Heart Rate and Physical Fitness

The circulatory system is responsible for the internal transport of many vital substances in humans, including oxygen, carbon dioxide, and nutrients. The components of the circulatory system include the heart, blood vessels, and blood. Heartbeats result from electrical stimulation of the heart cells by the *pacemaker,* located in the heart's inner wall of the right atrium. Although the electrical activity of the pacemaker originates from within the heart, the rhythmic sequence of impulses produced by the pacemaker is influenced by nerves outside the heart. Many things might affect heart rate, including the physical fitness of the individual, the presence of drugs such as caffeine or nicotine in the blood, and the age of the person.

As a rule, the maximum heart rate of all individuals of the same age and sex is about the same. However, the time it takes individuals to reach that maximum level while exercising varies greatly. Since physically fit people can deliver a greater volume of blood in a single cardiac cycle than unfit individuals, they can usually sustain a greater work level before reaching the maximum heart rate. Physically fit people not only have less of an increase in their heart rate during exercise, but their heart rate recovers to the resting rate more rapidly than unfit people.

In this experiment, you will evaluate your physical fitness. An arbitrary rating system will be used to "score" fitness during a variety of situations. Tests will be made while in a resting position, in a prone position, as well as during and after physical exercise.

Important: Do not attempt this experiment if physical exertion will aggravate a health problem. Inform your instructor of any possible health problems that might be affected if you participate in this exercise.

OBJECTIVES

In this experiment, you will

- Determine the effect of body position on heart rates.
- Determine the effect of exercise on heart rates.
- Determine your fitness level.
- Correlate the fitness level of individuals with factors such as smoking, the amount of daily exercise, and other factors identified by students.

MATERIALS

LabQuest
LabQuest App
Vernier Hand-Grip Heart Rate Monitor
Sphygmomanometer
Stethescope
Ice Bath

PROCEDURE

Each person in a lab group will take turns being the subject and the tester. When it is your turn to be the subject, your partner will be responsible for recording the data on your lab sheet.

1. Connect the receiver module of the Heart Rate Monitor to LabQuest and choose New from the File menu.
2. On the Meter screen, tap Length. Change the data-collection length to 600 seconds. Select OK.
3. Set up the Heart Rate Monitor. Follow the directions for your type of Heart Rate Monitor.

Using a Hand-Grip Heart Rate Monitor

a. The receiver and one of the handles are marked with a white alignment arrow as shown in Figure 1. Locate these two arrows.
b. Have the subject grasp the handles of the Hand-Grip Heart Rate Monitor so that their fingers are in the reference areas indicated in Figure 2. Hold the handles vertically.
c. Have someone else hold the receiver near the handles so that the two alignment arrows are pointing in the same direction and are at approximately the same height as shown in Figure 1. **Note:** The receiver must stay within 60 cm of the handles during data collection.

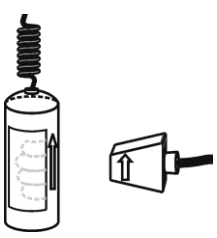


Figure 1

Figure 2

4. Start data collection to determine that everything is set up correctly. The readings should be consistent and within the normal range of the individual, usually between 55 and 80 beats per minute. When you have determined that the equipment is operating properly, stop data collection and proceed to Step 5.

Standing heart rate

5. Instruct the subject to stand upright for 2 minutes. Start data collection. When the 2 minutes have passed, record the subject's heart rate in Table 6.
6. Locate the subject's heart rate in **Table 1** and record the corresponding fitness point value in Table 6.

Table 1			
Beats/min	Points	Beats/min	Points
60–70	12	101–110	8
71–80	11	111–120	7
81–90	10	121–130	6
91–100	9	131–140	4

Reclining heart rate

7. Instruct the subject to recline on a clean surface or table for 2 minutes. When the 2 minutes have passed, record the subject's heart rate in Table 6. **Note:** If using the Hand-Grip Heart Rate Monitor, remember to move the receiver along with the handles to keep the arrows aligned.

