1. Consider the function \( f(x) = 5 - 4 \sin(3x) \). The derivative satisfies \( f'(x) = -4(3) \cos(3x) = -12 \cos(3x) \).

2. Consider the function \( f(x) = 2 \cos(7x) - x^2 \). The derivative satisfies \( f'(x) = -2(7) \sin(7x) - 2x = -14 \sin(7x) - 2x \).

3. Consider the function \( f(x) = 2e^{-6x} + 5 \cos(2(x - 9)) - 8 \sin(4(x - 4)) \). The derivative satisfies \( f'(x) = -12e^{-6x} - 10 \sin(2(x - 9)) - 32 \cos(4(x - 4)) \).

4. a. The mass follows \( y(t) = 2 \cos(10t) \). Since the cosine function is bounded between \(-1\) and \(1\), it follows that the maximum displacements occur with \( y(t) = 2 \) cm at times when \( 10t = 2n\pi \) (for any integer \( n = 0, 1, 2, ... \)) or \( t = \frac{n\pi}{5} \). The minimum displacements occur with \( y(t) = -2 \) cm at times when \( 10t = (2n + 1)\pi \), where \( n = 0, 1, 2, ... \), or \( t = \frac{n\pi}{10} + \frac{\pi}{5} \). The period satisfies \( 10T = 2\pi \) or \( T = \frac{\pi}{5} \approx 0.6283 \) sec.

   b. The velocity is \( v(t) = y'(t) = -20 \sin(10t) \), and the acceleration is \( a(t) = v'(t) = -200 \cos(10t) \). The maximum velocity is 20 cm/sec, occurring when \( 10t = \frac{3\pi}{2} + 2n\pi \), where \( n = 0, 1, 2, ... \), which is equivalent to \( t_{max} = \frac{3\pi}{20} + \frac{n\pi}{5} \approx 0.47124 \) sec. for \( t_{max} \in [0, T) \).

5. a. To create the model for the volume of air in the lungs, we find \( A = \frac{(2200 + 2800)}{2} = 2500 \) and \( B = 2800 - A = 300 \), then solve \( \left( \frac{1}{20} \right) \omega = 2\pi \), so \( \omega = 40\pi \). Thus, the model becomes

   \[ V(t) = 2500 + 300 \cos(40\pi t). \]

   b. The derivative is \( V'(t) = -300(40\pi) \sin(40\pi t) = -12000\pi \sin(40\pi t) \). The maximum rate of exhalation is \(-12000\pi \) ml/min and occurs when \( \sin(40\pi t) = 1 \) so

   \[ 40\pi t = \frac{\pi}{2} \quad \text{or} \quad t_{max} = \frac{1}{80} = 0.0125 \text{ sec}. \]

   The graphs are shown below.
6. a. To create the model for the concentration of FSH, we find $A = \frac{4.3 + 1.5}{2} = 2.9$ and $B = 4.3 - 2.9 = 1.4$, then solve $28\omega = 2\pi$ or $\omega = \frac{\pi}{14}$. The high concentration occurs at day 9, so $\phi = 9$. Thus, the model is given by:

$$F(t) = 2.9 + 1.4 \cos \left( \frac{\pi (t - 9)}{14} \right).$$

On day 14, around the day when ovulation occurs,

$$F(14) = 2.9 + 1.4 \cos \left( \frac{\pi (14 - 9)}{14} \right) \approx 3.5074.$$

The graph is shown below.

b. From our rules of differentiation $F'(t) = -1.4 \left( \frac{\pi}{14} \right) \sin \left( \frac{\pi (t - 9)}{14} \right) = -\frac{\pi}{10} \sin \left( \frac{\pi (t - 9)}{14} \right)$. We find the rate of change at $t = 14$,

$$F'(14) = -\frac{\pi}{10} \sin \left( \frac{\pi (14 - 9)}{14} \right) \approx -0.283.$$