

# PREPARATORY MATH SKILLS LAB

Lab **PM** 1  
**S**

## MATH ACTIVITY

### *Learning How to Draw and Measure to Scale*

## MATH SKILLS LAB OBJECTIVES

*When you complete this activity, you should be able to do the following:*

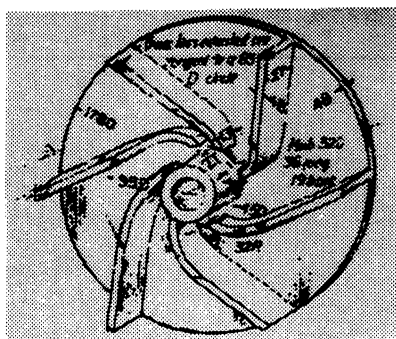
- 1. Draw a line to scale. This means, for example, that given a scale factor such as "1 inch = 5 pounds," you should be able to draw a line of correct length to represent 15 pounds, 50 pounds, 150 pounds, and so on.*
- 2. Interpret a line drawn to scale. This means, for example, that given a scale factor such as "one centimeter = 10 newtons," you should be able to measure the length of a given line drawn to that scale and convert the length of the line to the correct force in newtons.*

## MATERIALS

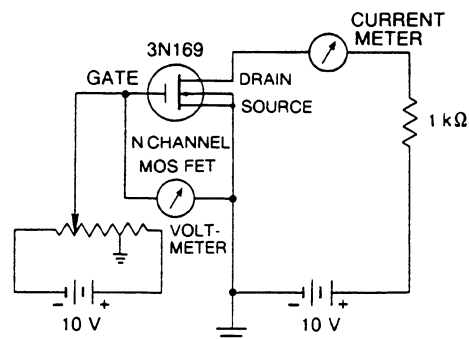
For this activity, you'll need paper and a sharp pencil, and a dual-scale ruler with both SI and English scales.

Technicians need to know how to read diagrams and graphs. Diagrams are similar to road maps. They show how the parts of a system are connected.

Technicians working with mechanical systems use a diagram called a "blueprint." A blueprint is a type of picture that shows how the pieces of a device or structure (building) fit together. For electrical and fluid systems, technicians use a diagram called a "**schematic**." A schematic is also a type of picture that shows how the parts of a device or system are connected. (See Figure 1.)



a. Blueprint



b. Schematic

**Fig. 1** Types of diagrams.

Graphs are another type of picture used by technicians. A graph shows you how one quantity, such as wire resistance, is related to another quantity, such as wire length.

Like a road map, diagrams and graphs are usually "drawn to scale." That means the size of the diagram or graph is smaller, or larger, than the real object it represents. A highway map is "scaled" very small. You can hold a map showing the interstate highways connecting Kansas City to Wichita in your hands. The "scale" on the map can be used to calculate the number of miles there are between those distant cities. (See Figure 2.)

Plastic model cars, airplanes and ships are made "to scale." Although the model is smaller than the real thing, each part of the model has been reduced in size by the same amount. For example, if a model of a Corvette is made to  $\frac{1}{10}$  scale, the tires, doors, fenders, engine, windshield wipers and all other parts of the model are  $\frac{1}{10}$  the size of the actual parts.

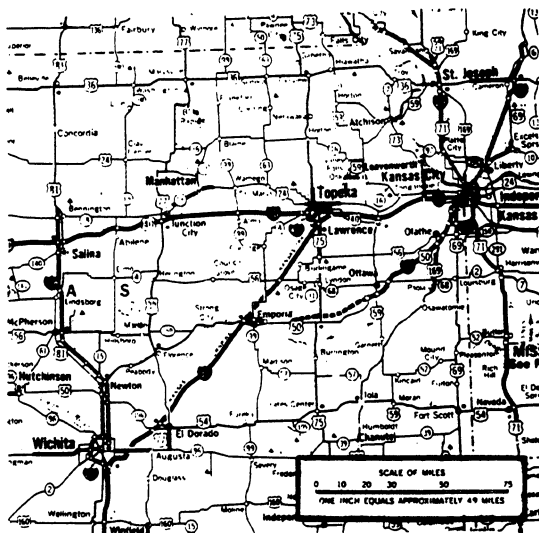


Fig. 2 Road map with scale.

Working with diagrams and graphs that are drawn to a given scale is a common part of many technical jobs. This Math Skills Lab will show you how a scale can be used to represent units such as pounds, grams, kilograms, feet and meters. A **scale** establishes a **ratio of length units** to the **units of another quantity**. Figure 3 shows a scale in which a length unit of one centimeter represents (equals) 10 lb of weight. That means each centimeter of length represents 10 lb. Therefore, a length of 2 cm represents (equals) 20 lb, 3 cm equals 30 lb, 4 cm = 40 lb, and so on.

SCALE:

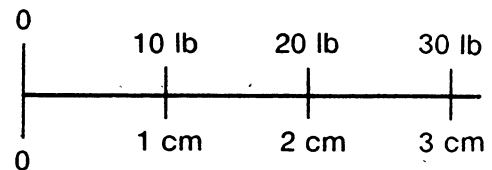


Fig. 3 Scale.

