Related Rates Extra Practice

Name________________________________

Solve each related rate problem.

1) A hypothetical cube shrinks so that the length of its sides are decreasing at a rate of 4 m/min. At what rate is the volume of the cube changing when the sides are 8 m each?

2) A hypothetical square grows so that the length of its diagonals are increasing at a rate of 5 m/min. How fast is the area of the square increasing when the diagonals are 11 m each?

3) A conical paper cup is 10 cm tall with a radius of 10 cm. The cup is being filled with water so that the water level rises at a rate of 4 cm/sec. At what rate is water being poured into the cup when the water level is 2 cm?

4) A hypothetical cube grows at a rate of 27 m^3/min. How fast are the sides of the cube increasing when the sides are 7 m each?

5) A hypothetical square shrinks at a rate of 9 m^2/min. At what rate are the sides of the square changing when the sides are 12 m each?

6) A conical paper cup is 20 cm tall with a radius of 10 cm. The bottom of the cup is punctured so that the water leaks out at a rate of $\frac{9\pi}{4}$ cm^3/sec. At what rate is the water level changing when the water level is 7 cm?

7) A spherical balloon is deflated at a rate of 36π cm^3/sec. At what rate is the radius of the balloon changing when the radius is 9 cm?

8) Oil spilling from a ruptured tanker spreads in a circle on the surface of the ocean. The area of the spill increases at a rate of 81π m^2/min. How fast is the radius of the spill increasing when the radius is 15 m?

9) A spherical balloon is deflated at a rate of $\frac{36\pi}{V}$ cm^3/sec, where V is the volume of the balloon. At what rate is the radius of the balloon changing when the radius is 2 cm?

10) A hypothetical square grows at a rate of 8 m^2/min. How fast are the diagonals of the square increasing when the diagonals are 10 m each?

Related Rates Extra Practice

Name_______________________________

Solve each related rate problem.

1) A hypothetical cube shrinks so that the length of its sides are decreasing at a rate of 4 m/min. At what rate is the volume of the cube changing when the sides are 8 m each?

V = volume of cube s = length of sides t = time

Equation: $V = s^3$ Given rate: $\frac{ds}{dt} = -4$ Find: $\left.\frac{dV}{dt}\right|_{s=8}$

$$\left.\frac{dV}{dt}\right|_{s=8} = 3s^2 \cdot \frac{ds}{dt} = -768 \text{ m}^3\text{/min}$$

2) A hypothetical square grows so that the length of its diagonals are increasing at a rate of 5 m/min. How fast is the area of the square increasing when the diagonals are 11 m each?

A = area of square x = length of diagonals t = time

Equation: $A = \frac{x^2}{2}$ Given rate: $\frac{dx}{dt} = 5$ Find: $\left.\frac{dA}{dt}\right|_{x=11}$

$$\left.\frac{dA}{dt}\right|_{x=11} = x \cdot \frac{dx}{dt} = 55 \text{ m}^2\text{/min}$$

3) A conical paper cup is 10 cm tall with a radius of 10 cm. The cup is being filled with water so that the water level rises at a rate of 4 cm/sec. At what rate is water being poured into the cup when the water level is 2 cm?

V = volume of material in cone h = height t = time

Equation: $V = \frac{\pi h^3}{3}$ Given rate: $\frac{dh}{dt} = 4$ Find: $\left.\frac{dV}{dt}\right|_{h=2}$

$$\left.\frac{dV}{dt}\right|_{h=2} = \pi h^2 \cdot \frac{dh}{dt} = 16\pi \text{ cm}^3\text{/sec}$$

4) A hypothetical cube grows at a rate of 27 m^3/min. How fast are the sides of the cube increasing when the sides are 7 m each?

V = volume of cube s = length of sides t = time

Equation: $V = s^3$ Given rate: $\frac{dV}{dt} = 27$ Find: $\left.\frac{ds}{dt}\right|_{s=7}$

$$\left.\frac{ds}{dt}\right|_{s=7} = \frac{1}{3s^2} \cdot \frac{dV}{dt} = \frac{9}{49} \text{ m/min}$$

5) A hypothetical square shrinks at a rate of 9 m^2/min. At what rate are the sides of the square changing when the sides are 12 m each?

A = area of square s = length of sides t = time

Equation: $A = s^2$ Given rate: $\frac{dA}{dt} = -9$ Find: $\left.\frac{ds}{dt}\right|_{s=12}$

$$\left.\frac{ds}{dt}\right|_{s=12} = \frac{1}{2s} \cdot \frac{dA}{dt} = -\frac{3}{8} \text{ m/min}$$

6) A conical paper cup is 20 cm tall with a radius of 10 cm. The bottom of the cup is punctured so that the water leaks out at a rate of $\frac{9\pi}{4}$ cm^3/sec. At what rate is the water level changing when the water level is 7 cm?

V = volume of material in cone h = height t = time

Equation: $V = \frac{\pi h^3}{12}$ Given rate: $\frac{dV}{dt} = -\frac{9\pi}{4}$ Find: $\left.\frac{dh}{dt}\right|_{h=7}$

$$\left.\frac{dh}{dt}\right|_{h=7} = \frac{4}{\pi h^2} \cdot \frac{dV}{dt} = -\frac{9}{49} \text{ cm/sec}$$

7) A spherical balloon is deflated at a rate of 36π cm^3/sec. At what rate is the radius of the balloon changing when the radius is 9 cm?

V = volume of sphere r = radius t = time

Equation: $V = \frac{4}{3}\pi r^3$ Given rate: $\frac{dV}{dt} = -36\pi$ Find: $\left.\frac{dr}{dt}\right|_{r=9}$

$$\left.\frac{dr}{dt}\right|_{r=9} = \frac{1}{4\pi r^2} \cdot \frac{dV}{dt} = -\frac{1}{9} \text{ cm/sec}$$

8) Oil spilling from a ruptured tanker spreads in a circle on the surface of the ocean. The area of the spill increases at a rate of 81π m²/min. How fast is the radius of the spill increasing when the radius is 15 m?

A = area of circle r = radius t = time

Equation: $A = \pi r^2$ Given rate: $\frac{dA}{dt} = 81\pi$ Find: $\left.\frac{dr}{dt}\right|_{r=15}$

$$\left.\frac{dr}{dt}\right|_{r=15} = \frac{1}{2\pi r} \cdot \frac{dA}{dt} = \frac{27}{10} \text{ m/min}$$

9) A spherical balloon is deflated at a rate of $\frac{36\pi}{V}$ cm³/sec, where V is the volume of the balloon. At what rate is the radius of the balloon changing when the radius is 2 cm?

V = volume of sphere r = radius t = time

Equation: $V = \frac{4}{3}\pi r^3$ Given rate: $\frac{dV}{dt} = -\frac{36\pi}{V}$ Find: $\left.\frac{dr}{dt}\right|_{r=2}$

$$\left.\frac{dr}{dt}\right|_{r=2} = \frac{1}{4\pi r^2} \cdot \frac{dV}{dt} = -\frac{27}{128\pi} \text{ cm/sec}$$

10) A hypothetical square grows at a rate of 8 m²/min. How fast are the diagonals of the square increasing when the diagonals are 10 m each?

A = area of square x = length of diagonals t = time

Equation: $A = \frac{x^2}{2}$ Given rate: $\frac{dA}{dt} = 8$ Find: $\left.\frac{dx}{dt}\right|_{x=10}$

$$\left.\frac{dx}{dt}\right|_{x=10} = \frac{1}{x} \cdot \frac{dA}{dt} = \frac{4}{5} \text{ m/min}$$