FITCH

Unit 5 Thermochemistry Review

Define Essential Vocabulary:

Energy: THE ABILITY TO DO WORK

Heat: A MEASURE OF KINETIC ENERGY → HIGH HEAT = HIGH KE

Temperature: AVG KE OF SOMETHING = ALSO A MEASURE OF HOW HOT OR COLD SOMETHING IS

Heat vs. Temperature: HEAT A MEASURE OF TOTAL KE, TEMP A MEASURE OF AVG. KE

ΔH: CHANGE IN ENTHALPY OR HEAT

~~ΔE:~~

~~ΔH vs. ΔE~~:

Endothermic: A SITUATION WHERE ENERGY/HEAT IS ABSORBED

Exothermic: " " RELEASED

Endothermic vs. Exothermic: OPPOSITE HEAT CHANGES - SEE ABOVE

Specific Heat: AMOUNT OF HEAT NECESSARY TO RAISE 1 g OF A SUBSTANCE 1°C

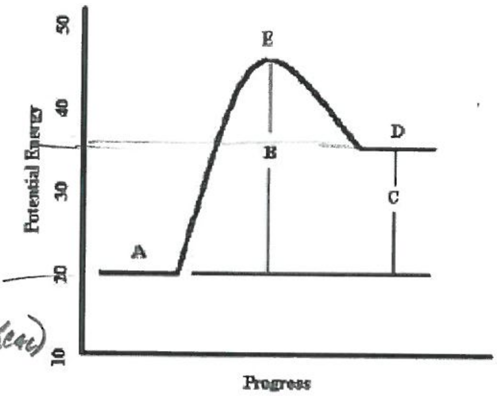
Joules (and kJ): A MEASURE OF HEAT

Calories (and Kcal): A MEASURE OF HEAT

Calorimeter: A DEVICE USED TO MEASURE CHANGES IN HEAT OF OBJECTS

Potential Energy Diagrams:

1.. Does this PE diagram represent and endothermic or exothermic reaction? ENDOTHERMIC

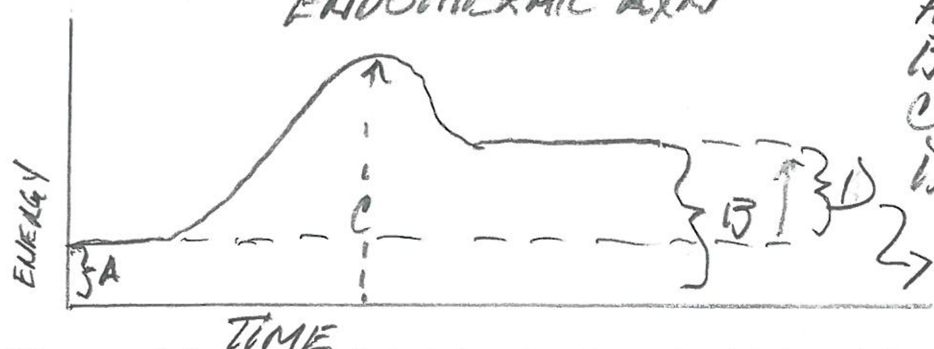


2. What does point A represent? ENERGY IN REACTANT BONDS
3. What does point B represent? ENERGY OF ACTIVATION
4. What does point C represent? ΔH
5. What does point D represent? ENERGY IN PRODUCT BONDS
6. Using the diagram, calculate the ΔH for the reaction shown.

~35 (J, KJ, CAL, KCAL?) − 20 (J, KJ, CAL, KCAL)
≅ 15 J, KJ, CAL, KCAL
(NO UNITS GIVEN IN DIAGRAM)

6.2 Draw an enthalpy diagram of a typical endothermic reaction. Label axes (of course), energy present in reactants, energy present in products, energy of activation, ΔH (including positive or negative) and title it by reaction type.

