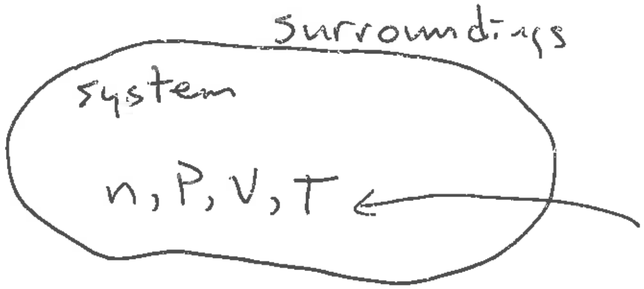
Exam 3 Review Notes (watch the video!!)

1 The chemical system and state functions *easy*



the state functions in the Ideal gas law. They are system variables measured to determine change: Δn, ΔP, ΔT, ΔV

good news: H, S, U, G are also state functions, but you don't learn about them until exam 4!!

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2 Famous gas laws *easy*

- Graham
- Dalton
- Charles
- Boyle
- Avagadro
- Guy Lussac

be able to explain each of these laws in a single sentence. You will have to sort through a collection of T/F statements on the question.

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3 Partial pressure (Dalton's Law) calculation *easy*

Isn't the Ideal gas law great? It says that

are all the same: simple countable hard spheres. So $5He + 6N_2 + 3SF_6 = 14$ gas molecules. And by extension

$$P_A + P_B + P_C = P_{TOT}$$

4 Combined gas law calculation medium

$$\frac{P_1 V_1}{T_1} = nR = \frac{P_2 V_2}{T_2}$$

$$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2}$$

This is classic Plug + Chug. You will be given 5 of 6 variables and will solve for unknown.

Steps
- Rewrite to solve for unknown first
- Plop in known values (change °C → K) **
- Perform simple math estimates to get answer without any actual calculations

a true sentence →

5 Using PV = nRT to calculate MW hard

Need to derive MW relationship

$PV = nRT \quad n = \frac{g}{MW}$

$PV = \frac{g}{MW} RT$

$MW = \frac{gRT}{PV}$ ← Now a simple plug and chug

(remember STP)

(remember diatomic gases)

So why is this hard?
- lots of exponents. Example $3.48\,ml \rightarrow 3.48 \times 10^{-3}\,l$
- need to get everything into R units $\frac{l\,atm}{K\,mole}$
- If the MW isn't a gas MW, it is wrong

6 Relating ~~number~~ mass density to pressure hard

$PV = nRT$

$\rightarrow PV = \frac{g}{MW} RT$

$\rightarrow P = \frac{g}{V} \frac{RT}{MW}$

$\rightarrow P = \rho \frac{RT}{MW}$

(P = pressure, ρ = density)

The derivation on left isn't needed because equation is on cover sheet, but it is instructive.

Note
- As mass density goes up, P goes up.
- As MW goes up, P goes down
- As T goes up, P goes up
- There is no V in equation (it is in ρ already)

(Be able to understand these functional relationships)

7 Gas reaction stoichiometry - combining volumes medium

you will be give a balanced gas reaction

g or # → moles$_{reac}$ → moles$_{product}$ → Volume of gas

Guy Lussac lets us avoid a lot of PV=nRT calculation

So once the Δn (difference in moles gas) is found, the volume of gases is easy to find ⇒

Hint: ① STP means 1 mole = 22.4 l

② Guy Lussac says Δn, ΔV, ΔP easily related

Example. At STP
$2H_2O_l \rightarrow 2H_{2g} + O_{2(g)}$
Δn = 3 moles gas = ~67.2 l

8 Gas reaction stoichiometry - partial pressures hardest

g or # (↑ convert to moles) → moles$_{reac}$ → moles$_{prod}$ → P of gases

figure out total Δn gas

$P = \frac{nRT}{V}$

- all moles gas make same P.
- Lots of math but answers are way far apart so ROUND!!
- limiting reagent problem!!
- distinguish what is a gas, liquid, solid

