KEY

Name: ______________________ Period: ______

Gas Law #3

Show all work and include units

1) There are 135 L of gas in a container at a temperature of 260°C. If the gas was cooled until the volume decreased to 75 L, what would the temperature of the gas be °C?

23°C

V = 135 L
T = 260 C
V = 75 L
T_2 = ?

$T_2 = \frac{V_2 T_1}{V_1} = \frac{(75L)(333K)}{(135L)}$ = 296 K − 273

2) A 75 L container holds 62 moles of gas at a temperature of 215 °C. What is the pressure in atmospheres inside the container?

33atm

V = 75 L
n = 62 mol
T = 215 C
P = ?

PV = nRT
P = nRT/V

$\frac{(62)(0.0821)(488K)}{(75L)}$

3) 6.0 L of gas in a piston at a pressure of 1.0 atm are compressed until the volume is 3.5L. What is the new pressure inside the piston?

1.7atm

P_1 = 1atm
V_1 = 6L
V_2 = 3.5
P_2 = ?

$P_2 = \frac{P_1 V_1}{V_2}$

$\frac{(1atm)(6L)}{3.5L}$

4) A gas canister can tolerate internal pressures up to 210 atmospheres. If a 2.0 L canister holding 3.5 moles of gas is heated to 1350 °C, will the canister explode?

233atm
yes

P = ?
V = 2L
n = 3.5mol
T = 1350C

PV = nRT
P = nRT/V

$= \frac{(3.5mol)(0.0821)(1623K)}{2L}$

5) The initial volume of a gas at a pressure of 3.2 atm is 2.9 L. What will the volume be if the pressure is increased to 4.0 atm?

2.3L

V_1 2.9L
P_1 3.2atm
V_2 ?
P_2 4atm

$V_2 = \frac{P_1 V_1}{P_2}$

$\frac{(3.2atm)(2.9L)}{4atm}$

6) An airtight container with a volume of 4.25 x 10^4 L, an internal pressure of 1.00 atm, and an internal temperature of 15.0 °C is washed off the deck of a ship and sinks to a depth where the pressure is 175 atm and the temperature is 3.00 °C. What will the volume of the gas inside be when the container breaks under the pressure at this depth?

232.7L

V = 4.25x10^4 L
P 1atm
T = 15°C
P_2 = 175atm
T_2 = 3°C
V_2 ?

$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{(1atm)(4.25x10^4)(276K)}{(288K)(175atm)}$

Name: KEY Period: ______

Gas Stoichiometry #4

mixed STP

Use the following balanced reaction for each problem:

$$2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(g)}$$

1) For the reaction ~~$2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(g)}$~~, how many liters of water can be made from 5 L of oxygen gas and an excess of hydrogen? at STP

10L

$5L\ O_2 \cdot \frac{1\ mol}{22.4L\ O_2} \left(\frac{2\ mol\ H_2O}{1\ mol\ O_2}\right) \frac{22.4L}{1\ mol\ H_2O}$

2) How many liters of water can be made from 55 grams of oxygen gas and an excess of hydrogen at STP?

77L

$55g\ O_2 \cdot \frac{1\ mol\ O_2}{32g\ O_2} \left(\frac{2\ mol\ H_2O}{1\ mol\ O_2}\right) \frac{22.4L}{1\ mol\ H_2O}$

3) How many liters of water can be made from 55 grams of oxygen gas and an excess of hydrogen at a pressure of 12.4 atm and a temperature of 85^0 C?

8.2L

$55g\ O_2 \cdot \frac{1\ mol}{32g\ O_2} = 1.72\ mol\ O_2 \left(\frac{2\ mol\ H_2O}{1\ mol\ O_2}\right) = 3.44\ mol\ H_2O$

$PV = nRT$

$V = nRT/P = (3.44\ mol)(0.0821)(273+85) / 12.4\ atm = 8.2L$

4) How many liters of water can be made from 34 grams of oxygen gas and 6.0 grams of hydrogen gas at STP? What is the limiting reactant for this reaction? Make sure you find the limiting reagent first.

47.6L

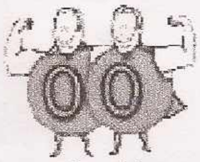
Find limiting 1st

$34g\ O_2 / 32g = 1.06$ ←

$6\ H_2 / 2.02g = 2.97/2 = 1.4$

$34g\ O_2 \cdot \frac{1\ mol\ O_2}{32g\ O_2} = 1.06\ mol\ O_2 \left(\frac{2\ mol\ H_2O}{1\ mol\ O_2}\right) \frac{22.4L}{1\ mol\ H_2O} = 47.6L$

Name: KEY Period: ______



REVIEW: Gas Laws and Stoichiometry

1. How many moles of gas occupy 98 L at a pressure of 2.8 atmospheres and a temperature of 292 K?

11.5mol

$PV=nRT$ $n=PV/RT$ $n=\frac{(2.8atm)(98L)}{(0.0821)(292K)}$

2. If 5.0 moles of O_2 and 3.0 moles of N_2 are placed in a 30.0 L tank at a temperature of 25 °C, what will the pressure of the resulting **mixture** of gases be? Assume atm pressure.

