CHEMISTRY | LEE

NAME ____

DATE _________________________ BLOCK __________

UNIT SIX

PROBLEM SET

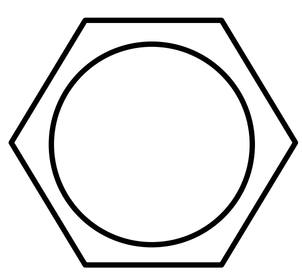
Score:

Do not cheat by copying the work of another person, or by allowing another person to copy your answers. Cheating results in a 0% grade for both parties involved.

Signature_________________________________ Date__________

In the event any or all of this Problem Set is assessed for a grade,
it <u>must be signed and dated</u> in order to receive a grade. The work shall be your own.

Problem Sets are generally not accepted late. Late assignments are 50% off.



Specific Heat
Chem Worksheet 16-1

Name ________________

Use the data in the table to answer the following questions.

Substance	Specific Heat Capacity (J/g °C)
water	4.184 J/g °C
aluminum	0.89 J/g °C
silicon	0.703 J/g °C
iron	0.45 J/g °C
copper	0.387 J/g °C
silver	0.24 J/g °C
gold	0.129 J/g °C
lead	0.128 J/g °C

Useful Equations

$q = mc\Delta T$

$\Delta T = T_{final} - T_{initial}$

1 kg = 1000 g

1 cal = 4.184 J

$T_c = 5/9(T_f - 32)$

$T_K = T_c + 273$

1 kcal = 1000 cal

1. Calculate the energy required to heat a beaker of water at 18 °C to boiling. The mass of the water is 70.0 g.

2. A water heater warms 35-L (35 kg) of water from a temperature of 22.7 °C to a temperature of 83.7°C. Determine the amount of energy (in joules) required.

3. Determine the temperature change that will occur when 250-J of energy is applied to 20. g of gold.

4. When 895-J of heat is applied to a sample of iron metal the temperature increases by 55.0 °C. Determine the mass of the metal sample.

5. A silver ring has a mass of 138.45 g. How many calories of heat are required to increase the temperature from 11.8 °C to 162.5 °C?

6. A heat energy of 645 J is applied to a sample of glass with a mass of 28.4 g. Its temperature increases from –11.6 °C to 15.5 °C. Calculate the specific heat of glass.

7. What is the mass of copper that increases its temperature by 285 °C when 186,000 J of energy is applied?

8. How much energy (in kJ) is lost by a 348-kg iron statue that goes from a temperature of 299 K to a temperature of 280 K?

9. When 5800 joules of energy are applied to a 15.2-kg piece of lead metal, how much does the temperature change by?

10. A 9.84 oz ingot of unknown metal is heated from 73.2 °F to 191.2 °F. This requires 3.91 kcal of energy. Calculate the specific heat of the metal and determine its identity.

Chapter 11 Thermal Stoichiometry Problems

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s) + 1204 \text{ kJ}$$

1. How many kilojoules of heat are released when 12 g of Mg reacts with an excess of oxygen according to the balanced equation?

2. How many liters of O_2 would be consumed to generate 2502 kJ at STP?

$$2Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + 2Fe\ (s) + 850 \text{ kJ}$$

3. How many grams of aluminum would be required to generate 932 kJ of energy?

4. How many kJ of energy would be produced by reacting 49 grams of aluminum with excess Fe_2O_3?

5. Consider the following balanced chemical reaction:

$$CH_3OH(g) \rightarrow CO(g) + 2H_2(g) \quad \Delta H = +90.7 \text{ kJ/mol}$$

   Is this reaction endothermic or exothermic.

   Calculate how much heat would be absorbed or released if 45.0 grams of CH_3OH decompose to products.

Answers: 1)3.0×10^2 kJ, 2)46.55 L O_2, 3)59.2 g Al, 4) 770 kJ 5)+127 kJ absorbed.

Enthalpy Stoichiometry
Chem Worksheet 16-3

Name ________________

The **molar enthalpy of reaction** (ΔH_{rxn}) is the amount of heat transferred during a reaction. It is reported in kilojoules per mole of reactant. A reaction that produces heat is **exothermic** and has a negative ΔH_{rxn}. A reaction that absorbs heat is **endothermic** and has a positive ΔH_{rxn}.

