

37.51 The flow of 20°C water through a hose with an inside diameter of 25mm is at the lower boundary of the fully turbulent range. How long will it take to fill a $50,000\text{L}$ swimming pool?

- A. 8 hours
- B. 27 hours
- C. 38 hours
- D. 59 hours

Pipe flow is considered **Fully Turbulent** once the **Reynolds Number** is greater than 12,000. Since the flow is at the lower boundary of the turbulent range, find the velocity which corresponds to $Re = 12,000$. Use the **Properties of Water** table to obtain the kinematic viscosity at 20°C .

$$Re > 12,000$$

$$Re = \frac{vD}{\nu}$$

$$v = \frac{Re \cdot \nu}{D} = \frac{(12,000) \left(0.000001003 \frac{\text{m}^2}{\text{s}}\right)}{(0.025\text{m})} = 0.481 \frac{\text{m}}{\text{s}}$$

Calculate the volume flow rate based on velocity and area. Since the pool volume is in liters, and the answer choices are in hours, convert to $\frac{\text{L}}{\text{hr}}$.

$$Q = vA = \left(0.481 \frac{\text{m}}{\text{s}}\right) \left(\frac{\pi}{4}\right) (0.025\text{m})^2 = 2.36 \times 10^{-4} \frac{\text{m}^3}{\text{s}} \left(\frac{1000\text{L}}{1\text{m}^3}\right) \left(\frac{3600\text{s}}{\text{hr}}\right) = 849.6 \frac{\text{L}}{\text{hr}}$$

By definition, volume flow rate is volume per unit time. Rearrange to solve for the time to fill the desired volume.

$$Q = \frac{\text{Volume}}{t}$$

$$t = \frac{\text{Volume}}{Q} = \frac{50,000\text{L}}{849.6 \frac{\text{L}}{\text{hr}}} = 58.9\text{hr}$$

Answer D