Exercise 66

Boyle's Law Boyle's Law says that the volume V of a gas at constant temperature increases whenever the pressure P decreases, so that V and P are inversely proportional. If $P = 14.7\ \text{lb/in}^2$ when $V = 1000\ \text{in}^3$, then what is V when $P = 23.4\ \text{lb/in}^2$.

Solution

V and P are inversely proportional:

$$V \propto \frac{1}{P}.$$

Make this proportionality an equation we can use by introducing a proportionality constant k.

$$V = \frac{k}{P} \tag{1}$$

Use the fact that $P = 14.7\ \text{lb/in}^2$ when $V = 1000\ \text{in}^3$ to determine k.

$$1000 = \frac{k}{14.7}$$

$$1000(14.7) = k$$

$$k = 14{,}700\ \text{lb} \cdot \text{in}$$

Equation (1) then becomes

$$V = \frac{14{,}700}{P}.$$

Therefore, when $P = 23.4\ \text{lb/in}^2$,

$$V = \frac{14{,}700}{23.4}$$

$$= \frac{24{,}500}{39}$$

$$\approx 628.2\ \text{in}^3.$$