5.2 Related Rates

Problems Worksheet



- 1. A spherical snowball rolls down a hill, increasing its radius at a constant rate of 3 cm/s. At the instant the radius is 20 cm, calculate exactly:
 - a. The rate at which the surface area is increasing.

b. The rate at which the volume is increasing.

- 2. A 5 m long ladder slides down a wall. At the instant the base is 3 m from the wall, calculate exactly:
 - a. The rate at which the base of the ladder is moving away from the wall, if the top is falling at 0.1 m/s.

b. The rate at which the top of the ladder is sliding down the wall, if the base is sliding away at 0.1 m/s.

3. Two vehicles simultaneously drive away from the same location; one northbound at 50 km/h and one eastbound at 60 km/h. Calculate exactly the rate at which the distance between the two vehicles is increasing two hours into their journeys.

4. Two vehicles simultaneously drive away from the same location; one northbound at $50 \ km/h$ and one with a bearing of $N60^{\circ}E$ at $60 \ km/h$. Calculate exactly the rate at which the distance between the two vehicles is increasing two hours into their journeys.

5. An observer at ground level watches a plane fly directly overhead with an altitude of 600 m and with a speed of 144 km/h. Calculate the rate at which the observer's angle of elevation is changing at the moment before it has flown overhead when the plane is 1000 m from the observer.

- 6. Consider the following related rates questions involving vessels of water. Each question below should be treated as separate from one another.
 - a. A conical container which is pointing downwards has water poured into it at the rate of $12 cm^3 / s$. Further, the cone has a perpendicular height of 40 cm and a base radius of 8 cm. How quickly is the water level rising when the water is 6 cm deep, measured vertically from the apex? State your answer exactly.

b. A hemispherical bowl has radius 18 cm. Water is added to the bowl at a constant 10 cm³/s. Calculate the rate at which the depth of water is increasing when the depth of water is 12 cm. Include a derivation for the volume of water in the unfilled bowl, assuming at capacity its total volume is $V = \frac{2}{3}\pi r^2$.

- 7. A 1.75 m tall man walks at 1 m/s away from a light which is 7 m above the ground.
 - a. At what rate is the tip of his shadow moving?

b. At what rate is the length of his shadow increasing?