2/25/2019

The effect of temp upon rxn rate

rate ↑ as T ↑ (for every ~10°C increase in temp., rxn rate doubles)

rate law: $rate = K[A]^m$

- K: rate const: has a strong T-dependence! K ↑ as T ↑
- [A]: slight decrease as we increase T. (why? V↑ T↑)

1889, Swedish Chemist: Svante Arrhenius

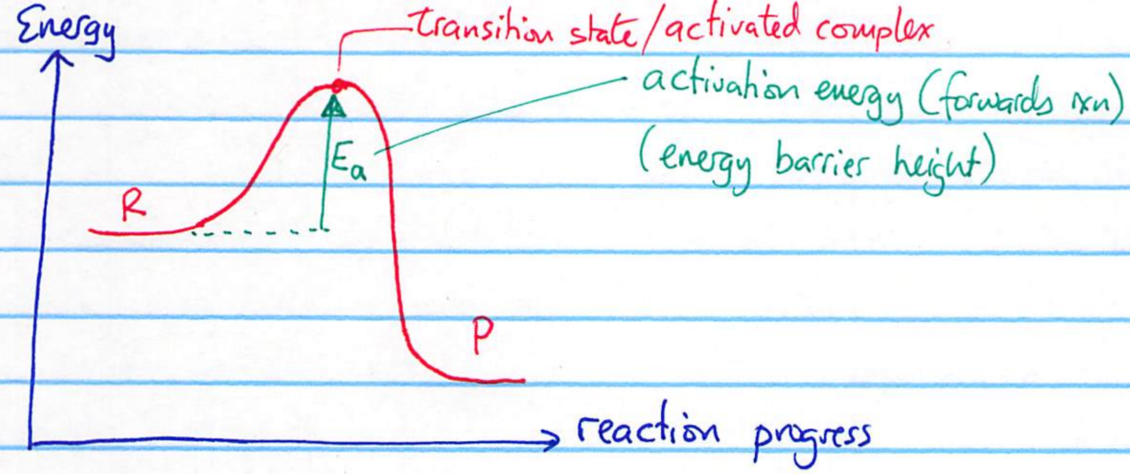
Arrhenius Equation

$$K = A \times e^{-\frac{E_a}{RT}}$$

- E_a — activation energy (J/mol, KJ/mol)
- T — absolute temp (K)
- R — gas constant = 8.3145 J/mol·K

A: pre-exponential factor (OR) frequency factor
- related to # reactant collisions/s

$e^{-\frac{E_a}{RT}}$: exponential factor (strong T-dependence) ex: $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g)$



note: exothermic rxn.

$\Delta H = -ve$

$\Delta H < 0$

$$K = A \cdot e^{-E_a/RT}$$

1. A ~ pre-exponential factor / frequency factor

$$A = p \cdot Z$$

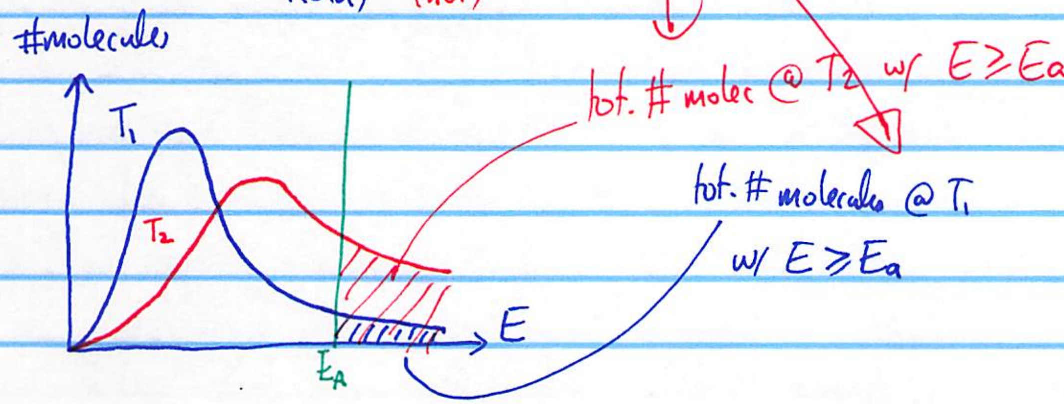
Z — collision frequency (#collisions/s)

p — orientation factor (prob. that molecules collide w/ proper orientation)

