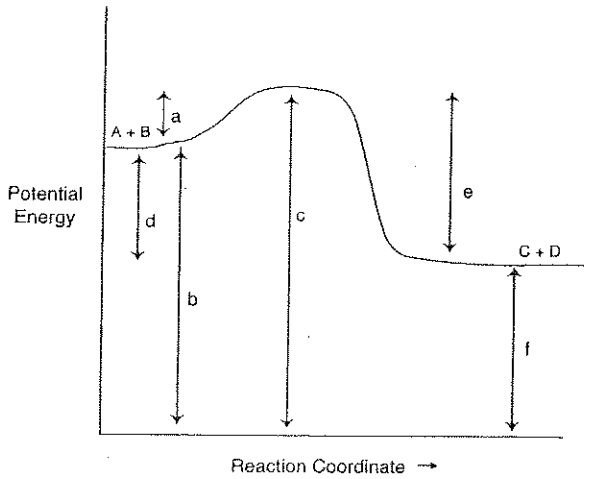
POTENTIAL ENERGY DIAGRAM

Name KEY



A + B ↔ C + D + energy

Answer the questions using the graph above.

1. Is the above reaction endothermic or exothermic? _____
2. What letter represents the potential energy of the reactants? b
3. What letter represents the potential energy of the products? f
4. What letter represents the heat of reaction (ΔH)? d
5. What letter represents the activation energy of the forward reaction? a
6. What letter represents the activation energy of the reverse reaction? e
7. What letter represents the potential energy of the activated complex? c
8. Is the reverse reaction endothermic or exothermic? _____
9. If a catalyst were added, what letter(s) would change? A, C, E

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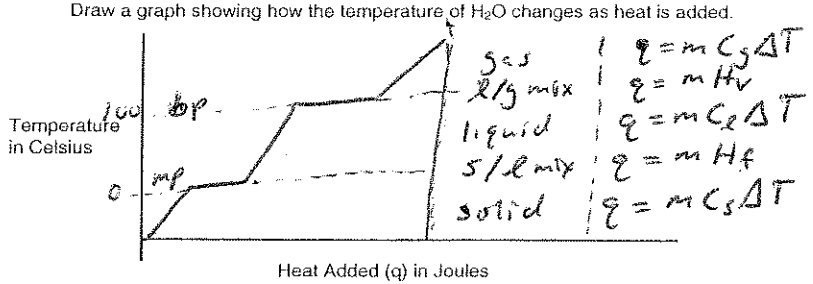
Specific Heat and Latent Heats of Water

Draw a graph showing how the temperature of H_2O changes as heat is added.



Graph

1. **Label the graph with the appropriate equations for finding Heat (q):**
   $q = mH_f$ $q = mH_v$ $q = mC_sΔT$ $q = mC_lΔT$ $q = mC_gΔT$
2. **Label the graph indicating the state(s) that water would be observed:**
   solid, liquid, gas, solid/liquid mix, liquid/gas mix
3. **Label the Melting Point and Boiling Point of water (in °C) on the y-axis.**
4. **What happens to temperature during a phase change?** _____
   WHY? breaking bonds

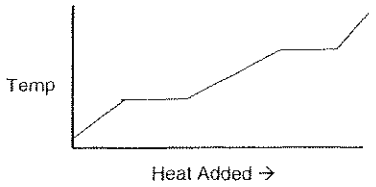
Level One Examples:

1. How much heat is added if 100 grams of liquid water increases in temperature from 30°C to 70°C? 16,720 J
2. How much heat is absorbed if 200 g of ice increases in temperature from -15°C to -5°C? 4100 J
3. How much heat is released if 80 grams of water vapor is decreases in temperature from 150°C to 125°C? -4040 J
4. How much heat is absorbed when 30 g of ice is changed into liquid water at 0°C? 10,020 J
5. How much heat is released when 50 grams of water vapor is changed into liquid water at 100°C? -113,000 J

Level One! The fun has just begun!

Level One Practice

Use the graph to help you visualize the change that is being described.

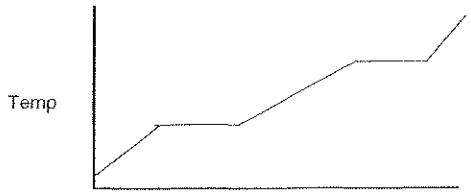


1. How much heat is needed to raise the temperature of 36 grams of ice from -18°C to 0°C? 1328 J
2. How much heat is needed to change 36 grams of ice into water at 0°C? 12024 J
3. How much heat is needed to raise the temperature of 36 grams of water from 0°C to 100°C? 15048 J
4. How much heat is needed to change 36 grams of water to vapor? 81360 J
5. How much heat is needed to raise the temperature of 36 grams of vapor from 100°C to 130°C? 2182 J
6. How much heat is needed to increase the temperature of 4 grams of water from -25°C to -15°C? 82 J
7. How much heat is released when 30 g of water changes from 40°C to 25°C? −1881 J
8. How much heat is released when 30 grams of liquid water changes into ice? −10020 J

Wahoo! You made it to Level 2!

