Topics 5.4 – 5.11: MCQ Practice

Step 1: $NO(g) + Cl_2(g) \rightarrow NOCl_2(g)$

Step 2: $NOCl_2(g) + NO(g) \rightarrow 2 NOCl(g)$

_____

Overall reaction: $2 NO(g) + Cl_2(g) \rightarrow 2 NOCl(g)$
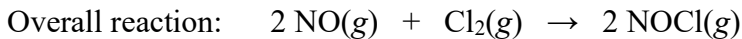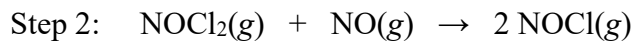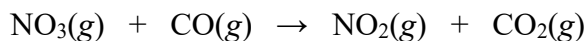
1. A proposed mechanism for a chemical reaction is represented above. Which of the following gives the correct expression for the rate law for Step 1 of this mechanism?

(A) rate = $k[NO][Cl_2]$

(B) rate = $k[NOCl_2]$

(C) rate = $k[NOCl_2][NO]$

(D) rate = $k[NO]^2[Cl_2]$

$$NO_3(g) + CO(g) \rightarrow NO_2(g) + CO_2(g)$$

2. The elementary reaction between $NO_3(g)$ and $CO(g)$ is represented by the equation above. Which of the following orientations of collision between $NO_3(g)$ and $CO(g)$ is most likely to be effective?

3. Which of the following best helps explain why an increase in temperature increases the rate of a chemical reaction?

   (A) At higher temperatures, reactions have a lower activation energy.

   (B) At higher temperatures, reactions have a higher activation energy.

   (C) At higher temperatures, every collision results in the formation of product.

   (D) At higher temperatures, high-energy collisions happen more frequently.

$$H_2(g) + Cl_2(g) \rightarrow 2\,HCl(g) \quad \Delta H = -185\ kJ/mol_{rxn}$$
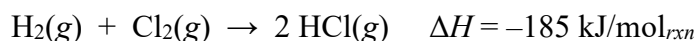
4. Hydrogen chloride, $HCl(g)$, is formed from the elements hydrogen and chlorine as represented by the equation above. Which of the following diagrams shows the correctly labeled activation energy, E_a, for the reaction between $H_2(g)$ and $Cl_2(g)$ to form $HCl(g)$?
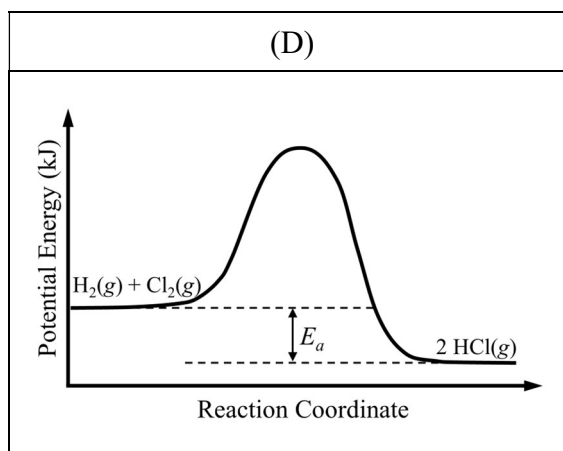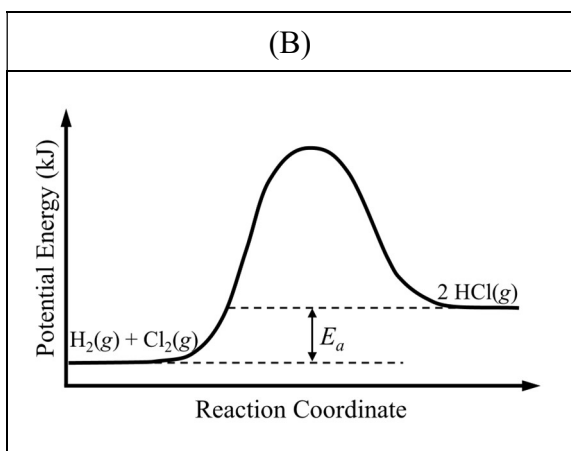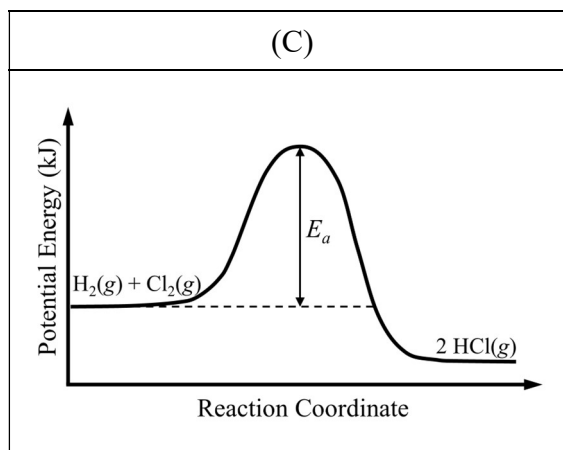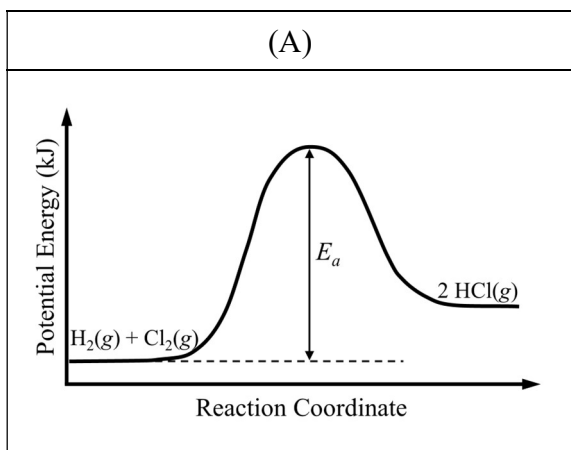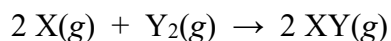
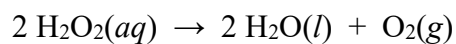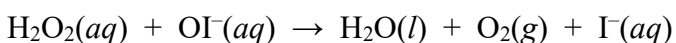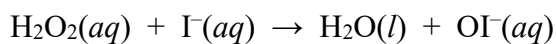$$2 \, X(g) + Y_2(g) \rightarrow 2 \, XY(g)$$

