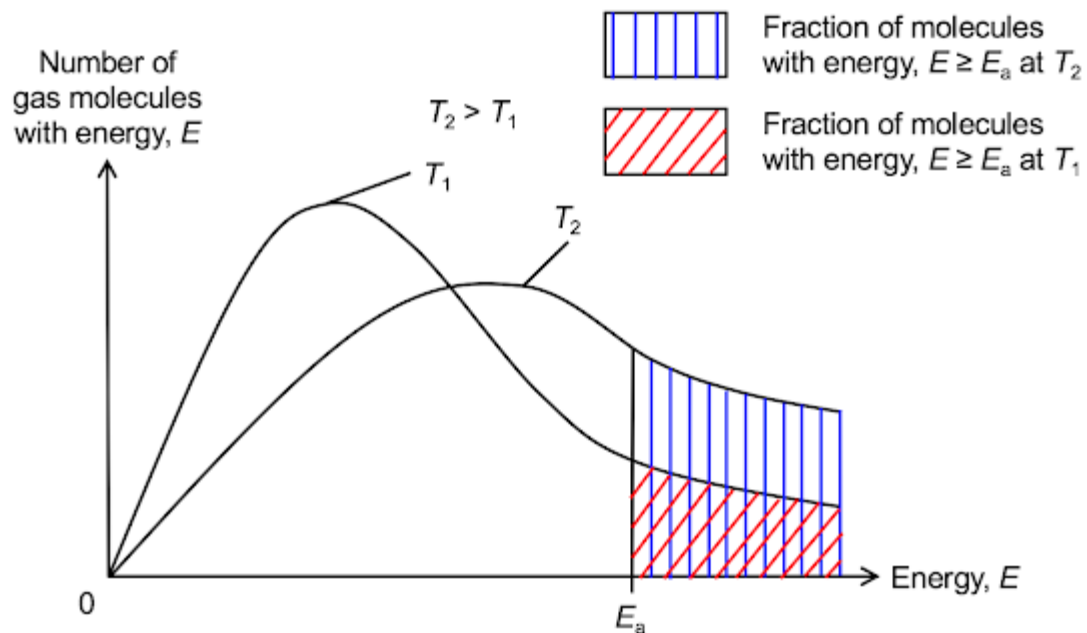


Types of Diagrams:

1. Boltzmann Distribution
2. Phases (solid, liquid, gas)
3. Particulate diagrams
4. Titration Curves
5. Equilibrium (Concentration vs. Time)
6. Chromatography
7. Cooling and Heating Curves
8. Solubility Graph
9. Real Gases vs. Ideal Gases
10. Photoelectron Spectroscopy
11. Potential Energy
12. Lewis Structures
13. Ball and Stick and Space Filling Atom Models
14. Orbital Diagrams
15. Galvanic or Voltaic Cell
16. Lab Setup
17. Reading Measurement Devices

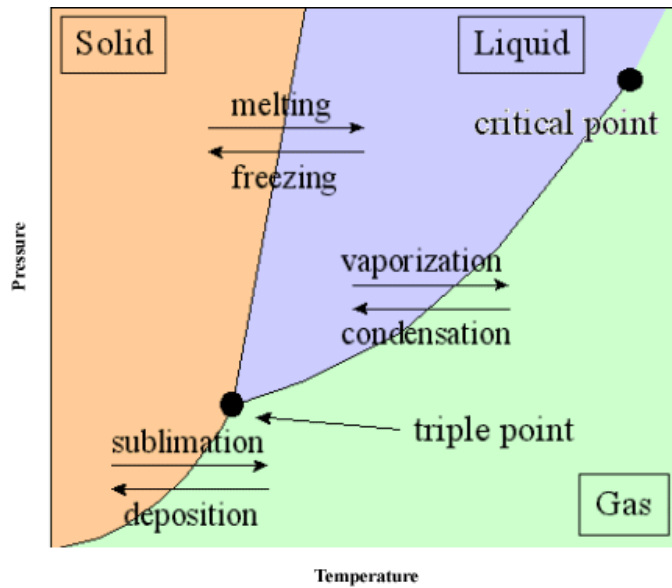
# Boltzman Distribution



## Key Notes:

- The peak for the higher temperature molecules is lower but farther the right
- The peak for the higher temperature molecules has a greater area under the curve past the  $E_a$ (activation energy)
- Both graphs start at (0,0)
- Both graphs eventually flatten out at # of particles=0
- # of particles is same as fraction of particles

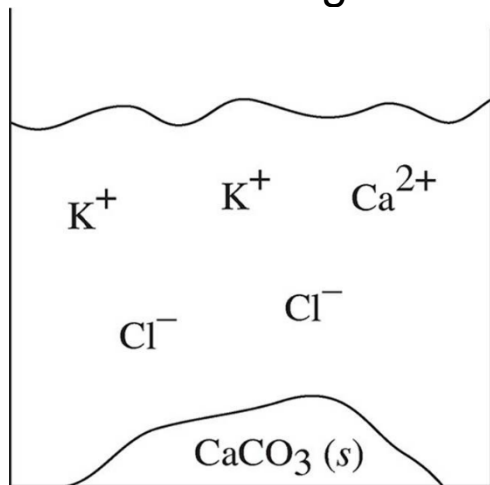
# Phases



## Key Notes:

- Questions will typically ask you how to arrive at a certain phase or position on the graph from another position
- They might ask you how to get there without going through another phase, typically liquid
- Answer these by looking at the Pressure and Temperature scaling and move left/right accordingly
- Above and to the right of the critical point is the supercritical fluids (weird stuff, not going to be on the exam)

