



# Study Guide

## Final Exam

### Block A: Solubility

- \* Know that alkanes generally have the lowest mp, bp, viscosity and hardness of substances with equal molar mass.
- \* Know that alkanes generally have the least solubility in water of substances with equal molar mass.
- \* Know that the physical properties of alkanes are mostly due to their inability to participate in dipole-dipole and hydrogen bonding intermolecular forces.
- \* Know alkanes and other substances unable to participate in dipole-dipole and hydrogen bonding intermolecular forces tend to be soluble (or miscible) in each other.
- \* Know adding a carbonyl group to an alkane makes it a ketone or aldehyde,
- \* Know carbonyl groups increase the polarity of a substance and allow it be a hydrogen bond receiver with substances (like water and alcohols) which are hydrogen bond donors.
- \* Know adding a hydroxy group to an alkane makes it an alcohol.
- \* Know hydroxy groups allow a substance to be both a hydrogen bond donor and receiver.
- \* Predict the relative physical properties of substances (mp, bp, viscosity and hardness) of two substance by whether their molecular structures contains carbonyls or hydroxy groups.
- \* Predict in which solvent a substance will have greater solubility (or miscibility) by whether the molecular structures of solvent and solute contains carbonyls or hydroxy groups.
- \* Know crystallization produces a solid phase of a solute from solution.
- \* Know chemists use crystallization as a way to get pure substances from reaction mixtures.
- \* Know chemists accomplish crystallization by varying a property of a solution (temperature, polarity, pH or other) to slowly reduce the solubility of a particular solute.
- \* Know the technique of crystallization requires finding a property which has a greater effect on the solubility of your desired solute, than it has on other solutes (impurities).
- \* Know the melting point of a mixture is always less than the melting point of either of it's components when they are pure.
- \* Know you can determine if two samples with similar melting points are the same substance by a mixed melting point test.
- \* Know a mixed melting point test is accomplished by comparing the mixed melting point of the two samples to the pure melting points of both.
- \* Predict the best solvent for crystallization of a particular substance based on solubility.
- \* Predict the best solvent for crystallization of a particular substance based on how solubility changes with temperature.
- \* Know extraction is the technique of separating a desired substance from a mixture using relative solubilities of two solvents.
- \* Estimate which solvent a substance will likely be more soluble in by considering alkane/aryl groups, polar groups, hydrogen bonding groups, and acid-base groups of that substance.
- \* Predict which of given immiscible solvent pairs are likely to be more useful for separating a given mixture.
- \* Given the mass of solute recovered from a given volume of solvent, determine the mass volume concentration of that solution.



- \* Know the distribution coefficient (also called factor or ratio) is the relative mass volume concentration of two immiscible phases at equilibrium.
  - \* Given the equilibrium concentration in mg/mL of a substance in two solvents, determine that substances distribution ratio between those solvents.
  - \* Use the distribution coefficient of a pair of immiscible solvents to determine how much of a given mass of solute can be extracted from a given volume of those solvents to a given volume of the other.
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## Block B: Chromatography

- \* Know chromatography is a technique for identifying and separating substances.
- \* Know elution is moving substances over a stationary phase using solvent in which they are sparingly soluble.
- \* Know the stationary phase strongly binds to substances so small differences in mobile phase solubility can produce large differences in the speed at which substances move.
- \* Know silica gel is commonly used as a solid phase and is extremely polar.
- \* Know ideal solvents for elution are ones in which the substances being solvated have medium solubility—too little solubility and the substances do not elute, too much and no separation occurs.
- \* Know thin layer chromatography measures elution as retention factor ( $R_f$ ), the ratio of distance a substance moves over the distance the solvent front moves.
- \* Calculate  $R_f$  from a developed TLC plate.
- \* Tentatively identify substances by eluting known substances on separate tracks with an unknown mixture
- \* Predict an effective elution solvent for separating two substances based on the molecular structure of the solvent and substrates being separated.
- \* Know elution mixtures can be more precisely tuned to give separation by using two miscible solvents as a mixture, one with greater and one with lesser solubility towards the substances being separated.
- \* Identify the solvents with greater and lesser solubility in an elution mixture of two solvents.
- \* Predict a better ratio of elution solvents for separating two substances, given one ratio of those solvents and the results of previously eluting substrates using that ratio.
- \* Recognize the carboxyl functional group and identify substances that are carboxylic acids.
- \* Know carboxylic acids have higher boiling and melting points than even alcohols.
- \* Know carboxylic acids with up to four carbons are very soluble in water.
- \* Show with an arrow pushing mechanism how carboxylic acids can release hydrogen ion.
- \* Explain why the water solubility of carboxylic acids can be greatly increased with even mild bases.
- \* Identify an ester group and substances that are esters.
- \* Explain why chemists modified salicylic acid to prepare methyl salicylate.
- \* Identify differences in properties between salicylic acid and methyl salicylate.
- \* Explain how structural differences produce these differences in properties.
- \* Predict the product of a carboxylic acid and an alcohol under acidic conditions.
- \* Identify conditions or predict the product for saponification or hydrolysis of an ester.
- \* Recognize esters are responsible for many fruity flavors and floral fragrances.