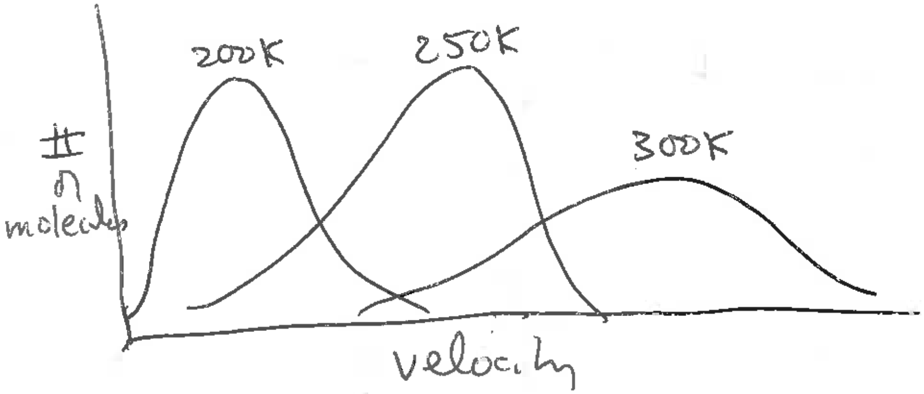
9 Kinetic Molecular Theory easy

Know the facts

- small hard spheres
- V gas <<< V container
- elastic collisions
- T ∝ K.E.
- KE ∝ mv^2

given various T/F statements
Identify correct answer

10 Maxwell distributions - graph interpretation medium



Be able to explain how these distributions happen. If you can't explain from first principles you can't answer question

given a collection of T/F statements, find the correct answer

11 Graham's law - ratio of gas speeds medium

diffusion, effusion, speed all follow equation of cover sheet

$$\frac{V_1}{V_2} = \sqrt{\frac{MW_2}{MW_1}}$$ } note inverse square root relationship

This is effectively a plug and chug, but have to be cautious about ratio

- bigger gas is slower
- Hint: a ratio has 1 in the denominator sometimes.

Example, H_2 (2) is 4 times faster than O_2 ← 32

$\sqrt{\frac{32}{2}} = \sqrt{16} = 4$

12 Gas non-ideality - theory - failing conditions of the IGL medium

Non-ideality happens

- gases have volume
- gases have IMF

you will be given a collection of T/F statements and must find the correct answer

This non-ideality occurs

- when P increases
- T decreases

} why?

13 Gas non-ideality – van der Waals' coefficients - meaning and use medium

The Vanderwaals equation (on cover sheet) corrects non-ideality with a + b coefficients

a ≡ corrects IMF in P term

b ≡ corrects size in V term

Be able to assign a and b to gases

Example: If a is .2 it is He while 4 is NH_3

If b is .01 it is H_2 while .06 is SF_6

Be able to do relative rankings

14 Distinguishing intra and Intermolecular forces easy

There are 5 kinds of forces built on Coulomb's Law in matter

Intermolecular IMF ← Exam 3 | both Intra + Inter | Intramolecular covalent

dispersion nonpolar ~1 kJ/mole | dipole-dipole polar ~5 kJ/mole | H-bond ~20 kJ/mole –NH –OH –FH | Ionic 200 kJ | 400 kJ

between molecules | within molecules

all those Lewis dot structures on Exam 2

15 Intermolecular force theory (dispersive forces) easy

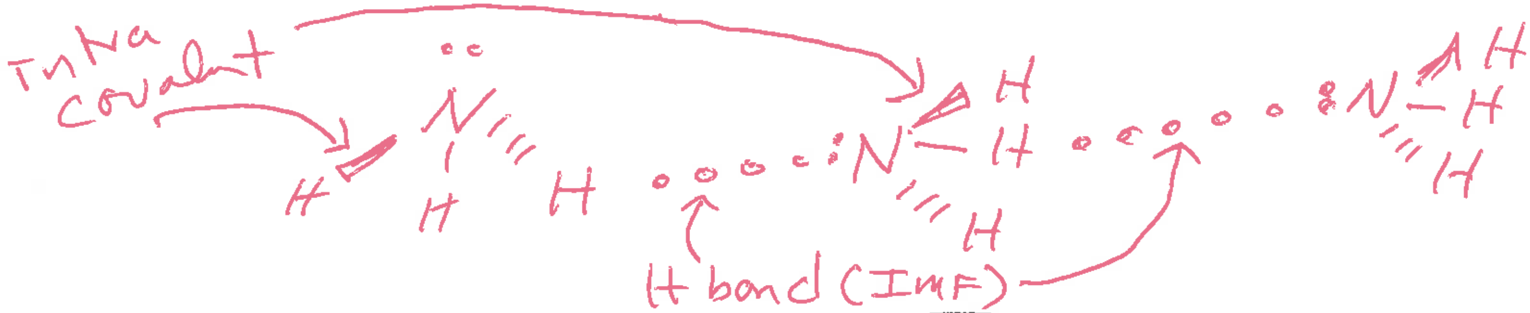
Explain dispersion forces (Instantaneous forces or London forces)

- created by induced dipoles in the electron cloud
- happen in all molecules and get larger as molecules gets larger
- only IMF in nonpolar compounds
- get so large that bigger molecules → l → s

You will be given several T/F statements and need to find correct one

16 Intermolecular force theory (H bonding) easy

Be able to draw simple compounds with H-bonding and distinguish different types of bonds (covalent vs H-bond)



17 Assigning Intermolecular force in molecules medium

You will be give a bunch of compounds and asked the dominant IMF in each

		dominant
Example	C_6H_6 =	dispersion
	CH_3OH =	H bonding
	O_3 =	dipole-dipole
	NaCl =	Ionic

make sure you remember how to draw 3D Lewis structures to assign polar/nonpolar

18 Assigning Intermolecular force in molecules easy

you will be given a compound and asked what IMF forces exist in it.

