

# PHY5100. Homework 1

Welcome to PHY5100! Let's kick off this semester with an easy 3-problem assignment. This homework assignment is due on **September 17** by 5 pm. Late ones will not be accepted, sorry...

## Suggested reading:

G. Arfken and H. Weber, *Mathematical Methods*, Chapter 1.

### Problem 1: A triangle (A&W, 1.1.8)

A triangle is defined by the vertices of three vectors  $\vec{A}$ ,  $\vec{B}$ , and  $\vec{C}$  that extend from the origin. In terms of  $\vec{A}$ ,  $\vec{B}$ , and  $\vec{C}$  show that the *vector* sum of the successive sides of the triangle ( $AB + BC + CA$ ) is zero, where the side  $AB$  is from  $A$  to  $B$ , etc.

### Problem 2: Orthogonality relation (A&W, 1.2.2)

Prove the orthogonality condition,

$$\sum_{i=1}^N a_{ji}a_{ki} = \delta_{jk}. \quad (1)$$

As a special case of this relation, show that the directional cosines satisfy the relation

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1. \quad (2)$$

### Problem 3: Fun with rotations. (A&W, 1.3.2)

Given that (1) the dot product of a unit vector with itself is unity and (2) this relation is valid in all (rotated) coordinate systems, show that  $\hat{x}' \cdot \hat{x}' = 1$  (with the primed system rotated  $45^\circ$  about z-axis relative to the unprimed system) implies that  $\hat{x} \cdot \hat{y} = 0$ .