## Block C: Purity

- \* Define or explain: melting point, melting point range, phase transitions, and eutectics.
- \* Understand the invariance of melting points and the wide range possible make mp data a reliable method of identifying a substance.
- \* Know melting point is one of the first and simplest methods chemists use to identify substances.
- \* Explain why chemists determine the melting point ranges of samples. (To identify unknown compounds, to determine the purity of the samples, and to characterize new compounds.)
- \* Predict the relative melting point of two substances based on the functional group family each belongs to.
- \* Explain how soluble and insoluble impurities will alter a melting point range.
- \* Explain how a melting point capillary is filled and how an accurate melting point range is obtained.
- \* Know a mixture of two or more substances will always have a lower melting point than either component.
- \* Know melting point depression is a measure of the purity of a sample.
- \* Identify the six processes that accomplish phase changes between solid, liquid, and gas states.
- \* Describe the temperature and pressure requirements for sublimation.
- \* Describe the advantages of sublimation as a separation technique.
- \* Recognize sublimation occurs most readily with non-polar, symmetric substances.
- \* Determine which of two substances is more likely isolatable by sublimation.
- \* Know vaporization is the process of thermal energy overcoming intermolecular forces.
- \* Know temperature is a measure of average thermal energy, some vaporization occurs at all temperatures.
- \* Know vapor pressure is the pressure created by vaporization of a liquid.
- \* Know boiling occurs when the vapor pressure of a liquid equals the pressure of the world around it.
- \* Know mixtures have weaker IMF than pure substances and lower boiling points than pure substances.
- \* Know distillation is a technique for separating liquids.
- \* Know a substance can be vaporized from a mixture below its boiling point by steam distillation.
- \* Know steam distillation is a technique for distilling substances that may decompose at their boiling point.
- \* Know a pure substance can be obtained by fractional or simple distillation.
- \* Identify the parts of a distillation apparatus (distillation flask, head, condenser and collection flask).
- \* Know a pure substance can be identified in a simple distillation by the temperature at which it condenses.
- \* Know the distillation head is where the temperature of condensing gas is identified in a simple distillation.

## Block D: Preparation

- \* Give examples of common uses of haloalkanes.
- \* Know what properties of haloalkanes make them useful in refrigeration, fire extinguishers, and aerosols.
- \* Classify a haloalkane as primary, secondary, or tertiary.



- \* Predict the relative melting point, boiling point, viscosity or hardness of a haloalkane relative to a hydrocarbon.
- \* Explain why haloalkanes have similar water solubility to hydrocarbons.
- \* Know what advantages haloalkanes have as an extraction solvent.
- \* Provide the reaction conditions for converting an alcohol to an haloalkane.
- \* Predict the product of a tertiary or secondary alcohol and a binary acid.
- \* Identify the boiling point of substance by capillary condensation.
- \* Know an unsaturation is a double or triple bond (two carbons less than saturated with hydrogen).
- \* Know olefins are hydrocarbons containing an unsaturation.
- \* Know burning olefins produces less heat than alkanes, but produces a hotter flame.
- \* Identify cis or trans isomers of an olefin.
- \* Know alcohols are hydrocarbons substituted with a hydroxy group.
- \* Identify primary, secondary, and tertiary alcohols.
- \* Know a dehydration reaction is a chemical reaction that eliminates water.
- \* Show the E1 mechanism for dehydration of an alcohol.
- \* Use that mechanism to explain why dehydration reactivity is greater for tertiary than secondary than primary alcohols.
- \* Predict the product of the dehydration of an alcohol.
- \* Apply Zaitsev's rule to predict which dehydration product is favored among regio-isomeric products.
- \* Know thermodynamically trans olefins are favored over cis in dehydration reactions.