

Section Preview of the Student Book for
Body Works, Issues and Life Science, 2nd Edition
Activities 17-19

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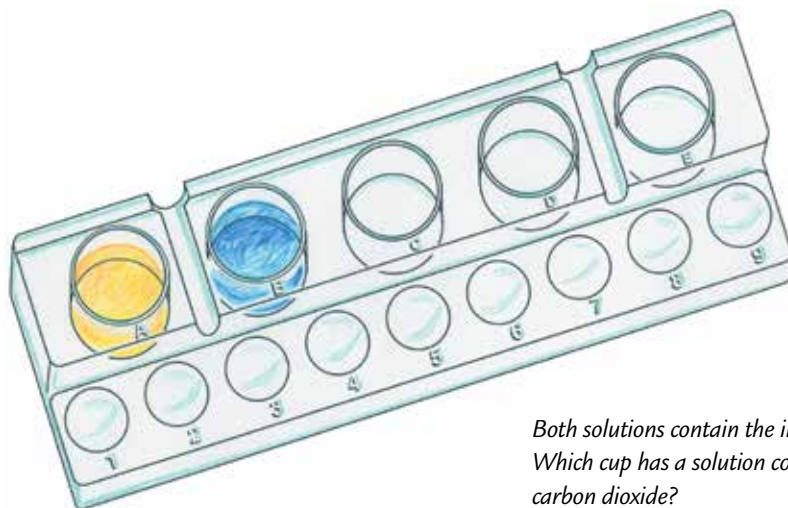


17 Gas Exchange



Your blood transports the nutrients that you eat to different parts of your body. It also carries oxygen from your lungs to other organs and tissues. Your lungs are part of your **respiratory system**. With every breath you take, you inhale oxygen and exhale carbon dioxide. Your body uses the oxygen to get energy from food. When your body breaks down food, it produces wastes. One of the wastes is carbon dioxide.

Indicators (IN-duh-kay-ters) are chemicals that change their appearance in different types of solutions. You will work with the indicator bromthymol (brome-THY-mall) blue, also known as BTB. BTB can be either blue or yellow. When added to a solution containing carbon dioxide, BTB is yellow.



*Both solutions contain the indicator BTB.
Which cup has a solution containing
carbon dioxide?*



How much carbon dioxide is in your exhaled breath?



SAFETY

In this activity, you will be blowing through a straw into chemicals. Do not inhale through the straw! Breathe in through your nose and exhale through your mouth. If you accidentally swallow liquid, rinse your mouth thoroughly and drink plenty of water. Be sure to tell your teacher.

MATERIALS



For each group of four students

- 1 dropper bottle of bromthymol blue (BTB) indicator
- 5 plastic cups
- supply of water



For each pair of students

- 1 dropper bottle of 0.05 M sodium hydroxide
- 1 SEPUP tray
- 1 dropper
- 1 30-mL graduated cup



For each student

- 1 1-gallon plastic bag
- 1 straw
- 1 stir stick
- access to a wall clock or watch with a second hand
- 1 Student Sheet 17.1, “Anticipation Guide: Gas Exchange”

PROCEDURE

Use Student Sheet 17.1, “Anticipation Guide: Gas Exchange,” to prepare you for learning about the respiratory system. Read each statement, and complete the “Before” column only.

Part A: Using BTB to Test for Carbon Dioxide

1. Work with your partner to add 5 mL water to each of the five large cups (A–E) of your SEPUP tray. Use the 30-mL graduated cup to measure the water.
2. Add 2 drops of BTB to each cup and stir.
3. Create a data table to record the initial and final colors of the solutions in each cup. Record the initial colors now. Cup A will provide a control.
4. Use your dropper to bubble air into Cup B. Place the dropper into the solution and press the air out of the bulb. Before releasing the bulb, remove the tip from the solution. This will prevent uptake of solution into the dropper. (If you accidentally get solution into the dropper, simply squirt it back into Cup B.) Repeat this for 15 seconds.
5. Record the final color of the solution in Cup B in your data table.

6. Add 3 drops of 0.05 M sodium hydroxide to Cup C. Record the final color in your data table.
7. Unwrap your straw and place one end in Cup D. Take a deep breath, and then gently blow through the straw for 15 seconds. (Remember not to inhale through the straw!) Record the final color of the solution in Cup D in your data table.
8. Have your partner blow through a clean straw into Cup E for 15 seconds. (Remember not to inhale through the straw!) Record the final color in your data table.
9. Add 3 drops of sodium hydroxide to Cups D and E. In your science notebook, record any changes that you observe.
10. Work with your partner to complete Analysis Questions 1 and 2.