2. Exponential factor, $e^{-E_a/RT}$

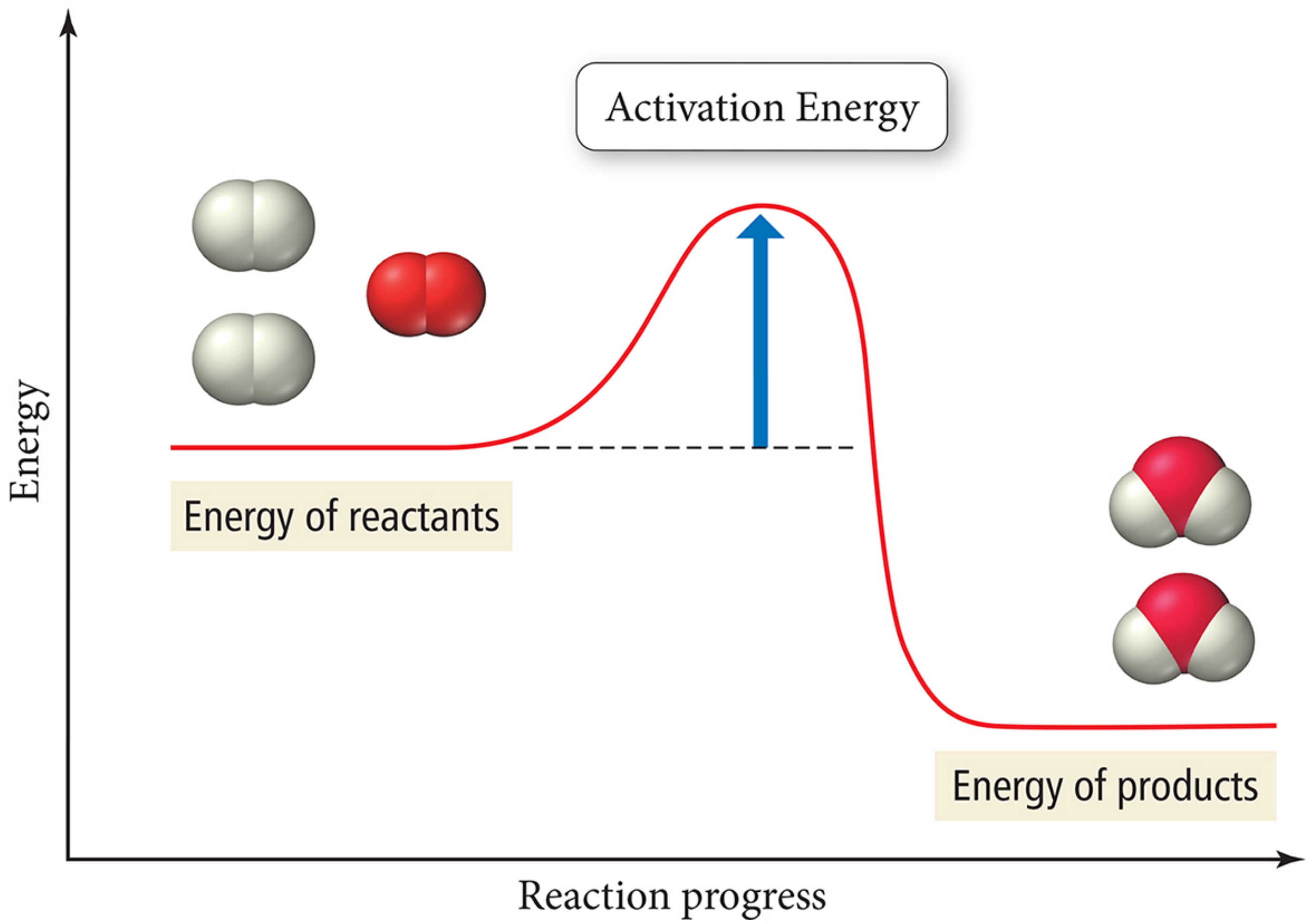
- represents prob. molecules collide w/ $E \geq E_a$

