

Investigating Heart Rate

Introduction

Resting heart rate, maximum heart rate, target heart rate—what do all these numbers mean?

What is the importance of these numbers and what criteria are used to determine them?

What factors influence each of these signs of cardiac health? The purpose of this activity is to learn how these indicators are measured or determined and to investigate the effects of physical activity and additional weights on the heart rate.

Concepts

- Cardiology
- Heart rate

Background

A *closed circulatory system* is one where blood never leaves the system of blood vessels and the heart. In animals with a four-chambered heart, the blood follows two distinct circuits as it passes through the body. The *systemic circuit* carries oxygenated blood from the left side of the heart, through the arteries and arterioles, and finally to the capillaries, where oxygen is delivered to the cells via diffusion. The deoxygenated blood then travels back through venules and the larger veins to the vena cava before being returned to the right atrium of the heart. In the *pulmonary circuit*, deoxygenated blood travels from the heart through the pulmonary arteries to the lungs, where oxygen diffuses into the blood. The blood then enters the pulmonary veins before returning to the heart. *Note:* Arteries carry blood away from the heart and veins carry blood to the heart, regardless of whether the blood is oxygenated or deoxygenated.

In order for muscle tissue to receive more oxygen during physical exertion, the heart increases its contraction rate. A *heart rate*, also called the cardiac rate or pulse, is measured in beats per minute (bpm). The more times the heart contracts (beats) within one minute, the faster the heart rate. Many physiological factors or conditions influence heart rate—some of the most important include age, gender, heart disease, stress, thyroid problems, anemia, stimulants, depressants, and other medications.

The maximum rate that a heart can beat is generally the same for people within the same age group. The *maximum cardiac rate* for an individual is calculated by subtracting the person's age from 220. Individuals who are in good physical condition can deliver more oxygen to their muscles before reaching the maximum cardiac rate than can individuals in poor condition.

People who are physically fit also pump a greater volume of blood with each contraction during physical exertion. As a result, a physically fit person's heart does not need to beat as fast to deliver the same amount of oxygenated blood to the muscle tissues. An adult athlete in peak fitness may have a resting heart rate of 50–57 bpm, compared to a resting heart rate of 70–76 bpm for an average adult male. During physical exertion, a person who is in poor physical condition reaches the maximum cardiac rate at a lower work level than a person of comparable age who is in better shape. During physical exertion, the goal is not to reach the maximum cardiac rate but rather the target heart rate. The *target heart rate* is actually a range of heart rates corresponding to the maximum cardiac rate multiplied by 50%–85%. The target heart rate is considered the optimum value for each age group to achieve physical conditioning and strengthening of the circulatory system. See Table 1.

Age	Average Maximum Heart Rate (beats per minute)	Target Heart Zone (beats per minute)
15	205	103–172
20	200	100–170
25	195	95–162
30	190	93–157
35	185	90–153
40	180	88–149
45	175	85–145
50	170	83–140
55	165	80–136

Table 1. Target Heart Rate and Zone

Materials

Isopropyl alcohol, 70%

Backpack

Books

Cotton balls

Scale

Stethoscope

Stopwatch or clock with second hand

Safety Precautions

Isopropyl alcohol is a highly flammable liquid and vapor; keep away from heat, sparks, open flames and hot surfaces. It causes mild skin irritation, serious eye irritation, and is slightly toxic by ingestion and inhalation. Wear chemical splash goggles and chemical-resistant gloves and apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Obtain three volunteers who are willing to perform the following physical tasks—jumping jacks for one minute, followed by rest for two minutes and then jumping jacks again with a 10-lb weight pack for one minute.
2. Each volunteer should select a second individual who will be the data collector, measuring the volunteer's heart rate after each interval.
3. Saturate two cotton balls with isopropyl alcohol. Use one cotton ball to clean the bell and diaphragm of the stethoscope and the second to clean the earpieces of the stethoscope. Discard cotton balls in the regular trash.
4. Each of the three volunteers should remain quietly seated for two minutes before their resting heart rate is measured.
5. The data collector should place the stethoscope over the volunteer's heart and count the number of beats for 20 seconds.
6. Record the number of resting heartbeats in 20 seconds for each volunteer. Calculate what the heart beat would be in beats per minute.
7. Each volunteer will perform jumping jacks for 60 seconds.
8. After 60 seconds measure the volunteer's heart rate again as described in steps 5 and 6. Record the results.
9. Allow the volunteer to sit and rest for two minutes.
10. Using a scale, weigh 10 lbs worth of books. Add this weight of books to each volunteer's back pack.
11. Wearing the 10-lb back pack, each volunteer should perform jumping jacks for 60 seconds.
12. Measure the number of heartbeats for each volunteer as described in steps 5 and 6. Record the results.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Isopropyl alcohol may be disposed of according to Flinn Suggested Disposal Method #18a. Used cotton balls may be disposed of in the regular trash according to Flinn Suggested Disposal Method #26a.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School

MS-LS1 From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function

Disciplinary Core Ideas: High School

HS-LS1 From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function

Science and Engineering Practices

Planning and carrying out investigations

Crosscutting Concepts

Structure and function

Stability and change

Tips

- Be sensitive when recruiting volunteers to perform this demonstration. Make sure volunteers do not have any health issues where this activity may cause physical stress.
- Paperback or soft cover books are preferred over hardcover books as they will be more comfortable for the volunteers to carry while performing the physical activity.
- Flinn Scientific offers this activity as a demonstration kit, Investigating Heart Rate, Catalog No. FB1987.

References

American Heart Association. Target Heart Rates. <http://www.americanheart.org/presenter.jhtml?identifier=4736> (accessed September 2016).

Materials for *Investigating Heart Rate* are available from Flinn Scientific, Inc.

Catalog No.	Description
FB1987	Investigating Heart Rate—Biology Activity Kit
AP5419	Bathroom Scale
I0021	Isopropyl Alcohol, 70%
AP1572	Timer, Stopwatch, Flinn

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.