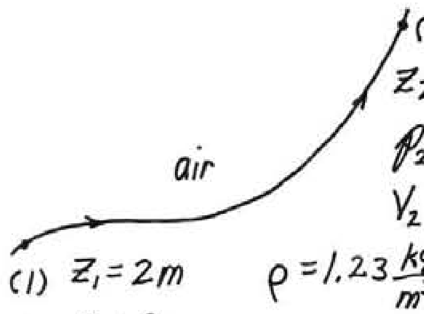
3.2

3.2 Air flows steadily along a streamline from point (1) to point (2) with negligible viscous effects. The following conditions are measured: At point (1) $z_1 = 2$ m and $p_1 = 0$ kPa; at point (2) $z_2 = 10$ m, $p_2 = 20$ N/m^2, and $V_2 = 0$. Determine the velocity at point (1).



$z_2 = 10\,m$
$p_2 = 20\,\frac{N}{m^2}$
$V_2 = 0$

$z_1 = 2\,m$
$p_1 = 0$
$V_1 = ?$

$\rho = 1.23\,\frac{kg}{m^3}$
$\gamma = \rho g$

$$p_1 + \tfrac{1}{2}\rho V_1^2 + \gamma z_1 = p_2 + \tfrac{1}{2}\rho V_2^2 + \gamma z_2$$

Thus, with $p_1 = 0$ and $V_2 = 0$,

$$\tfrac{1}{2}\rho V_1^2 + \gamma z_1 = p_2 + \gamma z_2$$

or

$$\tfrac{1}{2}\left(1.23\,\tfrac{kg}{m^3}\right)V_1^2 = 20\,\tfrac{N}{m^2} + \left(1.23\,\tfrac{kg}{m^3}\right)9.81\,\tfrac{m}{s^2}\,(10\,m - 2\,m)$$

or

$$V_1^2 = \frac{2(20)}{1.23}\,\frac{N\cdot m}{kg} + 2\left(9.81\,\tfrac{m}{s^2}\right)(8\,m) = 189\,\frac{m^2}{s^2} \quad \left(\text{Note: } \frac{N\cdot m}{kg} = \frac{\left(\frac{kg\cdot m}{s^2}\right)m}{kg} = \frac{m^2}{s^2}\right)$$

Thus,

$$\underline{\underline{V_1 = 13.7\,m/s}}$$