1. Charles Law  
\[ V_1 = \frac{V_2}{\frac{T_1}{T_2}} \] or P/T  
- vol inc as temp inc, constant pressure  
- Water will be driven off when the test tube’s heated  
- this volume of air is saturated with water vapor that contributes to the total pressure in the flask  
- y = 0 (volume)

2. Freezing point Depression (add solute)  
- freezing point directly proportional to conc. of particles dissolved in it  
- solute reduces mole fraction, decrease tendency of molecules to escape from solvent phase  
- solute added→ lowers temp, lowers tendency of molecules to escape  
- solidify = reached freezing point  
- freezing point → where lines intersect  
- get molecular weight, \( \Delta T = K_m \) \( (Kf = (4.6^\circ\text{C}-\text{kg/mol}) (\Delta T=\text{diff of Freezing pts.}) \)  
\[ \Delta T = 54.5749 – 53.7889 = 0.786 \]  
0.786 = (4.6)m  
\[ m = 0.1709 \]

3. Potentiometric Acid-Base Titrations  
- inflection points give pKa value  
- for characterizing acid; measured across analyte (not use indicator)  
- identify unknown where pH changes are great  
- convert vol of NaOH to moles acid (divide weight of unknown acid)  
- pH from graph (x=vol NaOH)  
- vol of NaOH → from graph using \( [(-b+\sqrt{b^2-4ac})÷2a] \), ave of 2 points  
- theoretical curve by getting \( \frac{1}{4}, \frac{1}{2}, \frac{3}{4}, \frac{5}{4}, \frac{3}{2} \) of the volume at equivalence point and equi point  
- multiplied by molality of NaOH to get moles → values used to get pH or pK  
- pKa = pH – log \( \frac{[A]}{[HA]} \)

4. Rate of Reactions  
- how rate is affected by conc and temp (make Arrhenius plot)  
- oxidation of sodium thiosulfate into sulfur, treat with HCl (time it takes to become S)  
- positive slope (conc and temp inc, rate inc; time dec)  
- first order = rate proportional to conc  
- cloudiness = start of reaction  
- method of initial rates = measuring rates at short times before changes in conc occur  
- under this cuz intial conc are known  
- initial rate and subsequent rates obtained as conc decreased  
- more conc, quicker reaction (more collisions)  
\[ K = A(Ea + RT) \] \( (Ea = \text{activation energy} (\text{J/mol}) \ A = \text{pre-exponential constant} \)  
\[ m = Ea + R \] (to get Ea) (m from graph (x))  
- Activation energy = minimum energy to start reaction  
- lowering it accelerates the rate by inc conc  
- Ln k uses energy/mole while Ln 1/t uses energy directly  
- 1/t equals rate of reaction as temp inc.  
- conc is directly proportional to 1/t

6. Ksp, G, H of Ca(OH)\(_2\) for the dissolution of Ca(OH)\(_2\) in Water  
- to get apparent equilibrium constant of Ca(OH)\(_2\)  
- solubility of hydroxides is determined by titration  
\[ M_{\text{HCl}}V_{\text{HCl}} = M_{\text{OH}}V_{\text{OH}} \]  
Ksp = [Ca][OH]  
\[ \Delta G = \text{RTln}K \] \( (R=8.314) \)  
\[ \Delta G = \Delta H - T\Delta S \]

- molar solubility of [Ca] is \( \frac{1}{2} \) of the molarity of [OH] → 2moles OH for every mole Ca(OH)\(_2\) dissociated  
- if actual > theoretical → still excess Ca(OH)\(_2\) in sol after titration  
- increase HCl, thus increase H ions  
- solubility of Ca(OH)\(_2\) varies with temp  
- CO\(_2\) can increase its solubility  
- Adding acid to the solution with a solid base will inc the solubility of the base  
- no solid base should be present when titrating  
- remaining solids won’t affect Ksp. → acidity of solution affects Ksp