Part B: Using BTB to Measure Carbon Dioxide in Exhaled Breath



11. Work with another pair of students to set up a control:
 - a. Measure 10 mL of water using the 30-mL graduated cup.
 - b. Add 5 drops of BTB to the graduated cup and stir.
 - c. Pour the BTB solution into a large plastic cup. This solution will be the control for every member of your group.
12. Have each person in your group set up his or her own bag of BTB solution:
 - a. Measure 10 mL of water using the 30-mL graduated cup.
 - b. Add 5 drops of BTB to the graduated cup and stir.
 - c. Pour the BTB solution into your own 1-gallon plastic bag.
13. Remove the air from your plastic bag by slowly flattening it. Be careful not to spill any of the BTB solution out of the bag. While keeping the air out of the bag, place a straw in the mouth of the bag. Make an air-tight seal by holding the mouth of the bag tightly around the straw.
14. Be sure you are sitting down. Then fill the bag with air from your lungs by blowing through the straw until the bag is fully inflated. When you finish blowing, pull out the straw. As you pull out the straw, squeeze the bag tightly shut so no air escapes.



15. Holding the bag closed, shake the bag vigorously 25 times.
16. Pour the BTB solution from the bag into a clean, empty plastic cup.
17. *How much carbon dioxide is in your exhaled breath?* You can find out by counting how many drops of sodium hydroxide are needed to make your BTB solution the same color as the control:
 - a. Add 1 drop of sodium hydroxide to your plastic cup.
 - b. Gently stir the solution and wait at least 10 seconds.
 - c. Record in your science notebook that you added 1 drop.
 - d. Compare the color of your solution to the control. *Is it the same color as the control for at least 30 seconds?*

If your answer is no, repeat Steps 17a–d. Be sure to keep track of the total number of drops!

If your answer is yes, go on to Step 18.

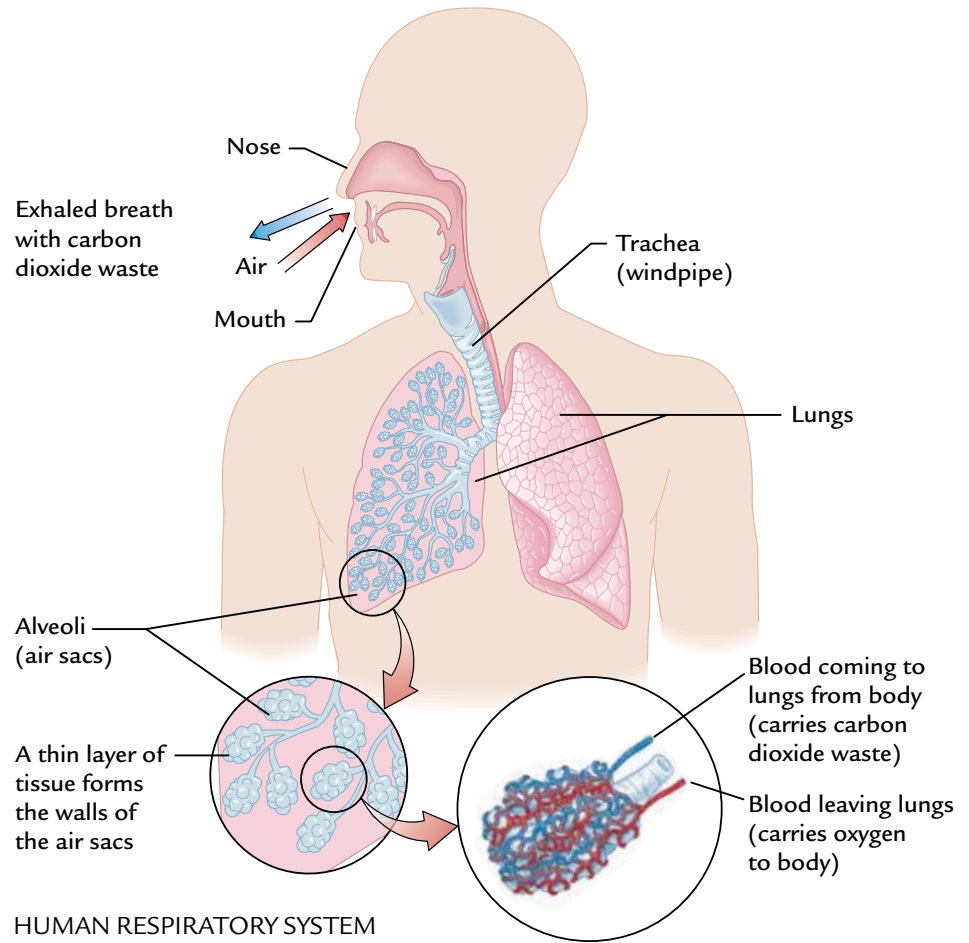
18. In your science notebook, record the total number of drops it took to change your solution back to the same color as the control. Then record your total on the class data table.
19. Draw a bar graph with the class results. Remember to title your graph and label the axes!

