Chapter 2
Probeware Laboratory
Effect of Temperature on Respiration Rate of Various Cold-Blooded Organisms

Purpose
To examine and compare the effect of temperature on the metabolisms of various cold-blooded organisms using a CO₂ gas sensor and a temperature sensor.

Problem
How can you study the effect of temperature on the respiration rates of various cold-blooded organisms?

Design
In this experiment, the type of organism used is the manipulated variable and the CO₂ generated is the responding variable. Controlled variables include the temperature of the water bath, the size of the enclosed container, the duration of the various experimental components.

Materials
computer interface
CO₂ gas sensor
temperature sensor
3 adult crickets
1 newt
1 frog
electronic balance
two 4 Litre containers
silly putty
basting bulb
water tub or laboratory sink (large enough for both of the two 4 Litre containers)

Procedure
1. Animals being used in this experiment must be treated with tremendous respect. Please adhere to the testing times and temperature values suggested to ensure that the organism are not exposed to extreme environments.
2. Set up the computer and connect the temperature and CO₂ sensor. Set your sampling rate to 10 samples per min and take data for 7 min.
3. Cut a hole in the top of one of the containers and fit the CO₂ sensor through it. To prevent leaks during experimentation, fill the space around hole and the sensor with silly putty.
4. Set up the water tub and fill with water at a temperature of 10 °C.
5. Place both containers in the water tub. Put the crickets in the open container that does not have the CO₂ sensor attached to the lid. Leave them in the container for 10 min. Monitor the temperature of the water bath and keep it as close to 10 °C as possible. Use the basting bulb to add or remove water as necessary.

6. After 10 min, transfer the crickets to the jar containing the CO₂ sensor and close the lid. Begin collecting data. Make sure to keep the water bath temperature constant. Again, use the basting bulb to add or remove water as necessary.

**Evidence**

7. After the computer has finished collecting data, immediately remove the lid from the container. Find the slope of your graph at this temperature and record in an appropriate table.

8. Fill both containers with water to remove the accumulated carbon dioxide and dry the inside of the container with a cloth.

9. Repeat steps 4-8 for the remaining organisms and record your data in your table.

10. Raise the water bath temperature to 20 °C and repeat steps 5-9.

11. Raise the water bath temperature to 30 °C and repeat steps 5-9.

**Analysis and Evaluation**

(a) After all testing has been completed, calculate the respiration rate at all temperatures for all three organisms. Do this by dividing each slope by the total mass of the organism(s) tested.

(b) How did the temperature affect the rate of respiration in crickets, frog and newt?

(c) How did the crickets' behaviour differ with the various temperatures that they were exposed to?

(d) Predict the rate of respiration for the newt at 60 °C. Explain.

(e) Using the data generated create a graph comparing the respiration rates of the three cold-blooded organisms to the temperatures they experienced.

(f) What errors might affect the results of this experiment?

**Synthesis**

(g) What time of year would be best to remove a beehive from an unwanted location? Why?

(h) If you performed this experiment on humans, what would their results look like plotted on the graph you created?

**Effect of Temperature on Respiration Rate of Various Cold-Blooded Organisms—Solutions**

**Evidence**

(a)
<table>
<thead>
<tr>
<th>Organism</th>
<th>Temperature (°C)</th>
<th>Slope (ppm/min)</th>
<th>Respiration Rate (ppm/min/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Crickets</td>
<td>10</td>
<td>2.732</td>
<td>3.240</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>4.164</td>
<td>4.941</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>6.370</td>
<td>7.560</td>
</tr>
<tr>
<td>1 Newt</td>
<td>10</td>
<td>39.933</td>
<td>11.727</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>45.753</td>
<td>13.437</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>51.991</td>
<td>15.269</td>
</tr>
<tr>
<td>1 Frog</td>
<td>10</td>
<td>32.898</td>
<td>3.448</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>50.068</td>
<td>5.248</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>93.365</td>
<td>9.786</td>
</tr>
</tbody>
</table>

(b) The warmer the temperature, the higher the rate of respiration for all organisms. In this case, the frog and the crickets displayed similar results when mass was eliminated from the equation.

(c) As the temperature warmed up, the students should note that the crickets become much more active in their containers.

(d) The respiration rate would be close to 0. The crickets could not handle this extreme heat. Enzymes responsible for respiration would denature and reactions would stop and the crickets would die.

(e)

(f) Errors could include: massing the organisms inaccurately, monitoring temperature inaccurately, leaks in the carbon dioxide sensor setup, calculation errors.

(g) Obviously, the cooler it is outside, the slower the metabolism of the bees. Therefore, the less chance they will become upset.
(h) Students should make note that humans are warm-blooded and need to maintain a stable internal temperature. Therefore, the graph would look opposite to that which they have just constructed. As external temperature rises, a warm-blooded organism would respond by lowering their rate of respiration because the difference between internal and external body temperature is decreasing.