

Vapor pressure of [Water](#), our most common fluid, is indicated below:

Temperature (°C)	Vapor Pressure (kN/m <sup>2</sup> )
0	0.6
5	0.9
10	1.2
15	1.7
20	2.3
25	3.2
30	4.3
35	5.6
40	7.7
45	9.6
50	12.5
55	15.7
60	20
65	25
70	32.1
75	38.6
80	47.5
85	57.8
90	70
95	84.5
100	101.33

Substance	Vapor Pressure (SI units)	Vapor Pressure (Bar);	Vapor Pressure (mmHg);	Temperature
<a href="#">Tungsten</a>	100 Pa	0.001	0.75	3203 °C
<a href="#">Ethylene glycol</a>	500 Pa	0.005	3.75	20 °C
<a href="#">Xenon difluoride</a>	600 Pa	0.006	4.50	25 °C
<a href="#">Water</a> (H <sub>2</sub> O)	2.3 kPa	0.023	17.5	20 °C
<a href="#">Propanol</a>	2.4 kPa	0.024	18.0	20 °C
<a href="#">Ethanol</a>	5.83 kPa	0.0583	43.7	20 °C
<a href="#">Methyl isobutyl ketone</a>	2.66 kPa	0.0266	19.95	25 °C
<a href="#">Freon 113</a>	37.9 kPa	0.379	284	20 °C
<a href="#">Acetaldehyde</a>	98.7 kPa	0.987	740	20 °C
<a href="#">Butane</a>	220 kPa	2.2	1650	20 °C
<a href="#">Formaldehyde</a>	435.7 kPa	4.357	3268	20 °C
<a href="#">Propane</a> <sup>[9]</sup>	997.8 kPa	9.978	7584	26.85 °C
<a href="#">Carbonyl sulfide</a>	1.255 MPa	12.55	9412	25 °C
<a href="#">Nitrous oxide</a> <sup>[10]</sup>	5.660 MPa	56.60	42453	25 °C
<a href="#">Carbon dioxide</a>	5.7 MPa	57	42753	20 °C

Calculate the vacuum necessary to cause cavitation in a water flow at a temperature of  $80^{\circ}\text{C}$  in Colorado where the elevation is 2500 m.

**Solution**

The vapor pressure of water at 80°C is given in Table B.1. It is 47.3 kPa absolute. The atmospheric pressure is found by interpolation using Table B.3:

$$p_{atm} = 79.48 - \frac{(79.48 - 61.64) \times 500}{2000} \cong 75.0 \text{ kPa}$$

$$\begin{aligned} p_{gage} &= p_{abs} - p_{atm} = 47.3 - 75.0 \\ &= -27.7 \text{ kPa gage} \\ &= 27.7 \text{ kPa vacuum} \end{aligned}$$

**TABLE B.3** Properties of the Standard Atmosphere

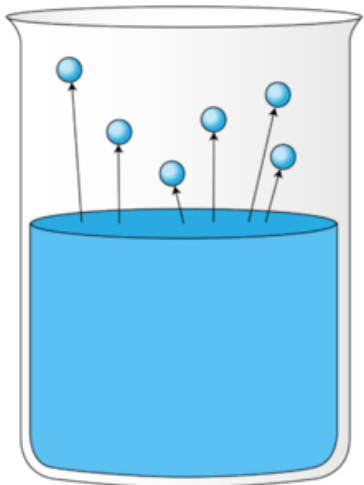
Altitude (m)	Temperature (K)	Pressure (kPa)	Density (kg/m <sup>3</sup> )	Velocity of sound (m/s)
0	288.2	101.3	1.225	340
500	284.9	95.43	1.167	338
1 000	281.7	89.85	1.112	336
2 000	275.2	79.48	1.007	333
4 000	262.2	61.64	0.8194	325
6 000	249.2	47.21	0.6602	316
8 000	236.2	35.65	0.5258	308
10 000	223.3	26.49	0.4136	300
12 000	216.7	19.40	0.3119	295
14 000	216.7	14.17	0.2278	295
16 000	216.7	10.35	0.1665	295
18 000	216.7	7.563	0.1216	295
20 000	216.7	5.528	0.0889	295
30 000	226.5	1.196	0.0184	302
40 000	250.4	0.287	4.00 × 10 <sup>-3</sup>	317
50 000	270.7	0.0798	1.03 × 10 <sup>-3</sup>	330
60 000	255.8	0.0225	3.06 × 10 <sup>-4</sup>	321
70 000	219.7	0.00551	8.75 × 10 <sup>-5</sup>	297
80 000	180.7	0.00103	2.00 × 10 <sup>-5</sup>	269