6.52atm

$P=\frac{nRT}{V}=\frac{(8mol)(0.0821)(298K)}{(30L)}$

3. Calcium carbonate decomposes at high temperatures to form carbon dioxide calcium oxide:

?g 2.5 L

$CaCO_3(s) \rightarrow CO_2(g) + CaO(s)$

How many grams of calcium carbonate will I need to form 2.5 liters of carbon dioxide? Assume this reaction is being performed 245K and 2.3 atm.

28.89g $CaCO_3$

2.5L CO_2

$PV=nRT$

$n=PV/RT$ $(2.3atm)(2.5L)/(0.0821)(245)=0.286mol$

$0.286mol\ CO_2 \cdot \frac{1mol\ CaCO_3}{1mol\ CO_2} \cdot \frac{100.9g}{1mol\ CaCO_3}=$

4. A balloon is filled with 35.0 L of helium in the morning when the temperature is 20.00 °C. By noon the temperature has risen to 45.00° C. What is the new volume of the balloon?

37.98L

$V_2=\frac{V_1T_2}{T_1}$ $\frac{(35L)(318K)}{(293K)}$

5. A 35 L tank of oxygen is at 315 K with an internal pressure of 190 atmospheres. How many moles of gas does the tank contain?

257mol

$n=PV/RT$ $\frac{(190atm)(35L)}{(0.0821)(315)}$

6. A helium balloon with an internal pressure of 1.00 atm and a volume of 4.50 L at 20.00 °C is released. What volume will the balloon occupy at an altitude where the pressure is 0.600 atm and the temperature is –20.00 °C?

6.5L

$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$ $\frac{(1 atm)(4.5L)(253k)}{(293k)(0.6 atm)}$

7. The initial volume of a gas at a pressure of 3.2 atm is 2.9 L. What will the volume be if the pressure is increased to 4.0 atm?

2.3L

$V_2 = \frac{P_1 V_1}{P_2} = (3.2 atm)(2.9L) / 4 atm$

8. Calcium carbonate decomposes at high temperatures to form carbon dioxide calcium oxide:

?g 3.2L

$$CaCO_{3(s)} \rightarrow CO_{2(g)} + CaO_{(s)}.$$

How many grams of Calcium Carbonate will I need to form 3.2 liters of calcium oxide? Assume this reaction is being performed at STP.

14.3g $CaCO_3$

$3.2L \cdot \frac{1 mol CaO}{22.4 L CaO} = 0.143 mol CaO \cdot \frac{1 mol CaCO_3}{1 mol CaO} \cdot \frac{100.1 g CaCO_3}{1 mol CaCO_3}$

= 9.7g CaCO

9. Ethylene (C_2H_4) burns in oxygen to form carbon dioxide and water vapor:

22.9L

$$C_2H_{4(g)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 2\ H_2O_{(g)}$$

How many liters of CO_2 can be formed if 22.9L of Oxygen are consumed in this reaction? Assume this reaction is being performed at a pressure of 1atm and 298K.

15.3L

$22.9L\ O_2$ $PV = nRT$

$n = PV/RT = (1 atm)(22.9L) / (0.0821)(298K)$

$= 0.936 mol\ O_2$

$0.936 mol\ O_2 \left(\frac{2 mol\ CO_2}{3 mol\ O_2}\right) = 0.624 mol\ CO_2$

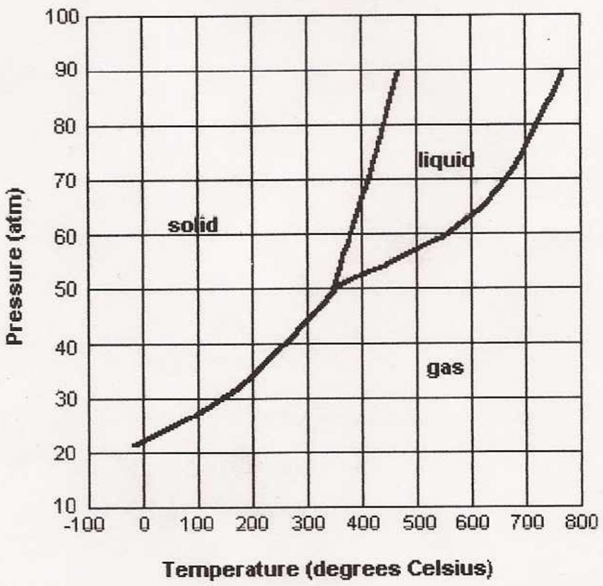
$PV = nRT$

$V = nRT/P = (0.624 mol)(0.0821)(298K) / 1 atm = 15.3L$

Phase Diagram Worksheet A

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

Phase diagram for mysterious compound X



1) ~~What is the critical temperature of compound X? ~770^0 C~~

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

Extrapolating from this diagram, it's most likely a gas.

