

"Competence in Chemistry" **Oral** Examination

This examination will last approximately 30 - 45 mins.

You should be prepared to answer questions (verbally and by writing on the board) to demonstrate competence in all the Chemistry courses you have taken.

The following is a list of *typical* topics covered, and *example* questions are in italics.

You should anticipate responses of "Why ?" or "But what does that mean...?" to your answers if they are incomplete or vague.

These are just examples, and are not the exact, or only questions that will be asked. This list will be regularly expanded and updated.

The mole concept and Avogadro's constant (*how many carbon atoms are in 16g of methane?*)

Formulas and Valency and the Octet Rule (*why is NH₃ a stable molecule but CH₃ is not ?*)

Chemical equations (*balance this equation: Fe + Cl₂ -> FeCl₃*)

Atomic structure (*describe the relative mass / charge / location of protons, neutrons and electrons*)

The Periodic Table and its trends/Periodicity (*which of two atoms is bigger/heavier/more electronegative/more reactive etc ?*)

Different types of Bonding (*Is that compound ionic or covalent / If this compound was dissolved in water would ions form ? If so, which ions ? etc*)

Different types of Covalent Bond (*difference between polar/non polar, sigma and pi*)

Lewis Structures (*draw from a formula*)

Valency, Oxidation States and Common Formulas (*what is the formula for calcium carbonate, nitric acid, what's the name of KMnO₄, what is the oxidation number of Mn in that species? etc*)

Hybridization (*what is that hybridization of this atom ? What is the bond angle of those atoms etc ?*)

Organic Functional Groups (*draw / identify them*)

Resonance Stabilization, Conjugation and Aromaticity (*explain, draw, predict, identify, etc*)

Thermodynamics (*explain and talk about the laws; work, heat, energy and enthalpy, etc*)

Kinetics (*talk about the concept of kinetics, different orders of reaction, etc*)

Equilibrium (*talk about the concept, calculation and influencing of equilibria*)

Energy Level Diagrams and their Interpretation (*is the reaction exothermic, how many steps, which is the RDS, how many transition states, etc?*)

Acids and Bases (*is this compound acidic or basic, different definitions of acidity, quantification of acidity via the pH scale, etc*)

Oxidation and Reduction (*identify oxidation states and understand their role in REDOX reactions, balance equations using half reactions, etc*)

Instrumental Techniques (*the electromagnetic spectrum, what is the theory behind a particular method, how is this theory implemented in practice, what information can be obtained, what are the advantages and limitations, etc ?*)

Quantum Mechanics (*explain the need for quantum mechanics, quantum numbers, the uncertainty principle, Schroedinger equation, functions and operators, wavefunctions, selection rules for spectroscopic transitions in atoms and molecules, Pauli Principle, Hund's rule, methods of quantum chemistry: Hartree-Fock vs Density functional theory, etc*)

Biochem (I) (DNA base pairing and double helix geometry; proteins and amino acids - draw them, discuss their generic and special properties - e.g. what is unique about the structure of Glycine, Proline, etc. Discuss topics such as Ramachandran plots, enzyme kinetics including Michaelis-Menten equation, Competitive Inhibition and Allosteric Inhibition.)

Biochem lab (Key techniques for protein separation e.g. ionic-exchange and size-exclusion. Principle and application of PCR)

Biochem (II) (How does an enzyme catalyze a reaction? Give some examples of biological cofactors in metabolic pathways. What are the differences between NAD⁺ and NADP⁺?)

Org Mech Nucs and Org Mech Elecs (Identify, understand and predict Chemical Reactivity on the basis of two electron movement i.e. Nucleophile/Electrophile interactions. Be able to predict and explain most acidic/basic atoms; most reactive site; have the ability to propose mechanisms for previously unseen reactions.)

Org Mech Rads (Identify, understand and predict the Chemical Reactivity of Free Radicals, including their (thermal/chemical/ionization/photochemical) generation and reactions, in terms of one electron movement Be able to propose radical mechanisms for previously unseen reactions. Explain and predict simple photochemical reactions of carbonyl compounds e.g. Norrish 1 and 2 reactions; 2+2 cycloadditions).

Fluorocarbons (Explain and discuss the synthesis, reactivity, mechanisms, properties, industrial relevance of these compounds.)

Inorganic (Explain and discuss Periodic trends e.g. EA; IE; size, etc.; electron configuration of atoms and ions; bonding theories e.g. VB; MO; VSEPR; shapes of molecules/species, etc.; Naming of inorganic compounds and species; Symmetry and point groups).

Inorganic II (Explain and discuss the Spectrochemical series; Crystal Field Theory; high and low spin complexes; Term symbols; Magnetic susceptibility; Wade's Rules for boranes and carboranes).

Forensic Toxicology (explain the ADME process; explain the difference between screening for drugs/metabolites in biological samples and confirmation; explain GC-MS and LC-MS).

Pharmacology & PK (explain the ADME process; talk about different routes of administration; the difference between pharmacology, pharmacodynamics and pharmacokinetics; discuss receptor theory; the difference between DOSE and CONCENTRATION).

Polymer Chem (Talk about Monomers and their Polymers (names and structures); different types of polymerization ; determination of MW; Tacticity; T_g)

An alternative opinion on what you should know is located [here](#)

Grade Scheme Used

A means "OUTSTANDING"

The student can answer (almost or) all of the posed questions correctly, and demonstrates a knowledge of facts AND an understanding of their scientific/molecular basis. There are no deficiencies in fundamental comprehension in important areas.

B means "GOOD"

The student can answer most of the posed questions, perhaps with some prompting. The student is aware of the facts, but struggles with explanations of their application (e.g. can state "X's LAW", but not fully explain why it operates). There may be an important area where the student is not as strong as others.

C means "SATISFACTORY"

The student can answer many of the basic questions, but struggles with others. The student is aware of rules/laws, and their general topic, but cannot recall pertinent details (e.g. "one of the laws of thermodynamics says something about entropy and absolute zero").

D means "POOR"

The student can answer only some of the basic questions, even with significant assistance. The student demonstrates large areas of deficient knowledge and comprehension.

F means "FAILING"

The student demonstrates too many unforgivable errors and omissions with the basic questions.