Why a small increase in temperature may double the rate of reaction.

What is the contribution of increased kinetic energy to the increase in reaction rate due to temperature? In other words, is the increase in molecular velocity sufficient to explain the increase in rate when raising the reaction temperature from 5 ^{O}C to 35 ^{O}C ?

$E_k = \frac{1}{2} mv^2$ m = molecular mass, v = molecular velocity

$E_k \propto T$ T = absolute temperature

Hence:

$T \propto \frac{1}{2} mv^2$

Since molecular mass is a constant, i.e. ½ m is a constant, thus:

$T \propto v^2$ i.e. $\sqrt{T} \propto v$

Thus for temperatures of 5 ^{O}C = 278 K and 35 ^{O}C = 308 K:

$\sqrt{278} \propto v_5$ and $v_{35} \propto \sqrt{308}$

Setting up a ratio to compare velocities with absolute temperatures we get:

$$\frac{v_{35}}{v_5} = \frac{\sqrt{308}}{\sqrt{278}} = 1.053$$

This means that the molecular velocity at 308 K is 5.3 % faster than that at 298 K.
Therefore, what is the other factor that is contributing to the increased rate as temperature increases?

Consider the following activity:
The following data represents a typical kinetic energy distribution for a sample of molecules:

Kinetic Energy (E_k)	**Number of molecules before heating**	**Number of molecules after an increase in temperature by 10 ^{O}C**
21	1	0
22	2	1
23	7	3
24	12	7
25	15	11
26	12	12
27	7	12
28	5	10
29	4	7
30	3	5

1. On one set of axes (i.e. same graph) plot two graphs of the number of molecules versus kinetic energy, E_k for before heating and after heating.

2. What is the most common kinetic energy value before heating? After heating?

3. Assume that the activation energy for this reaction is 28 units. How many molecules at the lower temperature have this energy or greater? At the higher temperature? Calculate the percentage increase in this number of molecules.

4. What does the area under the curve to the right of $E_k = 28$ represent? How do the areas compare for the two curves drawn?

5. Hence, what factor is responsible for an increase in the rate of the reaction due to a small increase in temperature.

Hopefully you will now understand how a small increase in temperature may double the rate of the reaction!