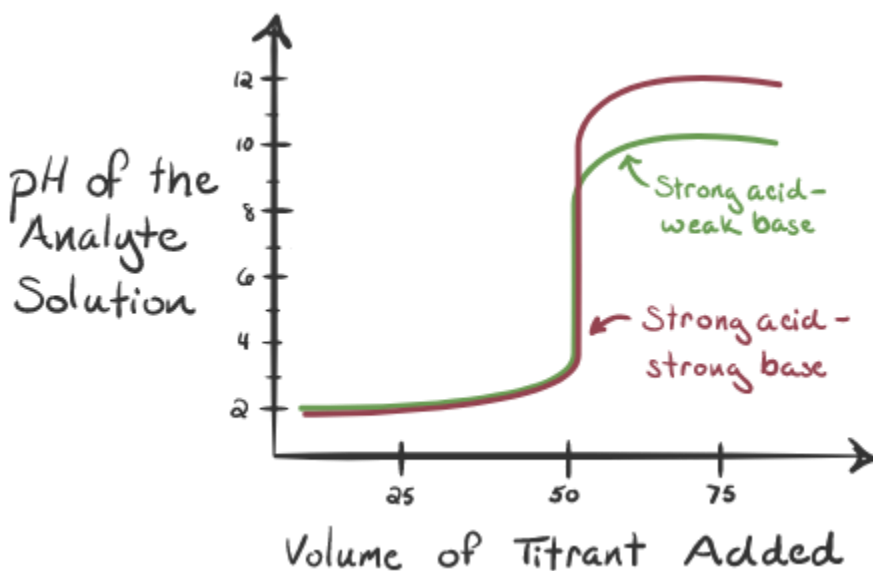
## Particulate Diagrams



### Key Notes:

- Solutions are represented with a squiggly line above the particles in solution
- Particles in solution can be represented as their names or labeled dots, but usually their names as seen above
- Solids are represented as blobs that DO NOT touch the sides of the container.
- They can be represented the same way as particles in solution but have some major differences.
- If you are drawing rigid, non-soluble solids draw them in a rigid structure
- For ionic solids dissolving draw a general rigid structure but have some particles coming off
- For gases the container must have a stopper or piston on top
- Gas particles fill the container but have no evidence of rapid motion (no swooshies!)

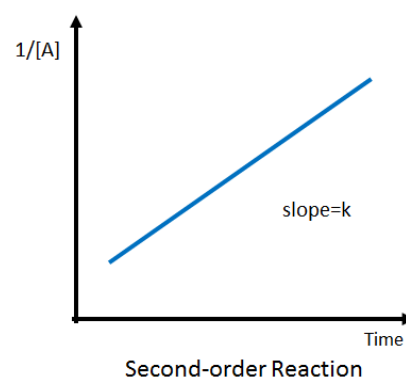
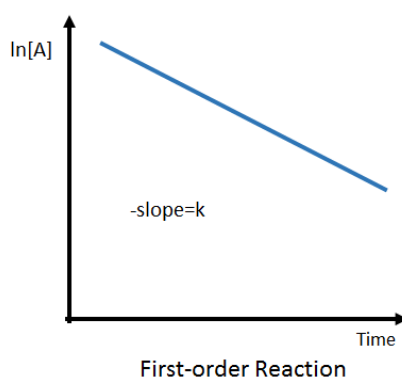
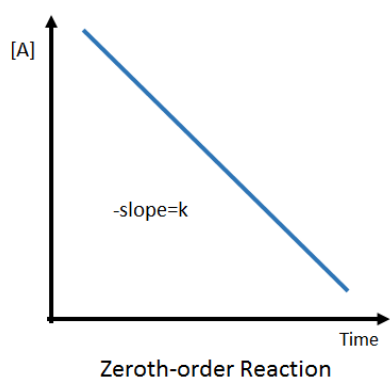
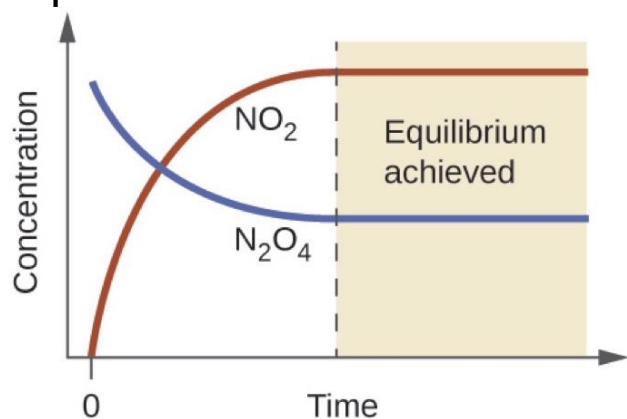
## Titration Curves