Example

How much heat is produced when 85 g of sulfur reacts according to the reaction below?

$$2S + 3O_2 \rightarrow 2SO_3 \quad \Delta H = -792 \text{ kJ}$$

- the ΔH value given in the equation is the amount of heat transferred when **2 moles** of sulfur and **3 moles** of oxygen react.

- write the 'given' and 'unknown' units: $\frac{85 \text{ g S}}{1} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} = \quad \text{kJ}$

- fill in factors: $\frac{85 \text{ g S}}{1} \times \frac{1 \text{ mol S}}{32.06 \text{ g S}} \times \frac{-792 \text{ kJ}}{2 \text{ mol S}} = \quad \text{kJ}$

- solve: $\frac{85 \cancel{\text{g S}}}{1} \times \frac{1 \cancel{\text{mol S}}}{32.06 \cancel{\text{g S}}} \times \frac{-792 \text{ kJ}}{2 \cancel{\text{mol S}}} = -1050 \text{ kJ}$

Answer the following questions. Show all work and report answers with units.

1. How much heat will be released when 6.44 g of sulfur reacts with excess O_2 according to the following equation?

   $2S + 3O_2 \rightarrow 2SO_3 \quad \Delta H = -791.4 \text{ kJ}$

2. How much heat will be released when 4.72 g of carbon reacts with excess O_2 according to the following equation?

   $C + O_2 \rightarrow CO_2 \quad \Delta H = -393.5 \text{ kJ}$

3. How much heat will be absorbed when 38.2 g of bromine reacts with excess H_2 according to the following equation?

   $H_2 + Br_2 \rightarrow 2HBr \quad \Delta H = +72.80 \text{ kJ}$

4. How much heat will be released when 1.48 g of chlorine reacts with excess phosphorus according to the following equation.

   $2P + 5Cl_2 \rightarrow 2PCl_5 \quad \Delta H = -886 \text{ kJ}$

5. What mass of propane, C_3H_8 must be burned in order to produce 76,000 kJ of energy?

   $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O \quad \Delta H = -2200 \text{ kJ}$

6. How much heat will be absorbed when 13.7 g of nitrogen reacts with excess O_2 according to the following equation?

   $N_2 + O_2 \rightarrow 2NO \quad \Delta H = +180 \text{ kJ}$

7. What mass of iron must react to produce 3600 kJ of energy?

   $3Fe + 2O_2 \rightarrow Fe_3O_4 \quad \Delta H = -1120 \text{ kJ}$

8. How much heat will be released when 12.0 g of H_2 reacts with 76.0 g of O_2 according to the following equation?
   (when one reactant runs out the reaction stops)

   $2H_2 + O_2 \rightarrow 2H_2O \quad \Delta H = -571.6 \text{ kJ}$

Ch 16: Structural Formulas and Polar Molecules Worksheet

Draw the Structural Formulas for the following molecules. Is the molecule polar on non-polar? The bolded element should be placed in the center

CH_4 Polar or non-polar?	**C**H_2Cl_2 Polar or non-polar?:
CCl_4 Polar or non-polar?	H_2**O** Polar or non-polar?
SO_3 Polar or non-polar?	**C**O Polar or non-polar?
NF_3 Polar or non-polar?	**C**O_2 Polar or non-polar?

Ch 16: Intermolecular Forces Worksheet

1. Non-polar molecules are attracted to each other by only London Dispersion Forces.
2. Polar molecules are attracted to each other by dipole-dipole attractions and London Dispersion Forces.
3. Polar Molecules with **O**-H, N-H, or H-**F** bonds are attracted to each other by intermolecular hydrogen bonding, dipole-dipole attractions, and London Dispersion Forces.

Instructions: Draw the Structural Formulas for each formula. Decide if the molecule is polar or non-polar. Indicate the Intermolecular Forces (IMFs) present in the substance.

