The first set is valid in the temperature range 344 K to 373 K and the second in the range 379 K to 573 K. Calculate (a) the saturation pressure at 100 °C and (b) the boiling temperature at 5 bar.

Solution (a) Notice that the equation is given in terms of the base-10 logarithm of pressure and that the units of pressure and temperature must be in bar and kelvin, respectively.

By numerical substitution into the Antoine equation using the first set of parameters and $T = 100 + 273.15 = 373.15$ K, we obtain

$$\log_{10} P^{\text{sat}} = 0.00572986 \quad \Rightarrow \quad P^{\text{sat}} = 1.01328 \text{ bar}$$

The result is in excellent agreement with the value 1.01325 bar for the standard atmosphere.

(b) To obtain the boiling temperature of water given the pressure, we solve the Antoine equation for T:

$$T = \frac{B}{A - \log_{10} P^{\text{sat}}} - C. \tag{2.12}$$

We use the second set of parameters since the boiling temperature of water at pressures higher than 1.013 bar is above ~~273~~ 373 K. We find

$$T = \frac{643.748}{3.55959 - \log_{10}(5)} - (-198.043) = 423.021 \text{ K} = 149.9 \text{ °C}.$$

This is within the range of the parameters and agrees well with the tabulated value, 151.8 °C.

Example 2.3: Determining the Phase

Based only on the Antoine equation given in Example 2.2, determine the phase of water at (a) 2 bar, 115 °C, and (b) 20 bar, 300 °C.

Solution (a) To answer this question we must either calculate the saturation pressure at the temperature of the system (115 °C), or the saturation temperature at the pressure of the system (2 bar). We use the second set of parameters for these calculations since temperatures are higher than 373 K.

At temperature 115 °C = 388.15 K, the saturation pressure is calculated from the Antoine equation to be 1.49 bar. Since the system pressure (2 bar) is higher, the state is compressed liquid (i.e., the pressure would have to be reduced isothermally to 1.49 bar to cause the liquid to boil).

Alternatively, the saturation temperature calculated from the Antoine equation at pressure 2 bar is 395.6 K = 122.4 °C. Since the system temperature is lower, it is compressed liquid.