### Key Notes:

- Most questions on this graph relate back to the Henderson Hasselbalch equation  $\text{pH} = \text{pK}_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$
- This is the basis for half-equivalence point where  $[\text{A}^-] = [\text{HA}]$  and  $\text{pH} = \text{pK}_a$
- At the equivalence point the analyte or titrand is neutralized but this does not mean the  $\text{pH} = 7$
- This is only true for strong acid-strong base titrations
- For weak base-strong acid or weak acid-strong base titrations there is  $\text{A}^-$  (base) created from neutralizing the HA
- Titration Curves can have multiple equivalence points if you have a polyprotic acid ( $\text{H}_2\text{SO}_4$  is the most common one)
- These graphs can be flipped left to right depending on what your analyte is
- For a basic analyte your pH will start as basic and vice versa for an acidic analyte

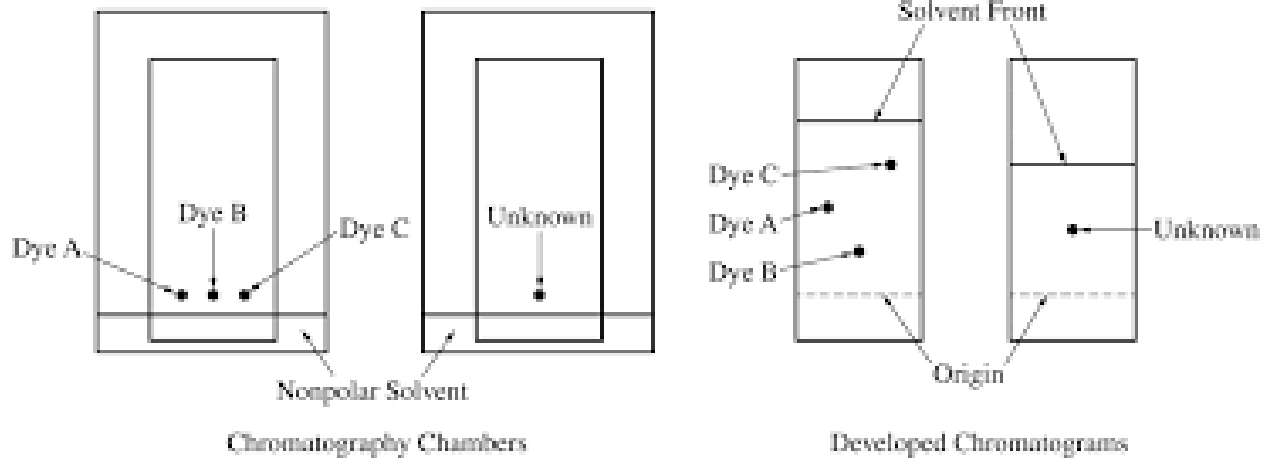
# Equilibrium



## Key Notes:

- Zero order no need to linearize
- First order is linearized with  $\ln[A]$
- Second order is linearized with  $1/[A]$
- Just know that third order exists but is extremely rare because it requires three molecules to collide in the correct orientation with the correct activation energy
- The first graph above you will most likely see in multiple choice questions asking where equilibrium is.
- You might also be asked about starting concentrations and rate(slope)

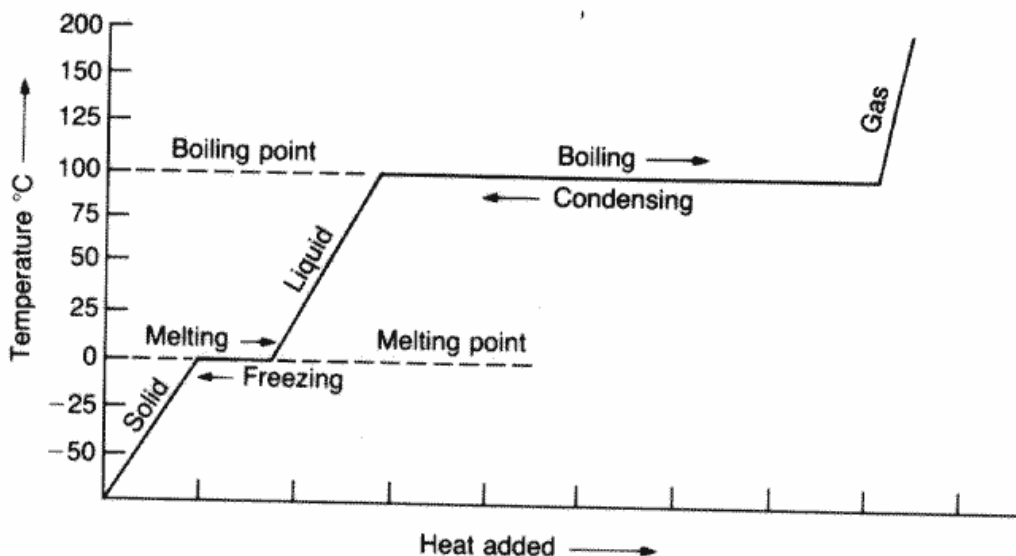
# Chromatography



## Key Notes:

- It is unlikely you will see this, however it is good to know the concepts behind it
- Know that nonpolar dyes are more attracted to nonpolar solvents and polar dyes are more attracted to polar solvents
- You can also justify that nonpolar solvents are less attracted to the polar paper.
- In general, concepts regarding this diagram are best explained with polarity