EXTENSION 1

Do you exhale more carbon dioxide after you hold your breath? Find out by modifying and repeating Part B of the Procedure.



Activity 17 • Gas Exchange



This is a plastic mold of the air ways and air sacs in the lungs. Compare it to the diagram of the lungs above.



ANALYSIS

Part A: Using BTB to Test for Carbon Dioxide

1. What was the purpose of the solution in Cup A?
2. **a.** Which of the solutions in Part A contained carbon dioxide? Support your answer with evidence from your experimental results.
 - b.** What does this tell you about the exhaled breath of human beings?
 - c.** Look at the table below. Compare the composition of air you breathe in to that of air you breathe out. Describe the differences.

Composition of Breath		
Components of earth's atmosphere	Composition of air breathed in (%)	Composition of air breathed out (%)
Nitrogen	78	75
Oxygen	21	16
Argon	0.9	0.9
Carbon dioxide	0.035	4.0
Water vapor	0.4	4.0

Part B: Using BTB to Measure Carbon Dioxide in Exhaled Breath



3. Review the class data table. What was the range of carbon dioxide in exhaled breath (as measured by drops of sodium hydroxide)?
4. Look again at the diagram of the human respiratory system. Considering all the oxygen that has to get into your blood and all the carbon dioxide that has to escape from your blood, why do you think the inside of the lung is structured the way it is?
5. **a.** Were the data collected in Part A qualitative or quantitative? Explain.
 - b.** Were the data collected in Part B qualitative or quantitative? Explain.
6. **a.** Look carefully at the diagram of the human respiratory system. What are some of the important structures in the respiratory system?
 - b.** Explain where gases are exchanged within the respiratory system.

7. Complete Student Sheet 17.1. Be sure to explain how the activity provided evidence for your initial ideas or caused you to change your thinking.
8. **Reflection:** Many respiratory diseases limit a person's capacity to exchange oxygen. One of these diseases is pneumonia, which causes the alveoli to fill up with fluid. Another is pleurisy, which is an inflammation of the lining of the lung, making it painful to inhale and exhale. If you had one of these diseases, how do you think you would feel?



EXTENSION 2

To find out more about how the lungs work and the effect of asthma on the lungs, go to the *Issues and Life Science* page of the SEPUP website.

EXTENSION 3

How do you think your body gets more oxygen when you exercise? Do you breathe faster (take more breaths per minute)? Or do you absorb more oxygen from the air with each breath? Use what you learned in this activity to develop an experiment to test your hypothesis.