5. The two mechanisms in the table below have been proposed for the reaction represented above.

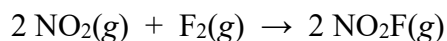| Mechanism 1	Mechanism 2
Step 1: $X(g) + X(g) \rightarrow X_2(g)$ *slow*	Step 1: $X(g) + Y_2(g) \rightarrow XY_2(g)$ *slow*
Step 2: $X_2(g) + Y_2(g) \rightarrow 2 \, XY(g)$ *fast*	Step 2: $XY_2(g) + X(g) \rightarrow 2 \, XY(g)$ *fast*

Which of the following observations would support mechanism 1 but not mechanism 2?

(A) The reaction rate is independent of $[X]$.

(B) The reaction rate is independent of $[Y_2]$.

(C) The reaction is exothermic.

(D) The reaction is second order overall.

6. The following reaction mechanism is proposed for the decomposition of H_2O_2.

$$H_2O_2(aq) + I^-(aq) \rightarrow H_2O(l) + OI^-(aq)$$

$$H_2O_2(aq) + OI^-(aq) \rightarrow H_2O(l) + O_2(g) + I^-(aq)$$

$$2 \, H_2O_2(aq) \rightarrow 2 \, H_2O(l) + O_2(g)$$

Which of the following choices has correctly identified a species that behaves as a catalyst <u>and</u> a species that behaves as an intermediate in the proposed mechanism?

	Species that Behaves as a Catalyst	Species that Behaves as an Intermediate
(A)	I^-	H_2O
(B)	OI^-	H_2O
(C)	I^-	OI^-
(D)	OI^-	I^-

$$2\ NO_2(g)\ +\ F_2(g)\ \rightarrow\ 2\ NO_2F(g)$$

7. The rate law for the reaction represented by the equation above is rate = $k\ [NO_2][F_2]$. Which of the following could be the first elementary step of a two-step mechanism for the reaction if the first step is slow and the second step is fast?

(A) $F_2(g)\ \rightarrow\ 2\ F(g)$

(B) $NO_2(g)\ +\ F_2(g)\ \rightarrow\ NO_2F(g)\ +\ F(g)$

(C) $NO_2(g)\ +\ F(g)\ \rightarrow\ NO_2F(g)$

(D) $2\ NO_2(g)\ +\ F_2(g)\ \rightarrow\ 2\ NO_2F(g)$

$$X_2\ +\ Y_2\ \rightarrow\ X_2Y_2$$
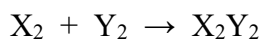
$$\text{rate} = k[X_2]$$

