Kinetic Molecular Theory of Gasses

1)When would real gasses most likely start to deviate from their ideal conditions?

2)What are the assumptions for an Ideal Gas?

3)If 5.0 moles of gas in a sealed glass flask is heated from 50ºC to 75ºC. Select the conditions that are true.

kinetic energy	**pressure**	**number of moles**
a. increases	increases	stays the same
b. increases	decreases	decreases
c. decreases	increases	stays the same
d. increases	increases	increases
e. stays the same	increases	increases

4) A real gas would act more ideal under:

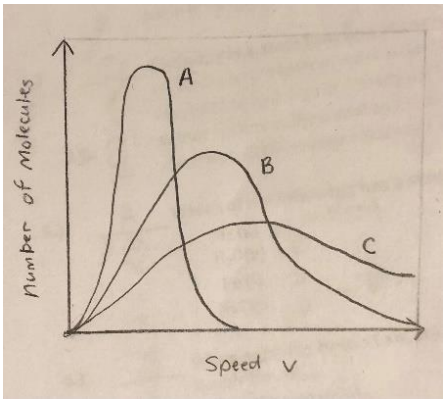
a. 1 atm and 273 K b. 10 atm and 547 K c. 10 atm and 273 K d. 0.5 atm and 546 K e. 0.5 atm and 273 K

5) At a temperature of 250K, the molecules of unknown gas Z, have an average velocity equal to that of HI at 500K. What of the following could be the identity of the gas?

SO_2 O_2 N_2 CO_2 NO_2 S_2O_4

From the list above, assuming everything is at STP, which molecule(s) would be most likely to exhibit ideal behavior and why?

6)Consider O_2, CO and CO_2 gas. Under STP, relate these gasses in terms of velocity and average kinetic energy.



7)A Maxwell Distribution graph is provided on the left. The distribution shows Helium, Neon, and Argon gas under the same temperature. Match each curve with the correct gas.

Gas Law Calculations

1) An ideal gas fills a balloon at a temperature of 27ºC and 1 atm pressure. By what factor will the volume of the balloon change if the gas in the balloon is heated to 127ºC at constant pressure?

2) A gas sample is heated from 253 K to 330 K while the volume increases from 2.00L to 4.50 L. If the initial pressure is 0.140 atm, what is the final pressure?

3) At STP, what volume does 40.5 g of N_2 occupy?

4) N_2O has has a density of 2.85 g/L at 25ºC. What is the pressure of the gas?

5) Marky is driving and gets distracted from a text from Naomi. He crushes James against a brick wall and sodium azide in Marky's airbag quickly decomposes to sodium and nitrogen gas upon impact in order to inflate. Because of this, James dies but Marky lives. If 11.8 L was inflated, how much sodium azide, in grams, was in Marky's airbag? Assume STP conditions.

$$2NaN_{3(s)} \rightarrow 2Na_{(s)} + 3N_{2(g)}$$

6) Methane reacts with water to form hydrogen gas and carbon monoxide. What volume of methane is required to produce 50.0g of $H_{2(g)}$ at 298K and 0.950 atm?

$$CH_{4(g)} + H_2O_{(l)} \rightarrow 3H_{2(g)} + CO_{(g)}$$

7) What will be the volume of 113 grams of gaseous propanol, C_3H_5OH, at 600 torr and 25 degrees C?

Partial Pressure

1) Equal masses of He and Ne are placed in a sealed container. What is the partial pressure of He if the total pressure in the container is 6 atm?

2) A gaseous mixture containing 1.5 mol Ar and 3.5 mol CO_2 has a total pressure of 7.3 atm. What is the partial pressure of CO_2?

3) James wants to find the identity of an unknown monoatomic ideal gas. He has a 7.5 L bulb containing He at 175 mmHg connected by a 2.5 L valve of unknown gas at 225 mmHg.

a) Calculate the molar mass of the unknown gas if 2.53 grams of it was placed at 298 K and then identify the gas.

b) Determine the pressures of each bulb after the valve between the flasks is opened.