Level Two

Use the graph to help you visualize the change that is being described.



Examples:

1. How much heat is absorbed if 30 grams of water at -10°C is converted into liquid water? 10635 J
2. How much heat is absorbed if 45 grams of water at 80°C is converted into steam at 105°C? 105917 J
3. How much heat is released if 500 grams of vapor at 120°C changes to liquid water 70°C? 1,212,900 J

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Level Two Practice

1. How much heat is added when 50 g of ice at -10°C is changed to liquid water? 17725 J

2. How much heat is added when 0.5 kg liquid water at 20°C is changed into vapor at 100°C? 1,297,200 J

3. How much heat is absorbed when 20 g of water at 82°C is raised to 110°C? 47109 J

4. How much heat is released when 45 g of water at 30°C is placed in a freezer at -10°C? -21596 J

5. How much heat is released when 15 grams of liquid water at 30°C freezes into ice? -6891 J

6. How much heat is released when 50 grams of liquid water at 100°C is placed in a -20°C freezer? -39650 J

7. How much heat is absorbed if 10 grams of ice at -3°C is converted into vapor at 108°C? 30343 J

Congratulations!!! You made it! ☺

Name: _____ Date: _____ Block: _____

Calorimetry Practice

1) The burning of methane in oxygen to yield carbon dioxide gas and liquid water causes the surrounding 1.52-kg of water in a calorimeter to change in temperature from 20° to 34°C. How much heat is released by this reaction? -88950J

2) The temperature of a sample of water increases from 20.0° to 46.6°C as it absorbs 5650 J of heat. What is the mass of the sample? 50.8g

3) A 4.5-g nugget of pure gold absorbed 276 J of heat. What was the final temperature of the gold if the initial temperature was 25.0°C? 500.5°C
Hint: Look up specific heat for gold on Reference Tables.

4) If 335 g of water at 65.5°C loses 9750 J of heat, what is the final temperature of the water? 72.5°C

5) Calculate the amount of heat required to raise the temperature of 22.8 g of copper from 20°C to 875°C. 7505 J

6) What is the temperature change (ΔT) when a 25-g block of aluminum absorbs 10 kJ of heat? 446°C

7) A 10-gram sample of zinc loses 560 J of heat and has a final temperature of 100°C. What was its initial temperature? 244°C

8) An unknown substance with a mass of 48 grams absorbs 1066 J and its temperature changes by 50°C. What is this substance? Ni

ENTROPY

Name _____

Entropy is the degree of randomness 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.

1. $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$ _____ I
2. $H_2O(l) \rightarrow H_2O(s)$ _____ D
3. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ _____ D
4. $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ _____ I
5. $KCl(s) \rightarrow KCl(l)$ _____ I
6. $CO_2(s) \rightarrow CO_2(g)$ _____ I
7. $H^+(aq) + C_2H_3O_2^-(aq) \rightarrow HC_2H_3O_3(l)$ _____ D
8. $C(s) + O_2(g) \rightarrow CO_2(g)$ _____ I
9. $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ _____ NC
10. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ _____ D
11. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ _____ I
12. $2Al(s) + 3I_2(s) \rightarrow 2AlI_3(s)$ _____ D
13. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ _____ D
14. $2NO(g) \rightarrow N_2(g) + O_2(g)$ _____ NC
15. $H_2O(g) \rightarrow H_2O(l)$ _____ D

Word Bank

Calorimeter
Specific Heat
Joule
Calorie
Enthalpy
Entropy
Heat
Temperature
Activation Energy
Endothermic
Exothermic
$q = mH_f$
$q = mH_v$
$q = mC\Delta T$

Can be used more than once!

Chapter 17 Review!

1. SI unit of energy _____
2. Potential energy of the products minus potential energy of the reactants _____
3. Quantity of heat needed to raise the temperature of 1 g of a substance by 1°C _____
4. A device used to measure the heat absorbed or released during a chemical or physical process. _____
5. Disorder _____
6. ΔH _____
7. This is transferred due to a temperature difference. _____
8. In this reaction, the energy of the reactants is less than the energy of the products. _____
9. This is used to calculate the heat required to melt a substance. _____
10. ΔS _____
11. Flows from a hot object to a cold object. _____
12. ΔH is negative for this type of reaction. _____
13. Is ice melting endothermic or exothermic? _____
14. Is water vapor condensing endothermic or exothermic? _____
15. On a potential energy diagram, the distance between the energy of the reactants and the energy of the activated complex. _____
16. During a phase change, _____ does not change.

