Problems 1 to 10. State an equation that expresses the rate of change described for each problem below.

1. The radius of a circle is increasing at a rate of 5 feet per second.

2. The height of a triangle is decreasing at a rate of 7 cm. per second.

3. The circumference of a circle is decreasing at a rate of $2\pi$ cm. per minute.

4. The water is draining from a pool at a rate of 3 cubic meters per hour.

5. The diameter of a circle is increasing at a rate of 9 meters per hour.

6. The measure of an angle is increasing at a rate of 4 radians per second.

7. The height of a cone is decreasing at a rate of 4 feet per minute.

8. The distance between a man and a pole is increasing at a rate of 1 meter per second.

9. The angle of elevation is decreasing at a rate of 2 radians per second.

10. The surface area of a sphere is decreasing at a rate of 5 sq. cm. per second.
11. Find an expression for the rate of change in the area of a square $\frac{dA}{dt}$
   if $A = S^2$

12. Find an expression for the rate of change in the diagonal of a square $\frac{dD}{dt}$
   if $D = \sqrt{2}S$

13. Find an expression for the rate of change in the volume of a cube $\frac{dV}{dt}$
   if $V = S^3$

14. Find an expression for the rate of change in the surface area of a cube $\frac{dSA}{dt}$
   if $SA = 6S^2$

15. Find an expression for the rate of change in the volume of a sphere
   if $V = \frac{4}{3}\pi R^3$

16. Find an expression for the rate of change in the surface area of a sphere
   if $SA = 4\pi r^2$

17. Find an expression for the rate of change in the volume of a cylinder
   if $V = \pi R^2 H$

18. Find an expression for the rate of change in the volume of a cone
   if $V = \frac{1}{3}\pi R^2 H$
19. Find an expression for the rate of change in the surface area of a cylinder if \( SA = 2\pi r^2 + 2\pi R^2 H \).

20. Find an expression for the rate of change in the surface area of a cone if \( SA = \pi R^2 + \pi RL \).

21. Find \( \frac{dV}{dt} \) if \( \frac{dV}{dt} = 4\pi R^2 \frac{dR}{dt} \), and \( R = 3 \text{ cm. and } \frac{dR}{dt} = 2 \text{ cm./sec.} \).

22. Find \( \frac{dSA}{dt} \) if \( \frac{dSA}{dt} = 16S \frac{dS}{dt} \), and \( S = 2 \text{ in. and } \frac{dS}{dt} = -3 \text{ in./sec.} \).
Find \( \frac{dSA}{dt} \) if

\[
\frac{dSA}{dt} = 4\pi R \frac{dR}{dt} + 2\pi R \frac{dH}{dt} + 2\pi H \frac{dR}{dt}
\]

and

\[
R = 3 \text{ in.}, \quad H = 4 \text{ in.}, \quad \frac{dR}{dt} = 3 \text{ in/sec.}, \quad \frac{dH}{dt} = -5 \text{ in/sec.}
\]

Find \( \frac{dR}{dt} \) if

\[
\frac{dSA}{dt} = 4\pi R \frac{dR}{dt} + 2\pi R \frac{dH}{dt} + 2\pi H \frac{dR}{dt}
\]

and

\[
R = 4 \text{ in.}, \quad H = 1 \text{ in.}, \quad \frac{dSA}{dt} = 2\pi \text{ sq.in. / sec.}, \quad \frac{dH}{dt} = -3 \text{ in. / sec.}
\]
Find \( \frac{dH}{dt} \) if \( \frac{dV}{dt} = \pi R^2 \frac{dH}{dt} + 2\pi H \cdot R \cdot \frac{dR}{dt} \)

25. and

\[ R = 2 \text{ in.}, \ H = 5 \text{ in.}, \ \frac{dR}{dt} = -3 \text{ in./sec.}, \ \frac{dV}{dt} = -6\pi \text{ cubic in./sec.} \]

Find \( \frac{dR}{dt} \) if \( \frac{dV}{dt} = \pi R^2 \cdot \frac{dH}{dt} + 2\pi H \cdot R \cdot \frac{dR}{dt} \)

26. and

\[ R = 3 \text{ in.}, \ H = 4 \text{ in.}, \ \frac{dH}{dt} = -2 \text{ in./sec.}, \ \frac{dV}{dt} = 30\pi \text{ cubic in./sec.} \]
27. A circle has a **radius increasing at the rate of 6 feet per second** when R is 7 feet.

