



*Drexel-SDP GK-12 ACTIVITY*

## Activity: Amp'd Up

**Subject Area(s)** Data Analysis & Probability, Measurement, Number & Operations, Physical Science, Science and Technology

**Associated Unit** Vital Mechanics

**Associated Lesson** Pressure

**Activity Title** Amp'd Up



**The many different forms of pressure.**

**Grade Level** 7 (6-12)

**Activity Dependency**

**Time Required** 60 minutes

**Group Size** 4 people

**Expendable Cost per Group** US \$3

### Summary

Students will have the opportunity to compare their heart rate and blood pressure before and after consuming candy or soft drinks. Sugar and caffeine are both stimulants, and their

effects can be measured by designating groups to consume candy that is sugar-free or sugared (without caffeine), or caffeine free and caffeinated soft drinks (7-UP, Mountain Dew).

### **Engineering Connection**

Pressure governs many biological and environmental processes, and engineers in particular have used the concepts to their advantage for many years. Similar to the previous lesson, **Collisions**, the energy of particles on the molecular level can be changed dramatically with pressure (gas laws). On a larger scale, pressure influences particle movement due to gravity (water tower), chemical reactions (engine pistons), and even weather patterns (areas of high and low pressure). Earthquakes, tsunamis, and sound are all caused by pressure waves that propagate through solids, liquids, and gases, respectively.

The good news is that, besides acts of nature, we can control pressure and use it to generate electricity (hydroelectricity, wind power), water and septic systems, and create mechanical motion (engines). Among these uses, pressure occurs naturally in our body's circulatory system. When we have our blood pressure taken, the doctor or nurse reads our systolic and diastolic pressure as a ratio, like "120 over 80." This is measure of the pressure in the cuff (around our arm) necessary to close our brachial artery. Under normal conditions, our vasculature is a closed system and responds to stimuli just as temperature has an effect on an ideal gas in a container.

### **Keywords**

Pressure, blood pressure, heart rate, sugar, caffeine, exercise, cardiovascular, candy, soda

### **Educational Standards**

- PA Science:
  - 3.1.7 – Unifying themes
  - 3.2.7.B – Apply process knowledge to make and interpret observations
- PA Math:
  - 2.1.8.D – Apply ratio and proportion to mathematical problem situations involving distance, rate, time, and similar triangles
  - 2.4.5.B – Use models, number facts, properties, and relationships to check and verify predictions and explain reasoning
  - 2.5.8.B – Verify and interpret results using precise mathematical language, notation and representations, including numerical tables and equations, simple algebraic equations and formulas, charts, graphs, and diagrams
  - 2.7.8.D – Compare and contrast results from observations and mathematical models
  - 2.8.8.B – Discover, describe, and generalize patterns, including linear, exponential, and simple quadratic relationships

### **Pre-Requisite Knowledge**

Introduction to meaning of pressure from accompanying lesson, **Pressure**.

### **Learning Objectives**

After this activity, students should be able to:

- Measure heart rate and blood pressure

- Detect changes in heart rate and blood pressure
- Relate chemical stimuli to physiological changes in heart rate or blood pressure
- Predict the effect of stimuli on heart rate or blood pressure

### **Materials List**

Each group needs:

- 1 sphygmomanometer (demonstration-grade)
- 1 stethoscope (demonstration-grade)
- 1 stopwatch
- 1 serving sugar-free candy
- 1 serving sugared candy
- 1 serving non-caffeinated soft drink
- 1 serving caffeinated soft drink
- PASCO Explorer GLX unit (optional)
- PASCO Heart Rate Monitor module (optional)

To share with the entire class:

- Scratch paper
- Graph paper

### **Introduction / Motivation [segue from Pressure lesson]**

I'm sure you've seen television commercials marketing a pharmaceutical product that controls high blood pressure conditions. *Hypertension*, the clinical term for high blood pressure, usually occurs in adults over 35 years old, and has been linked to African Americans, obese people, heavy drinkers, women taking birth control pills, diabetics, and individuals with a family history. Currently, causes of hypertension cannot be pinpointed but there has been evidence that the condition causes structural changes in the arteries those affected. Higher blood pressure not only increases the strain on the heart, but it puts smaller arteries, which behave elastically like a balloon, at risk for aneurysm (rupture).

