General Chemistry Review Sheet for Quest 2

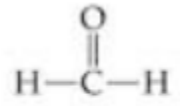
Intermolecular Forces

Rank the following by increasing boiling point and increasing vapor pressure

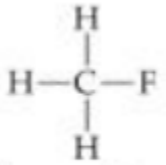
O_2 N_2 CO SiH_4 Al_2O_3 CH_2OH

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



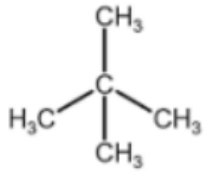
Formaldehyde



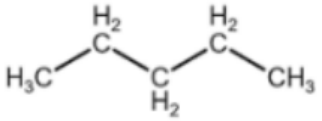
Fluoromethane

Hydrogen peroxide

Which one of these will be liquid at room temperature and the rest gaseous?



neopentane



n-pentane

Which of the following molecules above will have a higher vapor pressure?

Explain why the following occurs in terms of intermolecular forces:

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

-Ammonia, NH3, is very soluble in water, whereas phosphine, PH3, is only moderately soluble in water.

-At 25°C and 1 atm, F2 is a gas, whereas I2 is a solid

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

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

-On a hot day, you pour water on yourself to cool off. Pouring vegetable oil on yourself doesn't cool you off.

Chapter 13: Solutions and Colligative Properties

1) A 10.5-gram sample of Jamesonnium is dissolved in 125 mL of water. The resulting solution boils 103.5 deg C. What is the molar mass of Jamesonnium?

2) Calculate the vapor pressure of a solution at 25 deg C containing 99.5 g of galactose (molar mass = 180.156) and 400 ml of water. The vapor pressure of pure water at 25 deg C is 27 torr. Assume 1.00 g/ml for density of water.

3) A solution composed of two volatile liquids, A and B, has a vapor pressure of 369 torr at 0°C. Pure A and pure B have vapor pressures of 252 torr and 417 torr respectively at 0°C. What is the mole fraction of A in the solution?

4) A mixture of volatile Jamesonnium and ethyl ether are in a beaker at room temperature. It is well mixed and has a vapor pressure of 430 torr. At room temperature, pure Jamesonnium and ethyl ether has a vapor pressure of 420 torr and 520 torr, respectively. What is the mole fraction of Jamesonnium in the mixture?

5) The osmotic pressure of a solution containing 6.69 mg of Jamesonite per 50.0 ml of solution is 4.55 torr and 45 deg C. What is Jamesonite's molar mass?

6) What is the boiling point of an aqueous solution whose vapor pressure is 20.5 torr at 25 °C? Assume the solute is nonvolatile and that the vapor pressure of pure water at 25 °C is 23.76 torr.

7) What is the freezing point of a solution comprised of 47.4 g $CaCl_2$ dissolved in 359.5 g water? Kf=1.86 C/m

8) Is it possible to have an aqueous solution with a boiling point of 2.1 degrees C?

9) Rank the following by lowest freezing point

0.10 m KI 0.05 m $MgCl_2$ 0.25 m $C_6H_{12}O_6$ .05M HCl

Chapter 14: Chemical Kinetics: Rate Laws

1) A reaction is first order with respect to [X] and second order with respect to [Y]. When [X] is 0.20 M and [Y] = 0.20 M the rate is 8.00 × 10-3 M/min. The value of the rate constant, including correct units is?

2) What are four ways to increase the rate of reaction?

3) James is trying to synthesize Jamesonnium (J) via the following reaction:

$$3A_{(aq)} + 4B_{(aq)} \rightarrow C_{(g)} + 7J_{(g)}$$

a) Assume Product $J_{(g)}$ is shown to be forming at a rate of .0072 M/s. What are the rates of change for A, B and C?

b) Assume the rate of disappearance for A is 1.2M/min, what is the rate of appearance of J?

c) Calculate the average rate of change for [A] assuming from 600 seconds to 1200 seconds, the concentration of [A] changed from $1.24x10^{-2}$M to $0.93x10^{-2}$M.

4) James wants to experimentally determine the order and rate constant for each. What is the rate law? Determine the rate constant and the overall order. Remember units and to assume constant temperature.

