**ANSWER KEY.**

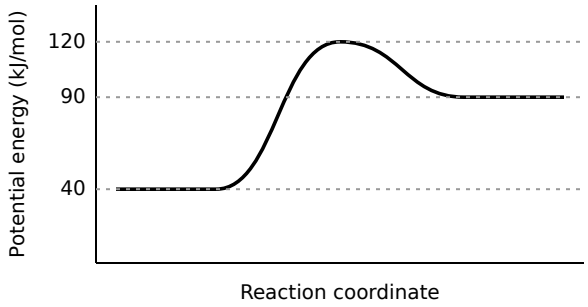


# 5.6 Reaction Energy Profile

AP Chemistry | ANSWER KEY

Measure $E_a$ from the reactants to the transition state. $\Delta H$ = energy of products − energy of reactants. Include units.

**1.** Use the energy profile to answer the questions.




(a) Find $E_a$ for the forward reaction.

(b) Find $\Delta H$.

(c) Is the reaction exothermic or endothermic? Explain.

(d) Find $E_a$ for the reverse reaction.

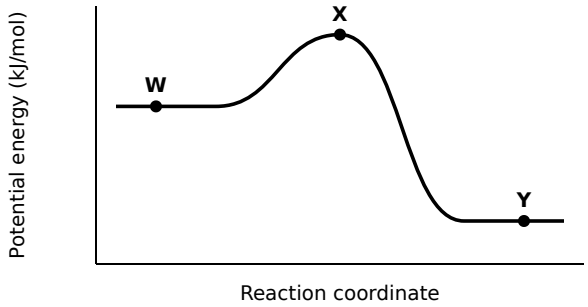
**(a) $E_a$ = 120 kJ/mol − 40 kJ/mol = 80 kJ/mol**

**(b) $\Delta H$ = 90 kJ/mol − 40 kJ/mol = +50 kJ/mol**

**(c) Endothermic. The products are higher in energy than the reactants ($\Delta H > 0$), so energy is absorbed.**

**(d) $E_a$(reverse) = 120 kJ/mol − 90 kJ/mol = 30 kJ/mol**

**2.** Points W, X, and Y are marked on the energy profile below.




(a) Which point is the transition state? Describe the bonds at that point.

(b) Is the reaction exothermic or endothermic?

(c) Can the species at the transition state be isolated in a bottle? Explain.

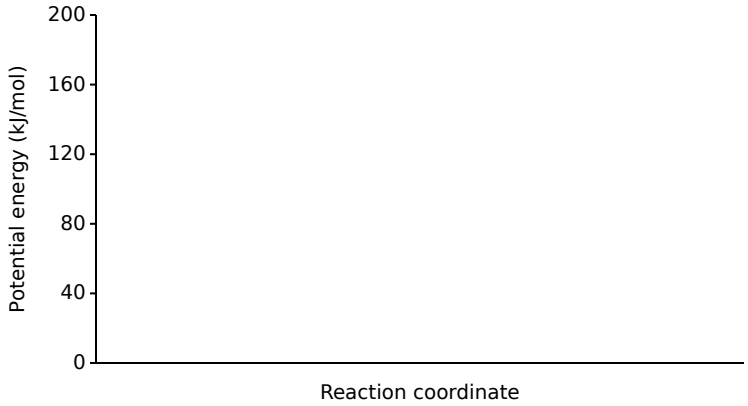
**(a) X, the top of the hill. Old bonds are partly broken and new bonds are partly formed. It is the highest-energy arrangement along the path.**

**(b) Exothermic. Products (Y) are lower in energy than reactants (W).**

**(c) No. The transition state lasts only an instant, so it cannot be isolated.**


CC BY-NC-SA 4.0 | zornscience.org

**3.** On the axes below, sketch the energy profile for an elementary reaction with reactants at 100 kJ/mol, $E_a$ = 60 kJ/mol, and $\Delta H$ = −80 kJ/mol. Label the reactants, the transition state, the products, $E_a$, and $\Delta H$.




**Reactants flat at 100 kJ/mol, a hill peaking at the transition state at 100 + 60 = 160 kJ/mol, then down to products at 100 − 80 = 20 kJ/mol. $E_a$ arrow from 100 up to 160. $\Delta H$ arrow from the reactant level (100) down to the products (20).**

---

**4.** An elementary reaction has $\Delta H$ = −45 kJ/mol and $E_a$ = 75 kJ/mol for the forward reaction. Calculate $E_a$ for the reverse reaction.

**The transition state is 75 kJ/mol above the reactants, and the products are 45 kJ/mol below the reactants.**
**$E_a$(reverse) = 75 kJ/mol + 45 kJ/mol = 120 kJ/mol**

---

**5.** The Arrhenius equation is $k = A \exp(-E_a/RT)$. No calculation is needed.

(a) What happens to $k$ when the temperature increases?

(b) At the same temperature, reaction 1 has $E_a$ = 35 kJ/mol and reaction 2 has $E_a$ = 85 kJ/mol. Which has the larger $k$? Explain using collisions.

**(a) $k$ increases, so the reaction is faster.**

**(b) Reaction 1. A smaller $E_a$ gives a larger $k$. At the same temperature, a larger fraction of collisions have energy ≥ 35 kJ/mol than ≥ 85 kJ/mol, so more collisions reach the transition state each second.**


CC BY-NC-SA 4.0 | zornscience.org