ENDOTHERMIC RXN



A = ENERGY IN REACTANTS
B = " " PRODUCTS
C = E_A
D = ΔH
→ ΔH IS POSITIVE

6.4 Draw an enthalpy diagram of a typical exothermic reaction. Label axes (of course), energy present in reactants, energy present in products, energy of activation, ΔH (including positive or negative) and title it by reaction type.

EXOTHERMIC RXN

D → ΔH IS NEGATIVE

Specific Heat Problems:

7. Water has a specific heat capacity of 4.18 J/g°C and iron has a specific heat capacity of 0.45J/g°C. If equal masses of iron and water have equal amounts of energy added, which will heat up more? Why?

IRON WILL HEAT UP MORE BECAUSE IT TAKES LESS HEAT TO RAISE 1g OF Fe 1°C THAN IT DOES WATER. THAT WHAT SPECIFIC HEAT VALUES SHOW (C_{H_2O} = 4.18J TO RAISE 1g H_2O 1°C VS. C_{Fe} = .45 J TO RAISE 1g Fe 1°C)

8. Desert sand is very hot during the day and very cold at night. What does this tell you about the specific heat capacity of sand? Explain. SAND MUST HAVE A RELATIVELY LOW SPECIFIC HEAT. IF IT HAD A HIGH SPECIFIC HEAT, IT WOULDN'T BECOME SO COLD AT NIGHT AS IT WOULD

9. A 591 g brass candlestick has an initial temperature of 98.0°C. If 21,100J of heat is removed from the candlestick to lower its temperature to 6.8°C, what is the specific heat capacity of brass?

$q = C \cdot m \cdot \Delta t$

$$\frac{q}{m\Delta t} = C = \frac{21{,}100\ J}{(591g)(91.2°C)} = \boxed{.39\ \frac{J}{g°C}}$$

10. The specific heat of ethanol is 2.46 J/g-°C. Find the heat required to raise the temperature of 193 g of ethanol from 19 °C to 35 °C.

$$q = \left(2.46\frac{J}{g°C}\right)(193g)(16°C) = \boxed{759.48\ J}$$

11. How many kJ of energy are needed to raise the temperature of 165 moles of water from 10.55 °C to 47.32 °C?

$$(165\ mol) \cdot 18.02\frac{g}{mol} = 2973.3g$$

$$q = \left(4.18\frac{J}{g°C}\right)(2973.3g)(36.77°C) = \boxed{\begin{aligned}&= 456992.0424\ J\\ &= 456.99\ KJ\end{aligned}}$$

Calorimetry

12. A calorimeter contains 100.0 mL of room temperature water (25°C) and a 75.0 g sample of aluminum at 100.0°C is added to it. The final temperature in the calorimeter is 36°C. What is the specific heat capacity of aluminum?

1ST $q_{H_2O} = C \cdot m \cdot \Delta t = \left(\frac{4.18J}{g°C}\right)(100g)(11°C) = 4598\ J$

2ND $C_{Al} = \frac{q}{m\Delta t} = \frac{4598J}{(75g)(64°C)} = \boxed{.9579\ \frac{J}{g°C}}$? (NOT THE ACCEPTED VALUE)

$q = C \cdot m \cdot \Delta T$

12.5 A 74 g piece of mystery metal was heated to 100 °C and placed in a calorimeter with 33 ml of water at 22 °C. After a few moments, the temperature of both the water and metal were at 26 °C.

a. What quantity of heat was transferred from the metal to the water?

$q_{H_2O} = (4.18\ J/g°C)(33g)(4°C) = \boxed{551.76\ J}$

b. What is the specific heat of the metal?

$C = \frac{q}{m\Delta t} = \frac{551.76\ J}{(74g)(74°C)} = \boxed{.10\ \frac{J}{g°C}}$

13. A sample of sodium bicarbonate ($NaHCO_3$) is dissolved in a calorimeter and the following data is collected. Use the following data to calculate the $\Delta H_{solution}$ of sodium bicarbonate (the heat of dissolution or dissolving of sodium bicarbonate).

