## 36.65 What is the kinematic viscosity of $140°F$ air at $50psia$?

A. $1 \times 10^{-5} \frac{ft^2}{s}$

B. $5 \times 10^{-5} \frac{ft^2}{s}$

C. $6 \times 10^{-5} \frac{ft^2}{s}$

D. $3 \times 10^{-3} \frac{ft^2}{s}$

Lookup Kinematic Viscosity in the reference handbook and recall the formula.

$$\nu = \frac{\mu}{\rho}$$

Dynamic Viscosity, $\mu$, is a function of temperature only. Look up the Dynamic Viscosity in the table Properties of Air at Low Pressure.

$$\mu_{@140°F \sim 600R} = 134.9 \times 10^{-7} \frac{lb_m}{sec \cdot ft}$$

The Kinematic Viscosity should not be looked up directly unless a standard temperature range associated with that table is applicable. Kinematic Viscosity changes as a function of temperature in accordance to how the density changes with temperature. Approximate the density by using the ideal gas law to determine the density of air at $600R$. Lookup Properties of Ideal Gases to get the value of the gas constant for air.

$$PV = mRT \rightarrow P = \rho RT \rightarrow \rho = \frac{P}{RT}$$

$$\rho = \frac{\left(50 \frac{lb_f}{in^2}\right)\left(\frac{144in}{1ft^2}\right)}{\left(53.35 \frac{ft \cdot lb_f}{lb_m R}\right)(600R)} = 0.225 \frac{lb_m}{ft^3}$$

Note that at more than triple atmospheric pressure, the density is substantially higher than we would typically see around standard temperature and pressure, atmospheric air.

Calculate kinematic viscosity.

$$\nu = \frac{\mu}{\rho} = \frac{134.9 \times 10^{-7} \frac{lb_m}{sec \cdot ft}}{.225 \frac{lb_m}{ft^3}} = 6 \times 10^{-5} \frac{ft^2}{s}$$

**Answer C**