The River of Life

Concepts

- Relationship between human body weight and blood volume

Overview

Students will graph human body weight and blood volume data to graphically analyze the relationship between these two factors. They will use this data to estimate concentrations of different blood components: i.e., red blood cells, white blood cells, and platelets in a certain volume of blood.

Materials

- TI-84 plus

Introduction

Blood is a body part that often gets overlooked because it is made, in large part, of liquid. This liquid portion of the blood is called the plasma, while the "solid" portion is made up of the blood cells.

Procedure

Discuss the data in the table below with a partner. What do you observe about the relationship between body weight and blood volume?

Weight in Pounds	Blood Volume in Pints
60	5
84	7
108	9
132	11
156	13
180	15
204	17
228	19
252	21
276	23
300	25

1. Press $\boxed{\text{STAT}}$ $\boxed{\text{ENTER}}$ (or press $\boxed{\text{STAT}}$ $\boxed{1}$).

2. Use the directional arrows ($\boxed{\triangleleft}$$\boxed{\triangleright}$$\boxed{\triangle}$$\boxed{\triangledown}$) on the calculator keypad to move to the very top of L1, making sure that L1 is highlighted.

3. Press $\boxed{\text{CLEAR}}$ $\boxed{\text{ENTER}}$.
    *   L1 should now be cleared of all data.

4. Follow the same procedure to clear L2 of all data.

5. Now move your cursor back to L1 and down to the first list entry position below the list name.

6. In L1, enter the data from the first column "Weight in Pounds" of the table above.
    *   To do this, simply type in the number, and press $\boxed{\text{ENTER}}$ or the down arrow.
    *   Repeat this until you have entered all of the data into L1.

7. Next, move the cursor to L2, and enter the data from the "Blood Volume in Pints" column.
    *   Make sure you have the same number of data entries in L1 as you do in L2.

8. You now need to tell the calculator what type of graph you would like to make by pressing $\boxed{\text{2nd}}$ $\boxed{\text{Y=}}$ (for $\boxed{\text{STAT PLOT}}$).

9. Press $\boxed{\text{ENTER}}$ on 1:Plot1…On, then make your screen look like Figure 1.

10. Next, press $\boxed{\text{2nd}}$ $\boxed{\text{ZOOM}}$ (for $\boxed{\text{FORMAT}}$), and make sure that everything on the left side of the screen is highlighted.
    *   If you need to change one or more of the settings, use the directional arrows to move the cursor to highlight the choices on the left, and press $\boxed{\text{ENTER}}$.

11. Next, press the $\boxed{\text{MODE}}$ key, and make sure all of these are also highlighted on the left only.

12. Press $\boxed{\text{WINDOW}}$, and set an appropriate window for the data you have entered and want to graph.
    *   A suggestion when setting your window is to set your "min" and "max" values for X and Y slightly lower and higher than the lowest and highest values in your data table.

13. Press $\boxed{\text{Y=}}$.
    *   If your calculator has any equations in this screen, erase them by pressing $\boxed{\text{CLEAR}}$ on any line with an equation.
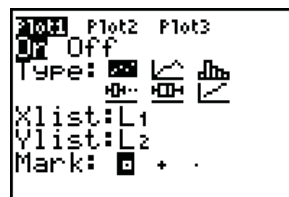
14. Finally, press $\boxed{\text{GRAPH}}$.

Figure 1

Now, you will ask the calculator to build a best-fit (regression) model for the data in your graph. Follow the procedure below.

15. Go to the Home Screen by pressing 2nd MODE (for [QUIT]).

16. Press STAT and move to the CALC menu.
    - You should see a list of regression models from which to choose.

17. Select 4:LinReg(ax+b).
    - You should now be back on the home screen.

18. Type in the following key strokes:
    2nd 1 , 2nd 2 , VARS ▶ ENTER ENTER ENTER.
    - You have instructed the calculator to build a linear regression model based on the data in L1 (weight) and L2 (blood volume), and then write the regression equation into Y1.
    - To check this, press Y=. You should see an equation next to Y1=.

19. Press GRAPH, and you should see your original data points and then see the best-fit line being drawn.

20. Press TRACE and ▲ or ▼.
    - Where do you see the cursor?

21. Press ◀ and ▶, and notice what is displayed at the bottom of the screen. What do these numbers mean?

Questions

1. According to the data table, what is the relationship between body weight and blood volume?

2. What is the change in weight from data point to data point?
   - This is also known as ΔX, or "delta X".
   - Is the ΔX the same between each two consecutive X values?

3. What is the change in blood volume from data point to data point?
   - This is also known as ΔY, or "delta Y".
   - Is the ΔY the same between each two consecutive Y values?

4. What is the significance of your answers to #2 and #3?

5. What is the formula for determining the volume of blood if you know your weight?

6. Using the regression model (best-fit line) you produced, estimate the volume of blood *you* have in *your* body.
   - How did you make your estimation?

7. How much blood would there be in a person who had a mass of 75 kg?
   - Hint: there are about 2.2 pounds in one kilogram.

8. Estimate the weight in pounds of a person who has 11.5 pints of blood in his body.

9. How much blood would a 7-pound newborn baby have?

10. If this weight/blood volume relationship were true for other animals, too, how many gallons of blood would there be in a horse that had a mass of 500 kg?

11. Estimate the weight of a person who has two gallons of blood in his body.

12. If you decided to donate blood at the blood bank, you would donate one pint. Using your own weight, calculate the percentage of your blood you would be donating.

13. If 52% of your blood is water, what is the volume of water circulating in your blood vessels right now?
    - Which of the two main blood components contains the water?

14. Sodium is an abundant ion in the bloodstream. Normally, there are about 2400 milligrams of sodium in one liter of blood.

- If one liter of blood is about the same volume as two pints of blood, approximately how much sodium do you have flowing through your blood vessels right now? Express your answer in both milligrams and grams.

15. One of the most important functions of the blood is to transport oxygen to all of your cells, and the cells that take care of this for you are called erythrocytes, or red blood cells. Red blood cells are by far the most numerous cells in the blood, averaging about 4.5×10^6 (4,500,000!) cells per microliter (1000 microliter = 1 milliliter; 1000 milliliters = 1 liter).

- How many microliters are there in one liter?
- Using this information, calculate the approximate number of erythrocytes you have in your blood vessels right now.

16. Leukocytes, or white blood cells, are another major variety of blood cell in your body. On average, human blood contains about 7.0×10^3 leukocytes per microliter.

- Calculate the approximate number of leukocytes you have in your body right now.

17. White blood cells function mainly in defending you against infections.

- Explain why the number of white blood cells in a person's body may tend to fluctuate a lot more than the number of red blood cells does.