Figure 4 shows a scale in which a length unit of one centimeter represents (equals) 25 miles. Therefore, 2 cm = 50 miles, 3 cm = 75 miles, and so on.

You can examine the process of using a scale ratio to calculate the length of a straight line that represents the magnitude of another unit by working through Examples A and B.

SCALE:

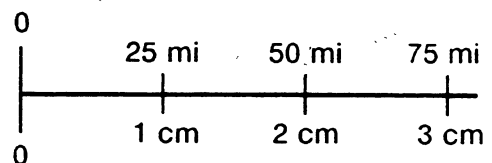


Fig. 4 Scale.

#### Example A: Using Scales to Convert Measurements

Given: Scale: 1 cm = 1 kg.

Find: The length of a line that represents 2.5 kg.

Solution: Multiply the magnitude of the kg unit by the scale ratio.

The scale ratio of 1 cm = 1 kg can be written as  $\frac{1 \text{ cm}}{1 \text{ kg}}$ .

So, 2.5 kg times the scale ratio gives:

$$2.5 \text{ kg} \times \left( \frac{1 \text{ cm}}{1 \text{ kg}} \right) = 2.5 \text{ cm} \quad (\text{Cancel like units.})$$

According to the given scale, a straight line that is 2.5 cm in length represents 2.5 kg.

**Example B: Using Scales to Convert Measurements**

Given: Scale: 1 cm = 20 newtons.

Find: The length of a straight line that represents 56.8 N.

Solution: Multiply the magnitude of the newton unit by the scale ratio.

The scale ratio of 1 cm = 20 N can be written as  $\frac{1 \text{ cm}}{20 \text{ N}}$ .

So, 56.8 N times the scale ratio gives:

$$56.8 \text{ N} \times \left( \frac{1 \text{ cm}}{20 \text{ N}} \right) = 2.84 \text{ cm} \quad (\text{Cancel like units.})$$

According to the given scale, a straight line that is 2.84 cm in length represents 56.8 newtons.

Example C shows you the process for using the scale ratio to calculate the magnitude of a unit that's represented by a known line length.

**Example C: Using Scales to Convert Measurements**

Given: Scale: 1 inch = 50 lb.

Find: The amount of weight represented by a line length of 3.25 inches.

Solution: Multiply the line length by the appropriate scale ratio:

The scale ratio of 1 in = 50 lb can be written as  $\frac{1 \text{ in.}}{50 \text{ lb}}$ .

The scale ratio can also be inverted and written as  $\frac{50 \text{ lb}}{1 \text{ in.}}$ .

So, 3.25 in. times the inverted ratio gives:

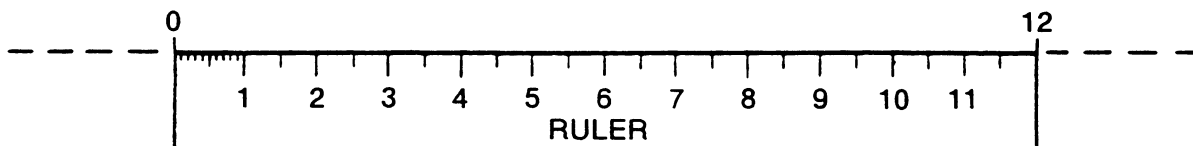
$$3.25 \text{ in.} \times \left( \frac{50 \text{ lb}}{1 \text{ in.}} \right) = 162.5 \text{ lb} \quad (\text{Cancel like units.})$$

According to the given scale, 1 inch = 50 lb, a line 3.25 inches long represents a weight of 162.5 lb.

**PRACTICE EXERCISES**

1.
  - a. On a separate piece of paper, make a scale drawing of 20 grams, using a scale of 1 in. = 4 gm.
  - b. Make a scale drawing of 5.3 kilograms, using a scale of 1 cm = 2 kg.
  - c. Make a scale drawing of 4000 pounds, using a scale of 1 in. = 500 lb.
  - d. Make a scale drawing of 4000 pounds, using a scale of 1 cm = 500 lb.

**Note:** Because of reduction of copy size that occurs during the printing of these materials, the scale of the drawings may not be the same as their original size. To ensure that your measurements result in the correct answer, we've provided a ruler that should be used as the measuring standard.



**HOW TO USE THIS RULER:** Place the edge of a sheet of paper along the ruler above. On your paper make a tiny mark corresponding to each of the ruler marks above. Label your marks just like those above. When you need to measure the lines in the exercises that follow, use *your* copy of the ruler.

2. Given the scale drawings that follow, measure the line length with your copy of the unit ruler and then calculate the magnitude represented by that length.

- a. Scale: 1 unit = 30 lb



Line length represents \_\_\_\_ lb.

- b. Scale: 1 unit = 10 kg



Line length represents \_\_\_\_ kg.

- c. Scale: 1 unit = 200 newtons



Line length represents \_\_\_\_ newtons.

- d. Scale: 1 unit = 2 miles



Line length represents \_\_\_\_ miles.