Dissolved Oxygen in Water

1. In the Electronic Resources you will find multiple versions of each student experiment—one for each supported data-collection software or app (Logger *Pro*, Graphical Analysis 4, Spectral Analysis, LabQuest App, and EasyData). Deliver to your students the version that supports the software and hardware they will use. Sign in to your account at **vernier.com/account** to access the Electronic Resources. See Appendix A for more information. **Note**: The printed version of the book and the PDF of the entire book (found in the Electronic Resources) include only the Logger *Pro* versions of the experiments.

2. Different styles of dissolved oxygen probes can be used for this experiment: Dissolved Oxygen Probes and Optical DO Probes. All versions of the experiment can be found in the Electronic Resources. **Note**: The printed version of the book and the PDF of the entire book contain the Optical DO Probe version of the experiment.

3. Temperatures of 5, 10, 15, 20, 25, and 30°C are typical.

4. When students are adding ice into their milk container, warn them to not add more than will melt while they are shaking the container.

5. If you are using Go Direct sensors, see **www.vernier.com/start/go-direct** for information about how to connect your sensor.

6. For additional information about the Vernier probeware used in this experiment, including tips and product specifications, visit **www.vernier.com/manuals** and download the appropriate user manual.

Dissolved Oxygen Probe Users Only

7. While the instructions for calibrating the Dissolved Oxygen Probe are included in the student instructions, it is not necessary to calibrate the Dissolved Oxygen Probe for this experiment. These instructions can be deleted from the student procedure.

8. If you calibrate a Dissolved Oxygen Probe using Logger *Pro* or LabQuest App, you can store the calibration directly on the probe (this cannot be done using EasyData). Once the calibration has been stored on the probe, it will be used automatically each time the probe is connected to an interface. Directions about how to store the calibration are included in the student version of this experiment. **Note**: Due to various factors, such as changes in the characteristics of the membrane over time, the stored calibration should be updated every few weeks.

9. In order for the Dissolved Oxygen Probe to warm up and stay polarized, power to the sensor must be continuous. LabPro, LabQuest, and CBL 2 deliver continuous power once the data-collection software is started even if the screen goes to sleep. However, EasyLink used with a TI-84 graphing calculator and the EasyData App stops powering the sensor when the calculator goes to sleep. The calculator goes to sleep to conserve battery power if no user

interaction is detected for 3 minutes. If power to the sensor is disrupted for more than a few minutes, the sensor must be warmed up again before calibrating or taking readings. To avoid having to warm up the sensor again, students must press a button on the calculator every few minutes to keep the calculator awake.

10. As a time-saving measure, you could instruct students to leave Logger *Pro* or LabQuest App running. This will keep power going to the probes. When the next group of students comes in, they can begin at the procedure. They can skip the probe preparation section because the initial group of students has completed all of the setup. Have the last group of students for the day shut everything off and put things away.

11. Between classes store the Dissolved Oxygen Probes in a beaker of distilled water. At the end of the day be sure to empty out the electrode filling solution in the Dissolved Oxygen Probe and rinse the inside of the membrane cap with distilled water.

ESTIMATED TIME

We estimate that setup and data collection can be completed in one 45-minute class period.

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Developing and Using Models	LS2.A: Interdependent Relationships in Ecosystems LS4.D: Biodiversity and Humans	Cause and Effect

SAMPLE RESULTS

Temperature (°C)	Dissolved oxygen (mg/L)
8.96	11.19
14.89	9.66
18.74	8.81
22.71	7.99
33.65	5.71

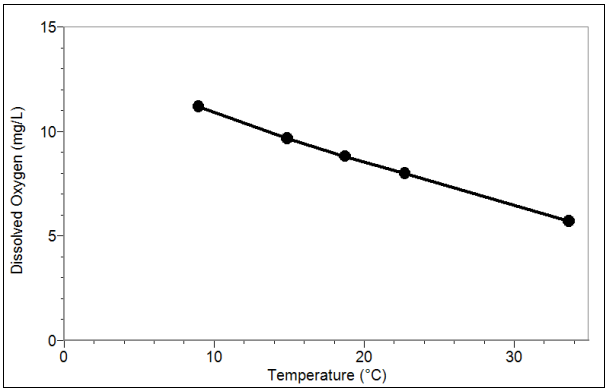

Figure 1

ANSWERS TO QUESTIONS

1. The amount of dissolved oxygen will be highest at the coldest temperature and lowest at the warmest temperature.

2. As the temperature increases, the amount of dissolved oxygen decreases. The relationship does not appear to be linear.

3. Since trout were present, the minimum amount of dissolved oxygen would be 6.5 mg/L. According to these data, fast-moving water could not be warmer than 30–32°C. This temperature is much higher than trout generally live in, however.

4. Other factors must have caused the low dissolved oxygen levels. Bacteria and other organisms can lower the dissolved oxygen of water when they respire aerobically.

5. Trout require high dissolved oxygen levels. Since trees shade the water from the sun, they help keep it cool. Cool water has a higher dissolved oxygen level than warm water and is preferred by trout.