## Cooling and Heating Curves

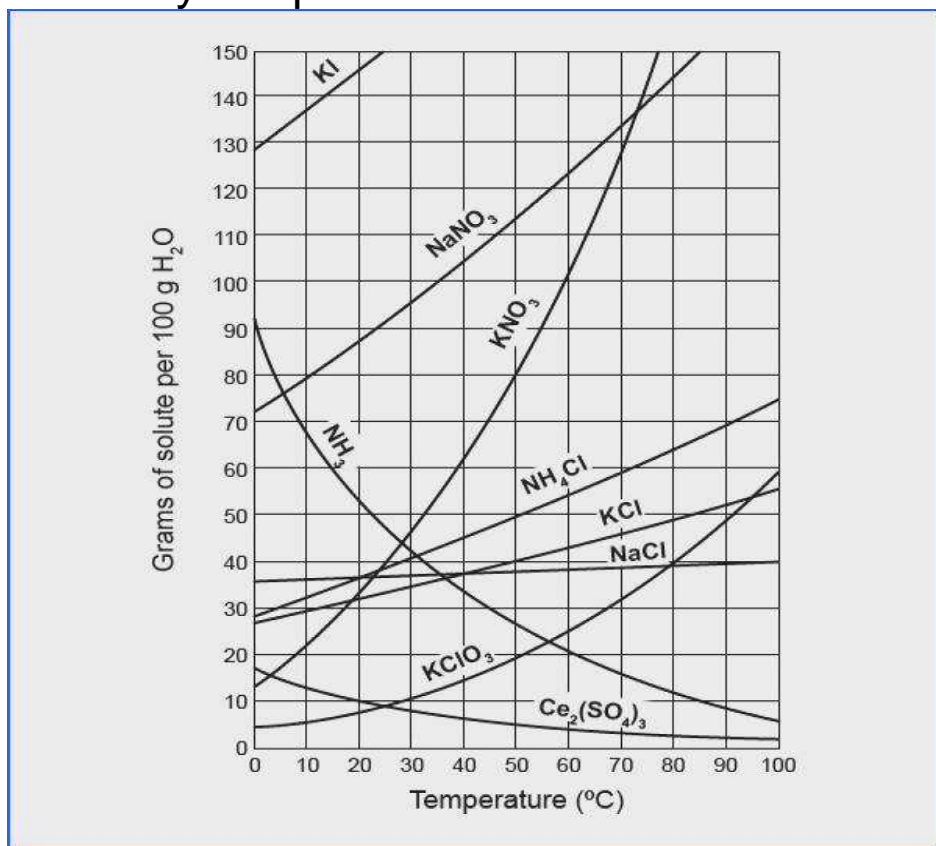


### Key Notes:

- Above is the heating curve for water
- Boiling/Condensing line is MUCH larger than that for Melting/Freezing
- This is because it takes more energy for a substance to break IMFs and become a gas than it does to become a liquid.
- Plateaus represent a increase/decrease in entropy(order), sloped sections represent a change in enthalpy(heat)
- You'll usually be asked to identify the temperature for boiling point and melting point



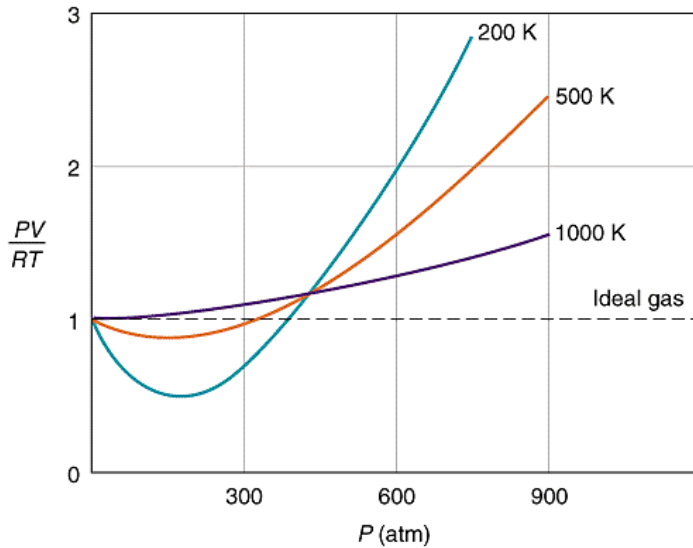
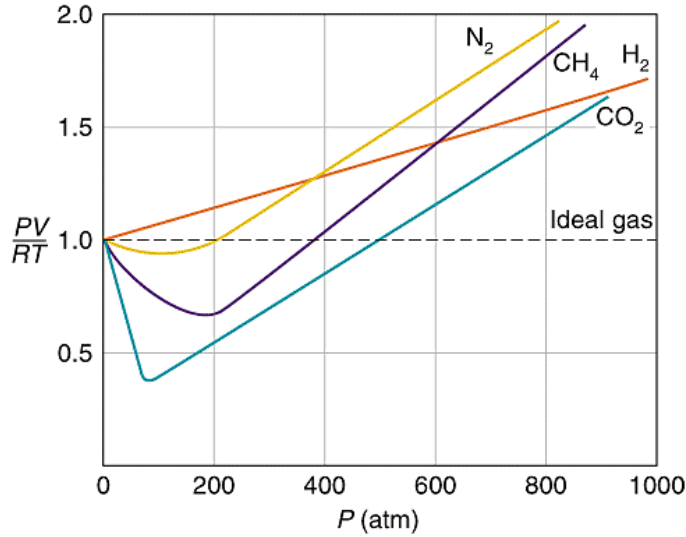
## Solubility Graph



