

3. A stone is dropped into a lake, creating a circular ripple that travels outward at a speed of 60 cm/s. Find the rate at which the area within the circle is increasing after 5 sec.
4. If a ball is thrown vertically upward with a velocity of 144 ft/s, then its height after t seconds is $s = 144t - 16t^2$.
- (a) What is the maximum height reached by the ball?
 - (b) What is the velocity of the ball when it is 320 ft above the ground on his way up?
 - (c) What is the velocity of the ball when it is 320 ft above the ground on his way down?
 - (d) When will the ball hit the ground?
 - (e) With what velocity does the ball hit the ground?

5. A bacteria culture starts with 1000 bacteria and the growth rate is proportional to the number of bacteria. After 2 h the population is 9000.
- (a) Find an expression for the number of bacteria after t hours.
 - (b) Find the number of bacteria after 3 h.
 - (c) In what period of time does the number of bacteria double?

6. An isotope of strontium, Sr^{90} , has a half-life of 25 years.
- (a) Find the mass of Sr^{90} that remains from a sample of 18 mg after t years.
 - (b) How long will it take for the mass to decay to 2 mg?

7. A cup of coffee has a temperature of 200°F and is in a room that has a temperature of 70°F . After 10 min the temperature of the coffee is 150°F .

8. A balloon is rising at a constant speed of 5 ft/s. A boy is cycling along a straight road at a speed of 15 ft/s. When he passes under the balloon it is 45 ft above him. How fast is the distance between the boy and the balloon increasing 3 s later?

9. A kite 100 ft above the ground moves horizontally at a speed of 8 ft/s. At what rate is the angle between the string and the horizontal decreasing when 200 ft of string have been let out?

10. A trough is 10 ft long and its ends have the shape of isosceles triangles that are 3 ft across the top and have a height of 1 ft. If the trough is filled with water at a rate of $12 \text{ ft}^3/\text{min}$, how fast is the water level rising when the water is 6 inches deep?

11. A paper cup has the shape of a cone with height 10 cm and radius 3 cm (at the top). If the water is poured into the cup at a rate of $2 \text{ cm}^3/\text{s}$, how fast is the water level rising when the water is 5 cm deep?

Review for Exam 2.

1. An object is moving along a straight path. The position of the object at time t is given by

$$s(t) = 2t^3 - 9t^2 + 12t + 1$$

, where t is measured in seconds and $s(t)$ is measured in feet. Find

- (a) the velocity and acceleration as functions of t .
- (b) the acceleration when the velocity is zero.
- (c) the total distance traveled in the first 2 seconds.

2. At what point on the curve $f(x) = 36\sqrt{x}$ is the tangent line parallel to the line $9x - y + 2 = 0$?

3. Find an equation of the tangent line to the curve $2e^{xy} = x + y$ at the point $(0,2)$.

4. Find the values of a and b that make the function

$$f(x) = \begin{cases} ax^2 + x + 1, & \text{if } x \leq 1 \\ bx - 1, & \text{if } x > 1 \end{cases}$$

differentiable everywhere. Find $f'(x)$.

5. If $f(x) = \sin(g(x))$, find $f'(2)$ given that $g(2) = \frac{\pi}{3}$ and $g'(2) = \frac{\pi}{4}$.

6. Find the derivative

(a) $f(x) = x^2 \cot(3x)$

(b) $f(x) = \frac{e^{\sqrt{x}}}{x + \sqrt{x}}$

(c) $f(x) = \tan^3(e^{-x} + ex - x^e)$

(d) $f(x) = \left(\frac{x^3 + 3x}{x^2 - 4x + 1} \right)^{5/2}$

7. The vector function $\mathbf{r}(t) = \langle t + e^{4t}, -t \cos(2t) \rangle$, $0 \leq t \leq 2\pi$, represents the position of a particle at time t . Find the velocity acceleration vectors of the object at $t = \frac{\pi}{4}$.

8. At what point(s) does the curve parametrized by $x = t^2 - 6t + 5$, $y = t^2 + 4t + 3$ have a horizontal or vertical tangent?