Trial	[A]	[B]	Initial Rate M/s
1	0.100	0.100	0.028
2	0.200	0.100	0.058
3	0.200	0.200	0.082
4	0.400	0.400	0.23

5) Using your rate from part above, how would the ratio of rate change if:

- A is tripled

- A and B are both halved

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Kinetics: Integrated Rate Laws and Half-Lives

1) The half-life for a second order reaction is 231 seconds. What percent remains after 10 minutes?

2) Jamesonnium has a half-life of 12 seconds. What percentage of Jamesonnium has been consumed after 1.8 minutes?

3) Mark is getting high. Some THC metabolites have a half-life of 20 hour and follow first order kinetics. If Mark is getting high midnight on Sunday (00:00), how much THC is still in his system by his next chemistry lecture? (12:00 Tuesday)

4) For a reaction of Jamesonnium, 2J → A, find k.

Time (s)	Ln[A]
8	1.61
16	1.43
24	1.27
32	1.14
40	1.02
48	0.92
56	0.82

5) Aqueous sodium benzoate reacts with aqueous benzene to form a reaction. The resulting reaction is highly unstable and has a half-life of 0.58 minutes. How long would it take, in minutes, for the concentration of benzoate to drop from 8.54 M to 1.12 M? Through experimental analysis, this reaction was shown to be a zero-order reaction.

6) The decomposition of Jamesium, Jm → 2A + B_2X is shown below and is a second order reaction. Find the half-life of this reaction.

Time (min)	Jm [M]
0	1.000
30	.799
40	.638
60	.510
80	.408
100	.326

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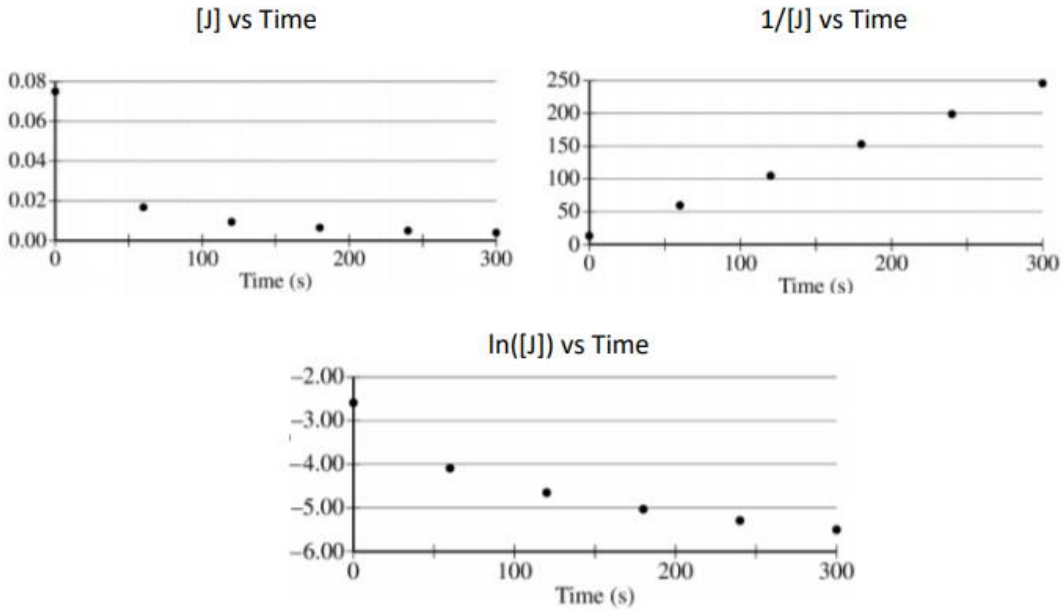
Kinetics: Reaction Mechanisms

1)Jamesonnium decomposes as follows:

$$2J_{(g)} \rightarrow 2A_{(g)} + B_{2(g)}$$

This decomposition is monitored, and its concentration is recorded on the following graphs:



a) Based on these graphs, what order is this reaction?

b) Write the late raw for the decomposition of Jamesonnium

c) Consider 3 possible mechanisms for the decomposition of Jamesonnium. All phases are gaseous. Comment on whether these proposed mechanisms are valid for the decomposition of Jamesonnium. For each, label the intermediate and decide if the rate laws described by these mechanisms are consistent with the rate law in part (b)

	Mechanism I	
Step 1:	$J + J \rightarrow A + C$	slow
Step 2:	$C \rightarrow A + B_2$	fast
	Mechanism II	
Step 1:	$J + J \rightleftharpoons AB$	fast equilibrium
Step 2:	$AB \rightarrow 2A + B_2$	slow
	Mechanism III	
Step 1	$J + D \rightarrow 3A + B$	slow
Step 2	$J + 2A \rightarrow AB + D$	fast
Step 3	$AB \rightarrow A$	fast

2) Are the valid mechanisms for their overall respective reactions?