### Key Notes:

- You will most likely be asked to identify the solubility of a compound at a certain temperature
- Keep in mind the scaling on the side, because they will ask you for how many grams/moles are soluble in different amounts of water
- They could also ask you about molar solubility, but unlikely
- Molar solubility is the number of moles of solute dissolved in liter of solution before it becomes saturated.

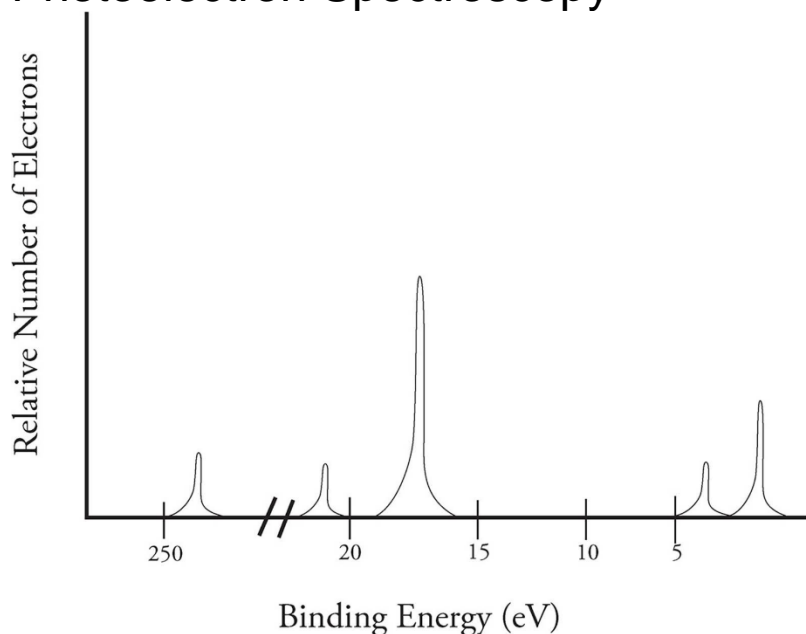
# Real Gases vs. Ideal Gases



## Key Notes:

- Gases behave less ideally at lower temperatures, higher pressures, higher molecular weights, and higher polarity between molecules
- This can all be explained with IMFs and Coulomb's law.
- $F = kQ_1Q_2/r^2$
- Higher molecular weights means a more polarizable bond and stronger LDFs
- $PV/RT$  is number of moles
- Yes, the scale is number of moles per atmosphere
- It describes how much of a substance it would take to produce a given pressure, which varies with IMFs

# Photoelectron Spectroscopy

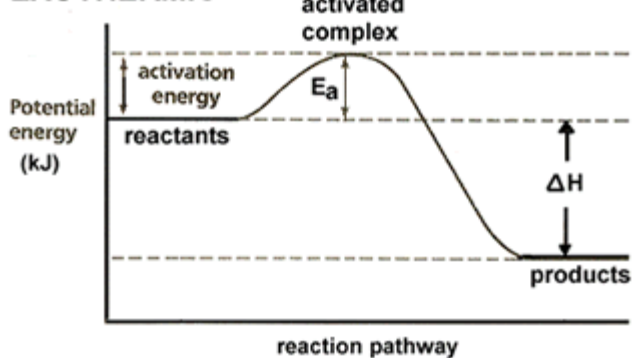


## Key Notes:

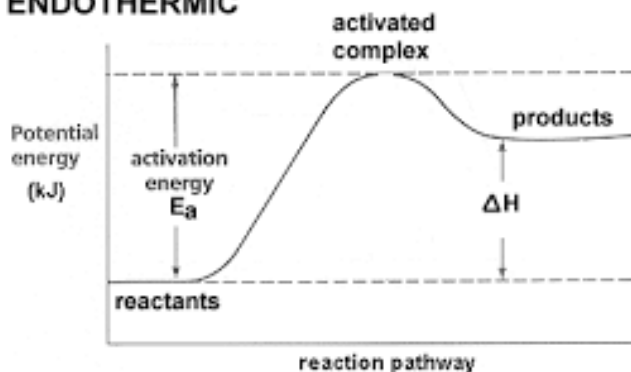
- Don't get intimidated by the name, these are actually pretty simple
- If it asks for the identity of the element, which it will if you are given this graph, you simply count the peaks--
- The height of the peaks should be a whole number multiple of the height of the smallest peak
- For example, the third peak above is about 3 times as high as the lowest peak so it represents 3 electrons
- In this case we can see a total number of 8 electrons in the diagram (one for the first, one for the second, three for the third, one for the fourth, and two for the fifth)
- However, do not assume this is Oxygen because there still may be more electrons that we cannot see.
- Make sure the binding energy of each spike coincides with the trends of your periodic table.
- This diagram is all about electrons

