

MCB 4U1 – Extra Related Rates Review

1. A spherical balloon increases in diameter at the rate of 10 cm/min. Find the rate of increase of the surface area of the sphere at the following:
 - a) when the radius is 45 cm
 - b) when the surface area is $4\pi \text{ m}^2$
 - c) when the volume is $\frac{\pi}{6} \text{ m}^3$
2. A weather balloon rises at a rate of 500 m/min. Every 1000m, the decrease of air pressure outside the balloon causes its radius to increase by 8 cm. How rapidly is the volume increasing at the instant the radius is 90 cm?
3. A conical tank has a total depth of 2 m, and a top radius of 0.8 m. If water runs out of the tank at a rate of 2 m³/min, how fast is the level descending at the following times:
 - a) when the depth of the water is 1.5 m?
 - b) when the tank is half full
4. A spherical hailstone is growing at a rate of 1 mm³/min. Find the rate of increase of the radius when the surface area is $4\pi \text{ cm}^2$.
5. A rectangular tank has the following dimensions: length is 10 m, width is 6 m, and depth is 8 m. The tank is being filled with water and the surface level is rising at a rate of 6 cm/min. What is the rate of flow of water into the tank?
6. A horizontal eaves trough 3 m long has a triangular cross-section 10 cm across the top and 10 cm deep. During a rainstorm, the water in the trough is rising at the rate of 1 cm/min when the depth is 5 cm.
 - a) How fast is the volume of water in the trough increasing?
 - b) After the rain stopped, the water drained out of the trough at a rate of 0.06 m³/min. How fast is the surface of the water falling when the depth is 1 cm?
7. At 1:00PM, ship *A* was 80km south of ship *B*. Ship *A* is sailing north at 30 km/h and ship *B* is sailing east at 40 km/h. How fast is the distance between them changing at 3:00PM?
8. A spotlight on the ground shines on a wall 15 m away. A woman 2 m tall walks from the wall toward the spotlight at a speed of 1.1 m/s. How fast is the length of her shadow on the wall changing when she is 3 m from the wall?
9. A woman 2 m tall walks away from a streetlight that is 6 m high at the rate of 1.5 m/s. At what rate is her shadow lengthening when she is:
 - a) 3 m from the base of the light?
 - b) 30 m from the base of the light?
10. A man 2 m tall walks at 1 m/s toward a streetlight 6 m high. How fast is his shadow shortening?
11. A female pedestrian 2 m tall walks directly away from a streetlight 6 m above the ground at 80 m/min. Determine the rate of increase in the length of her shadow at the instant she is 8 m from the base of the streetlight.
12. A spotlight on the ground shines on a wall 12 m away. A man 1.9 m tall walks from the spotlight toward the wall at a speed of 1.2 m/s. How fast is his shadow on the wall changing when he is 4 m from the wall?

ANSWERS

- | | | |
|---|--|--------------------------------------|
| 1a) $1800\pi \text{ cm}^2 / \text{min}$ | 2. $0.1296\pi \text{ m}^3 / \text{min}$ | 3a) 1.77 m/min |
| b) $4000\pi \text{ cm}^2 / \text{min}$ | | b) 1.58 m/min |
| c) $2000\pi \text{ cm}^2 / \text{min}$ | | |
| 4. $\frac{1}{400\pi} \text{ mm} / \text{min}$ | 5. 3.6 m ³ / min | 6a) $1500 \text{ cm}^3 / \text{min}$ |
| | | b) 2 m/min |
| 7. 31.5 km/h | 8. lengthening at $\frac{11}{48} \text{ m} / \text{s}$ | |
| 9 a) lengthening at 0.75 m/s | 10. shortening at 0.5 m/s | 11. 40 m/min |
| b) lengthening at 0.75 m/s | | 12. shortening at 0.4275 m/s |