EXAMPLE 5.5

$ORIGIN := 1$

$T := 274 \qquad P := 70$

$T_c := 304.2 \qquad P_c := 73.8 \qquad \omega := 0.239$

$T_r := \frac{T}{T_c} = 0.901 \qquad P_r := \frac{P}{P_c} = 0.949 \qquad R := 83.14$

Soave-Redlich-Kwong Equation of State

$$\alpha := \left[1 + \left(0.48 + 1.574\cdot\omega - 0.176\cdot\omega^2\right)\cdot\left(1 - \sqrt{T_r}\right)\right]^2$$

$A := 0.42748\cdot\frac{P_r\cdot\alpha}{T_r^{\,2}} = 0.544 \qquad B := 0.08664\cdot\frac{P_r}{T_r} = 0.091$

$p := -1 \qquad q := A - B - B^2 \qquad r := -A\cdot B$

$$M := Z^3 + p\cdot Z^2 + q\cdot Z + r \ \left|\begin{array}{l}\text{solve}\\ \text{assume}, Z = \text{real}\end{array}\right. \rightarrow 0.16020571045358467875$$

$ZL := \min(M) = 0.16$

$VL := \frac{ZL\cdot R\cdot T}{P} = 52.136$

Peng-Robinson Equation of State

$$\alpha := \left[1 + \left(0.37464 + 1.54226\cdot\omega - 0.26992\cdot\omega^2\right)\cdot\left(1 - \sqrt{T_r}\right)\right]^2$$

$A := 0.45724\cdot\left(\frac{P_r}{T_r^{\,2}}\right)\cdot\alpha = 0.575 \qquad B := 0.0778\cdot\frac{P_r}{T_r} = 0.082$

$p := -1 + B \qquad q := A - 3 \cdot B^2 - 2 \cdot B \qquad r := -A \cdot B + B^2 + B^3$

$$M := Z^3 + p \cdot Z^2 + q \cdot Z + r \;\Big|\; \begin{array}{l} \text{solve} \\ \text{assume}, Z = \text{real} \end{array} \rightarrow 0.14187177366147130875$$

$$ZL := \min(M) = 0.142$$

$$VL := \frac{ZL \cdot R \cdot T}{P} = 46.17$$

Rackett Equation

$$Z := 0.29056 - 0.08775 \cdot \omega = 0.27$$

$$V := \frac{R \cdot T_c}{P_c} \cdot Z^{1+\left(1-T_r\right)^{\frac{2}{7}}} = 46.92$$

Alternative Solution for Peng-Robinson Equation of State

```
root(p, q, r) :=  | v ← (r, q, p, 1)ᵀ
                  | x ← polyroots(v)
                  | for  i ∈ 1 .. 3
                  |    x_i ← 0   if   Im(x_i) ≠ 0
                  | x1 ← max(x)
                  | y ← min(x)
                  | x2 ← | max(x)   if   y = 0
                  |      | y   otherwise
                  | (x1, x2)ᵀ
```

$$V(T, P) := \begin{array}{|l} T_r \leftarrow \dfrac{T}{T_c} \\ P_r \leftarrow \dfrac{P}{P_c} \\ \alpha \leftarrow \left[1 + \left(0.37464 + 1.54226\omega - 0.26992\omega^2\right)\cdot\left(1 - \sqrt{T_r}\right)\right]^2 \\ A \leftarrow 0.45724\cdot\dfrac{P_r\cdot\alpha}{{T_r}^2} \\ B \leftarrow 0.07780\cdot\dfrac{P_r}{T_r} \\ p \leftarrow -1 + B \\ q \leftarrow A - 2B - 3B^2 \\ r \leftarrow -A\cdot B + B^2 + B^3 \\ Z_L \leftarrow \mathrm{root}(p, q, r)_1 \\ V_L \leftarrow \dfrac{Z_L\cdot R\cdot T}{P} \\ V_L \end{array}$$

$$V(T, P) = 46.17$$