A) Find the rate the **circumference** of the circle is changing when R is 7 feet.
B) Find the rate the **diameter** of the circle is changing when R is 7 feet.
C) Find the rate the **area** of the circle is changing when R is 7 feet.
28. A circle has a radius decreasing at the rate of 4 feet per second when R is 10 feet.

A) Find the rate the circumference of the circle is changing when R is 10 feet.
B) Find the rate the diameter of the circle is changing when R is 10 feet.
C) Find the rate the area of the circle is changing when R is 10 feet.
29. The height of a triangle is increasing at a rate of 3 feet per second and the base is decreasing at a rate of 4 feet per second. Find the rate the area of the triangle is changing when the base is 10 feet and the height is 8 feet.
30. The sides of an equilateral triangle are decreasing at the rate of 2 feet per second when the sides are 6 feet long. Find the rate the area of the triangle is changing when the sides are 6 feet long.

The area of an equilateral triangle is \( A = \frac{\sqrt{3}}{4} \cdot s^2 \)
31. The sides of a square are increasing at the rate of 4 feet per second when the sides are 10 feet long.

\[ V = \frac{4}{3} \pi r^3 \quad \text{SA} = 4\pi r^2 \]

A) Find the rate the area of the square is changing when the sides are 10 feet long.

B) Find the rate the diagonal of the square is changing when the sides are 10 feet long.
32. Air is being pumped into a spherical basketball at the rate of 5 cubic inches per second.

A. Find the rate of change in the radius of the sphere when the radius is 2 inches.

B. Find the rate of change in the surface area of the sphere when the radius is 2 inches.
33. A 15 foot long ladder is leaning against a wall. The top of the ladder is slipping down the wall at a rate of 3 feet per second when the top of the ladder is 12 feet from the ground?

A) Find the rate that the base of the ladder is moving away from the base of the wall when the top of the ladder is 12 feet from the ground

B) Find the rate that the area of the triangle is changing when the top of the ladder is 12 feet from the ground.
34. A 26 foot long ladder is leaning against a wall. The base of the ladder is slipping away from the base of the wall at a rate of 1 feet per second when the base of the ladder is 10 feet from the base of the wall?

A) Find the rate that the top of the ladder is moving down the wall when the base of the ladder is 10 feet from the base of the wall?

B) Find the rate that the area of the triangle is changing when the base of the ladder is 10 feet from the base of the wall.

C) Find the rate that the angle between the ladder and the ground is changing.
35. A missile is fired vertically upwards from a point 5 miles from the control station. The angle of elevation between the station and the missile changes at .2 radians a second for the first part of the flight. Find the velocity of the missile when the angle of elevation as $\frac{\pi}{4}$ radians.

36. A missile is fired vertically upwards from a point 2000 feet from the control station. The velocity of the missile is 200 feet per second when the angle of elevation as $\frac{\pi}{3}$ radians. Find the change in the angle of elevation between the station and the missile.
37. A 5 foot tall boy walks away from a light that is 15 feet off the ground at a rate of 4 feet per second. When he is 12 feet from the base of the light pole

A) How fast is the length of the shadow changing?

B) What is the rate that the tip of the shadow moving away from the pole?
38. A paper cup in the shape of a cone is filled with water. The cone is 8 inches tall and the top of the cup has a 6 inch radius. Water is leaking out the bottom of the cup at a rate of 1 cubic inch per minute. Find the rate of change in the height of the water when the water in the cup is 4 inches high.
39. A metal rod in the shape of a cylinder is being heated. The length of the rod is increasing at a rate of .05 cm per min. and the diameter is increasing at a rate of .002 cm per min. Find the rate of change in the volume of the rod when it is 20 cm long and the diameter is 2 cm.