Chemistry 232 Quest 1

Thermochemistry

1) Condensation is an exothermic process where thermal energy is released from system to surroundings. $H2O(g) \rightarrow H2O(l)$ $\Delta Hrxn = -44kJ$

Today, James' signature DutchBro's drink, the usual, is iced and the initial temperature of the cup is 12 degrees C. The longer James holds his cup, the more thermal energy is being transferred to the surroundings, causing water vapor to condense into liquid droplets.

a) If on his way back to the dorm, the cup warms by 0.85 degrees C and assuming the mass of the cup is 10 grams and has a heat capacity of 3.8 J/g C, how much water is collected onto the cup?

b) If during this time 8.5 kJ of energy were removed from his 600 ml drink (heat capacity = 4.184 J/gC), and his drink was initially 10 degrees C, what will the final temperature of his drink be?

2) James want to find the enthalpy of solution, $\Delta H_{soln,}$ for the alkali metal halides lithium chloride and sodium chloride. To do this, James measures 100.0 grams of water at initially 15.0 degrees Celsius to a calorimeter and then adds 10.0 g of the solid lithium chloride while stirring to let it dissolve. After the salt dissolves completely, he then measures temperature and records a maximum 35.6 degrees Celsius.
   a) Calculate the magnitude of heat absorbed by the solution during the dissolution process assuming a specific heat capacity of the solution to be 4.18 J/(g C).

   b) Determine the value of ΔH_{soln} for lithium chloride in $kJ/mol_{rxn.}$

3) James is walking back to his dorm from EBGBS after buying 650 ml of coffee and 170g of ice cream. He places the ice cream on top of the hot coffee and lets it sit until a final temperature has been reached.

A) Assuming there was no heat lost to surroundings, what would the final temperature be? Assume density=1g/ml

Initial temperature of coffee: 55 degrees C Specific heat of coffee: 1.4J/g*C

Initial temperature of ice cream: -18 degrees C Specific heat of ice cream: 3.1 J/g*C

4) James is making barbecue that contains 13.2 kg of propane, C_3H_8, calculate the heat (in kj) associated with the complete *combustion* of all the propane in the tank. ΔH_{rxn} = -2044 kJ

5) According to the reaction:

$$4Al + 3MnO_2 \rightarrow 2Al_2O_3 + 3Mn \qquad \Delta H_{rxn} = -1789 \text{ kJ/mol rxn}$$

a) Determine the energy released if 17g of Al are used.

b) What mass of Mn forms when 1000 kJ is detected?

6) Consider a reaction producing NF_3 at 298K. Approximate the average bond enthalpy of a F – F bond if the reaction takes places with ΔHrxn = -211 kJ/mol

Bond	Average Bond Enthalpy kJ/mol
N=N	418
N≡N	946
N-F	272
F-F	?

7)Consider the following reactions and their respective heats of formations. Assume D is in standard state. For the first reaction, calculate heat of formation for E. For the second reaction, find the enthalpy of the reaction.

		Reactant/Product	ΔHf (kJ/mol)
A + 2B → C + D + E	ΔHrxn = -1310 kJ/mol		
		A	-208
		B	333
2A + 3B → 2C + D		C	-148

8)Circle the chemical that would NOT have an enthalpy of formation equal to zero:

$He_{(g)}$ $Fe_{(g)}$ $H_2O_{(g)}$ $O_{2(g)}$ $Ag_{(l)}$

Intermolecular Forces

1) Rank the strength of all of the following forces:

Hydrogen bonding, London dispersion forces, dipole-dipole, induced dipole forces, ion-dipole force.

2) Determine all IMF's present in each element or compound (LD for dispersion, DD for dipole-dipole, H for hydrogen) Which is the most prevalent interaction?

N_2 NH_3 CO CCl_4 NCl_3 H_2O HF

3) Which of the following describes the changes in forces of attraction that occur as H2O changes phase from a liquid to a vapor?

A) H–O bonds break as H–H and O–O bonds form.

B) Hydrogen bonds between HO molecules are broken.

C) Covalent bonds between H2O molecules are broken.

D) Ionic bonds between H+ ions and OH- ions are broken.

E) Covalent bonds between H+ ions and H2O molecules become more effective.

4) Consider water in its gas, liquid, and solid phase. Which has stronger IMFs and why?
5) A hydrogen atom bonds with two oxygen atoms to form water. This is an example of what?
6) The hydrogen atom of a water molecule bonds with one of the oxygen atoms of another water molecule. What is this an example of?

