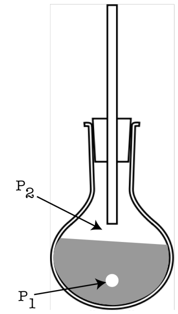
Name Period Date **Pre-AP Chemistry**

Homework: Phase Changes

DUE: Thursday, Feb. 12

1. A round bottom flask with **water** in it is heated. A bubble successfully forms inside the water.



a. What is *in* the bubble?

b. How does the pressure in the bubble, P_1, compare to the external pressure above the liquid, P_2.

c. As time passes, liquid collects on the walls of the flask. What is this liquid and why does it condense on the sides?

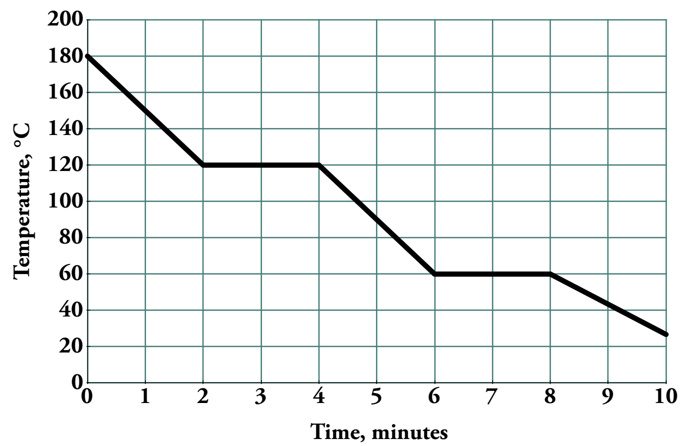
2. Why is the boiling temperature of **He** much lower than the boiling point of **H_2S**? Base your answer on molecular motion and attractions.

3. This cooling curve shows the temperature of a substance over time. The pressure remains constant throughout the process.

a. __________________ What phase change is occurring at 3 minutes?

b. __________________ What is the freezing temperature of this substance?

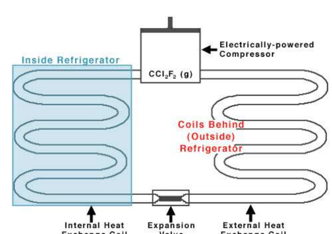
c. __________________ Is this overall process **endothermic** or **exothermic**? Explain your choice.



d. Why does the graph level off at 60°C?

4. A refrigerator uses a substance that is pumped through pipes or "coils" in a repeating cycle. Liquid enters the inside of the refrigerator and gradually changes to gas. This gas is pushed through the coils to the outside of the refrigerator and it is compressed back into a liquid.

a. Why does the change from a liquid to a gas cool the inside compartment?



b. __________________ Does the *expanding* liquid inside the refrigerator experience and **exothermic** or **endothermic** change?

c. __________________ Does the food inside the refrigerator experience an exothermic or endothermic process?

d. The coils on the **out**side of the refrigerator warm up. Why?

5. Make these temperature conversions: K=˚C + 273

a. 273 K= ____________________ ˚C
b. 3.34 K=____________________ ˚C
c. –115˚C= ___________________ K
d. 100.0˚C= __________________ K

6. Make these pressure conversions: $\frac{1\text{Pa}}{1\times10^{-3}\text{kPa}}$, $\frac{1\text{Pa}}{9.8692\times10^{-6}\text{atmospheres}}$

a. 34 Pa= ____________________ kPa
b. 4.5×10^7 Pa= ________________ kPa
c. 101.3 kPa= _________________ Pa
d. 8.0 kPa= ___________________ Pa
c. 1.0 atmosphere=_____________ Pa
d. 0.85 atm= __________________ Pa
e. 2.6 atm= ___________________ kPa
f. 110.8 kPa= _________________ atm

