

Books, watches, notes or cell phones are **not** allowed. The **only** calculators allowed are the Sharp EL-531\*\*\*. You **must** show all your work, the correct answer is worth 1 mark the remaining marks are given for the work.

**Question 1.** Let  $\mathbf{u}$ ,  $\mathbf{v}$ , and  $\mathbf{w}$  be pairwise orthogonal vectors.

a. (3 marks) Show that  $\|\mathbf{u} + \mathbf{v} + \mathbf{w}\|^2 = \|\mathbf{u}\|^2 + \|\mathbf{v}\|^2 + \|\mathbf{w}\|^2$ .

b. (3 marks) If  $\mathbf{u}$ ,  $\mathbf{v}$ , and  $\mathbf{w}$  are all the same length, show that they all make the same angle with  $\mathbf{u} + \mathbf{v} + \mathbf{w}$

**Question 2.** (3 marks each) Determine whether the following statement is true or false. If the statement is false provide a counterexample. If the statement is true provide a proof of the statement.

a. If  $\mathbf{u} \cdot \mathbf{v} = \mathbf{u} \cdot \mathbf{w}$ , then  $\mathbf{v} = \mathbf{w}$ .

b. If  $\mathbf{a}$  and  $\mathbf{b}$  are nonzero orthogonal vectors, then for every nonzero vector  $\mathbf{u}$ , we have  $\text{proj}_{\mathbf{a}}(\text{proj}_{\mathbf{b}}(\mathbf{u})) = \mathbf{0}$ .