3) At what temperature and pressure will all three phases coexist?

350^0 C, ~51 atm

4) If I have a bottle of compound X at a pressure of 45 atm and temperature of 100^0 C, what will happen if I raise the temperature to 400^0 C?

It will sublime

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

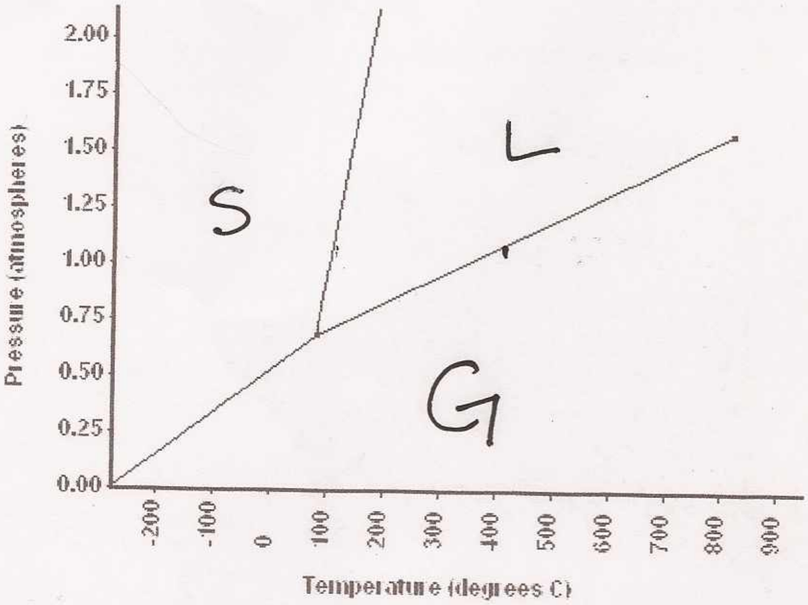
It does not form a liquid at this temperature. It only exists as a liquid at temperatures above 350^0 C.

6) If I wanted to, could I drink compound X?

No. At the temperatures and pressures that it forms a liquid, you'd probably die.

Phase Diagram Worksheet B

Refer to the phase diagram below when answering the questions on this worksheet:



1) What is the normal freezing point of this substance? ≈100°C (1atm)

2) What is the normal boiling point of this substance? 350 ≈410 °C (1atm)

3) What is the normal sublimation point of this substance? X (1atm)

4) If I had a quantity of this substance at a pressure of 1.25 atm and a temperature of 300° C and lowered the pressure to 0.25 atm, what phase transition(s) would occur?

Liquid → Gas = vaporization

5) ~~At what temperature do the gas and liquid phases become indistinguishable from each other?~~ ________

6) If I had a quantity of this substance at a pressure of 0.75 atm and a temperature of -100° C, what phase change(s) would occur if I increased the temperature to 600° C? At what temperature(s) would they occur?

Solid → Gas = sublimation

200°C and above

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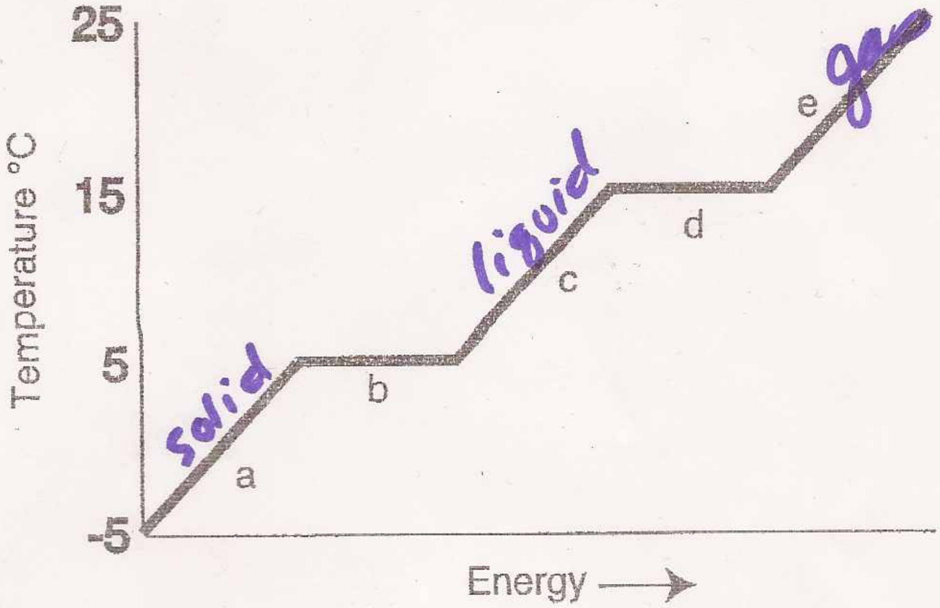
FREEZING AND BOILING POINT GRAPH