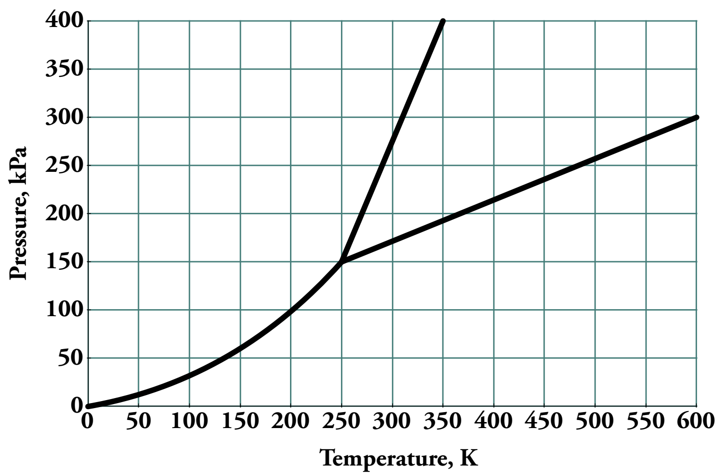
7. Use this phase change diagram for this question.

a. _________________ What phase exists at 200 K and 300 kPa?

b. _________________ What is the **boiling point** of this substance at 250 kPa?

c. _________________ If this substance is at 350 kPa and 300K, what **phase change** occurs if the pressure is lowered to 200 kPa, while keeping the temperature the same?

d. Would it be possible to cause this substance to undergo **deposition**? What range of pressure & temperature would cause this?



e. _________________ What the normal freezing point of this substance? (freezing under standard pressure conditions=101.3 kPa)

8. Complete and balance this equation for the **combustion** of butane:

a.

__ C_4H_{10} + ___ O_2 →

b. _________________ How many moles of oxygen would be needed to react with 4 moles of butane?

c. _________________ If 75.0 grams of carbon dioxide were produced, how many grams of butane were reacted?

d. _________________ What is the **empirical formula** for butane?

7. Provide the names or formulas for these compounds

a. __________________________ $Ni(NO_3)_3$
b. __________________________ $Ca(NO_2)_2$
c. __________________________ SI_2
d. __________________________ carbon tetrachloride
e. __________________________ NO_2
f. __________________________ iron(III) sulfate

8. _________________ What is the percent composition of $Al_2(SO_4)_3$?

Homework: Phase Changes

1. A round bottom flask with **water** in it is heated. A bubble successfully forms inside the water.

a. What is *in* the bubble?

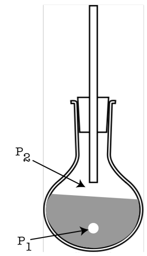
Water vapor which has escaped from the surrounding liquid.

b. How does the pressure in the bubble, P_1, compare to the external pressure above the liquid, P_2.

The vapor is exerting at least as much pressure as the outer pressure. That's why it is able to form. The vapor molecules are pushing out with enough force to hold up against the atmosphere pushing down. The vapor exerts enough pressure to keep the bubble from popping.

c. As time passes, liquid collects on the walls of the flask. What is this liquid and why does it condense on the sides?

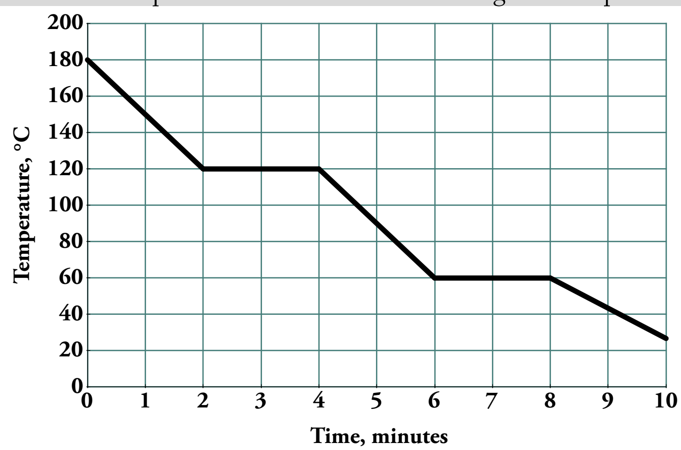
Water vapor collects on the walls of the glass because the glass is cooled by the room air. When water molecules bounce against these walls, they slow down and change back to the liquid phase (condense)



2. Why is the boiling temperature of **He** much lower than the boiling point of **H_2S**? Base your answer on molecular motion and attractions.

Helium is NOT polar so the molecules don't tend to stick to each other. H_2S is polar, so these molecules are more likely to stay stuck together in their current phase. Helium molecules also have a very small mass, so at any particular temperature they are moving much faster than the heavier H_2S molecules. These two factors mean that helium atoms will boil out of the liquid phase at a much lower temperature. As soon at they have enough energy, they fly apart and escape to the gas phase. H_2S is harder to speed up and the molecules stick together because of polar attractions so these molecules must be warmed up more to get them to escape to the gas phase.

