

WEAT OPERATIONS CHALLENGE 2006  
LABORATORY

ASSORTED LABORATORY CALCULATIONS

**EQUIPMENT**

Calculator  
Bench Sheets  
Paper  
Pen

**PROCEDURE**

Procedures are based on Standard Methods, 19<sup>th</sup> Edition.

1. Calculate problems showing all work.
2. All corrections on Bench Sheet must have a single strike through and both the original entry and correction must be legible. All Bench Sheet corrections must be initialed and dated.

Seeded BOD<sub>5</sub> Formula:

$$\text{BOD}_5 \text{ (mg/L)} = [(D_1 - D_2) - L_s] (300/S)$$

$$L_s = A(B_1 - B_2)/C$$

Where BOD<sub>5</sub> is the result of the 5 day Biochemical Oxygen Demand in mg/L  
D<sub>1</sub> is the initial Dissolved Oxygen concentration of the diluted sample.  
D<sub>2</sub> is the Dissolved Oxygen concentration of the diluted sample after 5 days.  
L<sub>s</sub> is the Seed Loss correction factor.  
S is the aliquot or volume of sample used.  
A is the milliliters of seed added to each BOD<sub>5</sub> bottle.  
B<sub>1</sub> is the initial Dissolved Oxygen concentration of the seed control bottle.  
B<sub>2</sub> is the Dissolved Oxygen concentration of the seed control bottle after 5 days.  
C is the milliliters of seed used in the seed control bottle.

Total Suspended Solids formula:

$$\text{TSS (mg/L)} = (W_F - W_I)(1000\text{mg/g})(1000\text{mL/L})/V$$

Where TSS is the Total Suspended Solids or total nonfilterable residue in mg/L.  
W<sub>F</sub> is the final weight of the crucible, filter and dried sample in grams.  
W<sub>I</sub> is the initial dried weight of the crucible and filter in grams.  
V is the volume of sample in milliliters.

**PENALTIES**

Penalties will be added to the physical time. The final score will be the physical time plus penalties plus safety violations.

**TEAM NUMBER:** \_\_\_\_\_

**TEAM NAME:** \_\_\_\_\_

**TEAM MEMBER:** \_\_\_\_\_ / \_\_\_\_\_  
PRINT SIGN

**BOD<sub>5</sub> CALCULATION WORK SHEET**  
**(Additional Page if needed)**

**TEAM NUMBER:** \_\_\_\_\_

**TEAM NAME:** \_\_\_\_\_

**TEAM MEMBER:** \_\_\_\_\_ / \_\_\_\_\_  
PRINT SIGN

**TSS CALCULATION WORK SHEET**  
**(Additional Page if needed)**

WEAT OPERATIONS CHALLENGE, 2006  
LABORATORY

pH METER CALIBRATION AND SAMPLE MEASUREMENT

MATERIALS

GENERIC Meter and Probe  
Buffer Solutions - 4, 7 and 10  
100 ml Beaker  
Sample  
Bench Sheet  
Distilled Water  
Wash Bottles  
Kimwipes  
Bucket

PROCEDURE

1. Turn the instrument on.
2. Rinse electrode with DI water and blot dry with Kimwipe.
3. Immerse electrode in sample, stir gently, wait for meter reading to stabilize.
4. Read approximate pH.
5. Remove electrode, rinse and blot dry.
6. From the pH reading mode, press CAL. CAL and flashing ? Will appear in the upper display area, along with Standard and 1
7. Place the pH electrode in one of the buffers.
8. Press READ. The instrument will automatically recognize the calibration buffer value. When the reading has stabilized or been accepted, the standard number will change to 2
9. Remove the probe from the first buffer and rinse with DI Water. Place the probe in the second buffer.
10. Press READ. When the reading has been accepted, the standard number will change to. To accept this calibration after 2 points, press EXIT. Press enter to accept the calibration.
11. After meter is calibrated, rinse the electrode with DI water and place the electrode in the sample, stirring gently.
12. When the reading is stable Stabilizing... will disappear.
13. Record pH value, date, time and initials on bench sheet and hand to judge.

PENALTIES

Each penalty will be added to the physical time. The final score will be the physical time plus the procedural violation time plus safety violation times.

Operations Challenge  
Laboratory  
Penalty Sheet

pH Meter Calibration and Sample Measurement

Team Member: \_\_\_\_\_  
Team Name: \_\_\_\_\_  
Team Number: \_\_\_\_\_

**Penalty  
Seconds**

Not rinsing probe when necessary

Not blotting probe after rinsing

Not stirring sample

Failing to use the buffers bracketing the sample pH for calibration

Failure to complete calibration properly

Incomplete/incorrect bench sheet

**Safety**

Not wearing gloves

Not wearing safety glasses

Date/Judge: \_\_\_\_\_  
Physical Time: \_\_\_\_\_  
Penalty Time: \_\_\_\_\_  
Total Time: \_\_\_\_\_

**WEAT OPERATIONS CHALLENGE 2006**  
**LABORATORY**

**PREPARATION OF A 0.5 N STANDARD SOLUTION**

**EQUIPMENT**

1 ml Volumetric Pipette, Class A  
5 ml Volumetric Pipette, Class A  
10 ml Volumetric Pipette, Class A  
20 ml Volumetric Pipette, Class A  
25 ml Volumetric Pipette, Class A  
100 ml Volumetric Flask  
250 ml Volumetric Flask  
1000 ml Volumetric Flask  
Bench Sheet  
Reagent Labels  
Pipette Bulb  
100 ml Beaker  
Wash Bottle  
Kimwipes  
Bucket

