THE ARRHENIUS EQUATION

1. Don't forget that you have to convert the temperatures into K, and that the activation energy has to be in joules per mole, ***not*** kilojoules per mole.

   At 20°C (= 293 K), the fraction of molecules having energies equal to or greater than E_A is

   $$e^{-(40000/(8.31 \times 293))} = 7.33 \times 10^{-8}$$

   At 40°C (= 313 K), the fraction of molecules having energies equal to or greater than E_A is

   $$e^{-(40000/(8.31 \times 313))} = 2.10 \times 10^{-7}$$

   Assuming A is constant, the value of the rate constant, k, will have increased by a factor of

   $$2.10 \times 10^{-7} / 7.33 \times 10^{-8} = 2.86$$

   If the concentrations of reactants in the rate expression are still the same as before, then the rate will have increased by this same amount.

   (Note: If the "rates double for an increase of 10°C" rule applied, this would give an increase in rate of 4 times. This rule only works for reactions with an activation energy of about 50 kJ mol^{-1} at temperatures around room temperature.)

2. At 21°C, the fraction of molecules having energies equal to or greater than an E_A of 50 kJ mol^{-1} is

   $$e^{-(50000/(8.31 \times 294))} = 1.29 \times 10^{-9}$$

   At 21°C, the fraction of molecules having energies equal to or greater than an E_A of 35 kJ mol^{-1} is

   $$e^{-(35000/(8.31 \times 294))} = 6.00 \times 10^{-7}$$

   The number of sufficiently energetic molecules has therefore increased by a factor of

   $$6.00 \times 10^{-7} / 1.29 \times 10^{-9} = 465$$