Graph: T_1, T_2 $T_1 < T_2$ (cold) (hot)



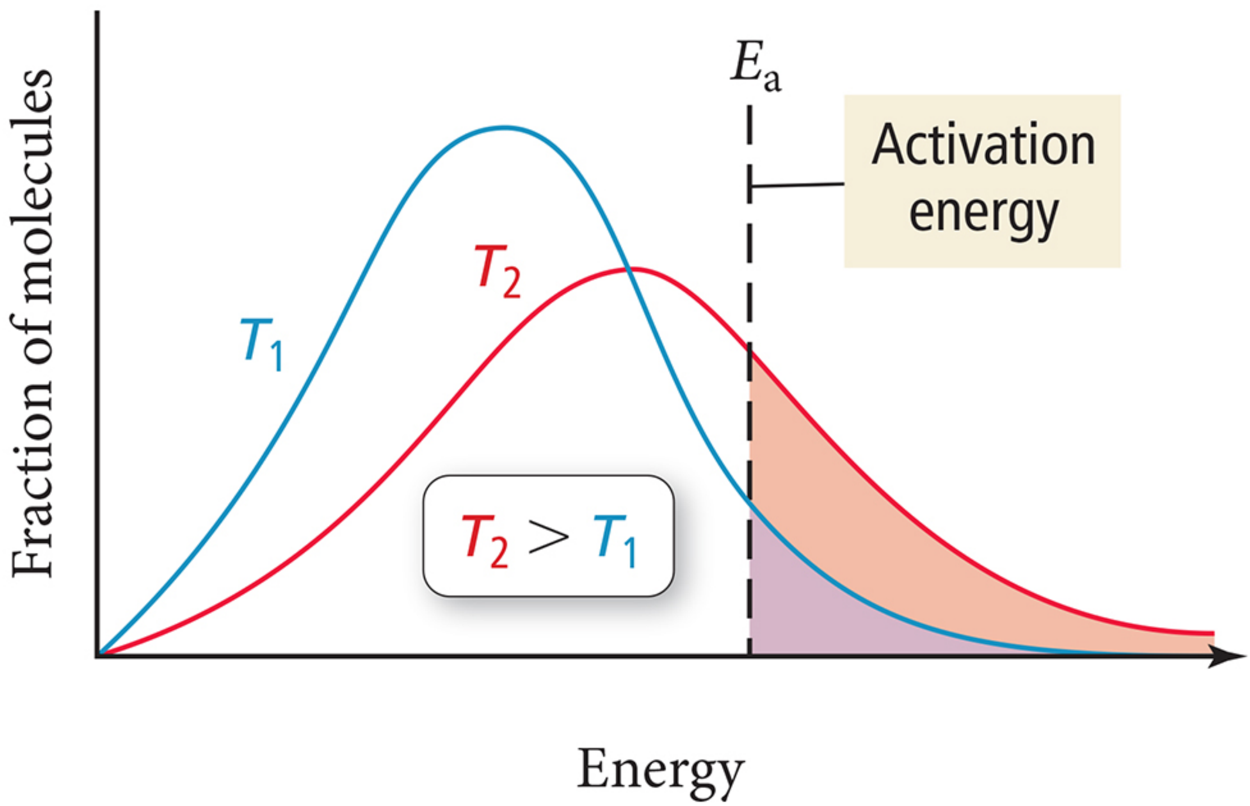
Activation Energy

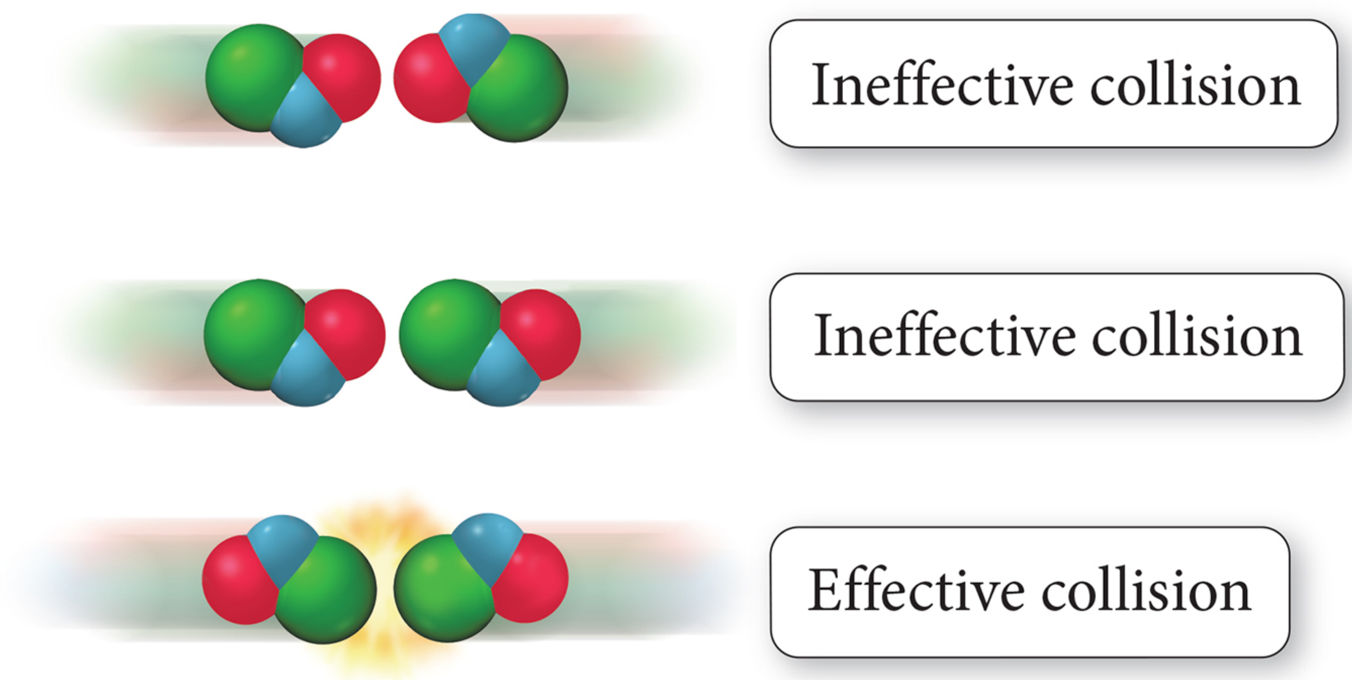
$$2\,H_2(g) + O_2(g) \rightleftharpoons 2\,H_2O(g)$$



Thermal Energy Distribution

As temperature increases, the fraction of molecules with enough energy to surmount the activation energy barrier also increases.




Ineffective collision
Ineffective collision
Effective collision

$e^{-E_a/RT}$ as $T \to \infty$ // as $T \to 0$

(prob $E \geq E_a$) $\cdot$ $e^{-E_a/RT} \to 1$ $e^{-E_a/RT} \to 0$

as $E_a \to \infty$ // as $E_a \to 0$

$e^{-E_a/RT} \to 0$ $e^{-E_a/RT} \to 1$

Arrhenius plots

graphical methods of finding A, and E_a

$$k = A \cdot e^{-E_a/RT}$$

ln( ) ↳

$$\ln k = \ln A - \frac{E_a}{RT}$$

OR: $\ln k = \frac{-E_a}{R} \cdot \left(\frac{1}{T}\right) + \ln A$

$$y = m \cdot x + b$$