

I. Thermochemistry:

II. Enthalpy (H):

A. Heat of Reaction (ΔH):

B. Endothermic reactions

1. Positive value for ΔH
2. Energy is absorbed during the reaction
3. Energy (or heat) is written on left side of the arrow in a chemical equation
(Reactants + ENERGY/HEAT \rightarrow Products)
4. Heat content of the products is higher than that of the reactants

C. Exothermic reactions

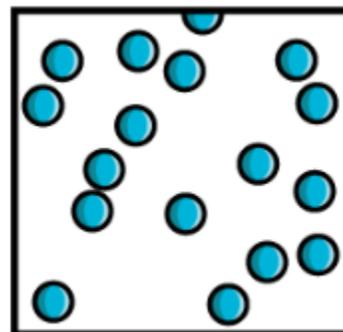
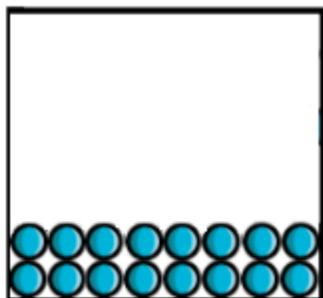
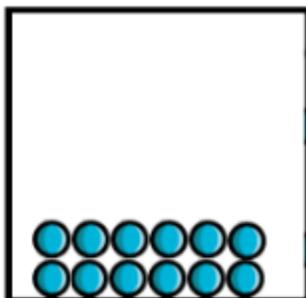
1. Negative value for ΔH
2. Energy is released during the chemical change
3. Energy (or heat) is written on right side of the arrow in a chemical equation
(Reactants \rightarrow Products + ENERGY/HEAT)
4. Heat content of the reactants is higher than the heat content of the products

III. Entropy (S):

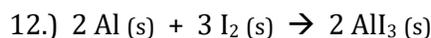
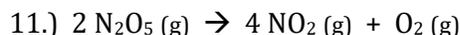
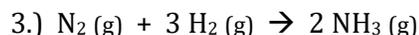
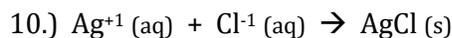
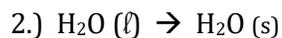
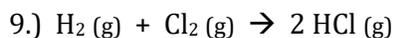
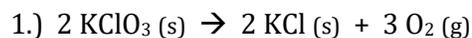
- A. Solids have (high / low) entropy compared to gases.
- B. Gases have (high / low) entropy compared to solids.

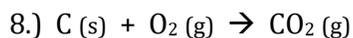
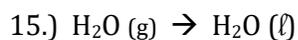
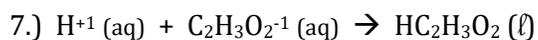
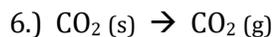
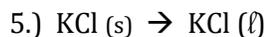
ENTROPY WORKSHEET

Entropy is the degree of disorder of the particles in a substance. The symbol for change in entropy is ΔS . Solids are very ordered and have low entropy. Liquids and aqueous ions have more entropy because they move about more freely, and gases have an even larger amount of entropy. According to the Second Law of Thermodynamics, nature is always proceeding to a state of higher entropy.



Determine whether the following reactions show an increase or decrease in entropy (positive ΔS or negative ΔS).