$H_2\mathbf{O}$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding	$\mathbf{C}H_4$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding	$\mathbf{S}O_3$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding
$\mathbf{C}F_4$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding	$\mathbf{C}H_2Cl_2$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding	$\mathbf{N}H_3$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding
$H_2\mathbf{S}$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding	$\mathbf{C}O_2$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding	$\mathbf{S}O_2$ Polar/non-polar Check IMFs present ☐ London ☐ Dipole-dipole ☐ Hydrogen bonding

Ch 10 Changes of State

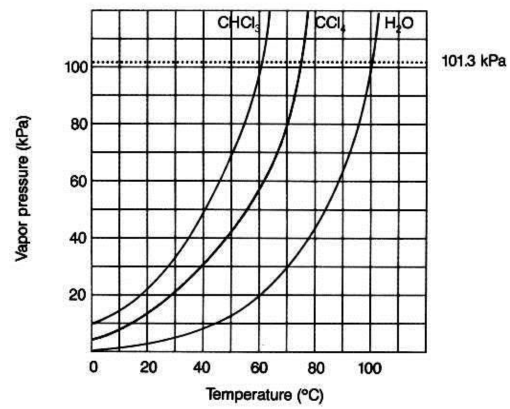
PART A – INTERMOLECULAR FORCES

1. Fill in the diagram (with high or low) to show how intermolecular forces influence the **volatility**, **vapor pressure**, and **boiling point** of a substance.

When IMF are…

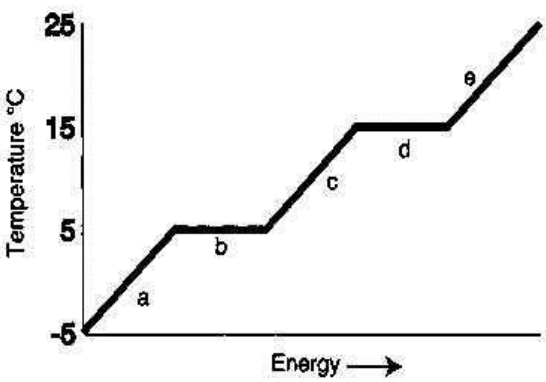
weak	strong
volatility is ____________	volatility is __________
vapor pressure is _______	vapor pressure is __________
boiling point is __________	boiling point is __________

PART B – VAPOR PRESSURE GRAPHS Use the graph below to answer the following questions.



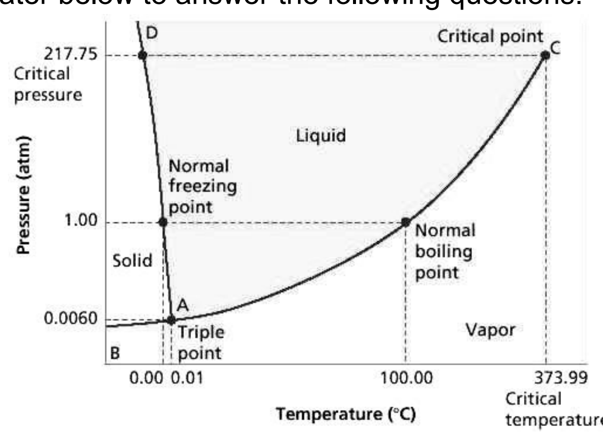
2. What is the vapor pressure of $CHCl_3$ at 50°C? _______________
3. What is the boiling point of H_2O when the external pressure is 30 kPa? _______________
4. What is the normal boiling point of CCl_4? _______________
5. Which substance has the weakest IMF? _______________

PART C – HEATING CURVES. Use the heating curve below to answer the following questions.



6. What is the melting point of the substance? _______
7. What is the boiling point of the substance? _______
8. Which letter represents heating of the solid? _______
9. Which letter represents heating of the vapor? _______
10. Which letter represents melting of the solid? _______
11. Which letter represents boiling of the liquid? _______

PART D – PHASE DIAGRAMS. Use the phase diagram for water below to answer the following questions.



