CARDIAC HILL

Challenge

Using your pulse rate as a guide, find the maximum steepness for a trail along which hikers can walk comfortably.

Background

Your muscles require more blood circulating through them when they are working than when they are resting. The harder your muscles work, the faster your heart pumps to provide the required blood. This increased heart rate is reflected in a faster pulse rate in your arteries. You can quickly test this effect of exercise on yourself. Count the number of pulses per minute in your wrist while you are inactive. Then run in place for one minute and count your pulse again. Run in place again, twice as fast, and count your pulse a third time. The harder you work, the faster your pulse.

In *Cardiac Hill* the youngsters use pulse rate as a measure of the effort expended walking on different slopes. Slope is an important factor to consider when designing a trail on a hillside. A very steep slope can pose difficulties for those traveling along it. A too-gradual slope may make a trail too long. By checking the participants' pulse rates for various slopes, your group can determine an appropriate slope for a trail over a hillside.

Materials

For the group:

1 watch with second hand
1 slope measuring device (see Tool Box 1) *
1 data board with three sheets of paper
1 marking pen
1 5- or 10-meter length of cord or twine (to measure distance)
6 to 8 flags (bright yarn or ribbon on small sticks)

Preparation

You will need a hillside, preferably one with a variety of slopes. Also you will need at least one slope-measuring rig. (See equipment card.)

Select three or four slopes for investigation BEFORE meeting with the students: one very steep, one gentle, and one or two in between. Mark these experimental slopes with start and finish flags about 25 to 35 meters apart. (The distance is not critical, but MUST be the same for all the slopes.) A pre-measured rope makes measuring easier. Prepare a graph on one sheet of your data board and leave a little room on the page to record some data.

ACTION

1. The Trail Commission. Meet at your hillside and introduce the activity with a story. Tell the students that the County Trail Commission has invited them to set a standard for the maximum steepness of a trail along which families can comfortably hike. The participants should base their decision on how the various slopes affect their pulse rates.
2. Introduce **pulse rate** as a measure of effort. Have each youngster find the pulse in his or her wrist. This activity hinges on the children's ability to count their own pulse rates. Show those having trouble how to use one, two, or three fingers (no thumbs!) to feel for the pulse without pressing too hard and shutting off the blood flow. When all the youngsters are calm, cool, and collected, take out a watch and have everyone count his or her pulse for thirty seconds (silently, please!). Have each child report his or her rate in **pulses per minute** (ppm). (Remember to multiply thirty-second counts by two.) Record the rates on a blank sheet of the data board. Average the rates to find the **resting pulse rate** for your group. Record the group's resting pulse rate at the top of the graph page. Draw a horizontal line across the graph at that resting-pulse value.
3. Next determine the pulse rate resulting from extreme exertion. Take y our group out for a fun (long and fast). When everyone is puffing, stop and *immediately* take a pulse reading. Again average the pulse readings. This group average will be the **excessive-exertion pulse rate**: too much work for walking over a trail. Record this as you did the resting-pulse rate. Now you have recorded two values, which represent two extremes of physical exertion: no exertion (resting) and excessive exertion (running).
4. Turn your attention to the experimental slopes. Explain that a test hike will be conduced as follows: the group will move to the upper end of an experimental slope and rest long enough to allow pulses to return to resting rate. Then the group walks at trail-hiking pace to the end of the experimental section and back to the starting point (round trip) and immediately takes pulse reading. Have two youngsters measure the slope of the trail section with the slope apparatus while you average the pulse rates. Graph this data. (See Step 5.) Repeat this procedure for the other experimental slopes to find the relationship between steepness of slope and physical exertion.
5. Graphing your data. Here is an example of data from one group of youngsters:

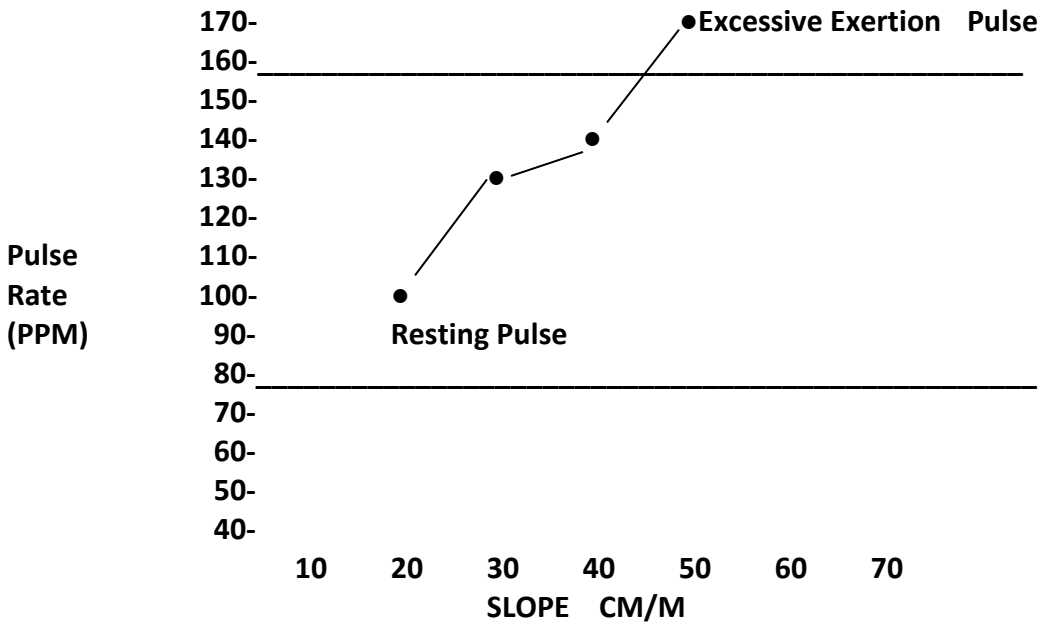
THEIR PRELIMINARY DATA:

