1. §12.2, #35 (4 points): Find the unit vectors that are parallel to the tangent line to the parabola \( y = x^2 \) at the point \((2, 4)\).

**Solution:** The slope of the tangent line to \( y = x^2 \) at \((2, 4)\) is \( \frac{dy}{dx} \bigg|_{x=2} = 2x \bigg|_{x=2} = 4 \). Hence, a vector parallel to this tangent line is \( \vec{i} + 4\vec{j} \) with length \( \sqrt{1^2 + 4^2} = \sqrt{17} \). It follows that the two desired unit vectors are \( \pm \left( \frac{1}{\sqrt{17}} \right)(\vec{i} + 4\vec{j}) \).

2. §12.3, #9 (4 points): Find \( \vec{a} \cdot \vec{b} \) when \( \|\vec{a}\| = 6 \), \( \|\vec{b}\| = 5 \), and the angle between \( \vec{a} \) and \( \vec{b} \) is \( \frac{2\pi}{3} \).

**Solution:** We have
\[
\vec{a} \cdot \vec{b} = \cos \theta \|\vec{a}\|\|\vec{b}\| = \cos \left( \frac{2\pi}{3} \right) \cdot 6 \cdot 5 = \left( \frac{1}{2} \right) \cdot 30 = -15.
\]

3. §12.3, #24 (6 points): Determine whether the given vectors are orthogonal, parallel, or neither. Briefly explain.

(a) \( \vec{u} = \langle -3, 9, 6 \rangle \), \( \vec{v} = \langle 4, -12, -8 \rangle \).

**Solution:** By inspection, we see that \( -4/3 \vec{u} = \vec{v} \), so \( \vec{u} \parallel \vec{v} \).

(b) \( \vec{u} = \vec{i} - \vec{j} + 2\vec{k} \), \( \vec{v} = 2\vec{i} - \vec{j} + \vec{k} \).

**Solution:** The ratio of coefficients of \( \vec{i} \) is \( 2/1 = 2 \), while the ratio of coefficients of \( \vec{j} \) is \( (-1)/(-1) = 1 \). Therefore, \( \vec{u} \) and \( \vec{v} \) are not parallel since they are not scalar multiples of each other. We compute \( \vec{u} \cdot \vec{v} = (1)(2) + (-1)(-1) + (2)(1) = 5 \neq 0 \), so \( \vec{u} \) and \( \vec{v} \) are not orthogonal.

(c) \( \vec{u} = \langle a, b, c \rangle \), \( \vec{v} = \langle -b, a, 0 \rangle \).

**Solution:** We compute \( \vec{u} \cdot \vec{v} = (a)(-b) + (b)(a) + (c)(0) = -ab + ab = 0 \). Hence, we see that \( \vec{u} \) and \( \vec{v} \) are orthogonal.