3. This cooling curve shows the temperature of a substance over time. The pressure remains constant throughout the process.



a. ________________ What phase change is occurring at 3 minutes?

Condensation (liquid and gas coexisting)

b. ________________ What is the freezing temperature of this substance?

60°C

c. ________________ Is this overall process **endothermic** or **exothermic**? Explain your choice.

Heat-energy must be removed from the substance to get the molecules to cool down and stick together. From the perspective of the substance, it is EXOthermic because heat-energy is "leaving" it or "exiting."

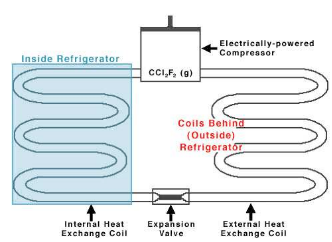
d. Why does the graph level off at 60°C?

During a phase change (in this case freezing) the energy that is leaving causes the molecules to slow down and STICK TOGETHER. As long as this sticking together process is happening, the temperature won't go any lower. AFTER all the molecules have frozen together, then the temperature will start to decrease. The temperature of a substance does not change during a phase change since the energy removed (or added) goes into getting those molecules to stick (or come apart)

4. A refrigerator uses a substance that is pumped through pipes or "coils" in a repeating cycle. Liquid enters the inside of the refrigerator and gradually changes to gas. This gas is pushed through the coils to the outside of the refrigerator and it is compressed back into a liquid.

a. Why does the change from a liquid to a gas cool the inside compartment?

The liquid refrigerant passes by the food inside (via tubes) and heat energy passes from the food to the liquid. This causes the liquid to gain energy and evaporate. Evaporation removes heat from the food and puts the energy into the liquid. The fast moving molecules of the food transfer their motion to the slower moving molecules of the liquid. The liquid molecules speed up and change to a gas.



b. ________________ Does the *expanding* liquid inside the refrigerator experience and **exothermic** or **endothermic** change?

The liquid refrigerant takes energy in so it experiences an ENDOthermic change.

c. ________________ Does the food inside the refrigerator experience an exothermic or endothermic process?

The food loses energy (to the refrigerator) so it experiences and exothermic change. Heat out from food, heat into refrigerator.

d. The coils on the **out**side of the refrigerator warm up. Why?

The gas travels to outer tubes. It is warm because it was vaporized by the food. Outer loop helps spread some of the heat to the room and allows the gas to cool down a little before it is compressed back to a liquid by the refrigerator (it's this compressor that usually makes most of the noise in a 'fridge.)

5. Make these temperature conversions: K=°C + 273

a. 273 K= __________ °C

K = C + 273 → C=0°

b. 3.34 K=__________ °C

3.34 = C + 273 → –269.66 = –270°C

c. –115°C= __________ K

K = –115 + 273 → 158 K

d. 100.0°C= __________ K

K=100.0+273 = 373 K

6. Make these pressure conversions: $\frac{1\text{Pa}}{1\times10^{-3}\text{kPa}}$, $\frac{1\text{Pa}}{9.8692\times10^{-6}\text{atmospheres}}$

a. 34 Pa= ____________________ kPa

$34\text{Pa}\bullet\frac{1\times10^{-3}\text{kPa}}{1\text{Pa}}$ =0.034 kPa

c. 1.0000 atmosphere ___________ Pa

$1\text{atm}\bullet\frac{1\text{Pa}}{9.8692\times10^{-6}\text{atm}}$ $=1.013\times10^5$ Pa

b. 4.5×10^7 Pa= ________________ kPa

$4.5\times10^7\text{ Pa}\bullet\frac{1\times10^{-3}\text{kPa}}{1\text{Pa}}$ $=4.5\times10^4$ kPa

d. 0.85 atm ____________________ Pa

$0.85\text{ atm}\bullet\frac{1\text{Pa}}{9.8692\times10^{-6}\text{atm}}$ $=8.6\times10^4$ Pa

c. 101.3 kPa __________________ Pa

$101.3\text{ kPa}\bullet\frac{1\text{Pa}}{1\times10^{-3}\text{kPa}}$ $=1.013\times10^5$ Pa

e. 2.6 atm ____________________ kPa

$2.6\text{ atm}\times\frac{1\text{Pa}}{9.8692\times10^{-6}\text{atm}}\times\frac{1\times10^{-3}\text{kPa}}{1\text{Pa}}$ =260 kPa

