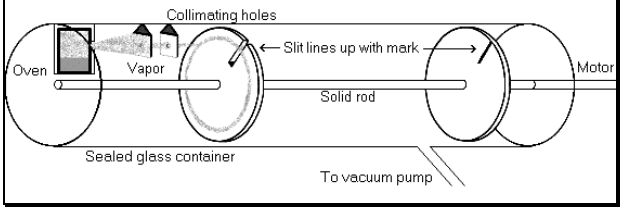
The Collision Theory and Activation Energy

Explaining how and why factors affect reaction rates

The Maxwell-Boltzman apparatus

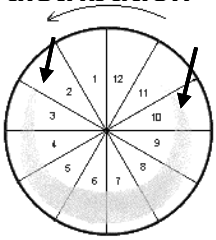
- Maxwell and Boltzman performed an experiment to determine the kinetic energy distribution of atoms
- Because all atoms of an element have roughly the same mass, the kinetic energy of identical atoms is determined by velocity ($KE = \frac{1}{2}mv^2$)

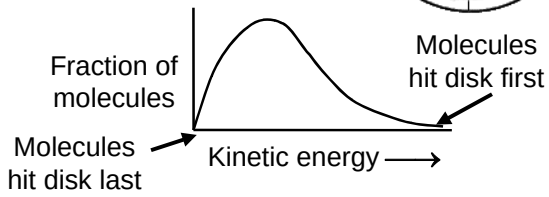


The Maxwell-Boltzman distribution

- The resulting disk looks like th

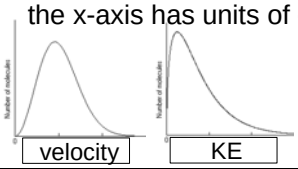
Basically, if we plot the intensity of the dots on a graph we get a graph of fraction of atoms/molecules vs. kinetic energy:





Why is the graph skewed?

- This curve is characteristic of all molecules
- The curve is elongated due to how atoms collide, and to the units of the graph
- Recall all particles are in motion. An average speed will be reached.
- The graph is skewed because 0 is the lower limit, but theoretically there is no upper limit
- More than that the graph is skewed because the x-axis has units of energy not velocity



Same data, different axes. E.g. v=1, KE=1
v=2, KE=4
v=3, KE=9

Temperature and reaction rate

- By understanding the Maxwell-Boltzman distribution, we can begin to understand the two reasons why an increase in temperature causes an increase in reaction rate
- Read pg. 754 - 755 (starting at 18.7), answer questions 18.61 - 18.64 on pg. 773 and …

Q- Look back at the five factors that affect reaction rates. Three of these factors can be (at least in part) explained by the collision theory. Identify the 3 factors and explain how the affect of each can be explained with reference to the collision theory

Temperature and reaction rate

- Demonstrations: $Mg + O_2$, $H_2 + O_2$
- By increasing the temperature, a small number of molecules reach Ea. The reaction is exothermic, further increasing temperature and causing more molecules to reach Ea, etc.
- Draw the M-B distribution for $H_2 + O_2$ before heat was applied. Show how heat affects the diagram.

Transition state theory

- Read remainder of 18.7