8. Locate the subject's heart rate in **Table 2** and record the corresponding fitness point value in Table 6.

Table 2			
Beats/min	Points	Beats/min	Points
50–60	12	81–90	8
61–70	11	91–100	6
71–80	10	101–110	4

Heart rate change from reclining to standing

9. Instruct the subject to quickly stand up and remain standing still.

10. Immediately record the subject's peak heart rate in Table 6.

11. Subtract the reclining rate heart rate recorded in Step 6 from the heart rate in Step 9 to find the heart rate increase after standing. Locate the row corresponding to the reclining heart rate in **Table 3** and use the heart rate increase value to determine the proper fitness points. In Table 6, record the fitness points. Stop data collection. Instruct the subject to rest for 2 minutes then proceed to Step 11.

Table 3					
Reclining heart rate	Heart rate increase after standing				
	0–10	11–17	18–24	25–33	34+
50–60	12	11	10	8	6
61–70	12	10	8	6	4
71–80	11	9	6	4	2
81–90	10	8	4	2	0
91–100	8	6	2	0	0
101–110	6	4	0	0	0

Step test

12. Start data collection. Before performing the step test, record the subject's heart rate (Pre-exercise) in Table 6.

13. Perform a step test using the following procedure:
    a. Place the right foot on the top step of the stool.
    b. Place the left foot completely on the top step of the stool next to the right foot.
    c. Place the right foot back on the floor.
    d. Place the left foot completely on the floor next to the right foot.
    e. This stepping cycle should take 3 seconds to complete.

14. When five steps have been completed, record the heart rate in Table 6. Quickly move to Step 15.

Recovery rate

15. With a stopwatch or clock, begin timing to determine the subject's recovery time. During the recovery period, the subject should remain standing and relatively still. Monitor the heart rate readings and stop timing when the readings return to the pre-exercise heart rate value recorded in Step 11. Record the recovery time in Table 6.

16. Stop data collection.

17. Locate the subject's recovery time in **Table 4** and record the corresponding fitness point value in Table 6. If the subject's heart rate did not return to within 10 beats/min from their pre-exercise heart rate, record a value of 6 points.

Table 4

Time (sec)	Points
0–30	14
31–60	12
61–90	10
91–120	8

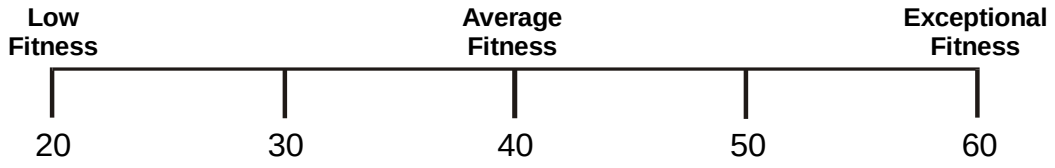
Step test for endurance

18. Subtract the subject's pre-exercise heart rate (from Step 11) from their heart rate after 5 steps of exercise. Record this heart rate increase in the endurance row of Table 6.

19. Locate the row corresponding to the pre-exercise heart rate in **Table 5** and use the heart rate increase value to determine the proper fitness points. In Table 6, record the fitness points.

Table 5					
Pre-exercise heart rate	Heart rate increase after exercise				
	0–10	11–20	21–30	31–40	41+
60–70	12	12	10	8	6
71–80	12	10	8	6	4
81–90	12	10	7	4	2
91–100	10	8	6	2	0
101–110	8	6	4	1	0
111–120	8	4	2	1	0
121–130	6	2	1	0	0
131+	5	1	0	0	0

20. Total all the fitness points recorded in Table 6. Determine the subject's personal fitness level using the scale below.



DATA

Table 6		
Condition	Rate or time	Points
Standing heart rate	beats/min	
Reclining heart rate	beats/min	
Reclining to standing	beats/min	
Pre-exercise heart rate	beats/min	
After 5 steps	beats/min	
Recovery time	seconds	
Endurance	beats/min	
		Total points:

QUESTIONS

1. How did your heart rate change after moving from a standing position to a reclining position? Is this what you expected? How do you account for this?

