1.2) PHYSICAL CONDITIONS AND DISSOLVED OXYGEN

Objective: In this laboratory exercise you will evaluate the main abiotic factors that determine dissolved oxygen levels in nature. **Video instructions:** https://vimeo.com/70477473

Introduction: Dissolved oxygen is one of the most important indicators that determine an aquatic ecosystem's overall health. Among the main abiotic factors affecting dissolved oxygen are atmospheric pressure, temperature, and aeration.

The amount of gas that is dissolved in water is directly proportional to the pressure of the gas and cold water absorbs more gas because the dissolution of gas in water is exothermic. This is also why opened soft drinks that are at room temperature go flat much more quickly than opened beverages that are chilled.

Maximizing the surface-to-volume ratio of water increases the rate at which oxygen is absorbed. This can be accomplished by passive means such as choosing a shallow container that exposes more surface area to the air or by active means such as aeration.

Procedure A: Aeration

1) Fill a flask (Fig. 1), a graduated cylinder, and shallow bowl with boiling tap water.
2) Cover only the flask with a rubber stopper (Fig. 2) and allow all containers to cool completely.
3) Measure the dissolved oxygen of the cooled water in the formerly sealed flask (Fig. 3).

Fig. 1

Fig. 2

Fig. 3

4) *Slowly* pour half the water from the formerly sealed flask into a beaker (Fig. 4).
5) Measure dissolved oxygen again to record the effect of pouring the water (Fig. 5).
6) Cover flask with a stopper and shake the remaining water for 3 seconds (Fig. 6).
7) Measure oxygen in the flask (Fig. 7).
8) Repeat steps 6-7 until there is no increase in oxygen.

Fig. 4

Fig. 5

Fig. 6

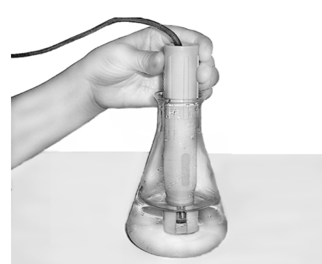

Fig. 7

9) Organize your data into the following table and use this to make a graph, placing the independent variable (seconds) on the x-axis and the dependent variable (oxygen) on the y-axis:

Table A: Effect of Aeration on Dissolved Oxygen

Agitation time	0 sec	Pour	3 sec	6 sec	9 sec	12 sec	15 sec	18 sec	21 sec	24 sec	27 sec
Oxygen (ppm)											

10) Measure oxygen in of the cooled water in the tall container and the shallow bowl and note it down. You will need this information to answer questions 3.

Procedure B: Temperature

1) Fill a flask about halfway with water that has been warmed to approximately 40 °C. Place a stopper in the flask and shake it for about 20 seconds (Fig. 6).
2) Set it down and measure the temperature and dissolved oxygen (Fig. 7).
3) Place 1-2 ice cube(s) in the flask (Fig. 8).
4) Shake again until the ice cubes are completely melted (Fig. 6).
5) Set it down and measure the temperature and dissolved oxygen (Fig. 7).
6) Repeat steps 3-5, gradually adding 1-2 ice cubes at a time until the final temperature is near freezing. You should end up with about 4-6 different readings.

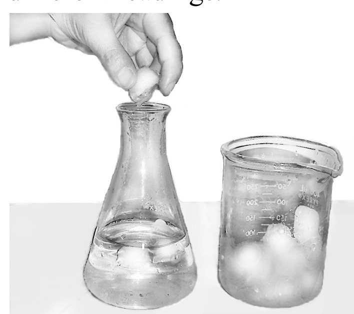

Fig. 8

7) Organize your data into the following table and use this to make a graph, placing the independent variable (temperature) on the x-axis and the dependent variable (oxygen) on the y-axis:

Table B: Effect of Temperature on Dissolved Oxygen

Temperature (°C)						
Oxygen (ppm)						

Procedure C: Pressure

1) Fill a 60-mL syringe with about 40 mL of this water and 20 mL of airspace (Fig. 9).
2) Place a cap on the syringe, insert the plunger and compress the air as much as possible. Read the marking on the syringe (usually mL), then shake the syringe while maintaining this pressure for at least 10 seconds. You may need both hands to enable you keep pressure on the plunger while shaking the syringe (Fig. 10)
3) Remove the cap and squirt the water into a small container (Fig. 11). Measure the dissolved oxygen of this water immediately.

4) Repeat the process for at least three different levels of pressure. Use the on markings on the syringe to have a numerical measurement that approximates the pressure applied.

Fig. 9

Fig. 10

Fig. 11

5) Organize your data into the following table and use this to make a graph, placing the independent variable (syringe reading) on the x-axis and the dependent variable (oxygen) on the y-axis:

Table C: Effect of Pressure on Dissolved Oxygen

Pressure (syringe reading)			
Oxygen (ppm)			

Questions:

1. At how many seconds does continued agitation fail to further increase the amount of dissolved oxygen?

2. What implications do these results have for the oxygen content of a flowing river versus a pond? Which one is less likely to suffer from oxygen depletion?

3. Which container gained more oxygen after cooling to room temperature; the tall container or the shallow bowl? What is responsible for this difference?

4. What is the effect of temperature on dissolved oxygen? Under what natural conditions can temperature have an important effect on dissolved oxygen? *Hint: At what time of year are bodies of water at the greatest risk of suffering from oxygen depletion?*

5. How does air pressure affect dissolved oxygen? What implication does this have for bodies of water that are at high altitudes?

Assignment Checklist:
1. Did you answer all the questions 1-5?
2. Did you graph the data (agitation, temperature, and pressure)?
3. Do all three graphs have titles, axis labels, and captions?
4. Are the graphs hand-drawn?