What is the final temperature of 50 grams of water at 82°C that loses 400 Joules of heat? (Show Work!)

Name: _____ Date: _____ Block:_____

Specific Heat and Latent Heats – More Practice

$Q = mC\Delta T$ $Q = mH_f$ $Q = mH_v$

1. How much heat is added if 100 grams of liquid water increases in temperature from 30°C to 70°C? 16720 J
2. How much heat is absorbed if 2 kg of ice increases in temperature from -15°C to -5°C? 41000 J
3. How much heat is released if 80 grams of water vapor is decreases in temperature from 150°C to 125°C? -4040 J
4. How much heat is released when 50 grams of water vapor is changed into liquid water at 100°C? -113000 J
5. How much heat is absorbed if 45 grams of water at 80°C is converted into steam at 105°C? 105916.5 J
6. How much heat is released when 15 grams of liquid water at 30°C freezes into ice? -6891 J
7. How much heat is absorbed if 10 grams of ice at -3°C is converted into vapor at 100°C? 30181.5 J
8. How much heat is released when 50 grams of water vapor at 130°C is placed in a -20°C freezer? 155600 J

CHATELIER'S PRINCIPLE

Name _____

Chatelier's Principle states that when a system at equilibrium is subjected to a stress, the system will shift its equilibrium point in order to relieve the stress.

Complete the following chart by writing left, right or none for equilibrium shift, and increases, increases or remains the same for the concentrations of reactants and products, and for the value of K.

$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g) + 22.0$ kcal

Stress	Equilibrium Shift	$[N_2]$	$[H_2]$	$[NH_3]$	K
1. Add N_2	right	———	decreases	Increases	remains the same
2. Add H_2	right		———		
3. Add NH_3	left			———	
4. Remove N_2	left	———			
5. Remove H_2	left		———		
6. Remove NH_3	right			———	
7. Increase Temperature	left				
8. Decrease Temperature	right				
9. Increase Pressure	right				
10. Decrease Pressure	left				

LE CHATELIER'S PRINCIPLE CONTINUED

Name _____

12.6 kcal $+ H_2(g) + I_2(g) \leftrightarrow 2HI(g)$

Stress	Equilibrium Shift	$[H_2]$	$[I_2]$	[HI]	K
1. Add H_2	right	———	decreases	Increases	remains the same
2. Add I_2	right		———		
3. Add HI	left			———	
4. Remove H_2	left	———			
5. Remove I_2	left		———		
6. Remove HI	right			———	
7. Increase Temperature	right				
8. Decrease Temperature	left				
9. Increase Pressure	none				
10. Decrease Pressure	none				

$NaOH(s) \leftrightarrow Na^+(aq) + OH^-(aq) + 10.6$ kcal

(Remember that pure solids and liquids do not affect equilibrium values.)

Stress	Equilibrium Shift	Amount NaOH(s)	$[Na^+]$	$[OH^-]$	K
1. Add NaOH(s)	none	———			
2. Add NaCl (Adds Na^+)	left		———		
3. Add KOH (Adds OH^-)	left			———	
4. Add H^+ (Removes OH^-)	right			———	
5. Increase Temperature	left				
6. Decrease Temperature	right				
7. Increase Pressure	none				
8. Decrease Pressure	none				

EQUILIBRIUM CONSTANT (K)

Name _____

Write the expression for the equilibrium constant K for the reactions below.

1. $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

2. $2KClO_3(s) \leftrightarrow 2KCl(s) + 3O_2(g)$

$$K_{eq} = [O_2]^3$$

3. $H_2O(l) \leftrightarrow H^+(aq) + OH^-(aq)$

$$K_{eq} = [H^+][OH^-]$$

4. $2CO(g) + O_2(g) \leftrightarrow 2CO_2(g)$

$$K_{eq} = \frac{[CO_2]^2}{[CO]^2[O_2]}$$

5. $Li_2CO_3(s) \rightarrow 2Li^+(aq) + CO_3^{-2}(aq)$

$$K_{eq} = [Li^+]^2[CO_3^{-2}]$$

CALCULATIONS USING THE EQUILIBRIUM CONSTANT

Name _____

Using the equilibrium constant expressions you determined on page 79, calculate the value of K when:

1. $[NH_3] = 0.0100$ M, $[N_2] = 0.0200$ M, $[H_2] = 0.0200$ M — 625

2. $[O_2] = 0.0500$ M — 1.25×10^{-4}

3. $[H^+] = 1 \times 10^{-8}$ M, $[OH^-] = 1 \times 10^{-6}$ M — 1×10^{-14}

4. $[CO] = 2.0$ M, $[O_2] = 1.5$ M, $[CO_2] = 3.0$ M — 1.5

5. $[Li^+] = 0.2$ M, $[CO_3^{-2}] = 0.1$ M — 4×10^{-3}