33.29 What is the stagnation pressure at the nose of a submarine travelling $20mph$ horzontally at a depth of $200ft$? Assume the ocean is stationary and the specific gravity of water can be taken as 1.

A. $24psi$

B. $49psi$

C. $87psi$

D. $92psi$

Use available Measurement Relationships to convert the velocity from mph to $\frac{ft}{s}$.

$$v = 20mph\left(88\frac{ft}{min \cdot mph}\right)\left(\frac{1min}{60s}\right) = 29.3\frac{ft}{s}$$

Use the Stagnation Pressure equation for an incompressible fluid. Since the velocity is known, and the static pressure is easily determined from the height of water above the submarine, rearrange the formula for the stagnation pressure, P_0, which turns out to be the sum of the velocity pressure and static pressure.

$$v = \sqrt{2g\frac{(P_0 - P_s)}{\gamma}}$$

$$P_0 = P_s + \frac{v^2\gamma}{2g}$$

Determine the static pressure, P_s,by converting ft of water to psi using the $2.31\frac{ft}{psi}$ rule of thumb conversion factor.

$$P_s = \frac{200ft}{2.31\frac{ft}{psi}} = 86.58psi$$

Calculate the stagnation pressure. Instead of multiplying by specific weight as the formula states and then dividing by $144\frac{in^2}{ft^2}$ to make the units work, simply use the $2.31\frac{ft}{psi}$ rule of thumb conversion factor for water.

$$P_0 = 86.58psi + \frac{\left(29.3\frac{ft}{s}\right)^2}{2\left(32.2\frac{ft}{s^2}\right)\left(2.31\frac{ft}{psi}\right)} = 92.4psi$$

Answer D