Calculations with Temperature, Atoms, and Molecules

Directions: The usual stuff. Use the factor-units method and give answers to the proper number of significant figures.

1. For practice in working with temperatures, complete the following table:

<table>
<thead>
<tr>
<th>Object</th>
<th>T (°F)</th>
<th>T (°C)</th>
<th>T (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>457</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sun (outer part)</td>
<td>5780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europa (moon of Jupiter)</td>
<td></td>
<td>125</td>
<td></td>
</tr>
</tbody>
</table>

2. If $6.022 \times 10^{23}$ atoms of fluorine weigh about 19.0 grams, then how much do 2 atoms of fluorine weigh (a) in grams and (b) in pounds?

3. On Christmas Day, 1985, Comet Halley’s production of water was about 18 Mg / sec.
   (a) How much water, in grams, did this comet release over a 24-hour period?
   (b) How many gallons of liquid H$_2$O would this represent on Earth?

4. Consider the air inside a dormitory room that is 20.0 feet long by 20.0 feet wide by 8.0 feet high.
   (a) What is the volume of the air, in liters?
   (b) If the density of the room’s air is about 1.18 g / L, what is the total mass of the room’s air, in grams?
   (c) What is the mass of nitrogen in the room, if air is about 79% nitrogen?
5. Mercury is the only metal which is a liquid at room temperature and pressure.

(a) If a liter of mercury weighs about 30.0 pounds, what is the density of mercury in g / mL? (You can check your answer by consulting the library or your textbooks.)

(b) How does the density of liquid mercury compare to the value of 8.20 g / L for gas-phase mercury?

6. Atoms can be approximated as spheres. In liquid helium, \(6.022 \times 10^{23}\) atoms take up about 0.0237 L of space.

(a) Use this information to estimate the radius of a single helium atom, in picometers.

(b) How many helium atoms, laid end-to-end, would be needed to reach the height of the Washington Monument, about 555 inches?

7. The computer of space ace “Barbarella” (alias Jane Fonda) reported that her planet has an atmosphere with 600,324 molecules / mm\(^3\).

(a) How many significant figures is that?

(b) How many molecules / L is that?

(c) If the average mass of an air molecule on that planet is \(4.78 \times 10^{-23}\) grams, then what is the total mass, in grams, of the molecules in 1.00 L of the atmosphere?

BONUS TRIVIA: Explain the significance of “Klaatu borada nikto.”