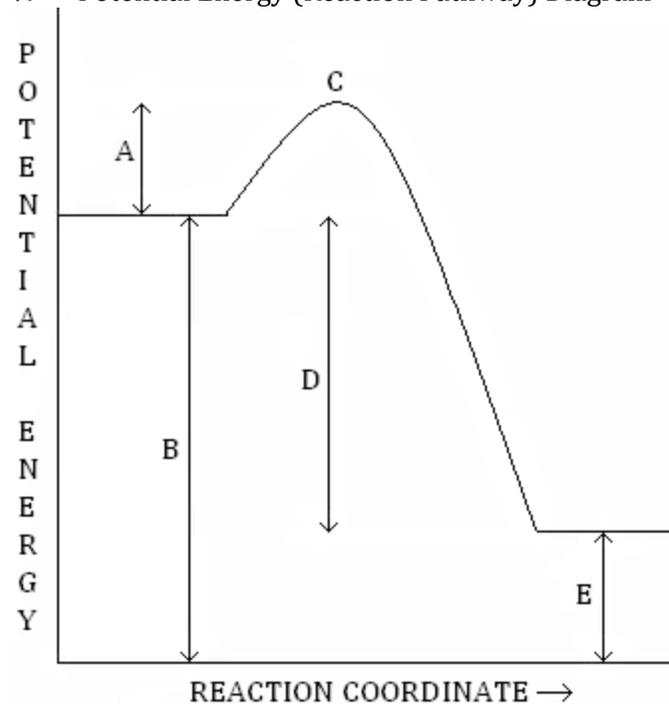




IV. Spontaneous reactions

- Two driving forces behind all chemical reactions: ENTHALPY and ENTROPY
- For a reaction to be spontaneous, it must move towards LESS ENERGY (exothermic) or MORE DISORDER (positive ΔS)
- Gibb's Free Energy (G) determines whether a reaction will occur spontaneously or not
 - If ΔG is **negative**, the reaction is spontaneous.

V. Potential Energy (Reaction Pathway) Diagram



A.

B.

C.

D.

E.

~ This diagram represents an _____ reaction.

F. Activation energy (E_a):

G. Catalyst:

H. An endothermic reaction's reaction pathway diagram would look like:

COLLISION THEORY NOTES (from Modern Chemistry textbook, published by Holt, Rinehart, Winston)

In order for reactions to occur between substances, their particles (molecules, atoms, ions) must collide. Furthermore, their collisions must result in interactions.

The most "effective" collisions produce the fastest reactions. What makes a collision "effective"?

- momentum of colliding particles
- correct orientation

→ Also, increased frequency of collisions means there is a more likely chance at interactions. More interactions, the more likely a reaction will occur.

RATE OF REACTIONS NOTES

Rate of reaction: the unit of time required to convert certain amounts of reactants to products; in other words, how fast a reaction will happen

FACTORS INFLUENCING THE RATE OF REACTION:

~ NATURE OF REACTANTS:

- Some substances are just more reactive than others. Iron will oxidize much _____ than zinc. Oxygen gas is _____ reactive than nitrogen gas. (Activity Series)

~ EFFECT OF TEMPERATURE:

- Usually, raising the temperature _____ the reaction rate. Increasing temperature _____ the kinetic energy and therefore the _____ and the _____ of colliding particles increases.

~ EFFECT OF CONCENTRATION:

- Cramping more particles into a smaller space increases the chance of _____. Therefore, increasing the concentration of the reactants _____ the rate at which a reaction occurs.

~ EFFECT OF PARTICLE SIZE:

- The _____ the particle size, the larger the surface area. Increasing the surface area _____ the rate of reaction. Powdered iron filings would rust _____ than a solid chunk of iron of the same mass.

~ EFFECT OF CATALYST:

- Catalysts _____ the rate of reaction without taking part in the reaction.

ENERGY & CHEMICAL REACTIONS WORKSHEET

1. In your best judgment, which of the following in the pair has the highest entropy?

- | | |
|-------------------------------------|-----------------------------|
| A. (A) messy room | (B) neat room |
| B. (A) ice | (B) steam |
| C. (A) solid salt crystals | (B) salt dissolved in water |
| D. (A) iron filings & sulfur powder | (B) solid iron sulfide |

2. Indicate whether the following describes endothermic or exothermic reactions.

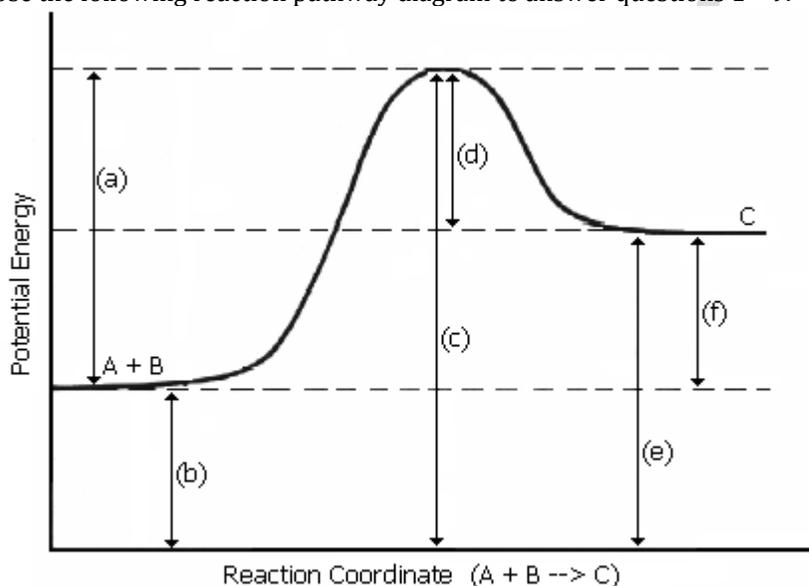
- | | |
|--|------------------------------------|
| (A) reactants have higher enthalpy than products | (B) produces energy as it proceeds |
| (C) products have very high enthalpy | (D) ΔH is always positive |
| (E) needs a continuous energy supply as they proceed | |