12. What is the state of water at 2 atm and 50°

    ____

13. What phase change will occur if the temperature is lowered from 80°C to -5°C at 1 atm?

    ____

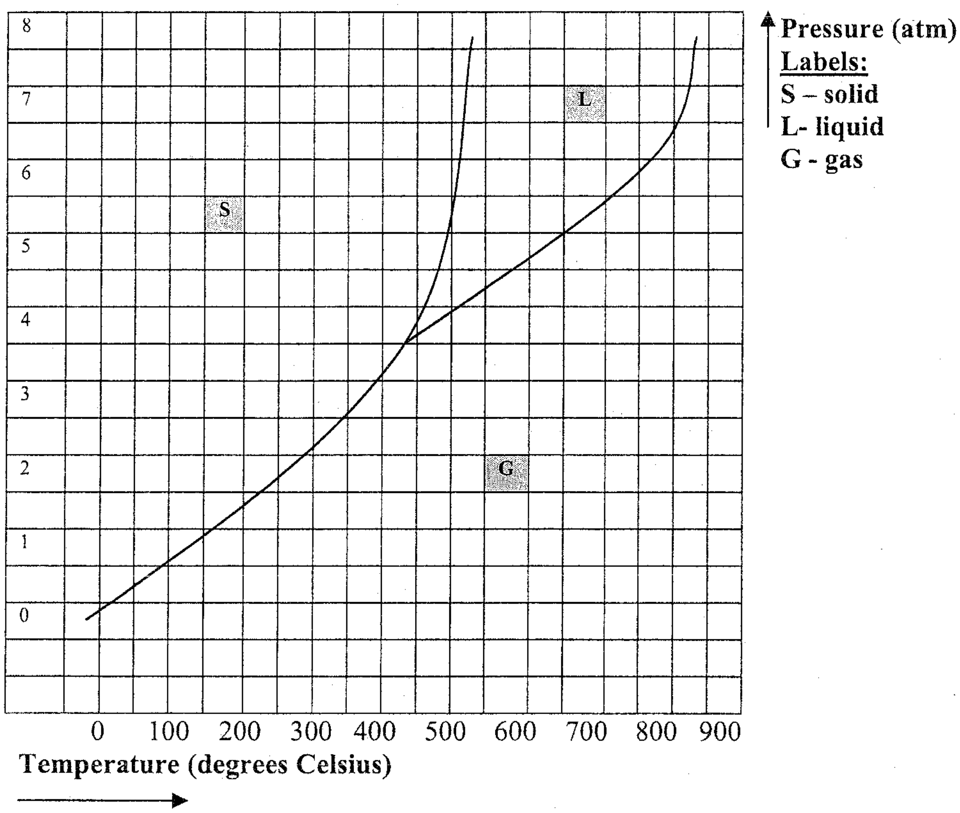
14. You have ice at -10°C and 1 atm. What could you do in order cause the ice to sublime?

    ____

Ch 10

Phase Diagram Worksheet (two sides) Name ________________ Date __________

(#1) For each of the questions on this worksheet, refer to the phase diagram for mysterious compound X.



(1) If you were to have a bottle containing compound X in your closet, what phase would it most likely be in? ____________________

(2) At what temperature and pressure will all three phases coexist? ___________________

(3) If you have a bottle of compound X at a pressure of 3 atm and temperature of 100^0C, what will happen if you raise the temperature to 400^0C? ____________________________________

(4) Why can't compound X be boiled at a temperature of 200^0C?

____

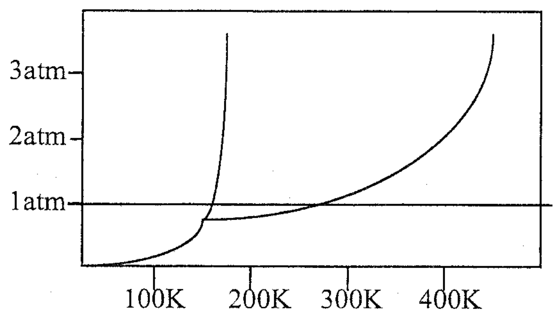
(5) Is it possible to drink compound X?

____

(6) What is the critical temperature of compound X? _________________

(#2) On the phase diagram below :

(a) Label areas of Gas, Liquid, Solid



Find the following data:

	T, ^{0}K	P, atm
Triple point		
Normal melting point		
Normal boiling point		
Critical point		

(b) What changes in phase will occur if this substance is slowly compressed at constant temperature, from 0.01 atm to 3.5 atm at:

► 100.K ________________
► 150. K________________
► 300.K________________
► 500.K________________

(c) What are the necessary conditions for this material to sublime?

