1. In an exothermic reaction:

   ☐ heat is taken in, the products are lower in energy, and ΔH is negative

   ☐ heat is taken in, the products are higher in energy, and ΔH is positive

   ☐ heat is given out, the products are higher in energy, and ΔH is positive

   ☐ heat is given out, the products are lower in energy, and ΔH is negative

2. Which statement is correct?

   ☐ breaking bonds takes energy in (endothermic); making bonds gives energy out (exothermic)

   ☐ breaking bonds and making bonds both take energy in

   ☐ breaking bonds gives energy out; making bonds takes energy in

   ☐ neither breaking nor making bonds changes the energy

3. Hess's law states that the total enthalpy change for a reaction:

   ☐ is the same no matter which route is taken from reactants to products

   ☐ is always positive, because energy is needed to react

   ☐ is always zero when the products return to the start

   ☐ depends on the route taken from reactants to products

4. The activation energy is:

   ☐ the difference between products and reactants

   ☐ always zero

   ☐ the energy given out by the reaction

   ☐ the least energy the particles need before they can react

5. Using bond energies, ΔH of reaction equals:

   ☐ bonds made ÷ bonds broken

   ☐ bonds broken × bonds made

   ☐ sum of bonds broken − sum of bonds made

   ☐ sum of bonds made − sum of bonds broken

6. Hess's law works because energy is conserved.

   ☐ True ☐ False

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8. Breaking bonds is exothermic and making bonds is endothermic.

   ☐ True ☐ False

9. The law stating that enthalpy change is independent of the route taken is _____ law.

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10. Use ΔH_c values (kJ/mol): C_2H_4 −1411, H_2 −286, C_2H_6 −1560. Find ΔH, in kJ/mol, for $C_2H_4 + H_2 \rightarrow C_2H_6$.

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1. **heat is given out, the products are lower in energy, and ΔH is negative**

   Exothermic reactions release heat; products sit below reactants, so ΔH is negative.

2. **breaking bonds takes energy in (endothermic); making bonds gives energy out (exothermic)**

   Energy is needed to break bonds and released when bonds form; ΔH is the difference.

3. **is the same no matter which route is taken from reactants to products**

   Because energy is conserved, the overall ΔH depends only on the start and end states, not the path.

4. **the least energy the particles need before they can react**

   Activation energy is the height of the "hill" – the minimum energy needed to start the reaction.

5. **sum of bonds broken − sum of bonds made**

   $\Delta H = \Sigma(\text{bonds broken}) - \Sigma(\text{bonds made})$; energy in to break minus energy out to make.

6. **True**

   Conservation of energy means the total enthalpy change is fixed by the start and end states alone.

7. **ΔH**

   Exothermic reactions have $\Delta H < 0$.

8. **False**

   False. Breaking bonds needs energy (endothermic) and making bonds releases energy (exothermic). ΔH = bonds broken − bonds made.

9. **Hess's**

   Enthalpy is a state function.

10. **-137**

    $\Delta H = \Sigma\Delta H_c(\text{reactants}) - \Sigma\Delta H_c(\text{products}) = (-1411 + -286) - (-1560) = -1697 + 1560 = -137$ kJ/mol.

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