

3-84 Determine the specific volume of superheated water vapor at 15 MPa and 350°C using (a) the ideal-gas equation, (b) the generalized compressibility chart, and (c) the steam tables. Also determine the error involved in the first two cases. *Answers:* (a) 0.01917 m³/kg, 67.0 percent, (b) 0.01246 m³/kg, 8.5 percent, (c) 0.01148 m³/kg

Part (a) : $Pv = RT \rightarrow v = \frac{RT}{P}$

$R = 0.4615 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$ (from Table A-1 for water)

$\rightarrow v = \frac{0.4615 \times (350 + 273)}{15000} = 0.01917 \frac{\text{m}^3}{\text{kg}}$

Part (b) : $Pv = ZRT \rightarrow v = \frac{ZRT}{P}$

To find Z from the generalized compressibility chart, we need

$P_R = \frac{P}{P_{cr}}$ & $T_R = \frac{T}{T_{cr}}$

$P_R = \frac{15}{22.06} = 0.68$, $T_R = \frac{(350 + 273)}{647.1}$

From Table A-1

$= 0.96$

From Fig A-15, $Z = 0.65$

$$v = \frac{ZRT}{P} = \frac{0.65 \times 0.4615 \times (350 + 273)}{15000}$$
$$= 0.0124 \text{ m}^3/\text{kg}$$

Part (c): Find v from Table A-6
at 15 MPa, $T = 350^\circ\text{C}$

$$v = 0.01148 \text{ m}^3/\text{kg}$$

$$\% \text{ error}_{\text{Part (a)}} = \frac{|v_a - v_c|}{v_c} \times 100$$
$$= \frac{|0.01917 - 0.01148|}{0.01148} \times 100$$
$$= 67\%$$

$$\% \text{ error}_{\text{Part (b)}} = \frac{|v_b - v_c|}{v_c} \times 100$$
$$= \frac{|0.0124 - 0.01148|}{0.01148} \times 100$$
$$= 8\%$$