8. A reaction and its experimentally determined rate law are represented above. A chemist proposes two different possible mechanisms for the reaction, which are given below.
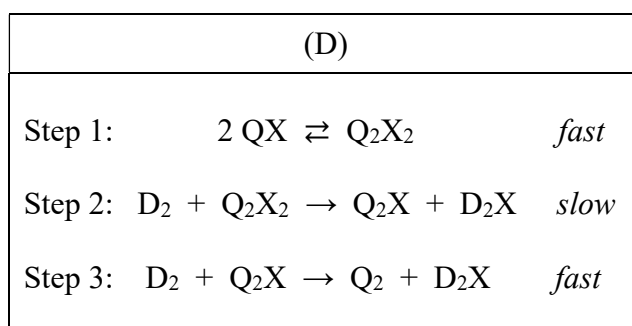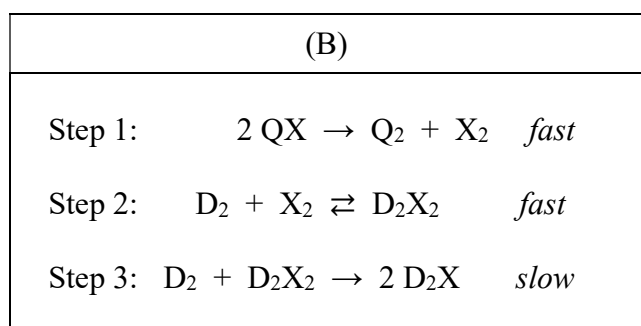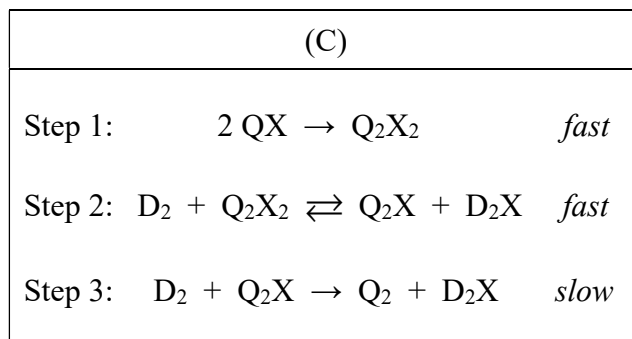
Mechanism 1	Mechanism 2
$X_2\ \rightarrow\ 2\ X$ *slow*	$X_2\ \rightarrow\ 2\ X$ *slow*
$X\ +\ Y_2\ \rightarrow\ XY_2$ *fast*	$X\ +\ Y_2\ \rightarrow\ XY\ +\ Y$ *fast*
$X\ +\ XY_2\ \rightarrow\ X_2Y_2$ *fast*	$X\ +\ XY\ \rightarrow\ X_2Y$ *fast*
	$X_2Y\ +\ Y\ \rightarrow\ X_2Y_2$ *fast*

Based on the information above, which of the following is true?

(A) Only mechanism 1 is consistent with the rate law.

(B) Only mechanism 2 is consistent with the rate law.

(C) Both mechanism 1 and mechanism 2 are consistent with the rate law.

(D) Neither mechanism 1 nor mechanism 2 is consistent with the rate law.

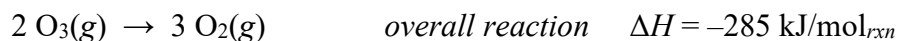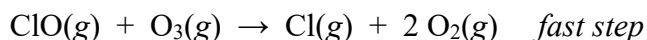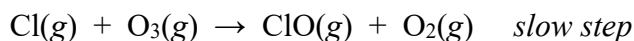$$2 \text{ D}_2(g) + 2 \text{ QX}(g) \rightarrow \text{Q}_2(g) + 2 \text{ D}_2\text{X}(g)$$
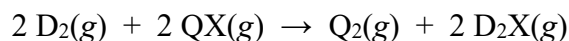
9. The experimental rate law for the reaction represented above is rate = $k[\text{D}_2][\text{QX}]^2$. Which of the following proposed mechanisms is consistent with the rate law?

(A)
Step 1:   2 QX → Q₂ + X₂   *slow*
Step 2:   D₂ + X₂ → D₂X₂   *fast*
Step 3: D₂ + D₂X₂ → 2 D₂X   *fast*

(C)
Step 1:   2 QX → Q₂X₂   *fast*
Step 2: D₂ + Q₂X₂ ⇌ Q₂X + D₂X   *fast*
Step 3:   D₂ + Q₂X → Q₂ + D₂X   *slow*

(B)
Step 1:   2 QX → Q₂ + X₂   *fast*
Step 2:   D₂ + X₂ ⇌ D₂X₂   *fast*
Step 3: D₂ + D₂X₂ → 2 D₂X   *slow*

