

A ladder is leaning against a wall. The top of the ladder is sliding down the wall at a rate of 2 ft/sec. How fast is the bottom of the ladder moving when it is 12 feet away from the wall?

**1.5 ft/sec**

How fast is the angle between the ladder & the ground changing at that same instant?

**-.167rad/sec**

A rocket is launched vertically at a rate of 6mi/sec. An observer is located 4mi away from the launching pad (horizontal distance). When the altitude of the rocket is 3 miles, how fast is the distance between the observer and the rocket is changing?

**3.6mi/hr**

At the same instant, how fast is the observer's angle of elevation changing?

**.959 rad/sec**

At that instant, the legs of a right triangle are 15 cm and 20 cm long. The short leg is increasing at a rate of 1.0 cm/sec and the long leg at a rate of 2.0 cm/sec.

At that instant, how fast is the hypotenuse changing?

**-1cm/sec**

How fast is the angle between the long leg and the hypotenuse changing?

**.0799rad/sec**

A plane is flying horizontally at a rate of 550 miles per hour at an elevation of 4 miles above the ground. An observer on the ground is directly below the plane. At the instant the distance between the plane and the observer is 5 miles (diagonal distance), how fast is the angle of elevation changing?

**-88.069rad/hr**

A car is driving away from an intersection at a rate of 40 feet per second. A truck is traveling toward the intersection perpendicular to the car at a rate of 30 feet per second. At the instant the car is 120 feet past the intersection and the truck is 30 feet from the intersection; calculate the rate of change of the angle between the path of the car and the hypotenuse.

**-.314rad/sec**

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Lesson Problems

Name \_\_\_\_\_

Sheet - Related Rates with Area and Volume

Date \_\_\_\_\_

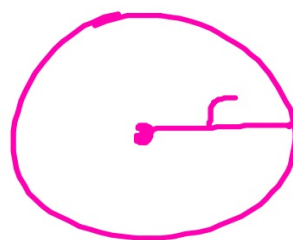
A tanker strikes an iceberg and has a hole ripped open on its side. Oil is leaking out and is forming a near circular shape. The radius of the oil spill is changing at a rate of 1.5 miles per hour. How fast is the area of the oil spill changing when the radius is 0.6 mile?

$$A = \pi r^2$$

$$\frac{dA}{dt} = 2\pi r \frac{dr}{dt}$$

$$= 2 \cdot \pi \cdot (.6) \cdot 1.5$$

$$\frac{dA}{dt} = 56.549 \text{ mi}^2/\text{hr.}$$



A spherical balloon is being inflated at a rate of 10 cubic centimeters per second. How fast is the radius of a spherical balloon changing at the instant the radius is 5 centimeters?

$$V = \frac{4}{3} \pi r^3$$

$$\frac{dV}{dt} = 4 \pi r^2 \frac{dr}{dt}$$

$$10 = 4 \cdot \pi \cdot 5^2 \frac{dr}{dt}$$

$$\frac{dr}{dt} = .032 \text{ cm/sec}$$

stone is being dumped from a conveyor belt and is forming a conical pile at a rate of 8.7 ft<sup>3</sup> per minute. The height of the pile is always  $\frac{3}{8}$  of the base radius. How fast is the pile changing when the pile is four feet high?

$$h = \frac{3}{8} \cdot r$$

$$\frac{8}{3} h = r$$

$$V = \frac{\pi}{3} r^2 h$$

$$V = \frac{\pi}{3} \left( \frac{8}{3} h \right)^2 \cdot h$$

$$V = \frac{64\pi}{27} h^3$$

$$\frac{64\pi \cdot 3}{27} h^2$$

$$\frac{dV}{dt} = \frac{64\pi}{9} h^2 \frac{dh}{dt}$$

$$8.7 = \frac{64\pi}{9} \cdot 4^2 \cdot \frac{dh}{dt}$$

$$\frac{dh}{dt} = .024 \text{ ft/min}$$

Company is filling an inverted conical water storage tank at a rate of 9 ft<sup>3</sup>/min. The height of the tank is 80 feet and the radius at the top is 40 feet. How fast is the water level inside the tank changing when the water level is 60 feet deep?

$$V = \frac{\pi}{3} r^2 h$$

$$V = \frac{\pi}{3} \left( \frac{h}{2} \right)^2 \cdot h$$

$$V = \frac{\pi}{12} h^3$$

$$\frac{dV}{dt} = \frac{\pi}{4} h^2 \frac{dh}{dt}$$

$$9 = \frac{\pi}{4} \cdot 60^2 \cdot \frac{dh}{dt} \longrightarrow \frac{dh}{dt} = .003 \text{ ft/min}$$

$$\frac{dh}{dt} = ? \text{ when } h = 60$$

$$\frac{dV}{dt} = 9 \text{ ft}^3/\text{min}$$

$$\frac{40}{r} = \frac{80}{h}$$

$$80r = 40h$$

$$r = \frac{1}{2}h$$