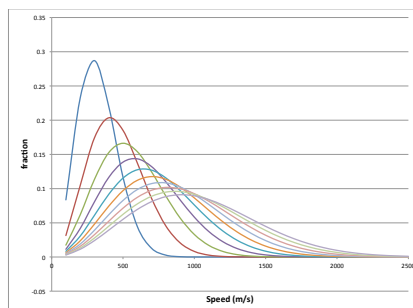
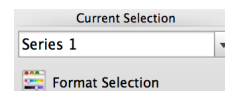


This assignment uses Excel to answer questions about the speed of gas molecules. The fraction of gas molecules with a mass of  $M$  grams/mole and a temperature of  $T$  Kelvin having a velocity between  $c$  and  $dc$  meters/sec is

$$\left(\frac{M}{2\pi RT}\right)^{3/2} 4\pi \exp\left(\frac{-Mc^2}{2RT}\right) c^2 dc.$$

To model and study this equation in Excel:

- Put a numerical value for the mass of a real gas in cell A1. See the Introduction to Excel handout.
- Store velocity  $c$  in multiples of  $dc = 100$  in column A. (Put 100 in cell A2. Put 200 in cell A3. Select cells A2 and A3, grab the lower right corner and drag *down* until the value is 2500).
- Store temperature  $T$  in multiples of 50 in row 1. (Put 50 in cell B1. Put 100 in cell C1. Select cells B1 and C1, grab the lower right corner and drag *right* until the value is 500.)
- Type the formula into cell B2. In Excel, the formula looks like  
 $=(\$A\$1/(2*PI()*8314*B\$1))^(3/2)*4*PI()*EXP(-\$A\$1*A2^2/(2*8314*B\$1))*A2^2*100$   
 Verify that this matches the formula above. Why do only some of the addresses have \$?
- Copy the formula to the remainder of the spreadsheet.
- Change the background color for the most probable speed at each temperature, i.e., the largest value in each column. (Select the values in one column. Choose Home > Conditional Formatting > Top/Bottom Rules > Top 10 Items and change the style to classic and the value in the field from 10 to 1. Repeat for each column.)
- Investigate how the speed of gas molecules change with temperature and mass by changing the value in cell A1 to that for hydrogen, neon, argon, nitrogen, and carbon dioxide. Report your answer orally to the instructor before continuing.
- Now plot the fraction of gas with mass  $M$  that has speed  $c$  (from 100 to 2500 m/sec) for a series of temperatures  $T$  (from 50 to 500 K). (Select A2 to K26 and then choose Charts > Scatter > Smoothed line scatter.)
- Use the chart layout toolbar to select Series 1 in the upper left then click on format selection or double click on the line. Change to line: weights & arrows : 2pt. Repeat for all 10 series. Click on the legend icon and delete it. Double-click on the x-axis and change scale maximum to 2500. Click on axis titles and supply horizontal axis title and vertical axis title (rotated title).
- Click on the chart area and Edit/Copy. Open Powerpoint to a blank slide. In Powerpoint, Edit/Paste Special/**Picture**. (If you Paste or Paste Special/Excel Chart Object the graph will change when you change the spreadsheet which is not what you want this time.) *Make three slides for three real gases with different molecular weights.* The graphs should all have the same size and page location so the axes do not move between slides during a show. Submit the file to Classroom.



- How does the speed of a gas molecule change with temperature? How does the distribution of speeds change with temperature? How does the speed of a gas molecule change with mass?
- Estimate how long would it take an air molecule to travel across room 401 lengthwise at room temperature if it didn't change direction or run into other molecules.