Mechanism I

Step 1:	$J + J \rightarrow A + C$	slow
Step 2:	$C \rightarrow A + B_2$	fast

Mechanism II

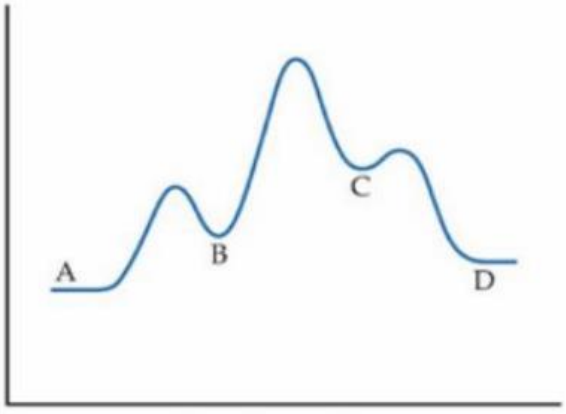
Step 1:	$C_4H_9Br \rightarrow C_4H_9^+ + Br^-$	Slow
Step 2:	$C_4H_9 + H_2O \rightarrow C_4H_9OH_2^+$	Fast
Step 3:	$C_4H_9OH_2^+ + H_2O \rightarrow C_4H_9OH + H_3O^+$	Fast

3) For the question above, assuming it is valid, draw a possible potential energy diagram for Mechanism II with relatively correct energies.

Arrhenius Equation

1) Write 3 forms of the Arrhenius equation.

2) A graph is shown for a particular reaction.



a) Label the axis, the reactants, and products.
b) Label the transition states, where intermediates could be found and show the activation energies.
c) How many steps would this mechanism have? Which step is rate-determining?
d) Which step is the fast step?
e) Which step has the smallest rate constant?
f) Show the effects of a catalyst being introduced in the first step of the mechanism.
g) Is this reaction overall endothermic or exothermic?

3) For an unknown reaction,
   a) find the activation energy required to have a reaction with a rate of 2.5 x10^{-4} $M^{-1}s^{-1}$ at 327 deg C to transition to a rate of 3.5 x 10^{-3} $M^{-1}s^{-1}$ at 377 deg C.

   b) Determine the rate constant at 700K

4) In a certain solvent is first order with respect to $(CH3)_3CBr$ and zero order with respect to OH- . In several experiments the rate constant k was determined at different temperatures. A plot of ln k versus 1/T was constructed resulting in a straight line with a slope value of -1.10×10^4 K and y-intercept of 33.5. Assume k has units of s^{-1}

Determine the activation energy, the frequency factor, and the k value at 25 degrees C.

Conceptual Question Review

A table is provided below containing properties of various fictitious compounds.

Compound	Molar Mass (g/mol)	Amount Present (g)	Heat Capacity J/gC	Molality (m)	Temperature (C)	Atomic Radii (pm)	Activation Energy (kJ/mol)
(AN_3)	90	50	18	0.15	100	77	85
(XF_2)	80	50	13	0.12	100	122	90
$(D_2H_6O_3)$	100	50	34	0.25	100	156	100

If enough information is provided,

Assuming gas, rank these by:

Increasing Velocity

Increasing Average Kinetic Energy

Increasing Partial Pressure

Increasing Volume Occupied

Increasing Mole Fraction

Increasing Density

Assuming solid, rank these by:

Greatest temperature when heat is added

Greatest temperature when heat is removed

Assuming Aqueous, rank these by:

IMF strength

Increasing Boiling Point (BP)

Increasing Vapor Pressure

Increasing BP Elevation in solution

Increasing Rate Constant