**REAGENTS**

10 N Stock Solution  
Reagent Water, Type II

**PROCEDURE**

Procedures are based on Standard Methods, 18<sup>th</sup> Edition

1. Calculate the volume of 10 N Stock Solution required to make a 0.5 N Standard Solution.
2. Rinse the 100 ml beaker with a small amount (~5 ml) of 10 N Stock Solution and discard.
3. Pour an aliquot of 10 N Stock Solution into the beaker.
4. Rinse the pipette selected based on the calculations from step 1 with 10 N Stock Solution from the beaker and discard the rinse.
5. Pipette the calculated volume of 10 N Stock Solution and transfer to the appropriate volumetric flask.
6. Bring to volume with reagent water.
7. Cap and invert 10 times, using the air column which rises to the bottom of the inverted volumetric flask to completely mix the stock and dilution water.
8. Record calculation, date, time, and initials on the Bench Sheet and Reagent Label.
9. Hand Bench Sheet and Reagent Label to the judge and tell him/her that you are finished.

**PENALTIES**

Penalties will be added to the physical time. The final score will be the physical time plus penalties plus safety violations.

**PREPARATION OF A 0.5N STANDARD SOLUTION**  
**(Show all calculations)**

WEAT OPERATIONS CHALLENGE 2006  
LABORATORY

TITRATION: STANDARDIZATION OF A WEAK CAUSTIC SOLUTION

**EQUIPMENT**

50 mL Burette  
10 ml Volumetric Pipette, Class A  
20 ml Volumetric Pipette, Class A  
25 ml Volumetric Pipette, Class A  
100 ml Volumetric Flask  
10 -250 mL Erlenmeyer Flasks  
Bench Sheet  
Reagent Labels  
Pipette Bulb  
100 ml Beaker  
Wash Bottle  
Kimwipes  
Bucket

**REAGENTS**

0.5 % Phenolphthalein indicator solution  
0.1 N Sulfuric acid solution  
Reagent Water, Type II  
Base solution, Sodium hydroxide solution of unknown concentration

**PROCEDURE**

Procedures are based on Standard Methods, 18<sup>th</sup> Edition.

1. Pipette 20 mLs of the unknown Base solution into the 250 mL Erlenmeyer flask.
2. Add 6 – 12 drops of 0.5 % Phenolphthalein indicator solution to give a visible pink color.
3. Fill the burette to the zero mark with 0.1 N Sulfuric acid.
4. Swirl by hand at a moderate rate.
5. Titrate to a colorless endpoint.
6. Record the amount of titrant used on the provided Bench Sheet.
7. Repeat steps 1 – 7 until your volume on two successive titrations agree within 0.1 mL
8. Calculate the average Normality of the unknown using the formula given on the Bench Sheet
9. Formula:

$$V_A = (V_1 + V_2) / 2$$
$$N_B = (V_A \times N_A) / V_B$$

Where  $V_A$  is average volume in milliliters of the Sulfuric acid solution used  
 $V_1$  is volume in milliliters of Sulfuric acid solution used in the first titration  
 $V_2$  is volume in milliliters of Sulfuric acid solution used in the second titration  
 $N_B$  is the Normality of the Base solution.  
 $N_A$  is the Normality of the Sulfuric acid solution.  
 $V_B$  is the volume on milliliters of the base solution used.

**PENALTIES**

Penalties will be added to the physical time. The final score will be the physical time plus penalties plus safety violations. Penalties may be added for inaccuracy in this procedure.



WEAT OPERATIONS CHALLENGE 2005  
LABORATORY

TITRATION: STANDARDIZATION OF A WEAK CAUSTIC SOLUTION  
BENCHSHEET

NAME: \_\_\_\_\_

TEAM NAME: \_\_\_\_\_

**Titration #1**

Initial Buret Reading: \_\_\_\_\_

Final Buret Reading: \_\_\_\_\_

Total Volume Used: \_\_\_\_\_

**Titration #2**

Initial Buret Reading: \_\_\_\_\_

Final Buret Reading: \_\_\_\_\_

Total Volume Used: \_\_\_\_\_

**Calculation (Show all work):**

1.  $V_A =$  \_\_\_\_\_

2.  $N_B =$  \_\_\_\_\_

2005 Operations Challenge  
Laboratory  
Penalty Sheet

Titration Standardization of a Weak Caustic Solution

Team Member: \_\_\_\_\_  
Team Name: \_\_\_\_\_  
Team Number: \_\_\_\_\_

**Penalty  
Seconds**

Sucking liquid into pipette bulb

Not drying pipette tip before delivery to Erlenmeyer flask

Not touching pipette tip to side of Erlenmeyer flask

Not stirring sample during titration

No second titration

Overshooting the endpoint

Incorrect calculation

Incomplete / incorrect bench sheet

Failure to produce titrations within 0.1 ml

**Safety**

Not wearing gloves

Not wearing safety glasses

Date/Judge: \_\_\_\_\_  
Physical Time: \_\_\_\_\_  
Penalty Time: \_\_\_\_\_  
Total Time: \_\_\_\_\_