THERMO WS 2: Potential Energy Diagrams & Thermochemical Equations

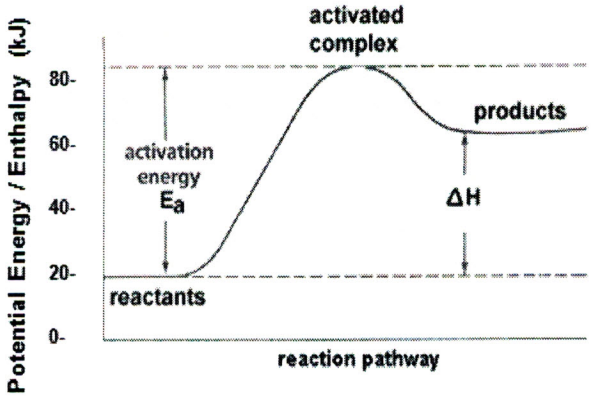

Figure 1

Use Figure 1 to answer questions 1-7.

1. How much stored P.E. do the reactants have? 20 KJ
2. How much stored P.E. do the products have? 65 KJ
3. How much activation energy, E_a, is needed for this reaction?
   $E_a = 80\ KJ - 20\ KJ =$ **60 KJ**
4. Is there a net gain or loss of energy?
   Net gain of E
5. How much P.E. must be added to the reactants to form the activated complex? $80\ KJ - 20\ KJ =$ **60 KJ**
6. Calculate the value of ΔH_{rxn}?
   ΔH = products - reactants = 65 KJ - 20 KJ = **45 KJ**
7. Is this reaction **endothermic or exothermic**?
   ENDOTHERMIC

Use Figure 2 to answer questions 8-14.

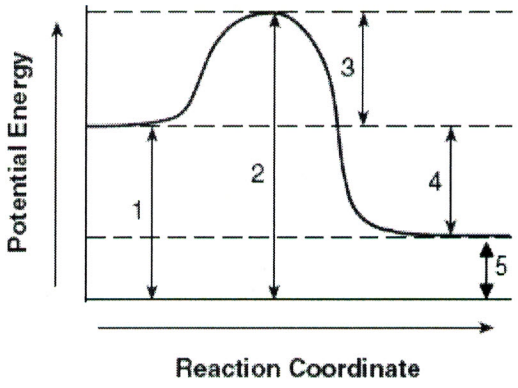

Figure 2

8. Which line segment represents the stored P.E. of the reactants? 1
9. Which line segment represents the stored P.E. of the products? 5
10. Which line segment represents the activation energy, E_a, that is needed for this reaction? 3
11. Which line segment represents the ΔH (change in P.E.) for the reaction? 4
12. Is ΔH **positive or negative?** Negative
13. Which line segment represents the P.E. of the activated complex? 2
14. Is this reaction **endothermic or exothermic**? EXOTHERMIC

Use Figure 3 to answer questions 15-21.

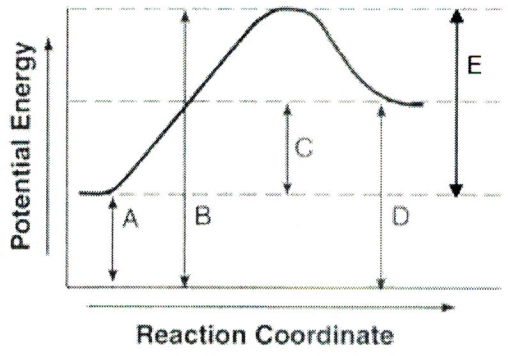

Figure 3

15. Is this reaction **endothermic / exothermic**? ENDOTHERMIC
16. Which line segment represents the stored P.E. of the reactants? A
17. Which line segment represents the stored P.E. of the products? D
18. Which line segment represents the activation energy, E_a, that is needed for this reaction? E
19. Which line segment represents ΔH (the change in P.E.) for the reaction? C
20. Is ΔH **positive or negative?** Positive
21. Which line segment represents the P.E. of the activated complex? B

Writing the Energy Terms in a Chemical Equation
In the equations below, the energy has been written on the reactants side (endothermic) or the products side (exothermic). Write the energy as a ΔH value with the correct sign for the reactions below.

22. $2\ KClO_3\ (s) + 156\ kJ \rightarrow 2\ KCl\ (s) + 3\ O_2\ (g)$ ΔH = +156 KJ

23. $CaCO_3\ (s) + 178.1\ kJ \rightarrow CaO\ (s) + CO_2\ (g)$ ΔH = +178.1 KJ

24. $NH_4NO_3\ (s) \rightarrow N_2O\ (g) + 2\ H_2O\ (g) + 100.\ kJ$ ΔH = -100. KJ

In questions 25 & 26, the enthalpy has been written as a ΔH value. Write the correct thermochemical reaction with the enthalpy as a reactant or a product.

25. ΔH = −185 kJ $H_2\ (g) + Cl_2\ (g) \rightarrow 2\ HCl\ (g) + 185\ KJ$

26. ΔH = +3351 kJ $2\ Al_2O_3\ (s) + 3351\ KJ \rightarrow 4\ Al\ (s) + 3\ O_2\ (g)$

Thermochemical Equations. Solve each problem. Show All Work!

27. Using the equation in #25, how many kJ of heat energy is associated with the formation of 3.33 moles of HCl?

$$3.33\ mol\ HCl \left| \frac{185\ KJ}{2\ mol\ HCl} \right. = 308\ KJ$$

28. Using the equation in #26, how many kJ of heat energy are absorbed when 1.75 moles of Al_2O_3 decomposes?

$$1.75\ mol\ Al_2O_3 \left| \frac{3351\ KJ}{2\ mol\ Al_2O_3} \right. = 2932 = 2930\ KJ$$

29. Calculate the kilojoules of heat required to decompose 2.24 mol $NaHCO_3$ (s).
$2NaHCO_3\ (s) \rightarrow Na_2CO_3\ (s) + H_2O\ (g) + CO_2\ (g)$ $\triangle H = 129\ kJ$

$$2.24\ mol\ NaHCO_3 \left| \frac{129\ KJ}{2\ mol\ NaHCO_3} \right. = 144\ KJ$$

30. How much heat is released when 8.0 g of oxygen react in: $C_2H_4\ (g) + 3O_2\ (g) \rightarrow 2CO_2\ (g) + 2\ H_2O\ (l) + 1411kJ$.

$$8.0\ g\ O_2 \left| \frac{1\ mol\ O_2}{32\ g\ O_2} \right| \frac{1411\ KJ}{3\ mol\ O_2} = 120\ KJ$$

31. Given the equation $Si\ (s) + 2Cl_2\ (g) \rightarrow SiCl_2\ (l) + 687\ kJ$, how much heat is produced when 106 grams of chlorine reacts?

$$106\ g\ Cl_2 \left| \frac{1\ mol\ Cl_2}{70.9\ g\ Cl_2} \right| \frac{687\ KJ}{2\ mol\ Cl_2} = 514\ KJ$$

Answers: #27) 308 kJ	#28) 2930 kJ	#29) 144 kJ	#30) 120 kJ	#31) 514 kJ