Resting Pulse Rate: 82 PPM
Exertion Pulse RATE: 154 PPM

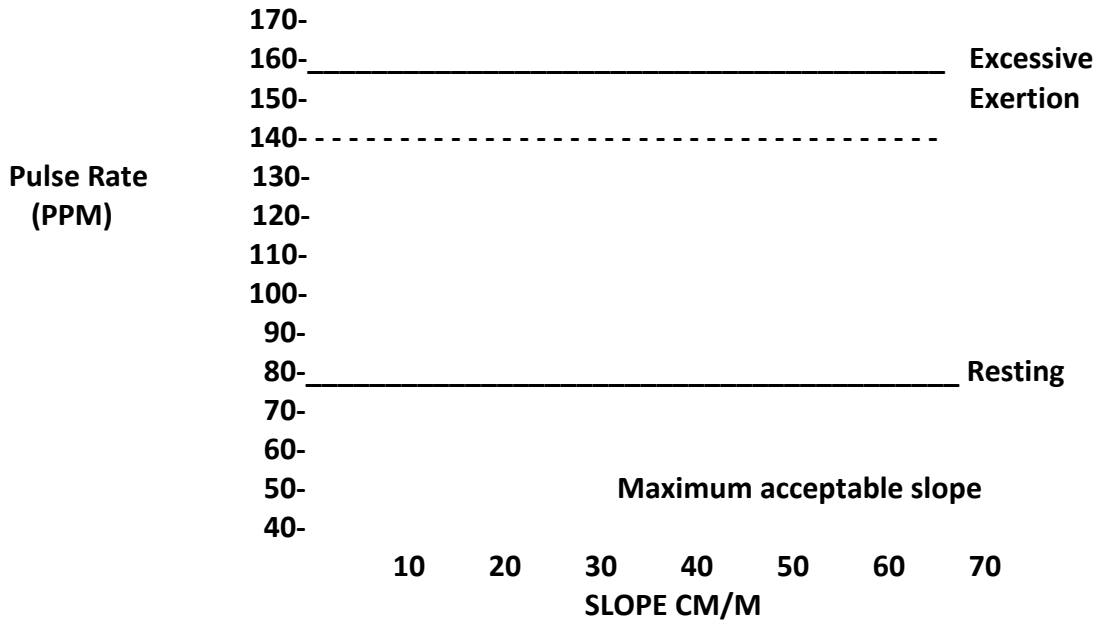
THEIR SLOPE DATA:

Slope (CM/M)	Pulse Rate
16	101
35	138
60	165
26	130

PLOTTING THEIR DATA:



6. Making a judgment. Review the pulse rates associated with the various slopes and have the students decide on the maximum acceptable pulse rate for trail hikers. The value should fall between the resting and the excessive-exertion pulse rate. Once a pulse rate is chosen, you can use your graph to discover the slope most closely representing that pulse rate. Youngsters who prepared this graph chose 140 ppm maximum pulse rate and use their graph to determine the slope represented by that exertion.



Maximum Trail Slope was determined to be 35 cm/m.

Follow Through

1. Use pulse rate to evaluate the amount of exertion used to perform other tasks: tree climbing, reclining, playing tag, tug-of-war, swimming, etc. Rank the tasks in order—most exertion to least exertion.
2. Visit some trails and measure maximum, minimum, and average slopes. Do maximum slopes on these trails fall within your acceptable range?

Thinking About Slope & Pulse

- What happens to a person's pulse rate as he or she walks on increasingly steep slopes? Does the pulse rate continue to rise with increase of slope or does it eventually level off?
- What was the range of pulse rates in your group for any one slope (difference between highest and lowest rates)? Who had the highest pulse rate? Lowest pulse rate? Did these people have the highest and lowest pulse rates on all slopes?
- If you were going to build a trail through your activity area, what other factors might affect the decision of the maximum acceptable slope? (Trail surface, plants and animals living in the environment, erosion, length of trail.)

What To Do Next

Hold a Hill
Trail Construction