sample weight} \times 100}{\text{wet sample weight}}$$

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GRADE 1

Given the following, find the percent solids and the percent volatile solids of the sample:

- Dish tare weight = 1.38 g
- Dish and wet sample weight = 32.40
- Dish and dry sample weight = 1.86 g
- Dish and ashed weight = 1.56 g

1. Look what's given (ashed weight)
2. What do we want? (%Solids and %VS)
3. Calculate wet, dry and ashed net weight

$$\% \text{ volatile solids} = \frac{(\text{dry wt.} - \text{ash wt.}) \times 100}{\text{dry wt.}}$$

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GRADE 1

# What is the normality of a sodium hydroxide solution if 25 mL of a 0.01 N sulfuric acid solution neutralizes 100 mL of the NaOH solution?

1. Look what's given (2 volumes, one concentration)
2. What do we want? (2$^{nd}$ concentration)
3. N1V1=N2V2

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GRADE 1

# A sample of ferrous chloride contained 30% ferrous chloride and had a density of 1.33 g/mL. Calculate the total ferrous chloride in one liter of the solution.

1. Look what's given (1.33g/mL sample, 30%=30/100)
2. What do we want? (grams/L ferrous chloride)
3. Convert to one unit (L)

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GRADE 1

A standard solution is prepared from a 0.100% stock solution of a pure metal. Ten mL of the stock solution is diluted to one liter, and 5 mL of this solution is diluted to 100 mL to make the standard. The concentration of the standard solution is:

1. Look what's given (0.1%→ ppm=parts per MILLION(=100%))
2. What do we want? (final concentration after serial dilution)
3. Draw the dilutions

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GRADE 1

# How many grams of chromium trioxide ($CrO_3$) are needed to prepare one liter of 1,000 mg/L Cr standard (Cr=52, O=16)?

MEMORIZE: molecular weight= g/gmole

1. Look what's given ($CrO_3$=calculate molecular weight)
2. What do we want? (g)
3. Convert mg to g Cr in 1,000 mg/L standard
4. Multiply by molecular weight of $CrO_3$

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# Questions?

Ask in Q&A box!

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# Grade 2

## Calculations

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GRADE 2

Potassium dichromate ($K_2Cr_2O_7$) is to be used in the COD test. How many grams would it take to make 2.0 liters of 0.5 N solution?

- Molecular weights: K=39, Cr=52, O=16
- Hint: $6Fe^{++} + Cr_2O_7^{=} + 14H^{+} = 6Fe^{+++} + 2Cr^{+++} + 7H_2O$

MEMORIZE: molecular weight= g/gmole

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GRADE 2

A bacterial culture was sampled and serially diluted prior to spread-plating onto triplicate plate-count agar plates. The dilutions were as follows:

- One mL of the original sample was added to 99 mL of solution B. One mL of solution B was added to 9 mL of solution C. Five mL of solution C was added to 5 mL of solution D. This final mix was plated in triplicate at 0.1 mL per plate. The plates were incubated at 35°C for 2 days before colonies were counted. The counts obtained were 57, 61, and 48 colonies per respective plate. Using the plate counts obtained, calculate the original concentration of the bacterial culture in CFU/mL.

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GRADE 2

One mL of the original sample was added to 99 mL of solution B. One mL of solution B was added to 9 mL of solution C. Five mL of solution C was added to 5 mL of solution D. This final mix was plated in triplicate at 0.1 mL per plate. The plates were incubated at 35°C for 2 days before colonies were counted. The counts obtained were 57, 61, and 48 colonies per respective plate.

1. Look what's given (serial dilutions)
2. What do we want? (CFU/mL)
3. Multiply all dilutions to find total dilution
4. Find average of colony counts
5. Divide colonies/dilution

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GRADE 2

A treatment plant receives 90 MGD of flow from Influent Line #1 and 10 MGD of flow from Influent Line #2. The flow from Influent Line #1 has a BOD of 300 mg/L and a suspended solids of 500 mg/L. The Influent Line #2 flow has a BOD of 2,000 mg/L and a suspended solids of 5,000 mg/L. What are the resultant BOD and suspended solids concentration of the mixture?

1. Look what's given (flows)
2. What do we want? (Final ratio)
3. Calculate total flow
4. Calculate BOD and SS for #1 and #2 using ratio and add

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 2

# What is the most correct answer to the following addition problem?

- 10.623 + 2.16 + 200.5 + 1478 =

1. Don’t miss easy questions!
2. Sig Figs!

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GRADE 2

In the BOD determination, the restrictions regarding accepting or rejecting analysis values are:

a. the blank must not deplete more than 0.2 mg/L dissolved oxygen, and the samples must deplete at least 1 mg/L and have at least 2 mg/L dissolved oxygen remaining.

b. the blank must not deplete more than 0.2 mg/L dissolved oxygen, and the samples must deplete at least 2 mg/L and have at least 1 mg/L dissolved oxygen remaining.

c. the blank must not deplete more than 2 mg/L dissolved oxygen, and the samples must deplete at least 2 mg/L and have at least 1 mg/L dissolved oxygen remaining.

d. the blank must not deplete more than 2 mg/L dissolved oxygen, and the samples must deplete at least 1 mg/L and have at least 2 mg/L dissolved oxygen remaining.

