1. Find $\dfrac{dS}{dt}$ if $S = 4\pi r^2$.   2. Find $\dfrac{dV}{dt}$ if $V = \dfrac{1}{3}\pi r^2 h$.   3. Find $\dfrac{dz}{dt}$ if $x^2 + y^2 = z^2$.

4. If $x = 4$, $y = 3$, $\dfrac{dy}{dt} = -2$, and $\dfrac{dx}{dt} = 0$, then find $\dfrac{dz}{dt}$ for $x^2 + y^2 = z^2$.

5. If $V = \dfrac{4}{3}\pi r^3$ and $\dfrac{dV}{dt} = 3\pi$ and $r = 6$, then find $\dfrac{dr}{dt}$

6. A ladder 15 ft long is leaning against a building. The bottom of the ladder is moved away from the building at the constant rate of $\dfrac{1}{2}\ \dfrac{ft}{sec}$. Find the rate at which the ladder is falling down the building when the ladder is 9 ft from the building.

7. Gas is escaping from a spherical balloon at the rate of $2ft^3$/min. How fast is the surface area shrinking when the radius is 12ft?

8. Water is running out a conical funnel at the rate of $1in^3$/sec. If the radius of the base of the funnel is 4 inches and the altitude is 8 inches, find the rate at which the water level is dropping when it is 2 inches from the top.

9. Sand falling from a chute forms a conical pile whose altitude is always equal to 4/3 the radius of the base. (a) How fast is the volume increasing when the radius of the base is 3 ft and is increasing at a rate of 3 in/min? (b) How fast is the radius increasing when it is 6ft and the volume is increasing at the rate of $24ft^3$/min?

10. The radius of a sphere is r in t seconds. Find the radius when the rates of increasing of the surface area and radius are numerically equal.

11. A rectangular trough is 8ft long, 2ft across the top, and 4 feet deep. If water flows in at a rate of $2\ ft^3$/min, how fast is the surface rising when the water is 1 ft deep?

12. A ladder 20ft long leans against a house. Find the rate at which the top of the ladder is moving downward if its foot is 12ft from the house and moving away at rate of 2ft/sec.

13. A boy flying a kite at a height of 150ft. If the kite moves horizontally away from the boy at 20ft/sec, how fast is the string being paid out when the kite is 250 ft from him?

14. A liquid is flowing into a vertical cylindrical tank of radius 6ft at a rate of $8ft^3$/min. How fast is the surface rising?

15. Ship A is 15 miles east of O and moving west at 20 miles/hour; ship B is 60 miles south of O and moving north at 15 miles/hour.   A) Are they approaching or separating after 1 hour and at what rate? B) After 3 hours ?   C) When are they nearest one another?

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1. $\dfrac{dS}{dt} = 8\pi r\dfrac{dr}{dt}$ 2. $\dfrac{dV}{dt} = \dfrac{1}{3}\pi r^2 \dfrac{dh}{dt} + \dfrac{2}{3}\pi r h\dfrac{dr}{dt}$ 3. $\dfrac{dz}{dt} = \dfrac{x\left(\dfrac{dx}{dt}\right) + y\left(\dfrac{dy}{dt}\right)}{z}$ 4. $-\dfrac{6}{5}$ 5. $\dfrac{1}{48}$

6. 3/8 ft/sec   7. $\dfrac{-1}{3}\ \dfrac{ft^2}{min}$ 8. $-\dfrac{1}{9\pi}$ in./sec.   9. (a) $3\pi\ ft^3$ / min   (b) $\dfrac{1}{2\pi} ft$ / min

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10. $\dfrac{1}{8\pi}$ in.   11. $\dfrac{1}{8}$ ft/min   12. $\dfrac{3}{2}$ ft / sec   13. 16 ft/sec

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14. $\dfrac{2}{9\pi}$ ft / min   15. (a) approaching $\dfrac{115}{\sqrt{82}}$ mi/hr   (b) separating $\dfrac{9\sqrt{10}}{2}$ mi / h   (c) 1 hr 55 min

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