# Potential Energy Graphs

## EXOTHERMIC

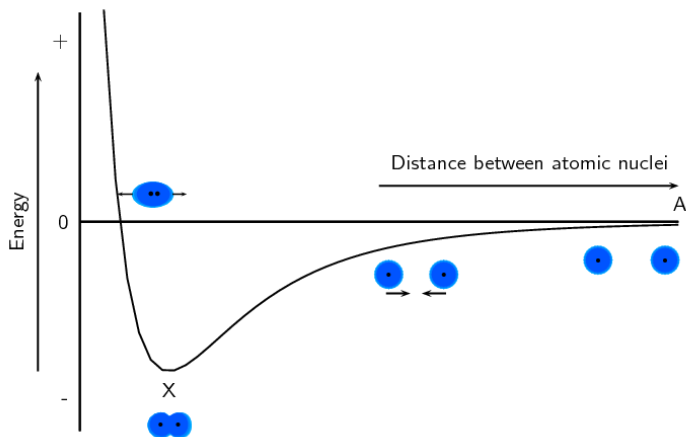


## ENDOTHERMIC



### Key Notes:

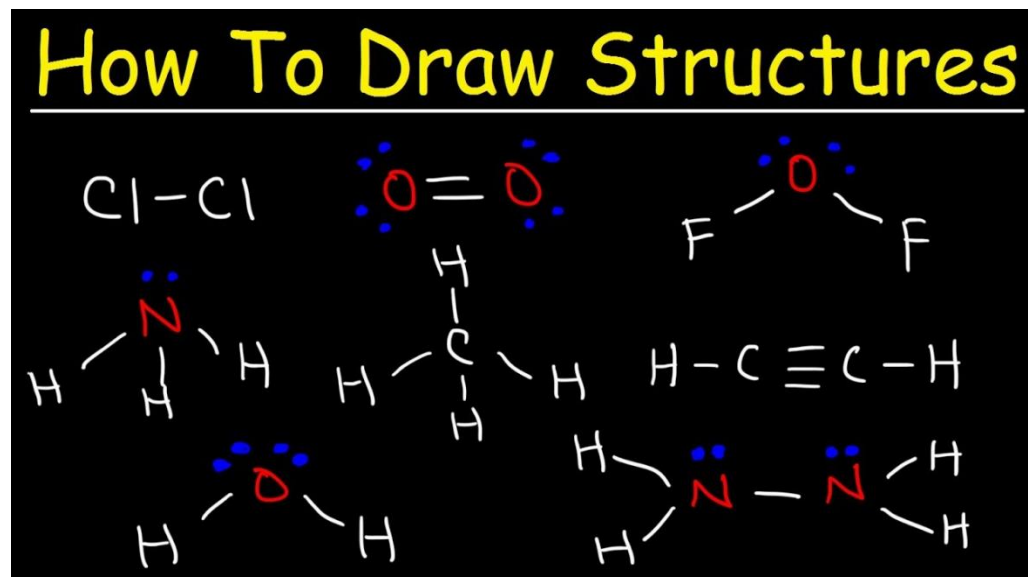
- These are one of the most important, if not the most important graphs on the exam!
- College Board can ask you a million different types of questions based on the enthalpy of the graph and activation energy and catalysts
- Know that catalysts are represented with peaks lower than that of the original activated complex because they lower activation energy
- If the products have a higher PE to start the reaction is exothermic and if they have a higher PE in the end the reaction is endothermic
- The activation energy is the vertical distance between the potential energy of the reactants and the potential energy of the activated complex



#### Key Notes:

- This is a different type of PE graph that relates to the energy of a single bond, not of a reaction.
- The diagram shows that as the two atoms/ions/particles that are attracted to each other are moved farther apart their PE generally increases
- However, at point x and before the atoms are so close together that they undergo repulsion in their electron clouds.
- This causes decrease in the potential energy as the distance between the atoms approaches point X
- Point X is the sweet spot
- Here the potential energy is the least because the attractive and repulsive forces are balanced.