ΔH is in J/g

Volume of Water	Mass of Sodium Bicarbonate Used	Initial Temperature of Water	Final Temperature of Water	Specific Heat of Water
500.0 mL	8.956 g	23.2 C	3.9 C	4.184 J/g C

$q = (4.184\ J/g°C)(500g)(19.3°C) = 40375.6\ J$

$\frac{40375.6\ J}{8.956\ g} = \boxed{4508.22\ J/g = \Delta H_{solution}}$

= POSITIVE BECAUSE THIS IS AN ENDOTHERMIC RXN

Enthalpy and Stoichiometry:

14. Limestone ($CaCO_3$) decomposes to form caves via the following reaction:

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O \quad \Delta H = 345.6\ KJ$$

Is this reaction endothermic or exothermic?

ENDO

How many kJ of energy are involved when 50.0 g of limestone is reacted with excess sulfuric acid?

$(50g\ H_2SO_4)\left(\frac{1\ mol}{98.08g}\right) = .50978...\ mol\ CaCO_3$

$(.50978...\ mol)\left(\frac{345.6\ KJ}{1\ mol\ CaCO_3}\right) = \boxed{176.18\ KJ}$

15. Making cement can release a lot of heat through the following reaction

$$CaO + H_2O \rightarrow Ca(OH)_2 \quad \Delta H = -150\ kJ$$

40.08
16.00
56.08

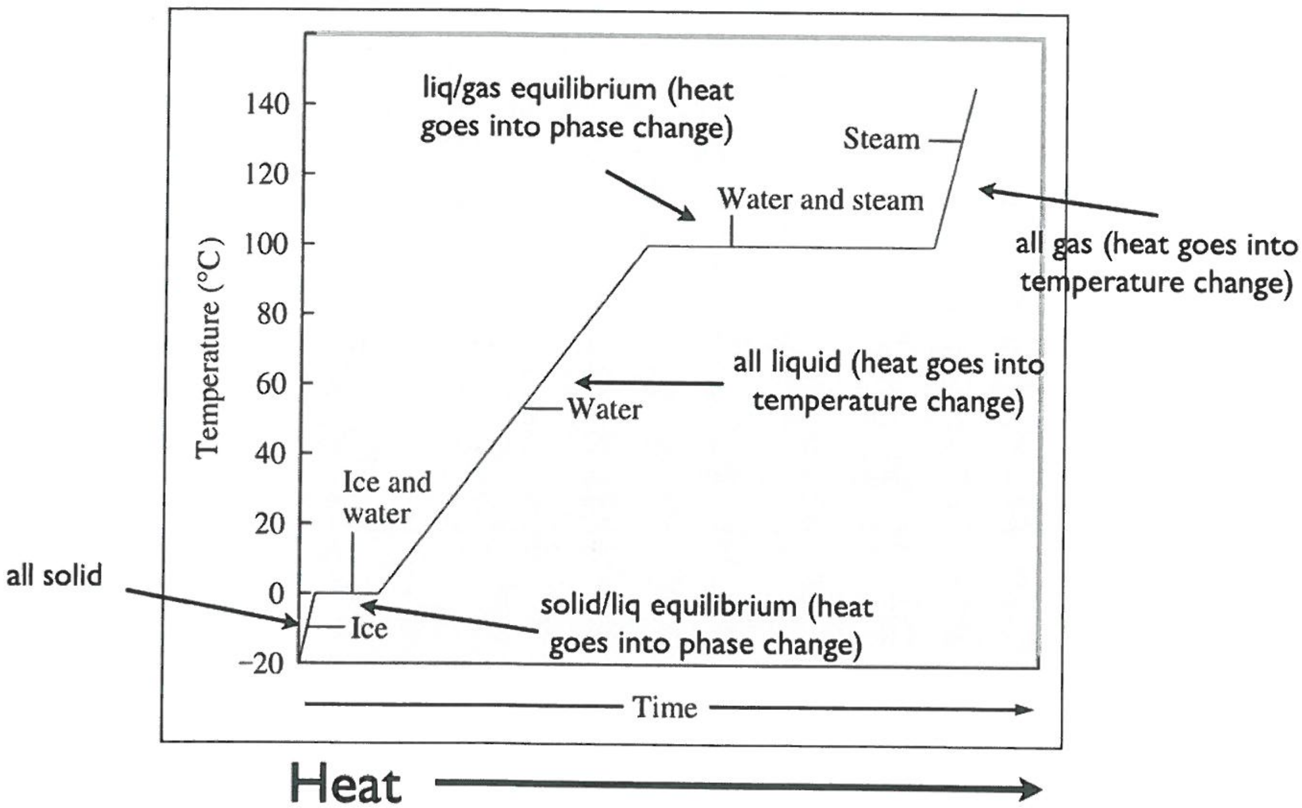
Is this reaction endothermic or exothermic? If 100.0 g of calcium oxide reacts, how much heat is released?