(D)
Step 1:   2 QX ⇌ Q₂X₂   *fast*
Step 2: D₂ + Q₂X₂ → Q₂X + D₂X   *slow*
Step 3:   D₂ + Q₂X → Q₂ + D₂X   *fast*
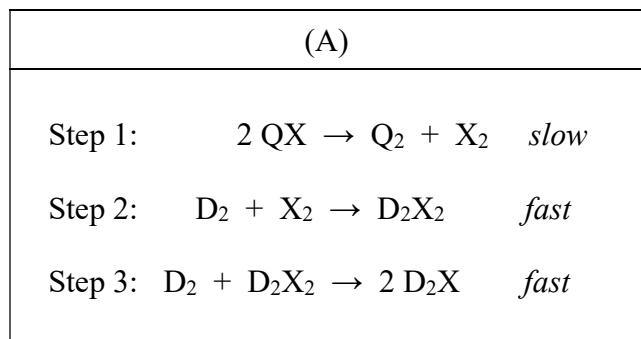
10. When free Cl(g) atoms encounter $\text{O}_3(g)$ molecules in the upper atmosphere, the following reaction mechanism is proposed to occur.

$$\text{Cl}(g) + \text{O}_3(g) \rightarrow \text{ClO}(g) + \text{O}_2(g) \quad \textit{slow step}$$

$$\text{ClO}(g) + \text{O}_3(g) \rightarrow \text{Cl}(g) + 2\text{ O}_2(g) \quad \textit{fast step}$$

_____

$$2 \text{ O}_3(g) \rightarrow 3 \text{ O}_2(g) \qquad \textit{overall reaction} \quad \Delta H = -285 \text{ kJ/mol}_{rxn}$$

Which of the following reaction energy profiles best corresponds to the proposed mechanism?

(A)	(B)	(C)	(D)

$$2\ X_2Y_2(g) \rightarrow 2\ X_2Y(g) + Y_2(g)$$
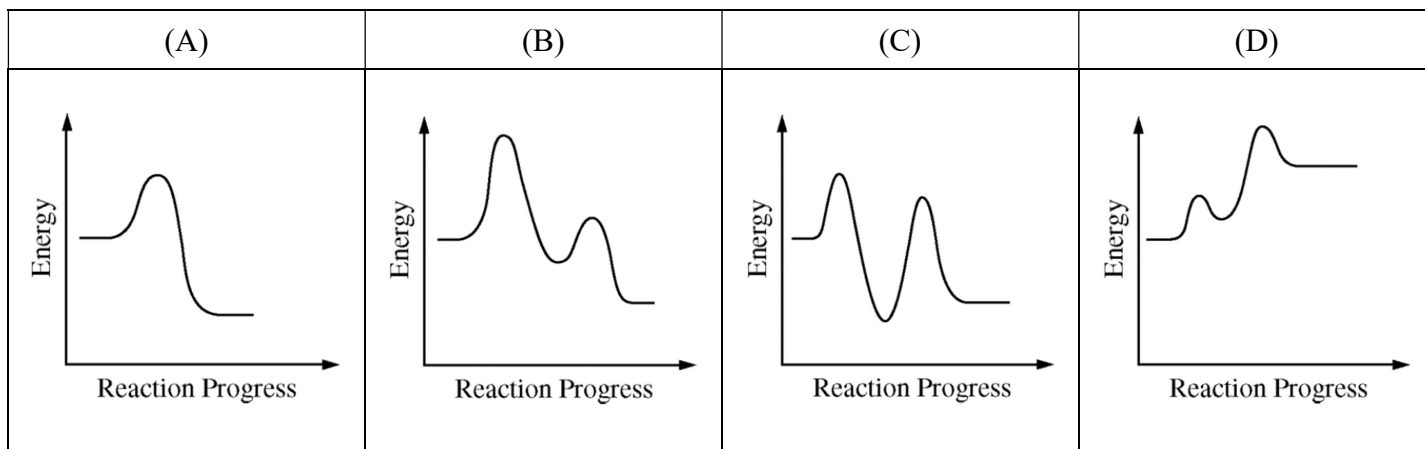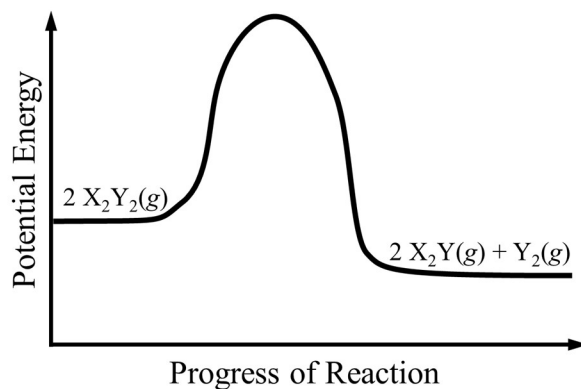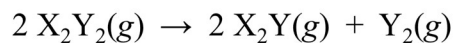
11. The potential energy diagram for the uncatalyzed decomposition of $X_2Y_2(g)$ is shown above. Which of the following best represents the energy diagram for the decomposition of $X_2Y_2(g)$ in the presence of a suitable catalyst, shown as a dashed line?

(A)

(C)

(B)

(D)