PREPARATORY MATH SKILLS LAB

Lab PMS 18

MATH ACTIVITY

Graphing

MATH SKILLS LAB OBJECTIVES

When you complete this activity, you'll be able to do the following:

1. ***Set up a graph.***
2. ***Plot data from a data table onto a graph.***
3. ***Extract data from a graph.***

MATERIALS

For this activity, you'll need a straightedge and a pencil.

Graphs and tables of data have one thing in common. They are both records of information. A table of data is useful because it shows actual values or sets of values. Sometimes a graph is even more useful because it shows how the values are related to each other. In this activity, you will learn how to draw a graph from a table of values and how to obtain even more information from your graph.

The table in Figure 1 contains two sets (or lists) of data. The first row is a list of motor speeds. A technician adjusted a certain motor for these speeds and measured the torque developed by the motor for each speed, as listed in the second row of the table.

DATA TABLE 1

Motor Speed (rpm)	100	200	300	400	500	600	700	800	900	1000
Torque (lb·ft)	10	20	30	40	50	60	70	80	90	100

Fig. 1 Table of torques developed at various motor speeds.

Notice that for each measurement of motor speed, there is a corresponding measurement of torque. This allows us to present the data in the form of a graph—a picture that will show the relationship between motor speed and torque.

To do this, we start by drawing a graph axis for each set of measurements. We have two sets of measurements, so draw two axes—at 90-degree angles to each other (see Figure 2). Each axis should include a scale (like a number line) that represents the range of values to be plotted. As shown in Figure 2, we have drawn the horizontal axis for torque, and marked the scale along it for values from 0 to 100 lb·ft. Similarly, the vertical axis for motor speed is scaled from 0 to 1000 rpm.

Notice that each axis in Figure 2 is labeled with the name of the measurement and the units of the measurement. It is very important to always remember to do this.

If you draw your axes on "quadrille" graph paper, then you can use the lines to help you locate points on the graph. Figure 3 shows how your graph might look if you have paper with these lines (we've shown them as dotted lines). Notice that the scale of values for each axis matches up with the lines. Thus, the first vertical line matches the unit of "10 lb·ft." If you had any torque measurements of 10 lb·ft, they would be plotted along this vertical line. Similarly, the horizontal lines match the motor speed values: 100 rpm, 200 rpm, and so on.

Let's say you want to plot a point on the graph that represents a torque of 10 lb·ft and a motor speed of 100 rpm. First locate the vertical line that corresponds to 10 lb·ft. Figure 4 shows this vertical line. Similarly, locate the horizontal line that corresponds to 100 rpm, as shown. The location on the graph where these two lines cross is where you'll draw a point (or a cross, an "X", etc.) to indicate the point for a torque of 10 lb·ft and a motor speed of 100 rpm. If you do this for all the values in Data Table 1, you should get a graph like that shown in Figure 5a.

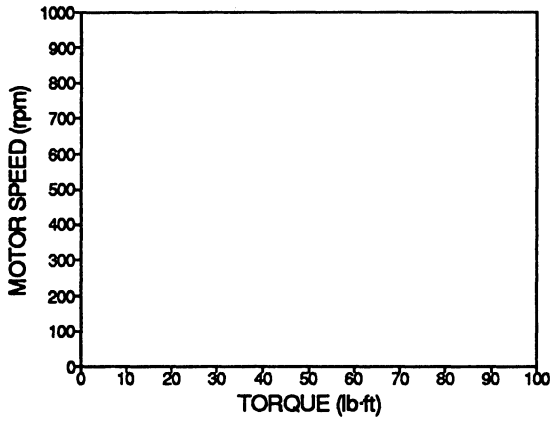


Fig. 2 Axes for plotting data in Data Table 1.