$(100g\ CaO)\left(\frac{1\ mol}{56.08g}\right) = 1.783\ mol\ CaO$ $\quad (1.783\ mol)\left(\frac{-150\ KJ}{mol\ CaO}\right) = \boxed{-267.48\ KJ}$

Use the following constants and figure to answer questions 15 – 22
All values are regarding water.

ΔH_{fusion} = 334 J/g $\Delta H_{vaporization}$ = 2264 J/g C_{ice} = 2.09 J/g°C C_{steam} = 1.84 J/g°C

ΔH_{fusion} = 1.44 Kcal/mol $\Delta H_{vaporization}$ = 9.7 Kcal/mol



16. How much heat is involved if 192.5 g of water freeze? If 2.70 mols of water freezes?

(192.5 g)(334 J/g) = 64295 J

(2.70 mol)(1.44 Kcal/mol) = 3.89 Kcal

Is the process endo-or exo-thermic?

17. How much heat is involved if 192.5 g of water melts? If 2.70 mols of water melts?

(192.5 g)(334 J/g) = 64295 J

(2.7 mol)(1.44 Kcal) = 3.89 Kcal

Is the process endo-or exo-thermic?

18. How much heat is absorbed when 4 g of water evaporates?

(4 g)(2264 J/g) = 9056 J

19. How much energy is released when 4 g of water condenses?

(4 g)(2264 J/g) = 9056 J

20. How much energy is released when 100 g of water goes from 40 °C to 23 °C?

$q = (4.18 \frac{J}{g°C})(100g)(17°C) = \boxed{7106 J}$

21. How much energy is involved when 75 g of water go from 106 °C to 98°C? Is the energy absorbed or released?

$q = (1.84 J/g°C)(75g)(6°C) = 828 J$

$(75g)(2264 \frac{J}{g}) = 169800 J$

$q = (4.18 J/g°C)(75g)(2°C) = 627 J$

$828 J + 169800 J + 627 J = \boxed{171255 J} = 171.26 KJ$

22. What amount of energy is put into a container with 2 L of water going from -10 °C to 101 °C?

$q = (2.09 \frac{J}{g°C})(2000g)(10°C) = 41800 J$

$(2000g)(334 \frac{J}{g}) = 668000 J$

$q = (4.18 \frac{J}{g°C})(2000g)(100°C) = 836000 J$

$(2000g)(2264 \frac{J}{g}) = 4528000 J$

$q = (1.84 \frac{J}{g°C})(2000g)(1°C) = 3680 J$

$41800 J + 668000 J + 836000 J + 4528000 J + 3680 J$

$\boxed{= 5476280 J = 5476.28 KJ}$

23. Why are people cooled as a result of sweating?

WHEN LIQUID WATER BECOMES A GAS, THE MOLECULES MOVE FASTER (HAVE MORE KE). THE ENERGY CAUSING THE FASTER MOTION COMES FROM HEAT. WATER ABSORBS HEAT TO BECOME VAPOR. THE HEAT COMES FROM THE PERSON, COOLING THEM.

Additional Resources: Quizzes, lecture, Workbook Practice, Labs and other Worksheets available on my website.