While the reality seems frightening, there are many steps that can be taken to avoid health problems: proper diet, frequent checkups, and knowledge of your family history and risk factors associated with your daily habits. We're actually going to take a snapshot of these by consuming different kinds of candy and soft drinks, and monitoring our heart rate and blood pressure.

### **[if using the PASCO Explorer unit]**

You're going to attach the clip to either the web of your hand (between thumb and index finger) or to your earlobe, then if you press the "Start" button (looks like "play" button), you can see the read-outs for heart rate and blood pressure (labeled "Heart Beat"). It may be helpful to demonstrate how to take the readings on a computer/projector with PASCO DataStudio software.

*N.B. When using these units I found the pressure waveform readouts to cycle between 240 and 0, which are clearly incorrect readings for normal blood pressure. Since some of the functions did not seem properly configured (and no way to calibrate them!), it may be more appropriate to use the "low-tech" approach, which students may use outside of the classroom.*

**[if using the low-tech approach: stopwatch and sphygmamonometer]**

We can measure our heart rate the same way nurses do: press your index and middle finger against your brachial (under your wrist) or carotid artery (on your neck) and count the number of pulses you feel in a 15-second period, then multiply this number by 4 to get your heart beats per minute (BPM). Use the stopwatch for timing purposes if necessary.

To use the sphygmamonometer (blood pressure cuff), wrap it around the arm, just above the elbow and secure it. Position a stethoscope on the inside of the elbow and pump up the pressure in the cuff until you have cut off circulation to the arm (until you cannot detect a beat). Listen for a pulse on the inside of the elbow as you slowly release the pressure in the cuff. As soon as you can hear a pulse, take note of where the pressure needle is. Keep going until the sound of the pulse goes away.

The point at which you can hear the pulse is called the systolic pressure. The point at which the sound goes away is called the diastolic pressure. The numbers are generally reported as "systolic/diastolic", with a relatively healthy BP being 120/80. ([WikiAnswers](#))

**[data collection]**

Use scratch paper to record your heart rate and blood pressure data every 5 minutes. After 30 minutes, graph "heart rate vs. time" and "blood pressure vs. time." *If 30 mins is not enough time to track changes, keep taking data and wrap-up with class discussion of their results for different stimuli.*

**Vocabulary / Definitions**

Word	Definition
Blood pressure	The amount of pressure necessary to close a blood vessel (usually the brachial artery), measured by a <i>sphygmamonometer</i> .
Heart Rate	The number of times your heart beats per minute (beats per minute → BPM). Normal BPM is 60. Measure BPM by counting number of pulse beats over a time period and scale to 60 sec.
Sugar	Sweet, crystalline substance to which humans ascribe a sweet taste and digest as a simple carbohydrate. Excessive consumption of sugar has been related to increased occurrence of Type II diabetes and obesity.
Caffeine	A psychoactive stimulant that is contained in coffee, tea, and energy drinks. <i>Caffeine</i> is recognized by the FDA as a safe substance.
Systole	The high limit (peak) of a blood pressure waveform. Normal systolic pressure is 120 mmHg.
Diastole	The pressure value at the trough of the pressure waveform. Normal diastolic pressure is 80 mmHg.
Sphygmamonometer	The inflatable cuff attached to a pressure gauge used to measure blood pressure occurring at <i>systole</i> and <i>diastole</i> .
Stethoscope	Device that amplifies acoustics (also pressure waves) in a concentrated area. When used with a <i>sphygmamonometer</i> , can detect sound of blood flow and beat when put on the inner angle of elbow (over bicep muscle).

**Procedure**

**Background**

Show demonstration about taking heart rate and blood pressure (**Introduction/Motivation**), write steps on board.

**Before the Activity**

- Distribute scratch paper and graph paper.
- Pre-measure serving sizes of candy, soft drinks
- Set up PASCO Explorer GLX units to display “Heart Rate” and “Heart Beat” (optional)

**With the Students**

1. Offer tips and instructions to groups having trouble taking data.
2. Encourage students to keep close track of their results.
3. Take outside for a walk around the block if class becomes too rowdy.

**Safety Issues**

- Peanut allergies

**Investigating Questions**

How do substances (sugar, caffeine) in candy and soft drinks affect our heart rate and blood pressure?

How does exercise affect our heart rate and blood pressure?

**Assessment**

Wrap-up with class discussion about the effect of each candy and soft drink group.

**Owner**

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