Table 13.5 Saturation Vapor Density of Water

Temperature $(^{\circ}\text{C})$	Vapor pressure (Pa)	Saturation vapor density (g/m^3)
−50	4.0	0.039
−20	1.04×10^{2}	0.89
−10	2.60×10^{2}	2.36
0	6.10×10^{2}	4.84
5	8.68×10^{2}	6.80
10	1.19×10^{3}	9.40
15	1.69×10^{3}	12.8
20	2.33×10^{3}	17.2
25	3.17×10^{3}	23.0
30	4.24×10^{3}	30.4
37	6.31×10^{3}	44.0
40	7.34×10^{3}	51.1
50	1.23×10^{4}	82.4
60	1.99×10^{4}	130
70	3.12×10^{4}	197
80	4.73×10^{4}	294
90	7.01×10^{4}	418
95	8.59×10^{4}	505
100	$\mathbf{1.01\times10^{5}}$	**598**
120	1.99×10^{5}	1095
150	4.76×10^{5}	2430
200	1.55×10^{6}	7090
220	2.32×10^{6}	10,200

Example 13.12 Calculating Density Using Vapor Pressure

Table 13.5 gives the vapor pressure of water at 20.0°C as $2.33\times10^{3}\ \text{Pa}.$ Use the ideal gas law to calculate the density of water vapor in g/m^3 that would create a partial pressure equal to this vapor pressure. Compare the result with the saturation vapor density given in the table.

Strategy

To solve this problem, we need to break it down into a two steps. The partial pressure follows the ideal gas law,

$$PV = nRT, \tag{13.70}$$

where n is the number of moles. If we solve this equation for n/V to calculate the number of moles per cubic meter, we can then convert this quantity to grams per cubic meter as requested. To do this, we need to use the molecular mass of water, which is given in the periodic table.