

You cannot use a calculator for this quiz

**Problem 1.** Suppose  $f(x, y)$  is a function satisfying  $\nabla f(1, 1) = \langle 2, 8 \rangle$ .

- (a) Find a unit vector  $\mathbf{u}$  pointing in the direction in which  $f$  decreases most rapidly at  $(1, 1)$ .

$$\|\nabla f(1, 1)\| = \sqrt{4 + 64} = \sqrt{68}$$

$$\Rightarrow \vec{u} = \frac{\langle -2, -8 \rangle}{\sqrt{68}}$$

- (b) **Short Answer:** If  $\mathbf{v}$  is a vector satisfying  $D_{\mathbf{v}}f(1, 1) = 0$ , what is the exact value of  $\mathbf{u} \cdot \mathbf{v}$ , where  $\mathbf{u}$  is the vector you found in part (a)? Briefly explain your answer. **Hint:** No computation is necessary or expected for this problem.

$$\vec{u} \cdot \vec{v} = 0 \text{ since } D_{\vec{v}}f(1, 1) = \nabla f(1, 1) \cdot \vec{v} = 0$$