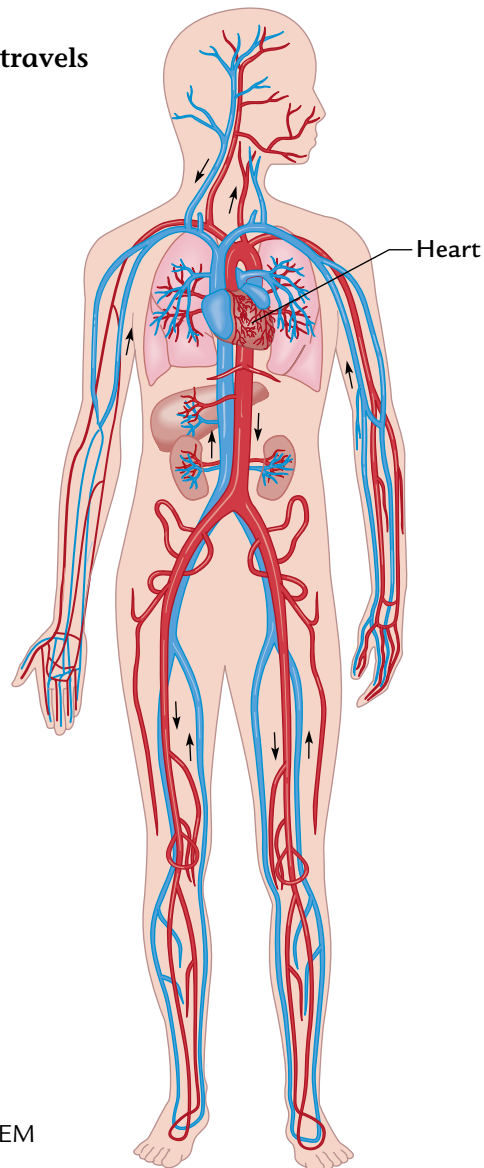
18 The Circulation Game



How do the nutrients absorbed from the digestive system get to every part of your body? They travel in your blood through your cardiovascular (kar-dee-oh-VASS-kyu-lar) system. In the diagram of the human circulatory system, below, you can see that your blood goes to every part of your body. The main function of your blood is to transport, or carry things around. Blood transports oxygen, nutrients, and wastes such as carbon dioxide. Some organs in your body help get nutrients and oxygen into your blood and also remove wastes. In this activity, you will model the path of your blood as it moves through your body and you will learn what happens along the way.



What does blood do as it travels around your body?



HUMAN CIRCULATORY SYSTEM

MATERIALS

Part B: Modeling Circulation

For the class



- 1 set of oxygen, nutrient, carbon dioxide, and waste cards



For each student

- 1 Role Card
- 1 paper clip, safety pin, hole-punch and string, or piece of transparent tape
- 1 Student Sheet 18.1, "KWL: The Cardiovascular System"

PROCEDURE

Complete the first two columns of Student Sheet 18.1, "KWL: The Cardiovascular System."

Part A: Blood Flow

1. Look at "Diagram of Blood Flow," below. This is a simplified map of how blood travels around your body. Use your finger to trace one of the possible paths of blood flow. Begin on the left side of the heart (on your right) and stop once you reach the left side of the heart again. Be sure to go in the direction of the arrows.

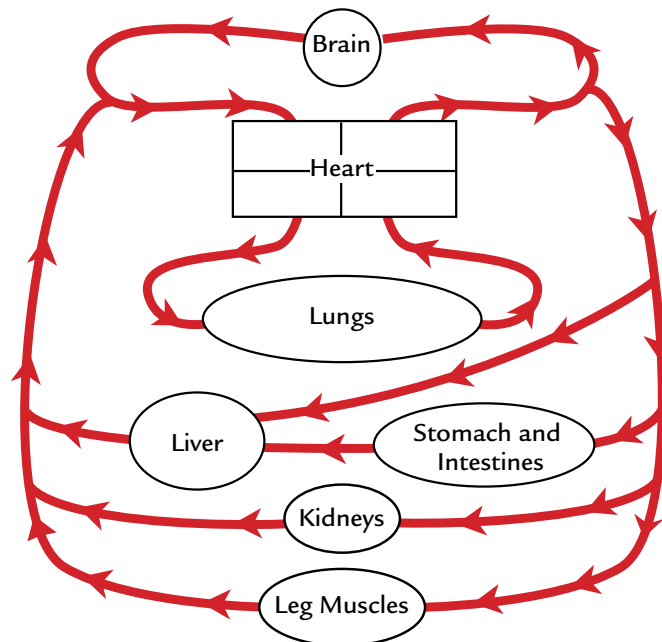


DIAGRAM OF BLOOD FLOW

2. In your science notebook, record which organs and structures you passed through in your path.
3. Repeat Steps 1 and 2 by tracing a different path of blood through the human body.
4. Discuss the following questions with your group members:
 - Did everyone trace the same paths? If not, compare the organs (and structures) along the different paths.
 - Which organs does the blood have to pass through each time it goes around the human body?
 - Why do you think blood always has to pass through these organs?
5. Use your discussion and your knowledge of the human body to complete a table like Table 1.

