**Reaction Mechanisms and Reaction Profiles Practice**

1. A. How many elementary steps are in the reaction mechanism shown below?

B. On the energy profile below, indicate

a. the position of the reactants and products

b. the activation energy for the overall reaction

c. ΔE for the reaction

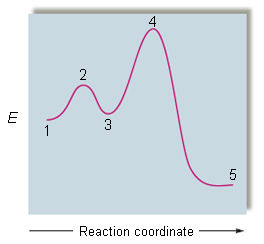
d. the point on the plot that represents the energy of the intermediate

e. the transition state (activated complex)

f. the rate-determing step

g. how a catalyst would affect the reaction

C. Is the overall reaction endothermic or exothermic?



2. Consider the following 3-step mechanism for an exothermic reaction.

Step 1: Cl2(g) ↔ 2Cl(g) *fast, k1 forward, k-1 reverse*

Step 2: Cl(g) + CHCl3(g) → HCl(g) + CCl3(g) *slow, k2*

Step 3: Cl(g) + CCl3(g) → CCl4(g) *fast, k3*

A. What is the overall reaction?

B. What are the reaction intermediates?

C. Write the rate law that is consistent with this mechanism, showing how you

derive it.

3. A. How many elementary steps are in the reaction mechanism shown below?

B. On the energy profile below, indicate

a. the position of the reactants and products

b. the activation energy for the overall reaction

c. ΔE for the reaction

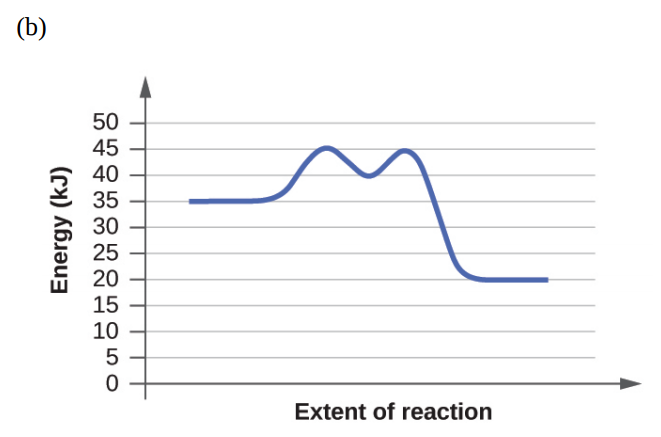
d. the point on the plot that represents the energy of the intermediate

e. the transition state (activated complex)

f. the rate-determing step

g. how a catalyst would affect the reaction

C. Is the overall reaction endothermic or exothermic?



4. A. How many elementary steps are in the reaction mechanism shown below?

B. On the energy profile below, indicate

a. the position of the reactants and products

b. the activation energy for the overall reaction

c. ΔE for the reaction

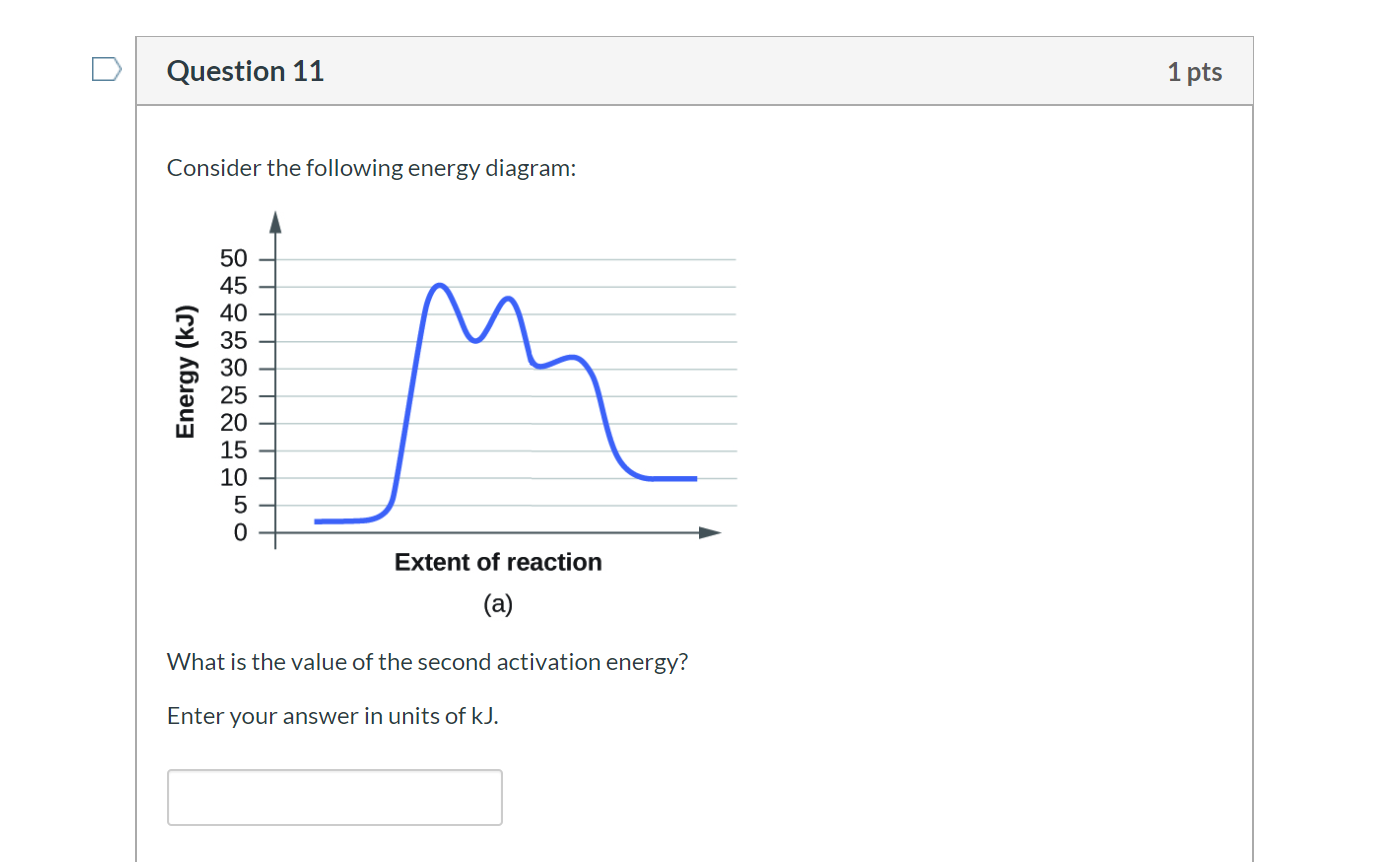
d. the point on the plot that represents the energy of the intermediate

