

Chapter 1

Solutions to Supplementary Check for Understanding Problems

Scientific Method

1. Do you agree with the following statement: “A scientific law is a mathematical statement of a scientific theory.”? Briefly explain your answer.

Solution

Disagree. Many theories contain mathematical statements that summarize existing observations, however, a scientific law, unlike a theory, is not an explanation of observations so it is not a theory in any form.

2. Suppose you want to test the effectiveness of various materials such as sunscreen lotions, clothing and sunglasses in shielding you from the ultraviolet radiation in sunlight. Describe an experiment you could do to test the effectiveness of these materials. What would serve as your control experiment? Will this be a quantitative or qualitative determination of the effectiveness of the sunscreen materials?

Solution

Sunlight can serve as the source of ultraviolet radiation, however, you need some sort of “sensor” that indicates how much ultraviolet radiation is passing through the various test materials. If you have skin that tans or reddens easily you might use this as your sensor. Otherwise, you might consider using UV-sensitive plastic beads. These beads contain a substance embedded in the plastic that rapidly changes color when exposed to UV radiation. When the beads are removed from sunlight the color quickly fades. The beads are not affected by visible light, such as that emitted from a light bulb, and remain white or pale as long as they are kept away from sunlight.

If you are able to use your skin as the sensor, you might place samples of the various test materials along each arm in a random order by taping them or applying them as lotions to your skin. Then go outside for a time long enough to cause reddening of your skin. When you come inside, remove the samples and assess the degree of reddening at each test sample location relative to that for uncovered skin adjacent to each sample (the control). This sort of result is qualitative since no numerical data are collected. A similar comparison could be done with covered and uncovered UV-sensitive plastic beads.

Pseudoscience

1. Suppose, as a parent of a newborn, you hear from television programs and Internet articles that there is a link between childhood immunizations and type 1 and type 2 diabetes. Meanwhile, your child's pediatrician claims there is no scientific basis for these claims. What would be your response in order to make an informed decision about this matter?

Solution

First, investigate the source of the claims. Many of such Internet articles are found in "peer-reviewed", "open" journals published by Bentham Science Publishers. Bentham charges the author a fee and then makes access to the article free. The quality of the peer-review process at Bentham has been questioned after a completely nonsensical computer science paper was accepted for publication along with the solicitation of peer reviewers for fields outside their area of expertise. A good starting point is to search well established medical resources such as the Centers for Disease Control (CDC), the National Institutes of Health (NIH) or the Mayo Clinic for information.

Representing Quantitative Information

1. For a rectangle of constant area, how would you describe the relationship between the length and width of the rectangle? Explain.

Solution

The area (A) of a rectangle is found by multiplying the length (L) times the width (W); that is, $A = L \times W$. If the area is constant, then one can write:

$$L = \frac{\text{constant}}{W}$$

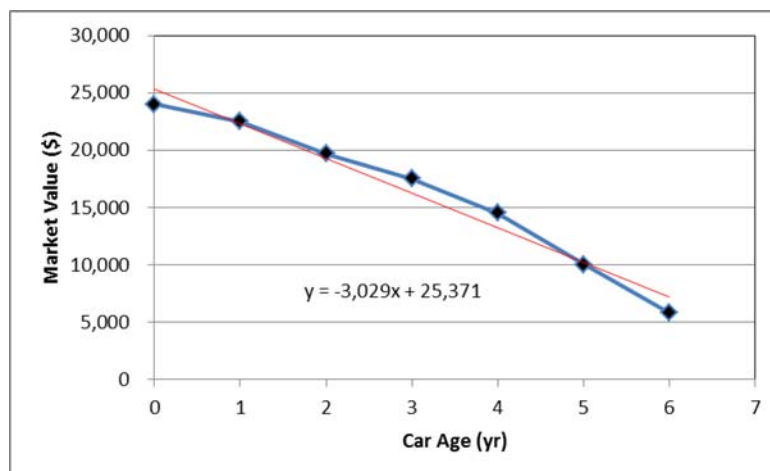
This indicates that L and W are inversely proportional since L will increase as W decreases.

2. A car was purchased in 2001 for \$24,000 and the market value of the car as a function of age (year after purchase) is listed below. Is there a linear relationship between market value and the age of the car? Explain why or why not.

Year	Market value
2001	\$24,000
2002	\$22,500
2003	\$19,700
2004	\$17,500
2005	\$14,500
2006	\$10,000
2007	\$5,800

Solution

No. A plot of market value versus car age is shown below. While there is a general trend toward lower values with increasing age, the straight line fit to the plotted data is not very good. The slope of the straight line (-3029 \$/yr) indicates that there should be an approximately \$3,000 decrease in the market value each year. The data show a yearly decrease that changes quite significantly (from \$1,500 to \$4,500) depending on the year. Also, the equation for the straight line suggests that the market value of the car will be zero after about 8.4 years (solve for x when $y = 0$) which is not very likely. Finally, there is no fundamental reason why there should be a linear relationship between the market value and the age of the car.



- 3.. For each of the following data sets, which quantity should be plotted on the x -axis. Explain.
- a) temperature ($^{\circ}\text{C}$) and density of water
 - b) for several countries, cigarette consumption (per person per year) and deaths from lung cancer (per million persons per year)

Solutions

- (a) Plot temperature on the x -axis. Density depends on the temperature so temperature is the independent variable and is plotted on the x -axis.
- (b) Plot cigarette consumption on the x -axis. The expectation is that smoking leads to cancer so cigarette consumption is the independent variable and is plotted on the x -axis.