(#3) Construct the phase diagram for a substance on the axes below based on the following data: (It need NOT be to scale)

	T, ^{0}K	P, atm
Triple point	55 K	0.10 atm
Normal melting point	68 K	
Normal boiling point	183 K	
Critical point	218 K	50 atm

► **Label:** S, L, G areas
► **Lines of equilibrium between solid and gas, liquid and gas, solid and liquid.**

Chapter 12: Dalton's Law of Partial Pressures

1. What is the equation for Dalton's Law of Partial Pressures?

2. What are the variants of Dalton's Law of Partial Pressures?

3. The planet Zook has an atmosphere that contains 3.0 mmHg of neon, 12.0 mmHg of xenon, and 8.0 mmHg of Krypton. What is the total atmospheric pressure of planet Zook?(Ans=23.0 mmHg)

4. A Martian visiting planet Zook has a breathing tank pressurized to 240 kPa with a mixture of carbon dioxide, oxygen and hydrogen. The partial pressure of the CO_2 is 20 kPa and the partial pressure of the O_2 is 50 kPa. What is the partial pressure of the hydrogen? (Ans = 170 kPa)

5. A sample of oxygen gas is collected over water at 28°C. The vapor pressure of water at 28°C is 20 mm Hg. If the total pressure is 380 mm Hg, what is the partial pressure of the oxygen?(Ans=360 mmHg)

6. In a mixture of hydrogen (H_2) and argon (Ar) gas, 15% of the total gas pressure is exerted by hydrogen. If the total pressure is 60.0 atm, what pressure does the hydrogen exert? (Ans = 9.0 atm)

7. A tank contains 12 moles of a mixture of neon, krypton, and radon at 300. kPa. If there are two moles of krypton in the tank, what is the partial pressure of krypton?(Ans = 50 kPa)

8. Argon makes up 0.93 percent of the earth's atmosphere by volume. What is the partial pressure of argon when the total pressure is 760 mm Hg? (Ans = 7.1 mm Hg)

Ch 12 Dalton's Law Practice 2

1. The partial pressure of the gases that comprise air are shown in the table.

Gas	Partial Pressure (mm Hg)
Ar	7.10
CO_2	?
N_2	593.44
O_2	159.20
Others	0.02

   If the total pressure is 760 mm Hg, what is the partial pressure of CO_2?(Ans = 0.24 mm Hg)

2. A sample of nitrogen gas is collected over water at 30°C. The vapor pressure of water at 30°C is 26 mm Hg. If the total pressure is 606 mm Hg, what is the partial pressure of the nitrogen?(Ans = 580 mm Hg)

3. Industrial deep-sea divers must breathe a mixture of helium and oxygen to prevent a disorienting condition known as nitrogen narcosis. If a diver's tank is filled with a helium-oxygen mixture to a pressure of 170 atmospheres and the partial pressure of helium is 110 atmospheres, the partial pressure of oxygen is _____.(Ans = 60 atm)

4. A mixture of gases with a pressure of 800.0 mm Hg contains 70% nitrogen and 30% oxygen by volume. What is the partial pressure of oxygen in this mixture?(Ans = 240 mm Hg)

5. The composition of dry air is approximately 78% nitrogen, 21% oxygen, and 1% other gases. What is the partial pressure of nitrogen in Denver at 85 kPa.(Ans = 66 kPa)

6. A tank contains N_2 at 1.0 atm and O_2 at 2.0 atm. Helium is added to this tank until the total pressure is 8.0 atm. What is the partial pressure of the helium?(Ans = 5.0 atm)

7. The total pressure of an O_2^-Ar-He gas mixture is 755 mm Hg. If the partial pressure of Ar is 174 mm Hg and the partial pressure of He is 389 mm Hg, then the partial pressure of O_2 is _____. (Ans = 192 mm Hg)

8. In a mixture of argon and helium gas, 70.0 percent of the total gas pressure is exerted by argon. If the total pressure is 4.0 atm, what pressure does the helium exert?(Ans = 1.2 atm)

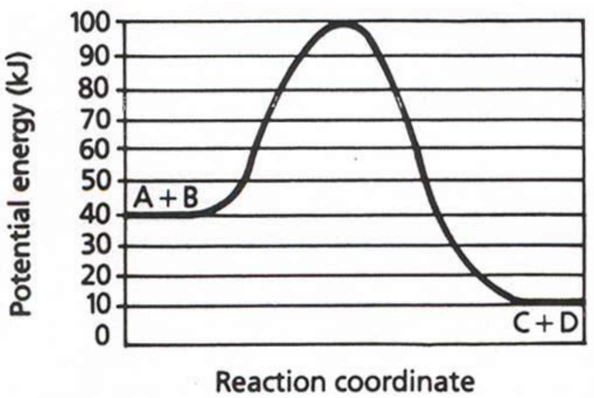
9. A sample of xenon gas is collected over water at 22°C and 85.6 kPa pressure. If the partial pressure of the water is 2.7 kPa, the partial pressure of the xenon is ________.(Ans = 82.9 kPa)