Remember that dispersion is found in all molecules
dipole-dipole in polar compounds
H-bonding in polar compounds with H-F, O-H, N-H

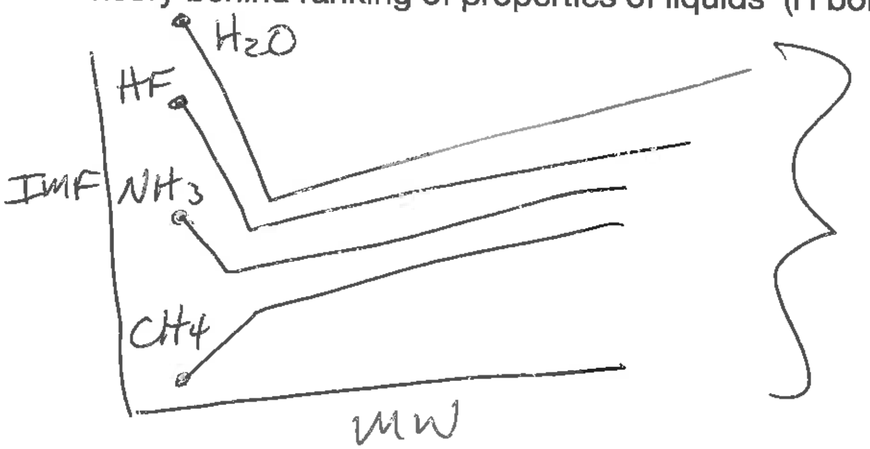
Hint: what IMF is found in H_2O?

19 Theory behind ranking of properties of liquids (dispersive forces) medium

you will be given a collection of T/F statements that describe dispersive (instantaneous dipole ≡ London ≡ dispersion) forces.

Be able to explain the origin and application of this most ubiquitous (everything has dispersion force) IMF

20 Theory behind ranking of properties of liquids (H bonding) medium



this is a very famous plot of H bonding that shows how special the OH, FH, NH in period 2 are. Be able to explain the trends.

21 Physical property definitions medium

Just like the Gas laws, be able to write a sentence explaining

boiling point
surface tension
viscosity
evaporation
vapor pressure
capillary action

be able to sort through a collection of T/F statements on the question

22 Ranking properties of liquids (direct relationship with IMF) medium

b.p., s.t., c.a., visc, ΔHvap, etc

Most liquid properties increase with increasing IMF

So to rank them, first need to rank IMF: the bucket method

[nonpolar dispersive rank by MW] < [polar perm. dipole] < [H bond rank by NH<OH] < [Ionic rank by charge density]

☆ Of course size matters and dispersive wins as molecules get bigger, but not something to know in ranking ☆

this is a rough first start and works often in ranking problems

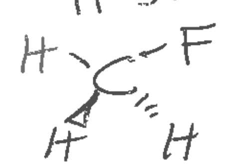
23 Ranking properties of liquids (inverse relationship with IMF) tricky

Evaporation and vapor pressure are inversely related to IMF

so do what you did for 22 above in reverse

V.P. + evap [dispersive] > [dipole dipole] > [H bond]

Hint: is CH_3F H-bond? Draw it



No!! F is no attached to H

24 Types of solids easy

There are 4 types of solids

- metallic
- ionic
- molecular
- network covalent

These will be mixed and matched with examples.

metals ≡ to left on table

ionic ≡ salts to left + right (cation + anion)

molecular ≡ molecules you can draw that have IMF

covalent ≡ elements to right on table too large to draw

25 Ranking properties of solids (melting point) easy

Ionic solids have properties easily ranked based on charge density

So in same way from Exam 2 charge density ∝ lattice energy, here charge density ∝ melting points of salts.

Example Al_2O_3 melts much much higher than NaCl

Giant Ranking Hint: Get the boundaries right in multiple choice and you usually don't have to waste time on rest of problem

Example Rank boiling He, random this, that, H_2O, whatever

a

b

c He, this, that, whatever , H_2O ⇐ must be right because He and H_2O are on boundaries

d