LOGO DELLA STRUTTURA PRIMARIA

COURSE: **GENERAL AND INORGANIC CHEMISTRY**			
ACADEMIC YEAR: **2016/2017**			
TYPE OF EDUCATIONAL ACTIVITY: **Basic/Characterizing**,			
TEACHER: **Prof. Angela Maria Rosa**			
e-mail: **angela.rosa@unibas.it**		website:	
phone: **0971205932**		mobile (optional):	
Language: **ITALIAN**			
ECTS: **12** (**8** Theory + **2** Numerical Applications + **2** Laboratory Activity)	n. of hours: **112** (**64**h Theory + 2**4**h NA + **24**h LA)	Campus: **Potenza** Dept.: **Science Department** Program: **Chemistry**	**Annual Course**

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

Skills

- reading/writing formulas for the most common inorganic compounds according to the IUPAC rules;
- stoichiometry elements;
- phisical and chemical properties of gas, liquid and solid phases of the matter, including solutions;
- qualitative and quantitative aspects of the most important classes of ionic equilibria in aqueous solution;
- elements of Electrochemistry: redox reactions, galvanic cells and electrolitic processes;
- elements of Kinetics: reaction rates; rate laws; reaction mechanisms; transition state theory and reaction profiles; temperature dependence of the reaction rates;
- electronic structure of the atoms according to the Quantum Mechanics (Schrödinger equation);
- periodic properties of the elements;
- salient aspects of the two main bonding models and of the intermolecular interactions;
- elementary laboratory techniques: mass and volume measurements, preparation and dilution of solutions, precipitation, filtration of precipitates;

Learning outcomes

- ability to solve stoichiometry problems;
- ability to treat numerically the acid-base equilibria in aqueous solution;
- ability to treat numerically solubility equilibria;
- ability to treat numerically redox processes occurring in galvanic and electrolitic cells;
- ability to write the kinetic law of a reaction and calculate the decay time of a substance using experimental kinetic data;
- ability to predict the geometry and the bond parameters of simple inorganic compounds;
- ability to correlate the physico-chemical properties of the elements with their electronic structure;
- ability to correlate the macroscopic properties of the compounds with the nature of the chemical bond;
- ability to correlate the main physical properties of the condensed phases with the nature of the intermolecular interactions;
- ability to report accurately and concisely the data of the laboratory experiments.

PRE-REQUIREMENTS

High school Algebra, Geometry and Physics.

SYLLABUS

Stoichiometry and the Fundamentals of Atomic Theory. (8h T + 4h NA)

Definition of substance, element, and compound. Dalton's atomic theory. Fundamental units in the International Sistem. Derived units and conversion between units. Significant figures. The mole concept, atomic masses and molecular masses. Chemical formulas and their determination. IUPAC rules for reading and writing the chemical formulas of the most important families of inorganic compounds. Chemical reactions and chemical equations (balancing chemical reaction). Reaction stoichiometry.

Gases. (4h T + 1h NA)

State parameters and state equation. Ideal gas and ideal gas laws (Boyle, Charles, Gay-Lussac, and Avogadro's laws). The state equation of the ideal gas. Mixture of ideal gases and Dalton's law. Kinetic theory of gases. Distribution of the molecular rates: the Maxwell-Boltzmann distribution function. Real gases and van der Waals state equation.

Condensed phases of the matter. (2h T)

Liquid phase: macroscopic properties and Maxwell-Boltzmann distribution of the molecular rates. Solid phase: macroscopic properties of crystalline solids; ionic, molecular, covalent, and metallic solids. Space Lattices.

Changes and equilibria of state. (4h T)
Changes of state and energetics of the changes of state. Definition of state function and of the main thermodynamic state functions (enthalpy, entropy, free energy). Enthalpy changes in physical process and chemical reactions (Hess law). Phase equilibria. Vapor pressure of pure liquids and solids and its dependence on the temperature. The phase rule. Phase diagrams for one-component systems (H_2O, CO_2, S).

Solutions. (6h T + 2h NA)
Definition of solution; types of solutions; concentration units and conversion of concentration units of solutions. Preparation of liquid solutions. Ideal solutions and Roult's Law. Electrolitic solutions. Nominal and actual concentration of electrolitic solutions. Colligative properties of ideal solutions. Ideal solutions containing two volatile components. Distillation principle. Positive and negative deviation from ideality.

Chemical equilibrium. (2h T)
Nature and properties of the chemical equilibrium. Equilibrium constants. Effect of concentration, pressure, volume, temperature on the equilibrium composition. Le Chatelier Principle. Reaction ratio. Qualitative and quantitative aspects of equilibria involving gases.

Acid-base equilibria in aqueous solution. (10h T + 6h NA)
Definition of acid and base by Arrhenius, Lowry-Bronsted, Lewis. Water equilibrium and the pH scale. Aqueous solutions of strong acids, strong bases and mixtures of both. Weak monoprotic acids and bases. Acid-base equilibria in salt solutions. Buffer solutions. Polyprotic acids and salts of polyprotic acids.