Table 1: Functions of Certain Organs

Function	Organ(s)
Pumps blood	
Brings oxygen into the body	
Carries carbon dioxide out of the body	
Absorbs nutrients	
Removes wastes	

6. As directed by your teacher, share your discussion with the rest of the class.

Part B: Modeling Circulation

The Model

You will model the way in which your blood transports oxygen, nutrients, and carbon dioxide and other wastes. Each student will receive a Role Card to role play one part of the human body: blood, brain, heart, lungs, stomach and intestines, liver, kidneys, or leg muscles.

In this model, as “blood” flows through the “human body,” it will absorb “oxygen” and “nutrients” and carry them to other parts of the body. “Organs” will use the nutrients and oxygen and get rid of carbon dioxide and other wastes by giving them to the blood. Colored cards will represent the four substances (oxygen, nutrients, carbon dioxide, and waste) that are being transported.

7. Your teacher will give you a Role Card. Read your Role Card carefully to see what your job will be. Be sure to note how many oxygen, nutrient, carbon dioxide, and waste cards you will need to collect before beginning.
8. Collect the cards that you need to begin. Keep oxygen, nutrient, carbon dioxide, and waste cards in separate stacks so that exchanges can take place quickly. Then attach your Role Card to your clothing.
9. Your teacher will assign one student to play the role of a blood cell on the blood flow diagram. The rest of the class should watch where the blood cell goes and what happens at each organ.
10. Now, students playing the role of blood cells should WALK through the model. You may start anywhere on the blood flow diagram, but be sure to follow the direction of the arrows.
11. Next, PLAY the Circulation Game. Your teacher may clap or keep a beat to simulate each pump of the heart. Only move forward on the beat.
12. As the blood flows through the body, carbon dioxide and waste products build up in the organs. The stomach and lungs start running out of food and oxygen. Your teacher will direct you on what to do to take care of these problems.
13. If you have time, switch role cards and play the Circulation Game again.

EXTENSION

Block one artery, and play the game again to see how a blocked artery affects circulation.

ANALYSIS



1. Compare this circulation model to the human body. How well did the Circulation Game represent what really happens inside your body?



2. Do all parts of the human body use oxygen and nutrients? Explain your answer.

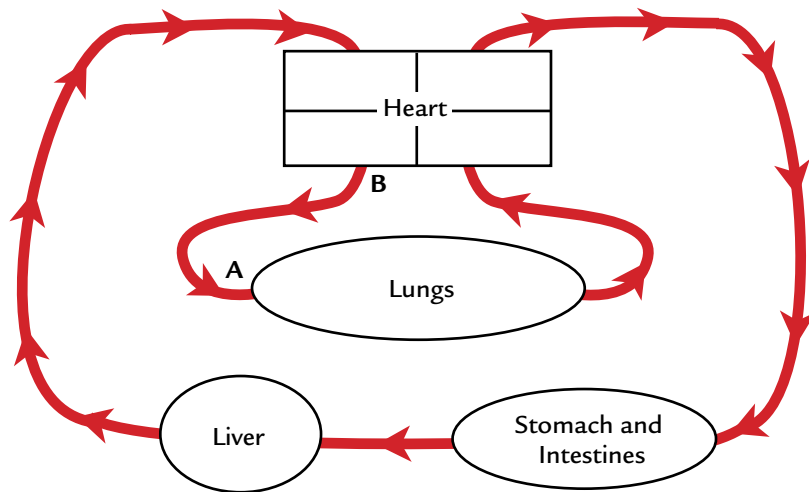
3. Why does blood flow from the stomach and intestines directly to the liver? **Hint:** Review your notes from Activity 13, “Living with Your Liver,” and Activity 15, “Digestion—An Absorbing Tale,” for help.



4. What are the functions of the blood as it travels around the human body? Be specific.



5. Look at the diagram below.



a. Use your finger to trace the path between Point A and Point B, making sure to follow the direction of the arrows. List the organs in the order in which you passed through them.

b. Imagine blood carrying only carbon dioxide and nutrients at Point A. Describe what happens to the blood as it flows from Point A to Point B.

6. Complete as much as you can of the third column of Student Sheet 18.1, “KWL: The Cardiovascular System.”

19 Heart-ily Fit



Imagine going on a long hike. How would this exercise affect your body? How could you measure this effect? When you exercise, your heart beats faster to provide more oxygen to the muscles in your body. The harder you exercise, the faster your heart beats. You can measure the speed at which your heart beats by taking your pulse, which reflects the contractions of your heart. Each time your heart beats, it sends blood through your body. You can feel this surge when you press on blood vessels near the surface of your skin.

