Complete the questions provided. I have included Example 2 from p. 295. Again, I borrowed from an old text, so I apologize for the bad formatting.

Practise

A 1. If $y = x^2 + 4x$ and $\frac{dx}{dt} = 10$, find $\frac{dy}{dt}$ when $x = 5$.

2. Given $V = \frac{4}{3}\pi r^3$, find $\frac{dr}{dt}$

a) if $\frac{dV}{dt} = 5$ when $r = 8$

b) if $\frac{dV}{dt} = -20$ when the diameter is 10

3. Given $V = \pi r^2 h$ and $r = h$, find $\frac{dh}{dt}$ if $\frac{dV}{dt} = -5$ when $r = 2$.

Apply, Solve, Communicate

B 4. How fast is the area of a square increasing when the side is 6 m in length and growing at a rate of 2 m/min?

5. **Inquiry/Problem Solving** In a baseball pitching machine, two rotating wheels with radius 60 cm project the ball toward the batter. For the ball's speed to be 60 km/h, at what rate should the wheels turn, in revolutions per second? (Hint: Review Example 1 on page 292.)

6. A piece of lumber at a construction site is resting against the frame of a house on a cement floor. The lumber is 4 m long. If the bottom of the lumber slides away from the wall at a rate of 0.25 m/s, how fast is the top of the lumber sliding down the wall, when the bottom of the lumber is 2 m from the wall?

7. **Application** Refer to Example 2 on page 295.

a) When will the sun's radius be 10% larger than it is today?

b) At what rate is the volume of the sun increasing when its radius is 1 000 000 km?

c) What is the sun's density today? Density is mass divided by volume, and the sun's mass is about 2×10^{30} kg.

d) At what rate is the density of the sun changing when its radius is 1 000 000 km? Assume that the sun's mass is constant.

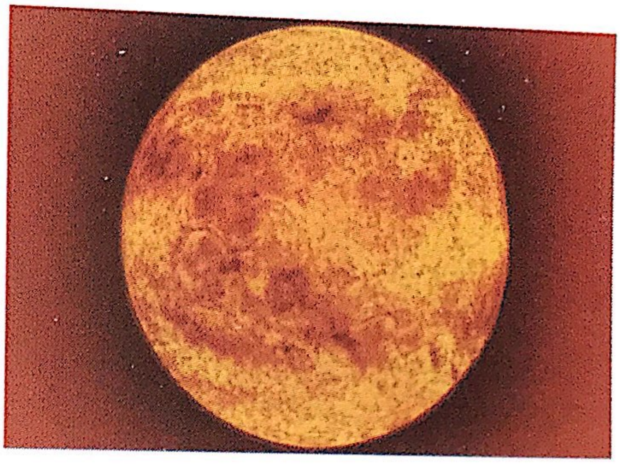
8. **Inquiry/Problem Solving** A water tank has the shape of an inverted circular cone with base radius 3 m and height 10 m.

a) If water is leaking out of the tank at a rate of 1 m^3/min, at what rate is the water level decreasing when the water is 2 m deep?

b) If the empty tank is being filled with water at a rate of 1.5 m^3/min, find the rate at which the water level is rising when the water is 7 m deep.

Example 2 Expansion of the Sun

It is thought that the sun is expanding rapidly enough that, in a few billion years, it will be too hot on Earth for life to exist. Assume that the sun's surface area is increasing at a rate of 5000 km^2/year. Determine the rate of increase of the sun's radius when it reaches a radius of 1 000 000 km. The current radius of the sun is about 700 000 km.



Solution

We start by identifying two things, the given information and the unknown. Given that the rate of increase in surface area of the sun is 5000 km^2/year, we want to determine the rate of increase of the sun's radius when the radius is 1 000 000 km.

Now we identify the variables and relate them in an equation. Let S represent the surface area of the sun, in square kilometres, let r represent its radius, in kilometres, and let t represent time, in years. The quantities S and r are related by the equation $S = 4\pi r^2$.

In this problem, the surface area and the radius are both functions of time, t. The rate of change of the surface area with respect to time is the derivative $\frac{dS}{dt}$, and the rate of change of the radius with respect to time is $\frac{dr}{dt}$.

Using the chain rule to differentiate each side of the equation $S = 4\pi r^2$ with respect to t, we have

$$\frac{dS}{dt} = \frac{dS}{dr}\frac{dr}{dt}$$
$$= \frac{d}{dr}(4\pi r^2)\frac{dr}{dt}$$
$$= 8\pi r\frac{dr}{dt}$$

Substituting the known information, $\frac{dS}{dt} = 5000$ and $r = 1\,000\,000$, into the equation allows us to solve for the unknown:

$$\frac{dS}{dt} = 8\pi r\frac{dr}{dt}$$
$$5000 = 8\pi(1\,000\,000)\frac{dr}{dt}$$
$$\frac{dr}{dt} = \frac{5}{8000\pi}$$
$$\doteq 0.000\,199$$

Web Connection

To learn more about changes in the size of the sun and other aspects of astrophysics, go to **www.mcgrawhill.ca/links/CAF12.**

So, when the radius of the sun is 1 000 000 km, the radius is increasing at a rate of approximately 19.9 cm/year.