- What is the "direction" or trend most chemical reactions move toward in terms of energy and disorder?
- What do the following symbols represent:
(A) ΔH (B) ΔS (C) ΔG
- What is the general formula for determining the free energy of a chemical reaction?
- What does a + ΔG value indicate about a reaction?
- What does a - ΔG value indicate about a reaction?
- Match the following:

___ + ΔH	(A) spontaneous reaction
___ - ΔH	(B) endothermic reaction
___ - ΔG	(C) exothermic reaction
___ + ΔG	(D) nonspontaneous reaction

REACTION PATHWAY DIAGRAM WORKSHEET

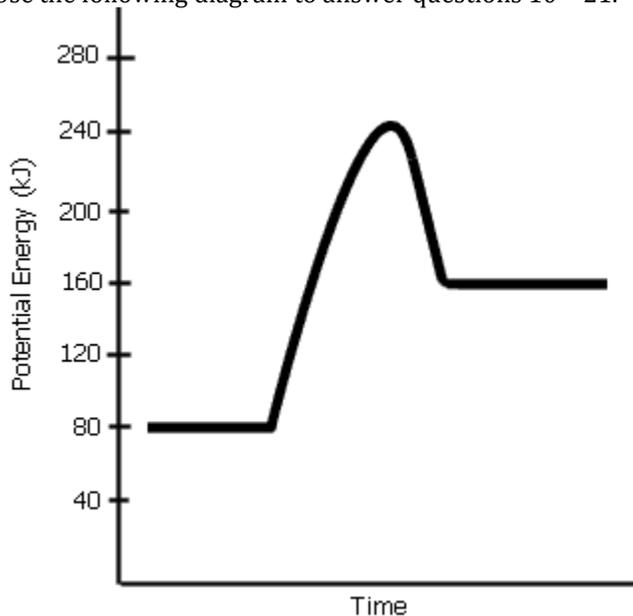
Use the following reaction pathway diagram to answer questions 1 - 9.



- Which of the letters a-f in the diagram represents the potential energy of the products?
- Which letter indicates the potential energy of the activated complex?
- Which letter indicates the potential energy of the reactants?
- Which letter indicates the activation energy of the $A + B \rightarrow C$?
- Which letter indicates the heat of reaction?
- Is the reaction exothermic or endothermic?
- Which letter indicates the activation energy of the reverse reaction?
- Which letter indicates the heat of reaction of the reverse reaction?

9. Is the reverse reaction exothermic or endothermic?

Use the following diagram to answer questions 10 – 21.



10. The heat content of the reactants of the forward reaction is about ____ kilojoules.
11. The heat content of the products of the forward reaction is about ____ kilojoules.
12. The heat content of the activated complex of the forward reaction is about ____ kilojoules.
13. The activation energy of the forward reaction is about ____ kilojoules.
14. The heat of reaction (ΔH) of the forward reaction is about ____ kilojoules.
15. The forward reaction is (endothermic/exothermic).
16. The heat content of the reactants of the reverse reaction is about ____ kilojoules.
17. The heat content of the products of the reverse reaction is about ____ kilojoules.
18. The heat content of the activated complex of the reverse reaction is about ____ kilojoules.
19. The activation energy of the reverse reaction is about ____ kilojoules.
20. The heat of reaction (ΔH) of the reverse reaction is about ____ kilojoules.
21. The reverse reaction is (endothermic/exothermic).

Answer the following questions.

22. Chemical reactions occur when reactants collide. For what reasons may a collision fail to produce a chemical reaction?
23. If every collision between reactants lead to a reaction, what determines the rate at which the reaction occurs?
24. What is the activation energy of a reaction, and how is this energy related to the activated complex of the reaction?
25. What happens when a catalyst is used in a reaction?
26. Name 4 things that will speed up or slow down a chemical reaction.

27. Draw an energy diagram for a reaction. (Label the axes.)

Potential energy of reactants = 350 kJ
 Activation energy = 100 kJ
 Potential energy of products = 250 kJ

28. Is the reaction in #27 exothermic or endothermic? Explain.

29. How could you lower the activation energy for the reaction in #27?

