

Question 4: Qualitative Quantitative Translation (QQT)

8 points

A For indicating $a_1 < a_2$ **Point A1**

For a justification that indicates that the blocks have the same weight or mass **Point A2**

For a justification that indicates that the salt water exerts a larger buoyant force than the freshwater exerts (or the freshwater exerts a smaller buoyant force than the saltwater exerts) **Point A3**

Example Response

There are identical downward forces (mg) on the block in both liquids. Each submerged block also has an upward buoyant force. Because the buoyant force is proportional to the density of the fluid, the block in salt water has a larger buoyant force exerted on it. Therefore, the block in salt water has a larger net force and so has a larger acceleration.

B For a multistep derivation that includes Newton's second law **Point B1**

For indicating ρVg is the buoyant force **Point B2**

For a correct expression for the initial upward acceleration a , consistent with the indicated expression for buoyant force **Point B3**

Scoring Note: A correct, isolated, final expression for a earns points B2 and B3.

Example Response

$$\Sigma F = m_{\text{sys}} a_{\text{sys}}$$

$$F_B - mg = ma$$

$$\rho Vg - mg = ma$$

$$a = \frac{\rho Vg}{m} - g$$

C For attempting to address the functional dependence between a and ρ in the equation derived in part B **Point C1**

Scoring Note: It is not necessary to use the functional dependence correctly to earn this point. The response only needs to use functional dependence language such as proportional, inversely proportional, related, numerator, and denominator, to relate a and ρ .

For correctly using functional dependence to evaluate the relationship between a and ρ consistent with the expression derived in part B and the claim made in part A **Point C2**

Example Response

The expression for the acceleration a is consistent with part A. In part A, I said the acceleration would be larger in salt water because the density is greater. In my expression, the acceleration increases with increasing density because of the $\frac{\rho Vg}{m}$ term.