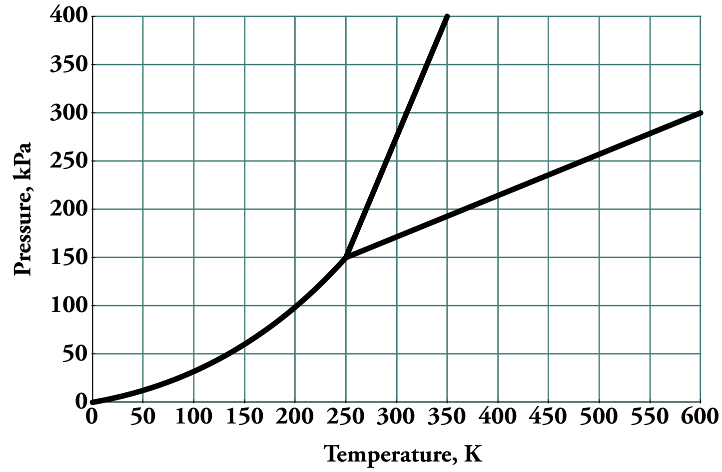
d. 8.0 kPa ____________________ Pa

$8.0\text{ kPa}\bullet\frac{1\text{Pa}}{1\times10^{-3}\text{kPa}}$ $=8.0\times10^3$ Pa

f. 110.8 kPa __________________ atm

$110.8\text{ kP}\times\frac{1\text{Pa}}{1\times10^{-3}\text{kPa}}\times\frac{9.8692\times10^{-6}\text{atm}}{1\text{Pa}}$ =1.094 atm

7. Use this phase change diagram for this question.



a. ________________ What phase exists at 200 K and 300 kPa?

solid

b. ________________ What is the **boiling point** of this substance at 250 kPa?

≈480 K; That's where the gas and liquid meet at 250 kPa

c. ________________ If this substance is at 350 kPa and 300K, what **phase change** occurs if the pressure is lowered to 200 kPa, while keeping the temperature the same?

That would drop it down from the solid to liquid zones = freezing.

d. Would it be possible to cause this substance to undergo **deposition**? What range of pressure & temperature would cause this?

Gas to solid; Down near the bottom. One route would be to keep it at 100 kPa and cool it from 250 K to 150 K. It would cross the gas to solid line.

e. ________________ What the normal freezing point of this substance? (freezing under standard pressure conditions=101.3 kPa)

8. Complete and balance this equation for the **combustion** of butane:

a.

$$2\ C_4H_{10} + 13\ O_2 \rightarrow 8CO_2 + 10H_2O$$

b. ________________ How many moles of oxygen would be needed to react with 4 moles of butane?

4 moles C_4H_{10} • 13 O_2/2 C_4H_{10} = 26 moles of oxygen needed

c. ________________ If 75.0 grams of carbon dioxide were produced, how many grams of **butane** were reacted?

$75\text{g}CO_2\bullet\frac{1\text{ mole}CO_2}{44.01\text{g}}\bullet\frac{2\text{ moles }C_4H_{10}}{8\text{ moles }CO_2}\bullet\frac{58.12\text{ g}}{1\text{ mole }C_4H_{10}}$ =24.761 = 24.8 grams of butane reacted.

d. ________________ What is the **empirical formula** for butane?

This means what is the simplest, whole number ratio = C_2H_5

7. Provide the names or formulas for these compounds

a. __________________________ $Ni(NO_3)_3$

Nickel (III) nitrate

b. __________________________ $Ca(NO_2)_2$

Calcium nitrite

c. __________________________ SI_2

Sulfur diiodide

d. __________________________ carbon tetrachloride

CCl_4

e. __________________________ NO_2

Nitrogen dioxide

f. __________________________ iron(III) sulfate

$Fe_2(SO_4)_3$

8. ________________ What is the percent composition of $Al_2(SO_4)_3$?

It's looking for the percentage break down of each element. I just use the molar mass as the starter amount: 1 mole = 342.17 grams

Al→ 2(26.98)=53.96 grams out of 342.17 = 0.1577 = 15.8%

S → 3(S) = 3(32.07) = 96.21 out of 342.17 = 0.2812=28.1%

O→ 12(O) = 12(16.0)=192.0 out of 342.17 = 0.5611=56.1%