10. A mixture of gases contains 5.0 moles of Ne, 3.0 moles of He, and 2.0 moles of Ar at 500 mm Hg. What is the partial pressure of Ar in the mixture?(Ans = 100 mm Hg)

Ch 19 Thermodynamics – Reaction Pathways Worksheet

1. The graph below is a potential energy diagram for the hypothetical reaction:

A + B $\rightarrow$ C + D



a. Is the forward reaction endothermic or exothermic? Calculate the value of ΔH for this reaction.

b. What is the value of the potential energy of the activated complex?

c. Calculate the activation energy for the forward reaction.

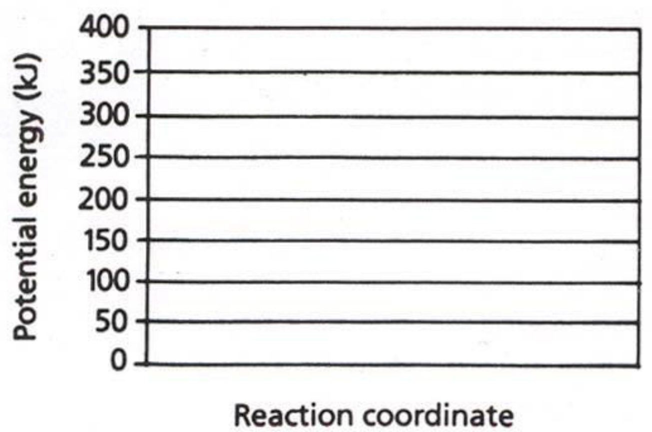
d. Draw a dashed line to show the effect of adding a catalyst to the system.

e. Name 4 things that speed up a reaction:

2. On the graph below, draw a potential energy diagram for the following reaction:

Q + R $\rightarrow$ S + T

given the following information:
the potential energy of Q + R is 150 kJ
the potential energy of S + T is 250 kJ
the potential energy of the activated complex is 375 kJ



a. Is the forward reaction endothermic or exothermic? Calculate the value of ΔH for this reaction.

b. Calculate the activation energy for the forward reaction.

c. What is the total potential energy content of the activated complex?

d. Draw a dashed line to show the effect of adding a catalyst to the system.

Thermochemistry Review

Chem Worksheet 16-5

Name ________________

The following represent some of the calculations we have mastered this chapter. These are the same types of calculations that will appear on the chapter test.

Heat Unit Conversions – 1 calories = 4.184 joules

1. A chemical reaction produces 330 kJ of heat. Convert this to joules.
2. A popular energy drink is said to contain 84 Calories. How many calories is this?
3. Convert 775 calories to joules.
4. Convert 1500 kilojoules to calories.

Using Specific Heats - $\boxed{Q = mC\Delta T}$

5. How much heat is transferred when 75 g of iron (C =0.45 J/g ºC) is heated from 30ºC to 650ºC?
6. If 1200 J of heat is added to 18 g of silver (C = 0.24 J/g ºC), how much will its temperature increase by?
7. When14 g of an unknown metal receives 325 joules of energy its temperature increases by 181ºC. What is its specific heat?

Enthalpy Stoichiometry

8. How much heat is released when 90 g of NO decomposes according to the following equation?
   $$2NO \rightarrow N_2 + O_2 \qquad \Delta H = -180 \text{ kJ/mol}$$
9. What mass of hydrogen must react in order to produce 1800 kJ of energy?
   $$2H_2 + O_2 \rightarrow 2H_2O \qquad \Delta H = -572 \text{ kJ/mol}$$

Calorimetry Calculation (just like Lab)

10. When 2.5 g of LiCl is dissolved in 112.0 g of water the temperature of the water increases from 18.2ºC to 22.9ºC. Use this information to calculate *ΔH* for the reaction.
    a. Find the amount of heat absorbed by the water in joules.
    b. Find the heat released by the reaction in joules
    c. Convert this heat to kilojoules
    d. Find the number of moles of LiCl that reacted.
    e. Divide the kilojoules produced by the moles of LiCl