In Class Exercise:
Oxygen Demand and DO Sag Curve

1. Determine the theoretical oxygen demand for 150 mg/L of glucose.

$$C_6H_{12}O_6 + 6\ O_2 = 6CO_2 + 6H_2O$$

MW of glucose = 180 g/mole

Therefore THOD = $\frac{6*32 \text{ g/mole } O_2 * 150 \text{ mg/L glucose}}{180 \text{ g/mole glucose}}$ = 160 mg/L

2. The BOD_5 of a sewage sample is 200 mg/L. What is the ultimate BOD_u at 20°C if $k_{20} = 0.16\ day^{-1}$? What is the BOD_5 and BOD_u of the sample at 30°C if k_{30} is 0.25 day^{-1}?

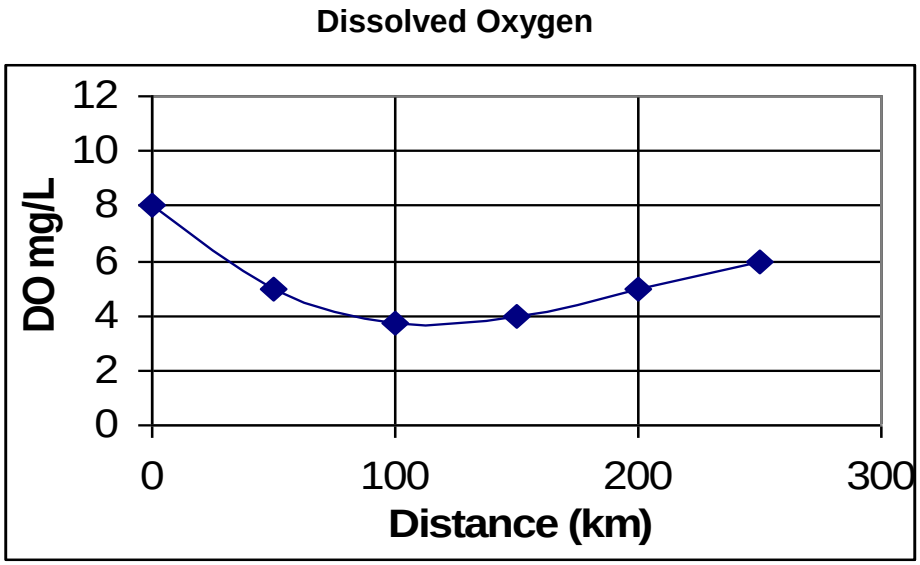
$L_t = L_o (1-e^{-kt})$ Given Lt = 200 Lo=? $k_{20} = 0.16\ day^{-1}$ t= 5 days

$200 = Lo(1-e^{-.16*5})$ or Lo = 363.19 mg/L = BODu

Note BODu is not a function of temperature. Therefore same BODu will be used at 30°C

BOD_5 =Lt = $363.19 (1 - e^{-.25*5})$ = 259.13 mg/L

3.



1. What is the value of the DO at saturation level if the temperature of the stream is 15°C?

LOOK UP VALUE IN BOOK **10.15 mg/L**

2. What is the value of the initial DO deficit in mg/L? **10.15 -8.0 =2.15** mg/L

3. What is the value of the critical DO? 4.0 mg/L

3. What is the value of the maximum deficit of DO in the stream in mg/L?

10.15-4.0= 6.15 mg/L (4.0 is the DO at the lowest point of the curve)

4. What is the distance in miles where the maximum deficit occurs? **100 km**

5. If the velocity of the stream is 0.065 km/sec at what is the value of critical time in days?

$$\text{Critical Time} = \frac{100 \text{ km} * \text{sec} * \text{min} * \text{hr} * \text{day}}{0.065 \text{ km} * 60 \text{ sec} * 60 \text{ min} * 24 \text{ hrs}} = \mathbf{0.0178 \text{ days}}$$

2. What causes oxygen depletion in a stream when an organic wastewater is discharged? Draw a qualitative DO sag curve.

3. Name three factors that impact the solubility of oxygen in water? Pressure, temperature, salinity

4. A waste stream has a dissolved oxygen concentration of 1.5 mg/L, a flow of 0.5 m^3/sec, a temperature of 26 ^oC and an ultimate BOD of 48 mg/L. The stream water is running at 2.2 m^3/sec at a saturated DO, a temperature of 12^oC and an ultimate BOD of 1.6 mg/L. Calculate the dissolved oxygen concentration 48.3 km downsteam.

   Given k_1 0.2 day^{-1} and k_2 = 0.4 day^{-1}

   Find mixing temperature, DO and BOD
   Find corresponding DO_{sat} for mixing temp. to calculate mixing DO.
   Calculate DO deficit using equation

   Mixing Temperature = $\frac{0.5\ m^3/sec * 26\ ^oC + 2.2\ m^3/sec * 12^oC}{(0.5+2.2)\ m^3/sec}$ = 14.6^oC = 15 ^oC

   Mixing BOD_u = $\frac{0.5\ m^3/sec * 48 mg/L + 2.2\ m^3/sec * 1.6\ mg/L}{(0.5+2.2)\ m^3/sec}$ = 10.19 mg/L

   Look up DO_{sat} at 12^{o}C from book = 10.83mg/L

   Mixing DO = $\frac{0.5\ m^3/sec * 1.5\ mg/L + 2.2\ m^3/sec * 10.83 mg/L}{(0.5+2.2)\ m^3/sec}$ = 9.10 mg/L

   At a temperature of 15^{o}C DO_{sat} = 10.15 mg/L

   Therefore Initial deficit = 10.15-9.1 = 1.05 mg/L

   Time t = 48 m/ 0.37 m/s = 129.73 sec = 0.0015 days

   Using equation 8-33 Deficit at48 m = 1.053 mg/L

   Therefore DO at 48 km = 10.15-1.053 = 9.09 mg/L

   Use eqn 8-35 and 8-37 for critical time and critical deficit

   tc = 2.92 days Dc = 2.84 mg/L

   Therefore DO at critical point = 10.15-2.84 = 7.31mg/L > 4mg/L required for aquatic life