Potential Energy Diagrams

**Aim:** Analyzing Potential Energy Diagrams

\[ H_2 + Br_2 \rightarrow HBr \]

- Sufficient energy
- Proper orientation

Effective collision

Activated complex

intermediate
Energy changes and Diagrams

• Every chemical reaction will either absorb or release energy.

• A potential energy diagram shows the change in energy during a reaction.

• Heat of Reaction, $\Delta H$: the overall difference in potential energy between the products and the reactants.

  $\Delta H = \text{PEP} - \text{PER}$

  **Endothermic**
  - Energy is absorbed
  - $\Delta H = +$ (net gain)

  **Exothermic**
  - Energy is released
  - $\Delta H = -$ (net loss)
Labeling the Diagram

PROGRESS OF THE REACTION
Potential Energy Diagrams 2016

$H_2 + Br_2 \rightarrow 2HBr$

1. PE reaction (50kJ)
   \[ (125-50 = 75kJ) \]

2. EA (activation energy)
   \[ energy \ required \ for \ reaction \ to \ occur \]

3. Activated complex energy (intermediate)
   \[ (EA \ cong.) \]

4. Reverse activation energy

5. \[ \Delta H = PE_P - PE_R = (75-50 = 25kJ) \]

6. PE products (75kJ)

7. Catalyzed activation energy
   - A catalyst provides an alternate pathway for the reaction with a lower activation energy.
   - \[ \Delta H \] will NOT change.

**PROGRESS OF THE REACTION**
1. What is the potential energy of the reactants? \(350 \text{ kJ}\)

2. What is the potential energy of the products? \(150 \text{ kJ}\)

3. In the potential energy diagram above, what is the activation energy of the forward reaction? \(500-150= 350 \text{ kJ}\)

4. What is the \(\Delta H\) (total energy change) of the reaction? Is this reaction endothermic or exothermic? \(\Delta H = \text{PEP-PER}=150-350= -200 \text{ kJ (exothermic)}\)
DIAGRAM #2

Example Reaction: \( A + B \rightarrow C + D + \text{Heat} \)

Potential Energy Diagram:

- Reactants: \( A + B \)
- Products: \( C + D \)
- Reaction Pathway:
  - Energy Levels: 100, 150, 200, 250, 300, 350, 400, 450, 500 kJ

Questions:

5. What is the potential energy of the products of the forward reaction? \( 400 \text{ kJ} \)
6. What is the potential energy of the reactants of the forward reaction? \( 200 \text{ kJ} \)
7. What is the \( \Delta H \) of the forward reaction?
   \[ \Delta H = \text{PEP} - \text{PER} = 400 - 200 = 200 \text{ kJ} \text{ (endothermic)} \]
8. What is the potential energy of the activated complex for the forward reaction? \( 500 \text{ kJ} \)
9. What is the potential energy of the products of the reverse reaction? \( 200 \text{ kJ} \)
10. What is the potential energy of the reactants of the reverse reaction? \( 400 \text{ kJ} \)
11. What is the \( \Delta H \) of the reverse reaction?
   \[ \Delta H = \text{PEP} - \text{PER} = 200 - 400 = -200 \text{ kJ} \text{ (exothermic)} \]
12. What is the potential energy of the products? **400 kJ**

13. What is the potential energy of the reactants? **200 kJ**

14. What is the activation energy of the forward uncatalyzed reaction? **500-200= 300 kJ**

15. What is the activation energy of the catalyzed reaction? **500-200= 300 kJ**

16. What is the $\Delta H$ of the both the uncatalyzed and catalyzed reactions? **200 kJ**