Name ______________



Answer the following questions using the chart above.

1. What is the freezing point of the substance? 5°C
2. What is the boiling point of the substance? 15°C
3. What is the melting point of the substance? 5°C
4. What letter represents the range where the solid is being warmed? A
5. What letter represents the range where the liquid is being warmed? C
6. What letter represents the range where the vapor is being warmed? E
7. What letter represents the melting of the solid? B
8. What letter represents the vaporization of the liquid? D
9. What letter(s) shows a change in potential energy? B, D
10. What letter(s) shows a change in kinetic energy? A, C, E
11. What letter represents condensation? D
12. What letter represents crystallization? ~~A~~ B (liq to solid)

1/11/24 1st UNITS

$C_{water} = 4.184 J/g°C$

Name ____________________________ Hour ________

Heat Calculations Worksheet #2

1. How many kilojoules of heat are absorbed when 100.0 g of water is heated from 18 deg C to 85 deg C?

   $100g(4.184 J/g°C)(85-18)$ = **28.03 kJ**

2. A piece of stainless steel weighing 1.55 g absorbs 141 J of heat when its temperature is increased 178 deg C. What is the specific heat of steel?

   $Q = mc\Delta T$ $\quad C = \frac{Q}{m\Delta T} = \frac{141 J}{(1.55g)(178°C)}$ = **0.511 J/g°C**

3. How many joules of heat are given off when 5.0 g of water cool from 75°C to 25°C?

   $Q = 5g(4.184 J/g°C)(25-75)$ = **-1046 J**

4. How many calories are given off by the water in Problem 5?

   $\frac{1046 J}{1} \cdot \frac{1 cal}{4.184 J}$ = **250c**

5. Calculate the number of joules of heat energy needed to increase the temperature of 50.0 g of copper metal from 21.0 °C to 80.0°C. The specific heat of copper is 0.382 j/g°C.

   $Q = (50g)(0.382 J/g°C)(80-21)$ = **1126.9 J**

6. Calculate the specific heat of a substance given that 46.9 joules of heat is required to raise the temperature of 40.0 g of the substance from 95.6° C to 99.4° C.

   $C = \frac{Q}{m\Delta T}$ $\quad 46.9 J / (40g)(99.4-95.6)$ = **0.3085 J/g°C**

7. Calculate the specific heat of a substance given that 221 joules of heat is required to raise the temperature of 55.0 g of the substance by 4.0 °C.

   $C = \frac{Q}{m\Delta T} = \frac{221 J}{(55g)(4°C)}$ = **1 J/g°C**

8. The specific heat capacity of concrete is 0.84 j/g°C. Determine the heat absorbed by a 5.00×10^3 g block of concrete if its temperature rises from 35.2° C to 77.1°C.

   $Q = 5 \times 10^3 (0.84 J/g°C)(77.1 - 35.2°C)$ = **175,980 J**

$Q = CM\Delta T$

9. What is the temperature change if a 235 g piece of copper absorbs 35,000. joules of heat energy? (Specific heat of copper is 0.385 joule/g°C.)

$\Delta T = \frac{Q}{CM} = 35{,}000J \,/\, 0.385 J/g°C\,(235g)$ — $\Delta T = 386°C$

10. Calculate the final temperature after 145 joules of heat energy is added to 7.73 g of water at 43.2°C (specific heat capacity of water = 4.184 j/gdegC).

$Q = CM(T_f - T_i)$ | $\frac{Q}{CM} + T_i = T_f$ | $T_f = \frac{145J}{(7.73g)(4.184J/g°C)} + 43.2°C = 47.7°C$

11. Calculate the final temperature after 145 joules of heat energy is removed from 6.55 g of water at 34.2° C.

$T_f = \frac{Q}{CM} + T_i = \frac{-145J}{4.184 J/g°C\,(6.55g)} + 34.2°C = 28.9°C$

12. Convert 153,000 joules to calories.

$153{,}000 J \cdot \frac{1\,cal}{4.184 J} = 36{,}567\,cal$