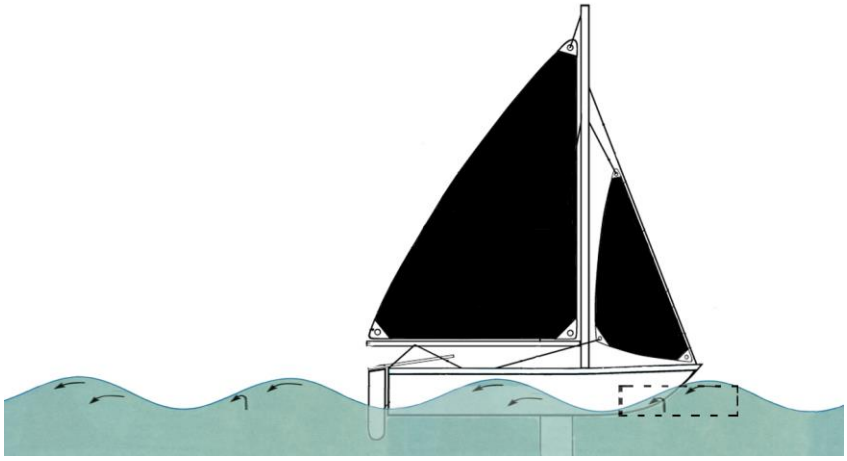
Round: **Sample**
Time: **5 minutes**

Bernoulli's equation is derived from the principle of conservation of momentum and energy. The equation describes how, in a system absent of external forces, energy in a continuous stream of fluid is conserved in the form of inertial, gravitational, and static forces. Bernoulli's equation only describes ideal fluid systems; fluid that is inviscid, incompressible, and steadily flowing.

Given Bernoulli's equation:

$$p_1 + \rho g h_1 + 1/2 \rho v_1^{\,2} = p_2 + \rho g h_2 + 1/2 \rho v_2^{\,2} = C$$

where p is the static pressure, ρ is the density of the fluid, ($\rho = 1025 \frac{kg}{m^3}$), g is the gravitational constant (g = $10 \frac{m}{\sec^2}$), h is the height of the water column, v is the velocity of the fluid, and C is a constant. The sum of the static, gravitational, and inertial terms at one point in the continuous, ideal fluid stream is equal to the sum of these terms at any other point in the ideal fluid stream.



Using the image above as a guide, if a boat is traveling through the ocean waters at 10 knots, work through the following problems.

1. What terms cancel in the equation? (5 pts)

2. What is the new equation? (5 pts)

3. What is the conversion of knots to m/sec? (5 pts)

4. Estimate the height of the wave. Show your work. (5 pts)

ANSWER **ANSWER** **ANSWER**

Round: Sample
Category: Physical
Time: 5 minutes

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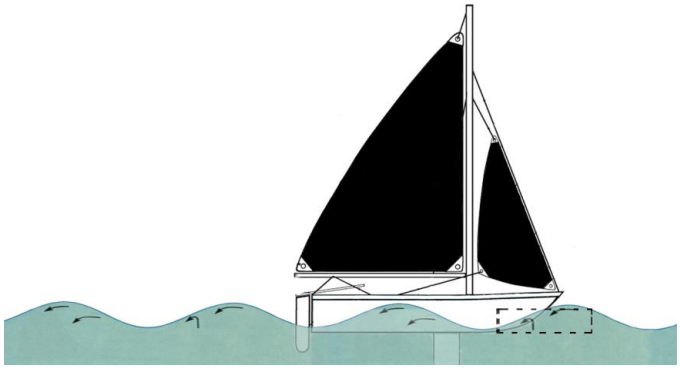
Given Bernoulli's equation: $p_1 + \rho g h_1 + 1/2 \rho v_1^2 = p_2 + \rho g h_2 + 1/2 \rho v_2^2 = C$

where *p* is the static pressure, ρ is the density of the fluid, ($\rho = 1025 \frac{kg}{m^3}$), *g* is the gravitational constant (g = $10 \frac{m}{\sec^2}$), *h* is the height of the water column, *v* is the velocity of the fluid, and *C* is a constant. The sum of the static, gravitational, and inertial terms at one point in the continuous, ideal fluid stream is equal to the sum of these terms at any other point in the ideal fluid stream.



Using the image above as a guide, if a boat is traveling through the ocean waters at 10 knots, work through the following problems.

1. What terms cancel in the equation?
   <u>p1 and p2 are the same on both sides of the equation</u> (2 pts) because the atmospheric pressure does not change, so we do not need to take these terms into account when calculating.
   <u>h1 is zero</u> (1 pt) because we assume there is no wave height in the water.
   <u>v2 is zero</u> (1 pt) because when the water hits the ship hull it cannot pass through the hull.
   <u>C can also be set to zero</u> (1 pt)

2. What is the new equation?
   $\frac{1}{2} \rho v_1^2 = \rho g h_2$ *(5 pts)*

3. What is the conversion of knots to m/sec?
   1 kt = 0.5144 m/s (5 pts)

4. Estimate the height of the wave. Show your work.
   $\frac{1}{2} v_1^2 = g h_2$ $h_2 = \frac{\frac{1}{2} v_1^2}{g}$ $h_2 = 1.32 m$ *(5 pts) (1.3 also acceptable)*