7) James performs various experiments to determine properties of an unknown white crystalline solid.

- It melts at 320 degrees Celsius
- It does not conduct electricity as a solid
- It conducts electricity in an aqueous solution

Which of the following molecules could it be?

$C_6H_{12}O_6$ NaOH SiO_2 Cu

8) For the following, draw the interaction and depict intermolecular forces with dashed lines and intramolecular forces with solid lines. Also label the types of bonds and forces present.

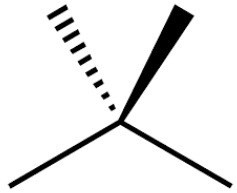
Hydrofluoric Acid, HF, bonds with another HF molecule

IMF's and Boiling Point

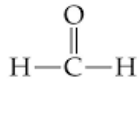
1) What is the relationship between IMF strength, boiling point and vapor pressure? Why?
2) Rank by increasing boiling point and explain why:

F_2 HCl HF

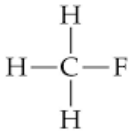
O_2 N_2 CO SiH_4 Al_2O_3 CH_2OH



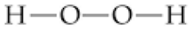
3) The 3D skeletal structure of neopentane (above) is provided above. Is this molecule polar or nonpolar? Will it have a relatively high boiling point or low boiling point?



Formaldehyde

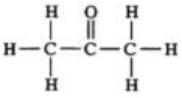
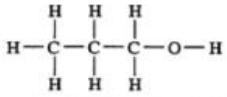
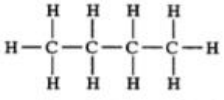


Fluoromethane



Hydrogen peroxide

4) From the list above, at room temperature, one of these molecules are a liquid and the rest are gas. Which one is liquid and why?

Name	Structural Formula	Molar Mass (g/mol)
Acetone		58.1
1-propanol		60.1
Butane		58.1

The table above shows the structural formulas and molar masses for three different compounds. Which of the following is a list of the compounds in order of increasing boiling points?

(A) Butane < 1-propanol < acetone
(B) Butane < acetone < 1-propanol
(C) 1-propanol < acetone < butane
(D) Acetone = butane < 1-propanol

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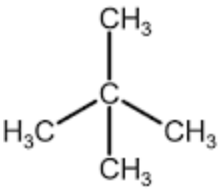
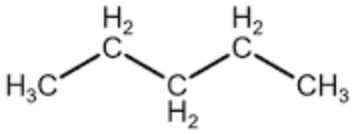


neopentane

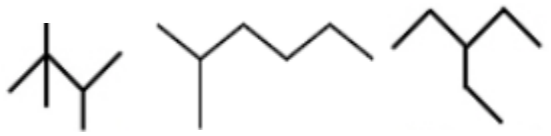


n-pentane

5)Neopentane and n-pentane have the same molar mass. Which will have a higher vapor pressure?

6)Dimethyl Ether and Ethanol are constitutional isomers (they have the same molecular formula, C_2H_6O) What will account for Ethanol's higher boiling point?

7)Which of the following constitutional isomer of heptane would have the greatest viscosity?



8) The boiling points of Fluorine, Chlorine, Bromine, and Iodine increase in that order. Which of the following statements is a valid reasoning for this observation?

A) The surface area of these molecules increases causing a decrease in electronegativity

B) The chemical reactivity becomes increasingly more unstable down a group for halogens

C) The dipole-dipole forces increase strengthening the interactions

D) The molar masses of these molecules are increasing

E) The electron cloud of these elements is increasing in polarizability

9) The intermolecular force(s) responsible for the fact that CH4 has the lowest boiling point in the set

CH4, SiH4, GeH4, SnH4 is/are _____.

A) mainly hydrogen bonding but also dipole-dipole interactions

B) hydrogen bonding

C) mainly London-dispersion forces but also dipole-dipole interactions

D) dipole-dipole interactions

E) London dispersion forces

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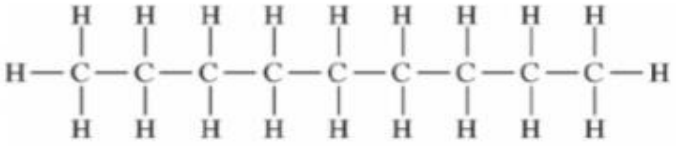
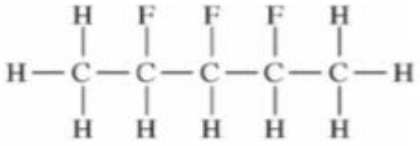


Nonane



2,3,4-trifluoropentane

Consider the molecules represented above and the data in the table below.

