change both to 20 °C

1/°C

In this equation, t is in °C, and the result is in K^{-1} or in °C (with respect to temperature *differences*, as in dT, one degree in the Celsius scale is equal to one kelvin). Using the values of the parameters given in the problem statement at $t = 25$ °C, we find

$$\beta_{25\ ^\circ\mathrm{C}} = 1.426 \times 10^{-3}\ \mathrm{K}^{-1}.$$

The volume change upon increasing temperature from t_1 to t_2 is found from eq. (2.54). Keeping pressure constant ($dP = 0$), integration with respect to temperature gives

$$\ln \frac{V_2}{V_1} = \int_{t_1}^{t_2} \beta\, dt. \qquad \text{[B]}$$

The coefficient β is a function of temperature and is given by eq. [A]. A quick approximation is obtained by assuming β to be constant and equal to some average value between t_1 and t_2. The above integral then becomes

$$\ln \frac{V_2}{V_1} \approx \bar{\beta}(t_2 - t_1) \quad \Rightarrow \quad \frac{V_2}{V_1} = e^{\bar{\beta}(t_2 - t_1)}. \qquad \text{[C]}$$

For the average β we will use the simple average between the values at 20 °C and at 30 °C. The coefficient at 30 °C is calculated from eq. [A] and we find $\beta_{30\ ^\circ\mathrm{C}} = 1.466 \times 10^{-3}\ \mathrm{K}^{-1}$. The mean β is

$$\bar{\beta} = \frac{(1.426 + 1.466) \times 10^{-3}}{2} = 1.446 \times 10^{-3}\ \mathrm{K}^{-1}.$$

The volume change is calculated from eq. [C] using $t_2 - t_1 = 10$ °C $= 10$ K:

$$\frac{V_2}{V_1} = e^{\bar{\beta}(t_2 - t_1)} = e^{(1.446 \times 10^{-3})(10)} = 1.01456.$$

eq. [B]

The volume increases by $1 - V_2/V_1 = 1.45\%$. If instead of using an average β we perform the integration in ~~eq. 2.11~~ using the full form of β from eq. [A], we $V_2/V_1 = 1.01457$. The approximate calculation in this case is ~~very close to~~ the exact result.

find

essentially the same as

Example 2.14: Constant-Volume Heating of Liquid

A glass container is filled with acetone at 25 °C and sealed, leaving no air inside. Determine the pressure that develops in the container when it is heated to 35 °C. The isothermal compressibility of acetone is (see Table 2-188 in *Perry's Chemical Engineers' Handbook* [2]),

$$\kappa = 52 \times 10^{-6}\ \mathrm{bar}^{-1}$$

You may ignore the expansion of the container.

Solution If the expansion of the container is neglected, the volume of the acetone (total, specific, or molar) remains constant. Using $dV = 0$ in eq. (2.55) we obtain a relationship between temperature and pressure: