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1. Which parameter, kinetic or thermodynamic, gives us information about the rate and mechanism of the reaction?

▷ **Kinetics**

- Kinetics refers to the rate of a reaction, while thermodynamics refers to the equilibrium concentrations of the reactants and products.

2. For a reaction to be spontaneous,  $\Delta G^\circ$  must be

▷ **Negative**

**Gibbs free energy ( $\Delta G^\circ$ ):** the maximum amount of non-expansion work that can be extracted from a closed system.

- Essentially a repackaged way of expressing entropy in a closed system.
- $\Delta G^\circ$  is just  $\Delta S^\circ$  multiplied by the negative temperature in order to measure the entropy of the surroundings.
- Thus,  $\Delta G^\circ$  must be **negative** for a reaction to be spontaneous. (second law of thermodynamics)

3. Which part of the energy level diagram shown below, represents the kinetic component, and which represents the thermodynamic component?

▷ **A is kinetic, B is thermodynamic**

- **A** represents the activation energy ( $E_a$ ,  $\Delta G_{\text{act}}$ ) required for a reaction to form products.
- **B** represents the difference in free energy ( $\Delta G^\circ$ ) of the products from the initial reactants.
  - **Endergonic:** nonspontaneous ( $+\Delta G^\circ$ ) processes.
  - **Exergonic:** spontaneous ( $-\Delta G^\circ$ ) processes.

4. Which factors affect the equilibrium of a reaction?

▷ **a and b** (temperature and concentration)

- Rate of the reaction and catalysts effect the kinetics (rate), not equilibrium (thermodynamics)

5. Which factors affect the rate of a reaction?

- ▷ **a, c, and c** (concentration, temperature, and presences of catalysts)
  - There are more, such as, substrate type, physical state, surface area, concentration, temperature, catalysts, pressure, and light absorption.
  - Essentially concentration effects the *rate order*, while everything else effects the rate constant  $k$  ( $\text{rate} = k[\text{reactants}]$ )
  - As described above, endergonic and exergonic has to do with  $\Delta G^\circ$  (equilibrium).

6. A small activation energy,  $\Delta G_{\text{act}}$ , corresponds to a

- ▷ **a fast reaction**
  - Lower the activation energy, the less potential energy is needed for a reaction to occur, and thus more likely (faster) that a larger portion of molecules will undergo the reaction upon collision.

7. Which parameter, kinetic or thermodynamic, determines the equilibrium constant and how much product will form?

- ▷ **Thermodynamic**
  - Kinetics refers to the rate of a reaction, while thermodynamics refers to the equilibrium concentrations of the reactants and products.

8. A large and negative  $\Delta G^\circ$  will correspond to

- ▷ **a large  $K_{\text{eq}}$** 
  - A large  $-\Delta G^\circ$  means the **products** are favored. ( $1 < K_{\text{eq}}$ )
  - A large  $+\Delta G^\circ$ : the **reactants** are favored. ( $K_{\text{eq}} < 1$ )
  - $K_{\text{eq}}$  says nothing about rate, that is determined by the kinetics, instead it just determines the direction and spontaneity.