

Skill Drill 4

This drill emphasizes working with direct proportion, including finding proportionality constants and slopes of lines, and using ratios. Except for the first exercise these questions also provide more practice in handling units and doing word problems. As before, frequently check your answers.

1. This exercise is to remind you of the key points in Review 4.

(a) Express the proportionality $v \propto w$ as an equation in terms of a proportionality constant C . Let v be the dependent variable.

(b) Referring to part (a), if $w = 2$ inches when $v = 4$ pounds, what is the proportionality constant C ? (Include units.)

(c) Refer to the graph in the first example in the Review: For a "rise" of 5.0 lb, what is the corresponding run?

(d) Consider two equal ratios $x:3 = 3:5$. Determine x .

2. Express each of the following statements as an equation which includes the given constant of proportionality. Make sure units are consistent:

(a) The rate of heat transferred W (in Watts) across a section of window pane is directly proportional to the temperature difference ΔT across the glass (in degrees Celsius). The proportionality constant (κA) has units of Watts/ $^{\circ}\text{C}$.

(b) The pressure p at the bottom of a lake and the depth of the lake d are related as a direct proportion. The proportionality constant is the weight of water per unit volume (usually written ρg). (NOTE: pressure units are always force units divided by area units, such as pounds/ inch^2 .)

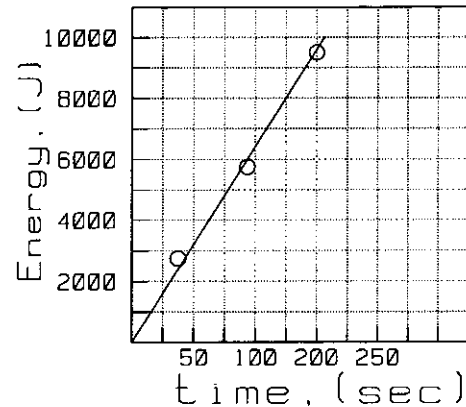
3. A conversion factor C is a type of proportionality constant relating different units which are directly proportional to one another. Find the conversion factor which relates each of the following pairs of units, using the given information.

(a) Feet – centimeters: a 3.00 ft yardstick measures 91.4 cm.

(b) Barrels – gallons: a 1500 gal tank truck holds 47.6 bbl.

(c) Pressure (in pascals, Pa) – pressure (in pounds per square inch, psi): atmospheric pressure is 1.013×10^5 Pa and is also 14.7 psi.

4. The graph at the right plots the energy J (in Joules) used by a light bulb versus the length of time t (in seconds) it is in use. Express the direct proportionality between J and t as an equation in terms of a proportionality constant W (in Joules/second, also called Watts). From the slope of the straight line in the graph determine W .



5. It takes more force F to push a heavy box along the floor than to push a light one. In fact, the force required is directly proportional to the weight of the box W . In other words $F = \mu W$; the proportionality constant μ is called the "coefficient of friction."

(a) Suppose you have to push with a force of 60 pounds to slide a filled packing crate weighing 300 pounds down the hall. What is the coefficient of friction?

(b) How much force is required to push it back up the hall after 200 pounds of equipment has been removed from the crate?

6. Use ratios to solve the following problems:

(a) A battleship sails 50 miles in the same time it takes a destroyer to sail 75 miles. The two ships set out to cross the Atlantic Ocean. After the destroyer has sailed 2500 mi, how far will the battleship have gone?

(b) On a car trip known from a very accurate map to be 300 miles, your odometer registers 270 miles. For each actual mile travelled how much does the odometer reading change?

(c) It takes 4 measures of ground coffee to make 7 cups of drink. How many measures should be used for 42 cups?

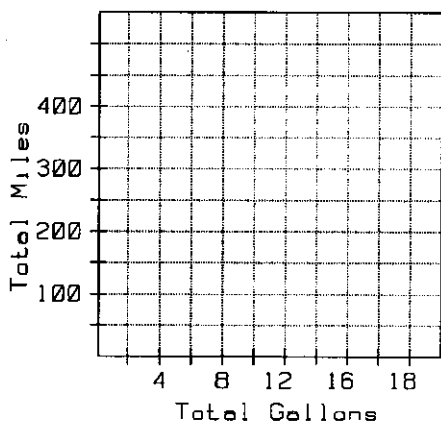
7. When a 200 lb man gets into his car its suspension compresses $1\frac{1}{2}$ inches. When his wife gets in with him the suspension compresses another $\frac{3}{4}$ inch. How much does his wife weigh? Consider the suspension to be a linear spring.

8. The volume of liquid contained in an oil drum is directly proportional to the depth of the liquid. If there are 23 gallons when the depth is 3 feet, how much liquid is left in the drum when the depth is 6 inches?

9. An important law governing the behavior of gases is Charles' Law which can be stated: "If the pressure of a sample of gas is kept constant, its volume is directly proportional to its absolute temperature." (Absolute temperature T is measured in Kelvin degrees, K.) Apply this law to the following problem.

The temperature of a liter of nitrogen gas boiling off the surface of an open container of liquid nitrogen is 77 K. What is the volume of this gas when it warms up to room temperature (300 K)? (As the gas is not confined, its pressure does not change during warming.)

10. George and Mary fill the gas tank in their car before driving home for school vacation. Every once in a while they fill the tank again as follows:



After 110 miles the tank takes 4.3 gallons;
" 250 miles " 4.0 gallons;
" 400 miles " 6.1 gallons.

(a) On the graph on the left plot points representing *total* miles driven vs. *total* gas consumed. (b) Draw a straight line through the data points and find its slope. (c) On the basis of the graph determine the average fuel mileage in mi/gal.

11. The mass m of a body is directly proportional to its weight W (see Essay following this Round). Suppose Mr. Smith's mass is 60 kg. A scale shows his weight to be 589 N. After he takes a strenuous hike the scale shows his weight to be 570 N. Use a ratio to determine the mass of slimmed down Mr. Smith.