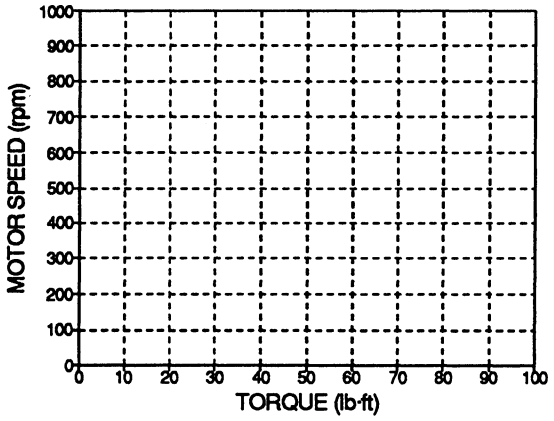


Fig. 3 Graph axes with grid.

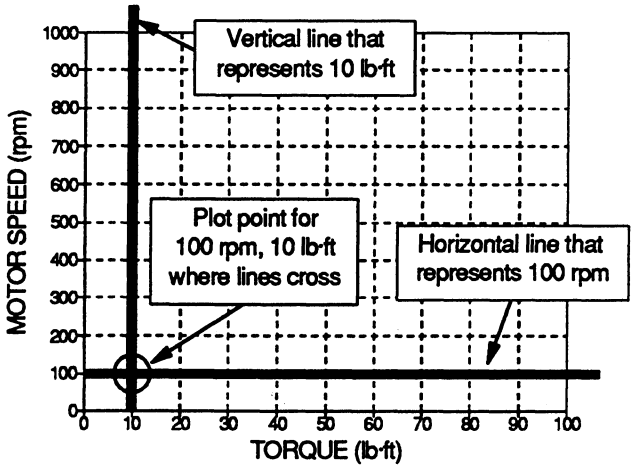
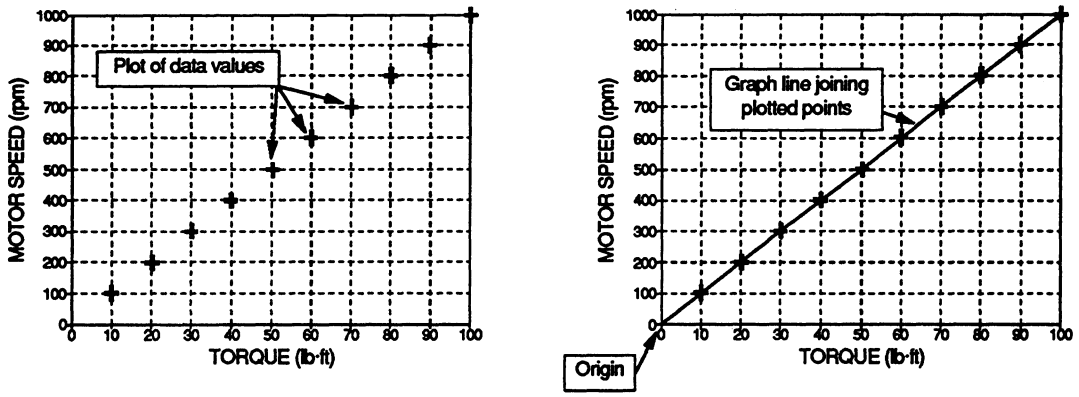


Fig. 4 Using axes to locate values.



a. A plot of the values

b. A line that fits the data

Fig. 5 Plotting the values and showing the line that represents the data.

In Figure 5b, we've connected the data points with a straight line. Notice also that we've extended the line down to the "origin" of the graph. The origin is the intersection of the Torque axis and the Motor Speed axis.

Now, let's see how well you understand the process of setting up and drawing a graph. On your own paper, draw a graph for each of the following data tables.

DATA TABLE 2

Distance traveled (miles)	100	200	300	400	500
Fuel used (gallons)	20	40	60	80	100

