

## Worksheet # 12: Higher Derivatives and Trigonometric Functions

- Given that  $G(t) = 4t^2 - 3t + 42$  find the instantaneous rate of change when  $t = 3$ .
- An object which is thrown upward with an initial velocity of 5 m/s from an initial height of 40 m. Find the velocity of the object when it hits the ground.
- Find the instantaneous rate of change in the area with respect to base  $b$  and height  $b$  of a triangle whose base equals its height when  $b = 7$ .
- Calculate the indicated derivative:
  - $f^{(4)}(1)$ ,  $f(x) = x^4$
  - $g^{(3)}(5)$ ,  $g(x) = 2x^2 - x + 4$
  - $h^{(3)}(t)$ ,  $h(t) = 4e^t - t^3$
  - $s^{(2)}(w)$ ,  $s(w) = \sqrt{w}e^w$
- Calculate the first three derivatives of  $f(x) = xe^x$  and use these to guess a general formula for  $f^{(n)}(x)$ , the  $n$ -th derivative of  $f$ .
- Differentiate each of the following functions:
  - $f(t) = \cos(t)$
  - $g(u) = \frac{1}{\cos(u)}$
  - $r(\theta) = \theta^3 \sin(\theta)$
  - $s(t) = \tan(t) + \csc(t)$
  - $h(x) = \sin(x) \csc(x)$
  - $f(x) = x^2 \sin^2(x)$
  - $g(x) = \sec(x) + \cot(x)$
- Calculate the first five derivatives of  $f(x) = \sin(x)$ . Then determine  $f^{(8)}$  and  $f^{(37)}$ .
- A particle's distance from the origin (in meters) along the  $x$ -axis is modeled by  $p(t) = 2 \sin(t) - \cos(t)$ , where  $t$  is measured in seconds.
  - Determine the particle's speed (speed is defined as the absolute value of velocity) at  $\pi$  seconds.
  - Is the particle moving towards or away from the origin at  $\pi$  seconds? Explain.
  - Now, find the velocity of the particle at time  $t = \frac{3\pi}{2}$ . Is the particle moving toward the origin or away from the origin?
  - Is the particle speeding up at  $\frac{\pi}{2}$  seconds?
- Find an equation of the tangent line at the point specified:
  - $y = x^3 + \cos(x)$ ,  $x = 0$
  - $y = \csc(x) - \cot(x)$ ,  $x = \frac{\pi}{4}$
  - $y = e^\theta \sec(\theta)$ ,  $\theta = \frac{\pi}{4}$