December 2013

Syllabus for Basic Academic Abilities in the EJU

(To be applied to the questions of the 2015 EJU 1st Session (June))

<Syllabus of Science>

[Purpose of the Examination]

The purpose of this examination is to test whether international students have the basic academic ability in science necessary for studying at universities or other such higher educational institutions in Japan.

[Classification of Examination]

The examination consists of three subjects, i.e. physics, chemistry, and biology; examinees will select two of these subjects.

[Scope of Questions]

The scope of questions is as follows. What is taught in elementary and junior high schools is regarded to have been already learned and therefore is to be included in the scope of the EJU. What questions consists of in each subject is classified into categories, each of which is presented by topics and scientific terms.

Chemistry

The scope of questions will follow the scope of “Basic Chemistry” and “Advanced Chemistry” of the Course of Study for high schools in Japan.

I Structure of Matter

1. Study of matter
   (1) Pure substances and mixtures
   Elements, allotropes, compounds, mixtures, separation of mixture, purification
   (2) States of matter
   Three states of matter (gas, liquid, and solid), changes of state
2. Particles constituting substances
   (1) Structure of the atom
   Electron, proton, neutron, mass number, isotope
   (2) Electron configuration
   Electron shell, properties of atoms, the periodic law, periodic table, valence electrons
3. Substances and chemical bonds
   (1) Ionic bonds
   Ionic bond, ionic crystal, ionization energy, electron affinity
   (2) Metallic bonds
   Metallic bond, free electron, metallic crystal, malleability
   (3) Covalent bonds
   Covalent bond, coordinate bond, crystal of covalent bond, molecular crystals, polar nature of bond, electronegativity

(4) Intermolecular force

van der Waals force, hydrogen bond

(5) Chemical bonds and properties of substances

Melting point and boiling point, electric conductivity and thermal conductivity, solubility

4. Quantitative treatment of substances and chemical formula

(1) Amount of substance

Atomic weight, molecular weight, formula weight, amount of substance, molar concentration, mass percent concentration, molarity

(2) Chemical formulas

Molecular formula, ion formula, electron formula (Lewis structures), structural formula, compositional formula (empirical formula)

II State and Change of Substances

1. Change of substances

(1) Reaction formula

Expression of reaction formula, quantitative relation of chemical reaction

(2) Acids and bases

Definition and strength of acids and bases, hydrogen ion concentration, pH, neutralization reaction, neutralization titration, salt

(3) Oxidation and reduction

Definition of oxidation and reduction, oxidation number, ionization tendency of metal, oxidizing agent and reducing agent

2. State and equilibrium of substances

(1) Change of state

Thermal motion of molecules and the three states of substance, thermal energy distribution of gas molecule, absolute temperature, boiling point, melting point, heat of fusion, heat of vaporization

(2) Properties of gases

State equation of ideal gas, mixed gas, law of partial pressure, real gas and ideal gas

(3) Equilibrium of solutions

Dilute solution, saturated solution and solubility equilibrium, supersaturation, solubility of solid, solubility of gas, Henry's law

(4) Nature of solutions

Depression of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, colloidal solution, Tyndall effect, Brownian motion, dialysis, electrophoresis

3. Change and equilibrium of substances

(1) Chemical reaction and energy

Heat and light in chemical reaction, thermochemical equation, heat of reaction and bond energy, Hess's law

(2) Electrochemistry

Electrolysis, electrode reaction, electrical energy and chemical energy, quantity of electricity and

amount of change in substance, Faraday's law

(3) Electric cell

Daniell cell and typical practical batteries (dry cell, lead storage battery, fuel cell, etc.)

(4) Rate of reaction and chemical equilibrium

Rate of reaction and rate constant, rate of reaction and concentration, temperature, and catalyst, activation energy, reversible reaction, chemical equilibrium and its shift, equilibrium constant, Le Chatelier's principle

(5) Eletrolytic dissociation equilibrium

Strength and degree of electrolytic dissociation of acid and base, ionic product of water, electrolytic dissociation equilibrium of weak acid and weak base, hydrolysis of salt, buffer solution

III Inorganic Chemistry

1. Inorganic substances

(1) Typical elements (main group elements)

Properties, reactions and uses of representative elements of each group and their compounds

Group 1: hydrogen, lithium, sodium, potassium
Group 2: magnesium, calcium, barium
Group 12: zinc, mercury
Group 13: aluminum
Group 14: carbon, silicon, tin, lead
Group 15: nitrogen, phosphorus
Group 16: oxygen, sulfur
Group 17: fluorine, chlorine, bromine, iodine
Group 18: helium, neon, argon

(2) Transition elements

Properties, reactions and uses of chromium, manganese, iron, copper, silver, and their compounds

(3) Industrial manufacturing methods of inorganic substances

Aluminum, silicon, iron, copper, sodium hydroxide, ammonia, sulfuric acid, etc.

(4) Separation and analysis of metallic ions

2. Inorganic substances and our daily life

In addition to the substances mentioned III-1, metals and ceramics widely utilized in human life.

(Examples of typical metal) titanium, tungsten, platinum, stainless steel, nichrome

(Examples of typical ceramics) glass, fine ceramics, titanium (IV) oxide

IV Organic Chemistry

1. Properties and reactions of organic compound

(1) Hydrocarbons

Structures, properties and reactions of representative alkanes, alkenes, alkynes, composition and uses of petroleum

Structural isomers and stereoisomers (*cis* - *trans* isomers, optical isomers (enantiomers))

(2) Compounds with functional groups

Structures, properties and reactions of representative compounds such as alcohols, ethers, carbonyl compounds, carboxylic acids, ester, etc.

Oils and soaps, etc.

(3) Aromatic compounds

Structures, properties and reaction of representative compounds such as aromatic hydrocarbons, phenols, aromatic carboxylic acids, and aromatic amines

2. Organic compounds and our daily life

(1) In addition to the substances listed in IV-1, organic compounds widely utilized in human life such as monosaccharides, disaccharides, and amino acids

(Examples) glucose, fructose, maltose, sucrose, glycine, alanine

(2) Main ingredients of typical drugs, dyes, and detergents

(Examples) derivatives of salicylic acid, azo compounds, sodium alkyl sulfate

(3) Polymeric compounds

i Synthetic polymers: structures, properties and syntheses of typical synthetic fibers and plastics

(Examples) nylon, polyethylene, polypropylene, poly (vinyl chloride), polystyrene, polyethylene terephthalate, phenol resin, urea resin

ii Natural polymers

Structures and properties of proteins, starch, cellulose, natural rubber, structures and properties of nucleic acid such as DNA

iii Applications of polymers widely utilized in human life (e.g. water-absorbent polymer, conductive polymers, synthetic rubber), recycling of resources, etc.