Related Rates

1. Suppose the resistance of a certain resistor varies with temperature according to

$$R = 0.2 + \frac{T^2}{50}$$

where T is in °C and R in Ω. If the temperature is increasing at the constant rate of 0.1 °C/s, how fast is the resistance changing when $T = 100$ °C?

   Answer: 0.4 Ω/s

2. Air is being pumped into a spherical balloon so that its volume increases at a rate of $100\,\text{cm}^3$/s. How fast is the radius of the balloon increasing when the diameter of the balloon is 20 cm?

   Answer: 0.08 cm/s

3. A ladder 5 meters long is leaning against a vertical wall. If the bottom of the ladder is pulled away at the constant rate of 2 m/s, how fast is the top of the ladder moving down the wall when the bottom is 3 meters from the wall?

   Answer: 1.5 m/s

4. A water tank has the shape of an inverted circular cone with a top radius of 2 m and a height of 6 m. If water is being pumped into the tank at a rate of $4\,\text{m}^3$/min, find the rate at which the water level is rising when the water is 4 m deep. *Hint:* $V = \frac{1}{3}\pi r^2 h$.

   Answer: 0.72 m/min

5. A rock is thrown into a small pond and causes a circular ripple. If the radius of the circle is increasing at 1.5 m/s, how fast is the area changing when the diameter is 4 meters?

   Answer: 18.85 m^2/s

6. A person two meters tall approaches a street light that is 5 meters above the ground at the speed of 1.5 m/s. How fast is the end of the person's shadow moving?

   Answer: 2.5 m/s

7. The tuning frequency f of an electronic tuner is inversely proportional to the square root of the capacitance C in the circuit. If $f = 920$ kHz for $C = 3.5$ pF, find how fast f is changing at this frequency if $dC/dt = 0.3$ pF/s.

   Answer: -39.43 kHz/s

8. A child is flying a kite on a windy day. Assume that the kite maintains a constant height of 40 meters above the ground At what rate is the string being let out when 50 meters of string is already out and the horizontal speed of the kite is 2 m/s ?

   Answer: 1.2 m/s

9. Assume that the population of wolves W and bears B in a certain forest satisfy the equation

$$W^2 + B^3 = \text{constant.}$$

At some time, there are 15 bears and 100 wolves in the forest and the bear population is increasing at a rate of 1 bear/year. Determine the rate of change of the wolf population?

   Answer: -3.38 wolves/year.

10. A variable resistor R and a 6 Ω resistor in parallel have a combined resistance R_T given by

$$R_T = \frac{6R}{R+6}.$$

If R is changing at a rate of 0.2 Ω/min when $R = 4.0\,\Omega$, find the rate at which R_T is changing.

   Answer: 0.07 Ω/min