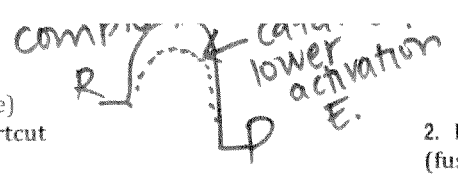
Name: _____ Thermo

Factors that Affect Reaction Rate (more products / unit of time)

1) **Catalysts**: (Not a reactant or a product) it is a **shortcut**



enzymes

FACTORS BELOW WILL ↑ # COLLISIONS= ↑ E TO SLIP OVER THE ACTIVATED COMPLEX

2) **Temperature:** ↑temp= ↑ kinetic energy = ↑ speed movement of reactants

3) **Concentration:** (amount of solute/area) ↑ # of reactants

4) **Particle Size:** ↓ size= ↑ **TOTAL** surface area = ↑ amount of reactant exposed

	Endothermic	Exothermic
Sign	+	−
Descriptive Words	added, absorbed	released; given OFF
Chemical Reaction Placement	A + B + KJ → C A + B → C ΔH + KJ	A + B → C + KJ A + B → C ΔH − KJ
Physical Changes	vaporization melting Sublimation (s→g)	Freezing condensation
Examples	cooking	make ice
Rxn Path diagram		

Heat is: transfer of energy due to temp. difference

Temp is: kinetic energy/movement of particles

Units: KJ, calorie

Units: °C, °F, K (273 + °C)

Types of Problems:

1. **Thermochemical Equations** *Keyword:* reaction with kJ

Calculate the heat (KJ) required to decompose 4.62 grams of sodium bicarbonate

$2NaHCO_3(s) + 129\ kJ \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$

$$4.62\ g\ NaHCO_3 \left| \frac{1\ mole\ NaHCO_3}{84.01\ g\ NaHCO_3} \right| \frac{129\ KJ}{2\ mole\ NaHCO_3}$$

3.55 KJ

2. **Physical Changes** *keyword:* phase changes *(values in table/given to you)*
(fusion = melting; vaporization = evaporate or boil; solidify = crystallization or freezing)

How much heat is absorbed when 5.32 g water is evaporated? 120 KJ

$\Delta H_{vaporization\ H2O} = 2256\ kJ/Kg$

$$5.32\ g \left| \frac{1\ kg}{1000\ g} \right| \frac{2256\ KJ}{Kg} \quad \text{or} \quad 0.00532\ kg \left| \frac{2256\ KJ}{Kg} \right.$$

heat (J) $Q = m\ C\ \Delta T$ mass; specific heat; $T_f - T_i$ *keyword:* specific heat capacity; two temps w/ heat

- A copper pot with a temperature of 25°C and a mass of 1350 g (3 lbs) was put on a warm stove coil, the temperature of the pot then increased to 48°C. Copper has a specific heat of 0.385 J/g°C, what was the amount of heat supplied to the pot to cause the temperature change? $Q = m\ C\ \Delta T$

$$1350\ g \times 0.385 \frac{J}{g°C} \times (48 - 25) = 1.2 \times 10^4\ J$$

Substance	C (J/gK)	Substance	C (J/gK)
Aluminum	0.900	Mercury	0.140
Bismuth	0.123	Ethanol	2.4
Copper	0.386	Water	4.186
Brass	0.380	Ice (-10 C)	2.05
Gold	0.126	Granite	.790
Lead	0.128	Glass	.84
Silver	0.233	Iron	0.4
Tungsten	0.134	Steam	1.7
Zinc	0.387	Chloroform	0.96

- When 435 J of heat is added to 3.4g of olive oil at 21°C, the temperature increases to 85°C. What is the specific heat of olive oil?

$$C = \frac{Q}{m\ \Delta T} = \frac{435\ J}{3.4\ g \times (85 - 21)} = 2.0 \frac{J}{g°C}$$

4. **Calorimeter** ($C_{water} = 4.184\ J/g°C$) $Q = -m_{water}\ C_{water}\ \Delta T_{water}$ *keyword:* calorimeter

A small pebble is heated and placed in a calorimeter continuing 25.0 g of water at 25.0°C. The water reaches a maximum temperature of 26.4 °C. How many joules of heat were released by the pebble?