**B. FLUID PROPERTIES**

**TABLE B.1** Properties of Water

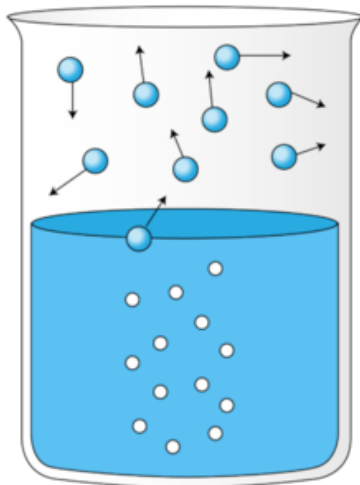
Temperature <i>T</i> (°C)	Density $\rho$ (kg/m <sup>3</sup> )	Viscosity $\mu$ (N·s/m <sup>2</sup> )	Kinematic viscosity $\nu$ (m <sup>2</sup> /s)	Surface tension $\sigma$ (N/m)	Vapor pressure $p_v$ (kPa)	Bulk modulus $B$ (Pa)
0	999.9	1.792 × 10 <sup>-3</sup>	1.792 × 10 <sup>-6</sup>	0.0762	0.610	204 × 10 <sup>7</sup>
5	1000.0	1.519	1.519	0.0754	0.872	206
10	999.7	1.308	1.308	0.0748	1.13	211
15	999.1	1.140	1.141	0.0741	1.60	214
20	998.2	1.005	1.007	0.0736	2.34	220
30	995.7	0.801	0.804	0.0718	4.24	223
40	992.2	0.656	0.661	0.0701	3.38	227
50	988.1	0.549	0.556	0.0682	12.3	230
60	983.2	0.469	0.477	0.0668	19.9	228
70	977.8	0.406	0.415	0.0650	31.2	225
80	971.8	0.357	0.367	0.0630	47.3	221
90	965.3	0.317	0.328	0.0612	70.1	216
100	958.4	0.284 × 10 <sup>-3</sup>	0.296 × 10 <sup>-6</sup>	0.0594	101.3	207 × 10 <sup>7</sup>

## Evaporation

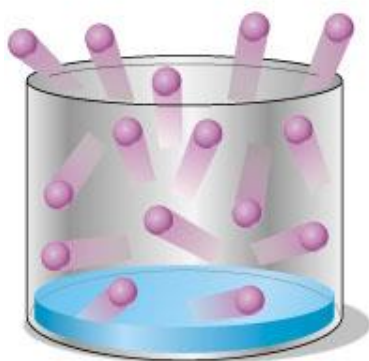


*Vapor Pressure < Atmospheric Pressure*  
Bubbles cannot form

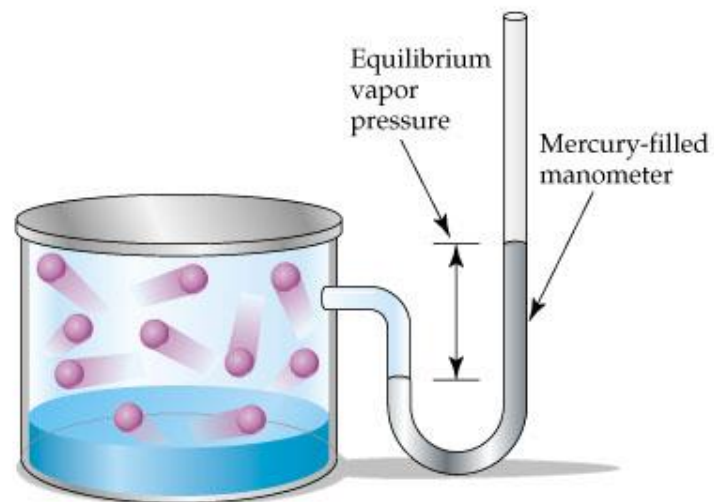
## Boiling



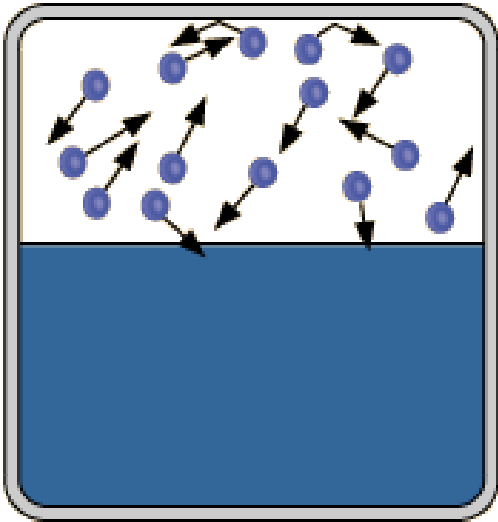
*Vapor Pressure = Atmospheric Pressure*  
Bubbles can form and rise



(a)



(b)



**Saturated Vapor Pressure**