**Take 2; Leave 1**

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GRADE 2

# If the anticipated BOD (unseeded) of a wastewater sample is 120 mg/L, what is the sample volume giving nearest to 50% oxygen depletion in a 300 mL bottle? (initial DO = 8 mg/L)

1. Look what's given (8mg/L initial DO)
2. What do we want? (initial sample volume)
3. Plug and chug!

$$\text{BOD, mg/L} = \frac{[DO(i) - DO(f) - seed] * 300mLs}{mLs\ sample}$$

GRADE 2

- A dechlorinated effluent sample was analyzed for BOD. Two dilutions were prepared. In the first, 30 mL of effluent was seeded with 1.5 mL of seed and diluted to volume in a 300 mL BOD bottle. In the second, 50 mL of effluent was likewise seeded with 1.5mL of seed and diluted to volume in a 300mL BOD bottle. A separate seed control was prepared by diluting 5 mL of seed into a 300mL BOD bottle. The samples were incubated at 20°C for 5 days. Given the initial DO and final DO data shown in the table, what is the average BOD to be reported?

| Sample Size (mL) | Initial DO (mg/L) | Final DO (mg/L) |
|---|---|---|
| 0 mL Blank | 7.8 | 7.8 |
| 30 mL Sample | 7.8 | 4.6 |
| 50 mL Sample | 7.8 | 2.6 |
| 5 mL Seed | 7.7 | 5.0 |

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GRADE 2

- 30 mL of effluent was seeded with 1.5 mL of seed
- Another 50 mL of effluent added 1.5mL of seed
- Seed control 5 mL of seed into a 300mL BOD bottle
- What is the average BOD to be reported?

| Sample Size (mL) | Initial DO (mg/L) | Final DO (mg/L) |
|---|---|---|
| 0 mL Blank | 7.8 | 7.8 |
| 30 mL Sample | 7.8 | 4.6 |
| 50 mL Sample | 7.8 | 2.6 |
| 5 mL Seed | 7.7 | 5.0 |

$$\text{BOD, mg/L} = \frac{[\text{DO(in)} - \text{DO (fin)} - \text{seed correction}] * 300\text{mL}}{\text{mL sample}}$$

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GRADE 2

- Memorize SVI

MEMORIZE:

$$SVI = \frac{\text{settleable solids, mL/L}}{\text{TSS, mg/L}}$$

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GRADE 2

In a secondary plant, a grab sample of mixed liquor was brought to the laboratory to be determined for total suspended solids. In the total suspended solids determination the tare weight of the filter paper was 0.0910 g. The dry weight of the paper and 10 mL of dried sample was 0.1094 g. After 30 minutes the sludge in the mixed sample settled to 230 mL in a 1 L graduated cylinder. What is the SVI of the mixed liquor?

1. Look what's given (TSS to calculate)
2. What do we want? (SVI-sludge volume index)
3. Calculate TSS in mg/L
4. Remember SVI formula!

$$SVI = \frac{\text{settleable solids, mL/L}}{\text{TSS, mg/L}}$$

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GRADE 2

A 24-hour composite sample from a primary clarifier had an influent TSS of 220 mg/L and an effluent TSS of 90 mg/L. How many pounds of solids were removed if the flow was 12.5 MGD, and what was the percent removal?

1. Look what's given (mg/L and flow in gallons)
2. What do we want? (pounds and %removed)
3. Watch sig figs! (round after calc)

$$\frac{TSS_{inf} - TSS_{eff}}{TSS_{inf}} \times 100 = \% \text{ removal}$$

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

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GRADE 2

# Memorize Cl2 residual formula

MEMORIZE:

mg Cl as $Cl_2$ = [A-(5B)] * (200/C)

Where:
A = mL PAO
B = mL iodine used
200 = mLs of sample
C = mL sample (could be < 200)

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GRADE 2

A 200 mL sample of chlorinated effluent is analyzed with an amperometric titrator for total residual chlorine. KI and pH 4 buffer are added to the sample. 5.0 mL of 0.00564 N PAO is added to the sample and back-titrated to the endpoint with 0.6 mL of 0.0282 N iodine (I2) solution. Calculate the total residual chlorine in mg/L.

1. Look what's given (2 mL and 2 N)
2. What do we want? (Cl2 residual)
3. Remember the equation??

mg Cl as $Cl_2$ = [A-(5B)] * (200/C)

Where: A = mL PAO

B = mL iodine used

200 = mLs of sample

C = mL sample (could be < 200)

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# Questions?

Ask in Q&A box!

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# Thanks for attending!

**Helpful trainings:**

https://events.cwea.org/events/?tribe_paged=1&tribe_event_display=list&tribe_eventcategory=8

https://www.events.rcac.org/rcac/Calendar.asp

https://quizlet.com/277338911/cwea-grade-i-laboratory-analyst-flash-cards/

**MBAS Website: www.mbasinc.com**

**Instagram Lab Adventures: @CaLabAnalyst**

Please fill out the survey at the end, I really look at it!

See you next week for:

**"Chemical Analyses"**

**Bring a pen, we're going to BLAST through each analysis and pertinent info