36. Driving at 55 mph, it takes approximately 3.5 hours to drive from Long Island to Albany, NY. Is the time the drive takes directly or inversely proportional to the speed? Explain your reasoning and write a formula for the proportion. To get to Albany in 3 hours, how fast would you have to drive?

37. On a map, $1/2$ inch represents 5 miles. Is the map distance between two locations directly or inversely proportional to the actual distance which separates the two locations? Explain your reasoning and write a formula for the proportion. How far apart are two towns if the distance between these two towns on the map is 3.25 inches?

38. A volcano erupts in a powerful explosion. The sound from the explosion is heard in all directions for many hundreds of kilometers. The speed of sound is about 340 meters per second.

  (a) Fill in Table 9.5 showing the distance, d, that the sound of the explosion has traveled at time t. Write a formula for d as a function t.
  (b) How long after the explosion will a person living 200 km away hear the explosion?
  (c) Fill Table 9.5 showing the land area, A, over which the explosion can be heard as a function of time. Write a formula for A as a function of t.
  (d) The average population density around the volcano is 31 people per square kilometer. Write a formula for P as function of t, where P is the number of people who have heard the explosion at time t.
  (e) Graph the function $P = f(t)$. How long will it take until 1 million people have heard the explosion?

Table 9.5

Time, t	5 sec	10 sec	1 min	5 min
Distance, d (km)				
Area, A (km^2)				

39. The thrust, T, delivered by a ship's propeller is proportional[7] to the square of the propeller rotation speed, R, times the fourth power of the propeller diameter, D.

  (a) Write a formula for T in terms of R and D.
  (b) What happens to the thrust if the propeller speed is doubled?
  (c) What happens to the thrust if the propeller diameter is doubled?
  (d) If the propeller diameter is increased by 50%, by how much can the propeller speed be reduced to deliver the same thrust?

40. Two oil tankers crash in the Pacific ocean. The spreading oil slick has a circular shape, and the radius of the circle is increasing at 200 meters per hour.

  (a) Express the radius of the spill, r, as a power function of time, t, in hours since the crash.
  (b) Express the area of the spill, A, as a power function of time, t.
  (c) Clean-up efforts begin 7 hours after the spill. How large an area is covered by oil at that time?

41. When an aircraft flies horizontally, its *stall velocity* (the minimum speed required to keep the aircraft aloft) is directly proportional to the square root of the quotient of its weight by its wing area. If a breakthrough in materials science allowed the construction of an aircraft with the same weight but twice the wing area, would the stall velocity increase or decrease? By what percent?

42. One of Kepler's three laws of planetary motion states that the square of the period, P, of a body orbiting the sun is proportional to the cube of its average distance, d, from the sun. The earth has a period of 365 days and its distance from the sun is approximately $93{,}000{,}000$ miles.

  (a) Find P as a function of d.
  (b) The planet Jupiter has an average distance from the sun of $483{,}000{,}000$ miles. How long in earth days is a Jupiter year?

43. A person's weight, w, on a planet of radius d is given by

$$w = kd^{-2}, \quad k > 0,$$

where the constant k depends on the masses of the person and the planet.

  (a) A man weighs 180 lb on the surface of the earth. How much does he weigh on the surface of a planet whose mass is the same the earth's, but whose radius is three times as large? One-third as large?
  (b) What fraction of the earth's radius must an equally massive planet have if, on this planet, the weight of the man in part (a) is one ton?

44. The following questions involve the behavior of the power function $y = x^{-p}$, for p a positive integer. If a distinction between even and odd values of p is significant, the significance should be indicated.

  (a) What is the domain of $y = x^{-p}$? What is the range?
  (b) What symmetries does the graph of $y = x^{-p}$ have?
  (c) What is the behavior of $y = x^{-p}$ as $x \to 0$?
  (d) What is the behavior of $y = x^{-p}$ for large positive values of x? For large negative values of x?

[7]Gillner, Thomas C., *Modern Ship Design*, (US Naval Institute Press, 1972).