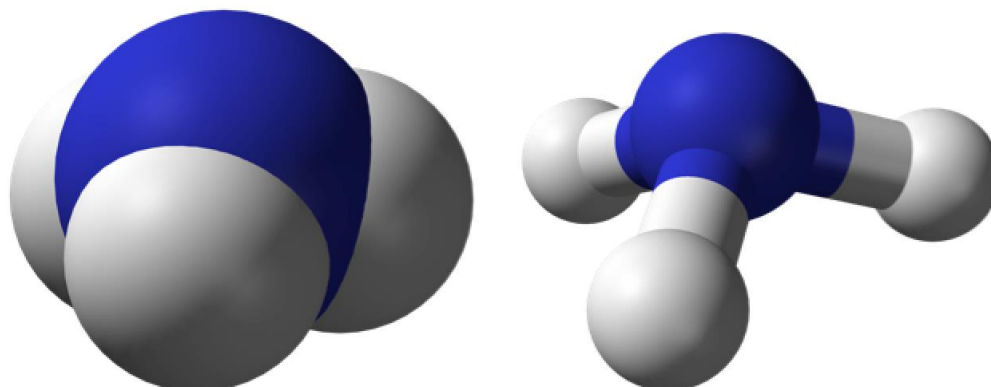
## Lewis Structures



### Key Notes:

- Represent individual atoms by their symbol
- Represent bonds with dashes
- Single bond is one dash, double bond is two, etc. i8nn 87
- When given a formula to draw, first identify how many valence electrons you should have in the molecule and write this to the side
- It helps you keep track of how many bonds you have and if you need to add unshared pairs of electrons after you have completed bonding.
- Second, identify the number of electrons needed to make an atom “happy”
- This is determined by the number of valence electrons the atom has in its neutral state
- NEVER FORGET unshared pairs of electrons
- Once you have the number of bonds you can add in the unshared pairs to make atoms “happy”
- It takes practice to balance what number of bonds you need on atoms and the number of unshared pairs in order to have the right number of electrons allocated to atoms.
- Hint: Hydrogen almost never carries extra electrons and typically only forms single bonds, so get those out of the way first
- Non-polar bonds are still represented with a dash
- Memorize common molecules that have a bent shape

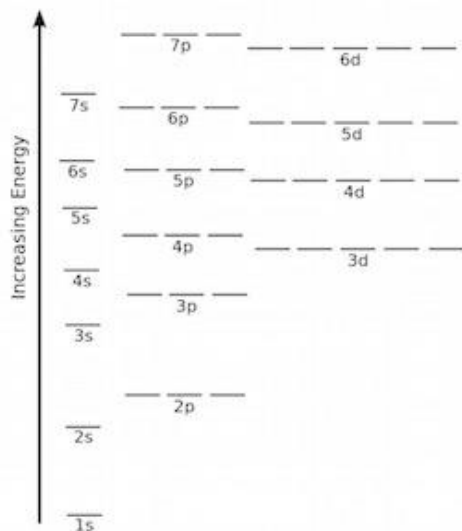
## Ball and Stick and Space Filling Atom Models



### Key Notes:

- Most of the questions you receive will be on identifying the identity of the atoms in the diagram or explaining if the diagram is consistent with a formula.
- You can identify the atoms in the diagram based on the size of the individual atoms, the shape of the molecule, and the number of bonds.
- Unshared pairs are not shown but you can identify if there is one by looking at irregularities in shape.
- For example, the above diagram shows  $\text{NH}_3$ . You know there is an unshared pair of electrons at the top of the central atom because the white hydrogen atoms are bent towards the bottom of the central atom.
- You could easily reason this is  $\text{NH}_3$  by saying that there is an unshared pair of electrons on the central atom plus three bonds so the central atom must share a total of 5 electrons. This is a characteristic of group 15 (5A) elements. You could justify the atoms bonded to the central atom are H based on their size and number of electrons shared.

# Orbital Diagrams

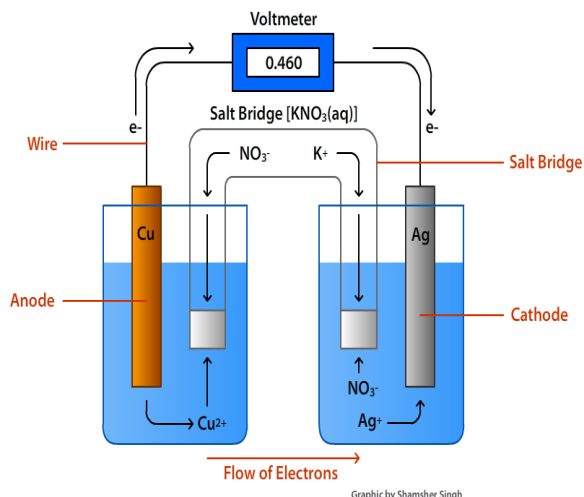
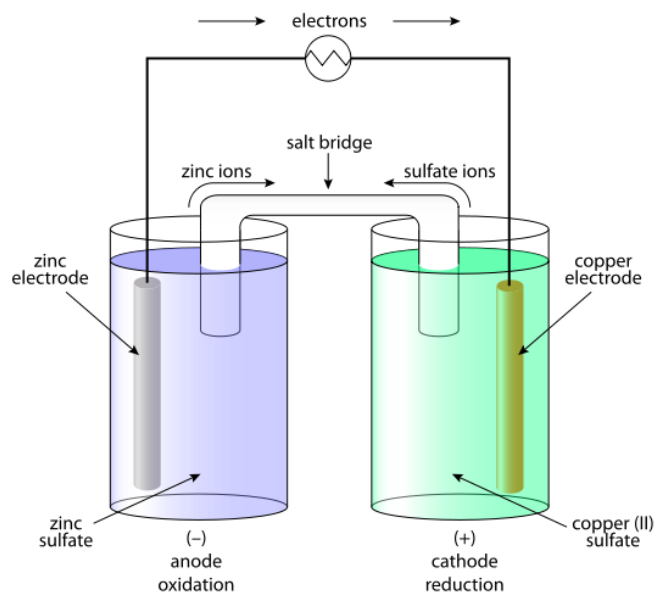