One way you can investigate your level of fitness is by measuring how long it takes for your heart to recover from exercise. The more physically fit a person is, the more efficiently oxygen and nutrients can be transported to the muscles. The faster your heart recovers from exercise, the more fit you are.



How can you quantitatively measure your level of fitness?



Did you know that you can have a career studying exercise and helping people get into shape and stay fit? This type of work is known as exercise physiology (fih-zee-AH-luh-jee).

MATERIALS



For the class

access to a wall clock or watch with a second hand



For each pair of students

1 calculator



For each student

1 Student Sheet 19.1, "Pulse Data"

Student Sheet 18.1, "KWL: The Cardiovascular System," from Activity 18



SAFETY

If you begin to feel dizzy or short of breath during exercise, stop exercising immediately. Do not participate in this activity if you have any condition that prevents you from exercising.

PROCEDURE

Part A: Resting Pulse

1. In your science notebook respond to the following questions:
 - a. When you are at rest, how many times do you think your heart beats (as measured by your pulse) in one minute?
 - b. After you have done some moderate exercise, how many times do you think your heart beats (as measured by your pulse) in one minute?
2. To take your pulse at rest, sit comfortably. (The best and most accurate time to measure resting pulse is immediately after you wake up in the morning, before you get out of bed. You can check your resting pulse at that time to see how it varies from the values taken in class.)



You can monitor your pulse at a number of sites. Two convenient sites to use are:

- *the artery at the base of the wrist (of either hand).*
- *the artery at the side of the neck.*

3. Use the first two fingers of one hand to locate your pulse at the base of your wrist.
4. Measure your pulse for 15 seconds. Have your partner keep track of the time.
5. Record your data for Trial 1 on Student Sheet 19.1, “Pulse Data.”
6. Repeat Step 3 two more times and record your data for Trials 2 and 3.
7. Repeat Steps 1–5 for your partner.
8. Calculate your pulse for 60 seconds (1 minute) by multiplying each 15-second pulse by 4.
9. Calculate your average resting pulse per minute. Do this by adding all the numbers in the column titled “60-Second Pulse.” Then divide your total by 3. Record your average resting pulse per minute on Student Sheet 19.1.
10. Your teacher will tell you how to share your responses with the class. What is the range of the class? Did your prediction fall within that range? If so, where did it fall? Record these results in your science notebook.
11. Use the class data to create a scatterplot.

Part B: Recovery Time

12. As discussed in class, exercise for 5 minutes. You should begin to feel your heart beating faster. **Hint:** If you can have a normal conversation while exercising, you are not exercising hard enough. If you cannot talk at all, you are exercising too hard.
13. After 5 minutes, stop exercising and sit down. Immediately begin taking your pulse every 30 seconds for the next 5 minutes. Record your 15-second pulse every 30 seconds on Student Sheet 19.1.
14. Calculate your 60-second pulse for each time period by multiplying each 15-second pulse by 4.



ANALYSIS



1. What happened to your breathing rate during exercise? Discuss what was happening inside your body that caused this to happen.



2. What caused the difference between your resting pulse and your pulse after exercise? In other words, what was happening inside your body that caused your pulse to change?

-  3. a. Recovery time is the time it takes for your pulse to return to within 20% of your resting pulse. In order to measure your recovery time, you must first know when you are within 20% of your resting pulse. Calculate this value by multiplying your resting pulse by 1.2.
Resting pulse \times 1.2 = _____ beats/min
- b. Look at your 60-second pulse values in Section III, “Recovery Time,” of Student Sheet 19.1. How many minutes after you stopped exercising did it take you to return to within 20% of your resting pulse? (This is your recovery time.)
4. Prepare a line graph of your pulse during the time of the recovery period.
5. If you improved your level of physical fitness, would you expect your resting pulse to increase or decrease? Explain.
6. What do you predict would happen to your recovery time if you exercised at least three times a week for a month?
-  7. Complete the third column of Student Sheet 18.1, “KWL: The Cardiovascular System.”

EXTENSION

Brainstorm exercises you can easily do and like to do. Develop a plan to exercise regularly for the next month. You should exercise at least three times a week for at least 20 minutes each time. Keep a record or log of the dates and time that you exercise. After exercising for a month, repeat Part B of the procedure. What effect does regular exercise have on your recovery time?