Solubility equilibria. (4h T + 2h NA)
Low-solubility salts and solubility product constants. Effect of the shared ion and pH on the solubility of a salt. Precipitation reactions. Selective precipitation reactions.

Electrochemistry. (6h T + 3h NA) Redox reactions and oxidation numbers. Standard reduction potentials. Galvanic cells and redox reactions. Nernst equation. Classification of the half cells. Equilibrium constants of redox reactions. Concentration cells. Qualitative and quantitative aspects of the electrolitic processes.

Kinetics. (4h T + 2h NA)
Reaction rates and rate laws. Determination of reaction rate laws using experimental data. Integrated rate low for first and second order reactions involving only one reagent and determination of the halving time. Reaction mechanisms and elementary processes. Temperature dependence of the reaction rates. Arrhenius equation and its applications. Activated complex theory. Transition state and activation energy. Reaction profiles of stepwise reactions. Homogeneous and eterogeneous catalysis.

Electronic structure and periodic properties of the Elements. (6h T + 2h AN)
Atomic models. Quantum Mechanics principles and the Schrödinger equation. Quantum numbers, wave function, and atomic orbitals. Electronic configuration of the elements and Periodic Table. Periodicity of the atomic properties: ionization potentials, atomic radii, electron affinity, electronegativity.

The chemical bond. (8h T + 2h NA)
Bond parameters (bond energy, bond length, bond angles), bond models. The Ionic bond in the ionic solids. Lattice energy and Born-Haber cycle. Covalent bond: the molecular orbital concept; molecular orbital as linear combination of atomic orbitals (LCAO-MO). Electronic configuration of omonuclear and eteronuclear biatomic molecules using the MO approach. Empyrical methods to determine the number of bonds in polyatomic molecules: Lewis structures and evaluation of the relative stabilities of resonance structures using the formal charge concept.

Molecular geometry: the Valence Shell Electron Pair Repulsion (VSEPR) model. Polarity of a chemical bond. Dipole moment of biatomic and polyatomic molecules. Hybrid orbitals and molecular geometry. Weak bonds: London's forces, dipole-dipole and ion-dipole interactions, hydrogen bonds.

Laboratory Applications . (24h)
Lab introduction: (1) absolute and relative error definition; random and systematic errors in the experimental measurements; instrument sensibility; accuracy and precision of a measure; (2) lab tour, lab safety; description of the main instruments for volume and weight measurements (analytical balances, cylinders, becker, pipettes, burettes).

Lab experiences: **1.** Masss and volume measurements and determination of the density of some liquids and solids.

2. Density and concentration of some aqueous solutions. Construction of a calibration curve.

3. Elementary techniques of a chemical laboratory. Acid-base, precipitation, complexation reactions of the copper(II) ion in a copper sulfate pentahydrate solution.

4. Electrochemistry Experiments: **(A)** Redox reaction betwee metallic zinc and the copper(II) ion and determination of the quantum yield**. (B)** Construction of the Daniell's galvanic cell.

(C) Electrolysis of a solution of sulforic acid.

TEACHING METHODS

The lectures will be comprised of PowerPoint slides provided by the teacher and supplemented with chalkboard presentations. Numerical application will be comprised of chalkboard problem solving and discussions. Laboratory activities will be introduced by PowerPoint and chalckboard presentations. The students will be also provided with supplementary worksheets.

EVALUATION METHODS

There will be five midterm written exams, each consisting of three numerical problems and three open questions, and a final exam. The final exam will comprise a written examination consisting of six numerical problems and an oral examination. A score of at least 18/30 in the written examination is mandatory to access the oral examination. The evaluation of the laboratory written reports will contribute to the final score of the exam. The students who pass the five midterm exams will be exempted from the final written examination. To pass the midterm exams an average score of 18/30 with a score of 15/30 in the first and 18/30 in the next ones is required.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

The students will be provided with PowerPoint slides of the lectures.

Required textbooks:

- P. Atkins e L. Jones , Principi di Chimica, Casa Editrice Zanichell, Terza edizione italiana condotta sulla quinta edizione americana
- Mahan B. H. e Myers R. J., Chimica, Casa Editrice Ambrosiana
- Bertini I. e Mani F., Stechiometria: un avvio allo studio della Chimica, Casa Editrice Ambrosiana
- Michelin Lausarot P. e Vaglio G. A., Stechiometria per la Chimica Generale, Casa Editrice Piccin

INTERACTION WITH STUDENTS

Office Hours: 8:30–10:30 Monday and Thursday and by e-mail appointment.

EXAMINATION SESSIONS (FORECAST)[1]

20/1/2017, 24/02/2017, 24/3/2017, 12/5/2017, 16/6/2017, 14/7/2017, 6/10/2017, 15/12/2017

SEMINARS BY EXTERNAL EXPERTS YES □ NO □ **X**

FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.