Compound	Molecular Formula	Molar Mass (g/mol)	Boiling Point (°C)
Nonane	C_9H_{20}	128	151
2,3,4-trifluoropentane	$C_5H_9F_3$	126	89

Nonane and 2,3,4-trifluoropentane have almost identical molar masses, but nonane has a significantly higher boiling point. Which of the following statements best helps explain this observation?

(A) The C–F bond is easier to break than the C–H bond.
(B) The C–F bond is more polar than the C–H bond.
(C) The carbon chains are longer in nonane than they are in 2,3,4-trifluoropentane.
(D) The carbon chains are farther apart in a sample of nonane than they are in 2,3,4-trifluoropentane.

Explain why:

Salt and sugar dissolved in water will have a larger boiling point than pure water

Ammonia, NH_3, is very soluble in water, whereas phosphine, PH_3, is only moderately soluble in water.

At 25°C and 1 atm, F_2 is a gas, whereas I_2 is a solid

The melting point of NaF is 993°C, whereas the melting point of CsCl is 645°C

A glass of water takes longer to evaporate compared to if it were spilled on the ground.

On a hot day, Emily pours water on herself to cool off. Seeing this, Mark decides to pour vegetable oil on himself and he doesn't cool off.

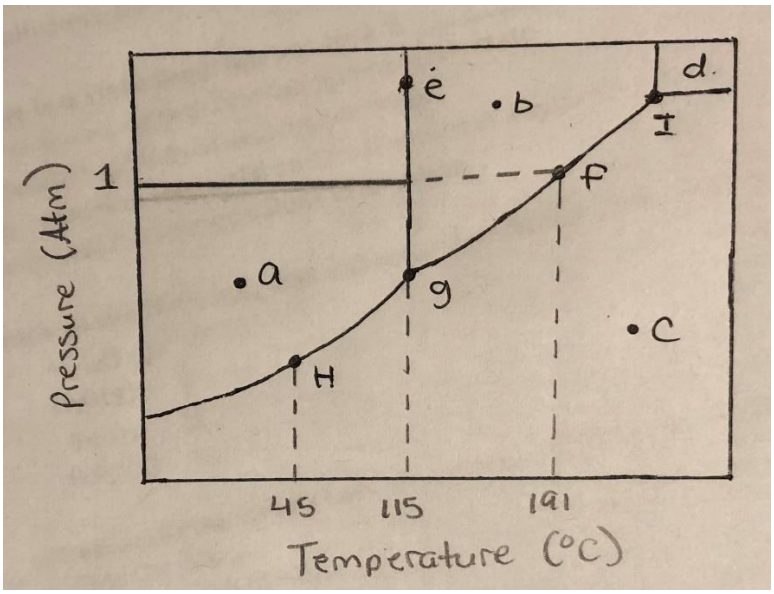
In the absence of gravity, water droplets are perfectly spherical.

Compare how liquid water were to look if spilled onto a normal surface to that of liquid mercury (picture provided below). What accounts for the difference?

Chemistry 232 Quest 1

Phases

1) A phase diagram for Jamesonnium is shown below.
a) Label each area of the graph with correct areas, phase boundaries and points.
b) What is the normal boiling point for Jamesonnium?
c) What is melting point at 1 atm?
d) What is the phase at 1 atm and 50 degrees C?
e) Draw a line segment showing sublimation and constant pressure of 0.5 atm
f) Draw line segments showing condensation under constant temperature of 140 C and then freezing under constant pressure



2) Gaseous Jamesonnium is freezing. Consider these values:

$C_{gasg)}$ = 2.51 J/g C | ΔH_{fus} = 9.2 kJ/mol | Boiling point of Jamesonnium = 75ºC

$C_{liquid(l)}$ = 4.44 J/g C | ΔH_{vap} =56.7 kJ/mol | Freezing point of water = 25ºC

$C_{solid(s)}$ = 2.39 J/g C

Draw a temperature curve and calculate the total heat involved in freezing Jamesonnium from gas to solid.