DATA TABLE 3

Distance traveled (miles)	5	10	15	20	25
Elapsed time (minutes)	6	12	18	24	30

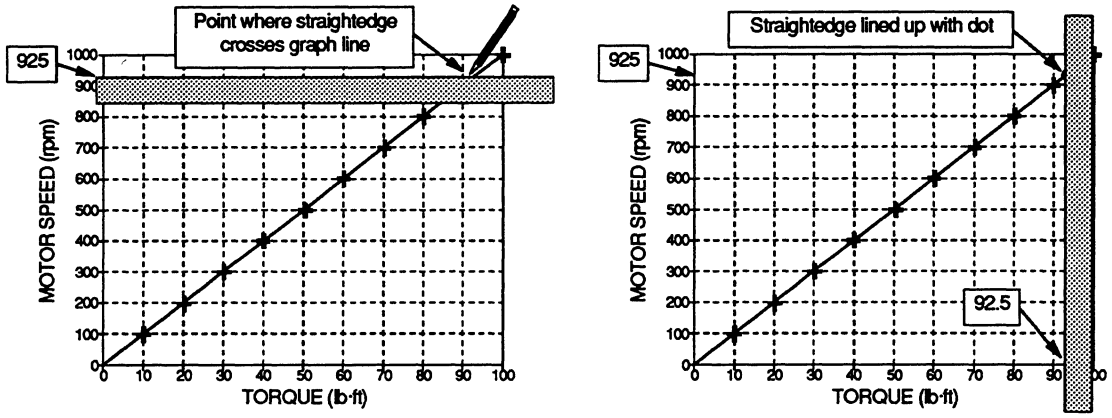
DATA TABLE 4

Force (newtons)	50	100	150	200	250
Distance moved (centimeters)	25	50	75	100	125

Graphs have an important advantage over data tables. Graphs usually contain more information than data tables. The data in Data Table 1 gave us information about the torque developed by an electric motor at various speeds. But what do you do if you need to know the torque developed by the motor at a speed that isn't listed in the table? You might try to find the torque by doing a lot of mathematical calculations. Or you could use the graph of the data, like you saw in Figure 5b.

Using a graph to find a value not in the table is usually easier than doing the calculations. Here's how it's done. Let's say you need to know how much torque is developed when the motor is running at 925 rpm. First, find the point on the Motor Speed axis that represents 925 rpm. (See Figure 6a.) Place a straightedge on this point and align the straightedge parallel with the Torque axis—the horizontal axis. Place a dot at the point where the straightedge crosses *the graphed line.*

Keep the straightedge on this dot, but turn the straightedge so it's parallel with the Torque axis—the vertical axis. (See Figure 6b.) The point where the straightedge crosses the Torque axis represents the torque value when the motor speed is 925 rpm. For this example, the torque value is 92.5 lb·ft. With this graph, you can find the torque developed by the motor at any speed. You can also find the motor's speed that corresponds to any torque value.



a. Finding the motor speed of 925 rpm

b. Finding the corresponding torque

Fig. 6 Reading a value from the graph that's not in the table.

The graph in Figure 7 shows the speed and volume output of a water pump. Use the graph to help you answer the following questions. Some of the answers will be approximate values.

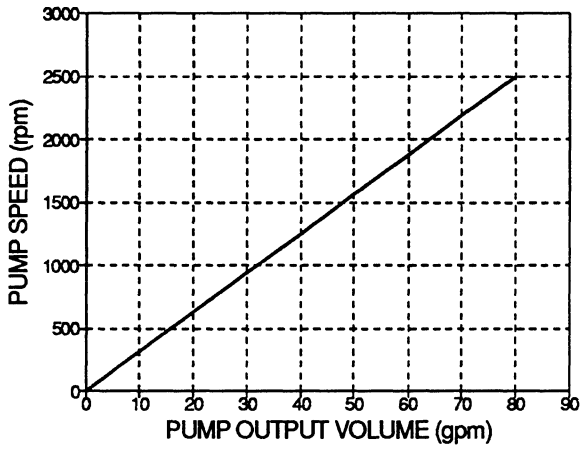


Fig. 7 Graph of water pump output versus pump speed.

1. What's the pump's output volume (in gallons per minute) when the speed of the pump is 1500 rpm?
2. What's the pump's output volume when its speed is 750 rpm?
3. What's the pump's output volume (approximately) at 850 rpm?
4. If the pump's output volume is 10 gpm, what is the speed of the pump (in rpm)?
5. What's the speed of the pump (in rpm) when its output volume is 50 gpm?
6. What's the speed of the pump (in rpm) when its output volume is 65 gpm?