2. How did your heart rate change after moving from a reclining position back to a standing position? Is this what you expected? How do you account for this?

3. Predict what your heart rate might be if you had exercised for twice the length of time that you actually did. Explain.

4. How does your maximum heart rate compare to other students in your group. Is this what you expected? How do you account for this?

5. Why would athletes need to work longer and harder before their heart rates were at the maximum value?

6. How do you evaluate your physical fitness? Do you agree with the rating obtained from this experiment? Explain.

7. Current research indicates that most heart attacks occur as people get out of bed after sleep. Account for this observation.

EXTENSION

Your total blood pressure reading is determined by measuring your systolic and diastolic blood pressures. Systolic blood pressure, the top number, measures the force your heart exerts on the walls of your arteries each time it beats. Diastolic blood pressure, the bottom number, measures the force your heart exerts on the walls of your arteries in between beats.

A sphygmomanometer is a device that measures blood pressure. It is composes of an inflatable rubber cuff, which is wrapped around the arm. A measuring device indicates the cuff's pressure. A bulb inflates the cuff and a valve releases pressure. A stethoscope is used to listen to arterial blood flow sounds.

As the heart beats, blood forced through the arteries cause a rise in pressure, called systolic pressure, followed by a decrease in pressure as the heart's ventricles prepare for another beat. This low pressure is called the diastolic pressure.

The **sphygmomanometer** cuff is inflated to well above expected systolic pressure. As the valve is opened, cuff pressure (slowly) decreases. When the cuff's pressure equals the arterial systolic pressure, blood begins to flow past the cuff, creating blood flow turbulence and audible sounds. Using a stethoscope, these sounds are heard and the cuff's pressure is recorded. The blood flow sounds will continue until the cuff's pressure falls below the arterial diastolic pressure. The pressure when the blood flow sounds stop indicates the diastolic pressure.

Systolic and diastolic pressures are commonly stated as systolic 'over' diastolic. For example, 120 over 80. Blood flow sounds are called Korotkoff sounds.

Using a sphygmomanometer, learn how to measure blood pressure.

Blood Pressure = _____

What factors might influence blood pressure readings? _____

_____

Pulse pressure is the difference between the systolic and diastolic blood **pressure**. It is measured in millimeters of mercury (mmHg). It represents the force that the heart generates each time it contracts. For example, if resting blood **pressure** is 120/80 mmHg, then the **pulse pressure** is 40 mmHg.

Pulse Pressure = _____

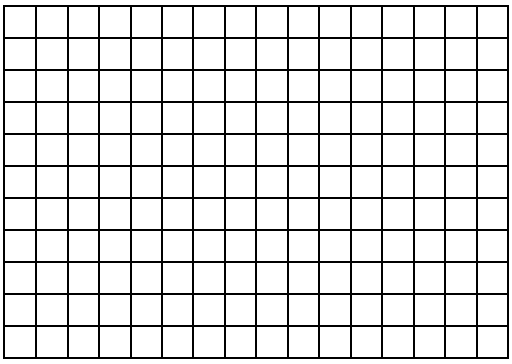
What value might there be in knowing pulse pressure? _____

_____

Exercise and Blood Pressure

1. Graph your resting blood pressure in Figure 1
2. Do some vigorous exercise to change your pulse rate and measure your blood pressure immediately after exercise. Graph your post-exercise results in Figure 1.
3. Rest for 3 minutes and measure your recovery blood pressure. Graph your recovery blood pressure in Figure 1.

Figure 1: Bar Graph of Blood Pressure



Was your partner's blood pressure back to normal after 3 minutes?_____

If not, what factors could account for the difference? _____

_____

Cold Pressure

1. Graph your resting blood pressure in Figure 2.
2. Place your hand in ice water for about 1 minute. Immediately Record your blood pressure. Graph your cold water results in Figure 2.
3. Wait for 3 minutes and measure your cold recovery blood pressure. Graph your cold recovery blood pressure in Figure 2.

Figure 2: Effects of Cold on Blood Pressure