Name: _____

Quiz I

Leonhard Euler (1707–1783)

This is a 50 minute closed-book exam. Please put your name on the top sheet. Answer all four questions. Explain your working and state any assumptions you have made.

1   (3 points) Circle the correct answer.

1. A fluid is a substance that

   - deforms continuously when subjected to a shear stress.
   - cannot change phase.
   - cannot deform.
   - flows when squeezed hard enough.
   - can be modelled by a collection of hard spheres.

2. Dimensions

   - should be the same on both sides of an equation.
   - can be ignored in engineering.
   - always include feet.
   - can be added together (e.g. feet + seconds).
   - are dimensionless.

3. Pressure

   - depends only on height.
   - is only defined in a fluid at rest.
   - is minus the normal stress in a fluid at rest.
   - is always constant in a fluid.
   - is a vector.

2 (5 points) You are given $\mathbf{a} = (2yz - 3x^3, 5y, z^2)$, $\mathbf{b} = (x - y, 0, 3x^2 z)$, $f = 2x - 3x(y + z)z$. Calculate $\mathbf{a} \cdot \mathbf{b}$, $\mathbf{a} \cdot \nabla f$, $\nabla \cdot \mathbf{a}$, $\nabla \times \mathbf{b}$ and $\nabla(f\mathbf{u})$.

3 (10 points) An iceberg of volume V made of ice with density ρ_i floats on water with density ρ_w. Calculate the submerged volume fraction V_s/V of the iceberg; what does this give for $\rho_i = 920 \text{ kg/m}^3$ and $\rho_w = 1025 \text{ kg/m}^3$? Does this result depend on the shape of the iceberg? Is the center of pressure above or below the centroid of the iceberg? If the iceberg drifts into warmer water, does the submerged volume fraction increase or decrease (neglect melting and changes in temperature of the ice)?

4 (12 points) A watertight bulkhead 22 ft high forms a temporary dam for some construction work. The top 12 ft behind the bulkhead consist of seawater with density 2 slugs/ft^3, but the bottom 10 ft being a mixture of mud and water can be considered a fluid of density 4 slugs/ft^3. Calculate the total horizontal load per unit width and the location of the center of pressure measured from the bottom.