$$Q = -m_{H2O}\ C_{H2O}\ \Delta T_{H2O}$$

$$-25.0\ g \times 4.184 \frac{J}{g°C} \times (26.4 - 25)$$

$$= -146\ KJ$$

Entropy = ΔS = disorder

Entropy = measure of disorder, randomness

Example: Determine if the ΔS is ↑(+) or ↓(-)

disorder

1. air escaping from a tire ↑ ΔS
2. snow melting ↑ entropy ↑ ΔS
3. salt dissolving in H_2O
4. liquid cooling ↓ ΔS
5. $2\,KClO_{3\,(s)} \rightarrow 2KCl\,(s) + 3O_2\,(g)$ ↑ ΔS
6. $H_2O\,(l) \rightarrow H_2O\,(s)$ ↓ ΔS
7. $2Al\,(s) + 3I_2\,(s) \rightarrow 2AlI_3\,(s)$ ↓ ΔS
8. $N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)$ ↓ ΔS
9. $KCl\,(s) \rightarrow KCl(l)$ ↑ ΔS
10. $CO_2\,(s) \rightarrow CO_2\,(g)$ ↑ ΔS
11. $Ag^+\,(aq) + Cl^-\,(aq) \rightarrow AgCl(s)$ ↓ ΔS
12. $2N_2O_5\,(g) \rightarrow 4NO_2\,(g) + O_2\,(g)$ ↑ ΔS

SOL Questions:

The table shows the specific heat capacity of four substances

1. For an equal mass of each, which one will require the least amount of heat to raise its temperature from 20°C to 30°C ?

Substance	Heat Capacity $\frac{J}{g \cdot °C}$
Aluminum	0.900
Glass	0.50
Carbon dioxide	0.843
Water	4.18

A. Aluminum
B. Glass
C. Carbon Dioxide
D. Water

2. Solid magnesium has a specific heat of 1.01 J/g°C. How much heat is given off by a 20.0 gram sample of magnesium when it cools from 70.0°C to 50.0°C?

F 202 J
G 404 J
H 808 J
J 1010 J

3. When 92.0 g of ethanol (C_2H_5OH) are vaporized at its boiling point of 78.3°C, it requires 78.6 kJ of energy. What is the approximate molar heat of vaporization of ethanol in kJ/mol?

A 0.854
B 1.17
C 39.3
D 78.3

4. If 89.6 joules of heat are needed to heat 20.0 grams of iron from 30.0°C to 40.0°C, what is the specific heat of the iron in $\frac{J}{g \cdot °C}$?

A 0.448
B 2.23
C 8.96
D 896

Homework:

1. Given the equation $3CO\,(g) + Fe_2O_3\,(s) \rightarrow 2Fe\,(s) + 3CO_2\,(g) + 24.7$ kJ, how much heat is released when 7.00 mole of CO react?

2. How many grams of water can be melted if 55.0kJ of heat is added? ($\Delta H_{fusion\ H2O}$=334 kJ/Kg)

3. How much heat is required to raise the temperature of 50.90 g of **mercury** from 13.0°C to 85.0°C? (use value on front)

4. A 155g sample of an unknown substance was heated from 25.0°C to 40.0°C. In the process, the substance absorbed 5694J of energy. What is the specific heat of the substance? Identify the substance (use the table on the front)

5. A 16.5g sample of an unknown metal is at 88.0°C is added to a calorimeter of 25.2g of water at 14.6°C. The final temperature of the system is 20.5°C. What is the specific heat of the metal?

6. Determine if there is an increase or decrease in entropy:

a. Melting of ice cubes
b. Dissolving sugar in a cup of hot coffee
c. A solid sublimes
d. Volume of a gas increases
e. Condensation of water
f. $H_2\,(g) + Br_2\,(l) \rightarrow 2HBr\,(g)$
g. $CuSO_4\,(s) \rightarrow CuSO_4\,(s) + 5H_2O(g)$
h. $2XeO_3\,(s) \rightarrow 2Xe\,(g) + 3O_2\,(g)$

Use the diagram to the right:

7. Is this reaction endothermic or exothermic?
8. What do all the letters represent? (omit c)