## Key Notes:

- Remember these three/four rules
- Aufbau principle: Electrons are added to the orbitals with the lowest energy level first, and then sublevels are filled in order of increasing energy (fill from the bottom of the diagram to the top)
- Pauli exclusion principle: Each orbital can only hold a maximum of 2 electrons. Two electrons in the same orbital must have opposite spins. (each box has a max of two half arrows)
- Hund's Rule: If more than one orbital is present at the same energy level, put single electrons into each orbital (with parallel spins) before you put a second electron into an orbital. (each box in a sublevel has to be filled with arrows facing one direction before you fill in with arrows facing the other direction)
- Most importantly, when you strip electrons from an atom, DO NOT take them out in reverse aufbau order, take them out of the highest energy level
- You most certainly will be asked to write the electron configuration for an ion of something that has a 3d or 4d sublevel as its sublevel of highest energy. If you are given an atom with a 3d sublevel as its sublevel of highest energy, take electrons out of the 4p sublevel first. Same thing for the 4d sublevel except you are taking electrons out of the 5p sublevel first.



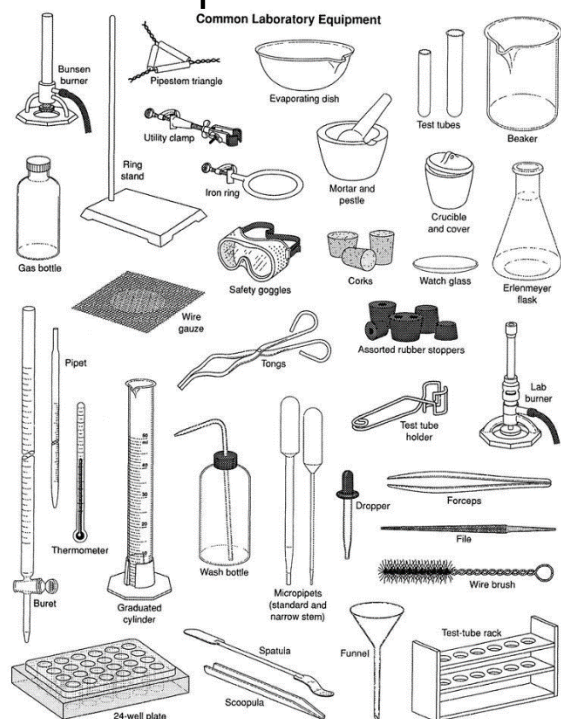
# Galvanic/Voltaic Cell



## Key Notes:

- Electrons are produced at the anode and flow to the cathode
- Reduction occurs at the cathode
- Oxidation occurs at the anode
- Reduction is gain of electrons
- Oxidation is loss of electrons
- Remember RedCat and AnOx
- Negative ions from salt bridge flow to anode to neutralize positive ions being placed in solution
- Positive ions from salt bridge flow to cathode to replace positive ions being precipitated
- Increasing concentration around cathode increases voltage

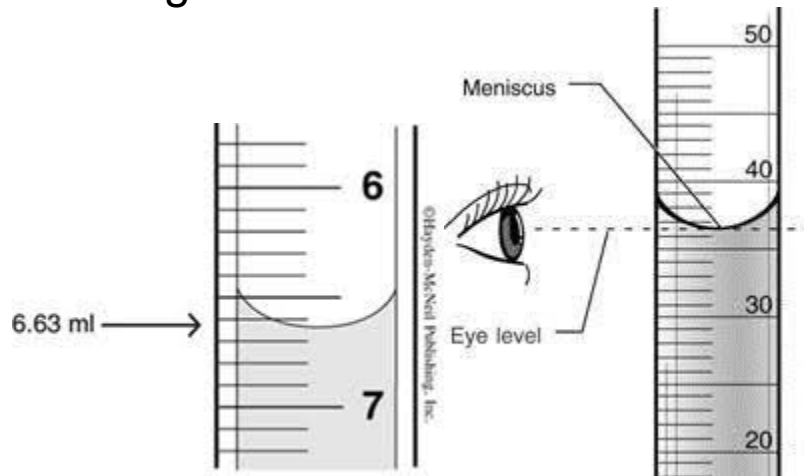
# Lab Setup



## Key Notes:

- Know what a typical distillation, filtration, and decantation process looks like
- Decantation is pouring off liquid from a beaker after solid has settled out
- Filtration is separating liquid from solid through a porous material such as filter paper
- Distillation is evaporating off a liquid to precipitate out a solid in solution

# Reading Measurement Devices



## Key Notes:

- Always read a volume measurement device at the meniscus (The base of the curve)
- Burettes read from top to bottom, the opposite of beakers and other measurement devices
- Always read a measurement to the accuracy of one decimal place past displayed on the device