e. the transition state (activated complex)

f. the rate-determing step

g. how a catalyst would affect the reaction

C. Is the overall reaction endothermic or exothermic?



5. Consider the following 3-step mechanism for an exothermic reaction.

Step 1: I2(g) ↔ 2I(g) *fast, k1 forward, k-1 reverse*

Step 2: l(g) + H2(g) ↔ H2I(g) *fast, k2 forward, k-2 reverse*

Step 3: H2I(g) + I(g) → 2HI(g) slow*, k3*

A. What is the overall reaction?

B. What are the reaction intermediates?

C. Write the rate law that is consistent with this mechanism, showing how you

derive it.

6. A. How many elementary steps are in the reaction mechanism shown below?

B. On the energy profile below, indicate

a. the position of the reactants and products

b. the activation energy for the overall reaction

c. ΔE for the reaction

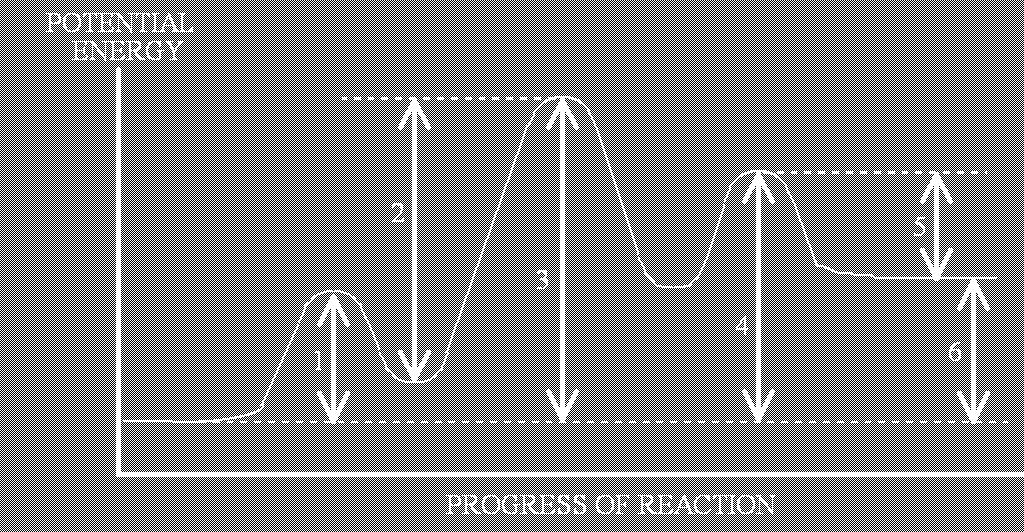
d. the point on the plot that represents the energy of the intermediate

e. the transition state (activated complex)

f. the rate-determing step

g. how a catalyst would affect the reaction

C. Is the overall reaction endothermic or exothermic?



7. The activation energy for the reaction

NO2(g) + CO(g) 🡪 NO(g) + CO2(g)

is 125 kJ/mole, and ΔE for the reaction is -216 kJ/mole. What is the activation

energy for the reverse reaction [NO(g) + CO2(g) 🡪 NO2(g) + CO(g)]?

8. For a certain reaction, the activation energy is greater for the forward reaction than the reverse reaction. Does the reaction have a positive or negative value for ΔE?

9. The following mechanism has been proposed for the reaction of methane gas with chlorine gas. All species are in the gas phase.

Step 1: Cl2 ↔ 2Cl *fast equilibrium*

Step 2: CH4 + Cl → CH3 + HCl *slow*

Step 3: CH3 + Cl2 → CH3Cl + Cl  *fast*

Step 4: CH3Cl + Cl → CH2Cl2 + H *fast*

Step 5: H + Cl → HCl *fast*

A. In the mechanism, is CH3Cl a catalyst, or is it an intermediate? Justify your answer.

B. Identify the order of the reaction with respect to each of the following according to the mechanism. In each case, justify your answer.

(i) CH4

(ii) Cl2

10. The rate law for a reaction is found to be Rate = k[A]2[B]. Which of the following mechanism gives this rate law?

1. A + B ↔ E (fast) II. A + A 🡪 E (fast)

E + B 🡪 C + D (slow) E + B 🡪 C + D (slow)

III. A + B ↔ E (fast)

E + A 🡪 C (slow)

11. The following mechanism has been proposed for the decomposition of ozone into oxygen gas. All species are in the gas phase.

O3 ↔ O2 *fast, reversible (k1 forward, k-1 reverse)*

O3 + O2 → 2O2 *slow (k2)*

A. What is the overall reaction?

B. What are the reaction intermediates?

C. Write the rate law that is consistent with this mechanism, showing how you

derive it.