

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.

Physics

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

I Mechanics**1. Motion and force****(1) Description of motion**

Position, displacement, velocity, acceleration, relative motion, free fall, projectile motion

(2) Various forces

Force, gravity, frictional force, normal force, tension, elastic force, force exerted by liquid or gas

(3) Equilibrium of forces

Resultant and resolution of forces, equilibrium of forces

(4) Equilibrium of forces acting on rigid bodies

Torque, resultant force, couple of forces, equilibrium of rigid bodies, center of mass

(5) Laws of motion

Newton's laws of motion, unit of force and equation of motion, system of units and dimension

(6) Motion in the presence of friction and/or air resistance

Static friction force, kinetic friction force, air resistance and terminal velocity

2. Energy and momentum**(1) Work and kinetic energy**

Principle of work, power, kinetic energy

(2) Potential energy

Potential energy due to gravity, potential energy due to elastic force

- (3) Conservation of mechanical energy
- (4) Momentum and impulse
 - Momentum and impulse, law of conservation of momentum, fission and coalescence
- (5) Collision
 - Coefficient of restitution, elastic collision, inelastic collision
- 3. Various forces and motion
 - (1) Uniform circular motion
 - Velocity and angular velocity, period and rotational frequency, acceleration and centripetal force, centripetal force in non-uniform circular motion
 - (2) Inertial force
 - Inertial force, centrifugal force
 - (3) Simple harmonic motion
 - Displacement, velocity, acceleration, restoring force, amplitude, period, frequency, phase, angular frequency, spring pendulum, simple pendulum, energy of simple harmonic motion
 - (4) Universal gravitation
 - Planetary motion (Kepler's laws), universal gravitation, gravity, potential energy of universal gravitation, conservation of mechanical energy

II Thermodynamics

- 1. Heat and temperature
 - (1) Heat and temperature
 - Thermal motion, thermal equilibrium, temperature, absolute temperature, heat quantity, heat capacity, specific heat, conservation of heat quantity
 - (2) States of matter
 - Three states of matter (gas, liquid, solid), melting point, boiling point, heat of fusion, heat of evaporation, latent heat, heat expansion
 - (3) Heat and work
 - Heat and work, internal energy, the first law of thermodynamics, irreversible change, heat engine, thermal efficiency, the second law of thermodynamics
- 2. Properties of gas
 - (1) Equation of state of ideal gas
 - Boyle's law, Charles' law, Boyle-Charles' law, equation of state of ideal gas
 - (2) Motion of gas molecules
 - Motion of gas molecules and pressure/absolute temperature, internal energy of gas, monatomic molecule, diatomic molecule
 - (3) Change of state of gases
 - Isochoric change, isobaric change, isothermal change, adiabatic change, molar specific heat

III Waves

- 1. Waves

(1) Properties of waves

Wave motion, medium, wave source, transverse and longitudinal waves

(2) Propagation of waves and how to express it

Wave form, amplitude, period, frequency, wave length, wave velocity, sinusoidal wave, phase, energy of wave

(3) Superposition principle and Huygens' principle

Superposition principle, interference, standing wave, Huygens' principle, law of reflection, law of refraction, diffraction

2. Sound

(1) Properties and propagation of sound

Velocity of sound, reflection, refraction, diffraction and interference of sound, beat

(2) Vibrations of sounding body and resonance

Vibration of string, vibration of air column, resonance

(3) Doppler effect

Doppler effect, case of moving sound source, case of moving observer, case of moving sound source and moving observer

3. Light

(1) Properties of light

Visible light, white light, monochromatic light, light and color, spectrum, dispersion, polarization

(2) Propagation of light

Velocity of light, reflection and refraction of light, total reflection, scattering of light, lenses, spherical mirror

(3) Diffraction and interference of light

Diffraction, interference, Young's experiment, diffraction grating, thin-film interference, air wedge interference

IV Electricity and Magnetism

1. Electric field

(1) Electrostatic force

Charged object, electric charge, electric quantity, principle of conservation of charge, Coulomb's law

(2) Electric field

Electric field, electric field of a point charge, principle of superposition of electric field, lines of electric force

(3) Electric potential

Potential energy by electrostatic force, electric potential and potential difference, electric potential of a point charge, equipotential surfaces

(4) Matter in electric fields

Conductor in an electric field, electrostatic induction, electrostatic shielding, ground, insulator in an electric field, dielectric polarization

(5) Capacitor

Capacitor, electric capacitance, dielectrics, electrostatic energy stored in a capacitor, connection of capacitors

2. Electric current

(1) Electric current

Electric current, voltage, Ohm's law, resistance and resistivity, Joule's heat, electric power, electric energy

(2) Direct current circuits

Series and parallel connections of resistors, ammeter, voltmeter, Kirchhoff's rules, temperature dependence of resistivity, measurement of resistance, electromotive force and internal resistance of battery, circuit with capacitors

(3) Semiconductor

n-type semiconductor, *p*-type semiconductor, *p-n* junction, diode

3. Current and magnetic field

(1) Magnetic field

Magnets, magnetic poles, magnetic force, magnetic charge, magnetic field, lines of magnetic force, magnetization, magnetic materials, density of magnetic flux, permeability, magnetic flux

(2) Magnetic fields generated by currents

Magnetic fields generated by straight currents, magnetic fields generated by circular currents, magnetic fields generated by solenoid currents

(3) Magnetic forces on currents

Magnetic force on a straight current, force between parallel currents

(4) Lorentz force

Lorentz force, motion of charged particles in a magnetic field, Hall effect

4. Electromagnetic induction and electromagnetic wave

(1) Laws of electromagnetic induction

Electromagnetic induction, Lenz's law, Faraday's law of electromagnetic induction, induced electromotive force in a conductor crossing a magnetic field, Lorentz force and induced electromotive force, eddy current

(2) Self-induction, mutual induction

Self-induction, self-inductances, energy stored in a coil, mutual induction, mutual inductances, transformer

(3) Alternating current (AC)

Generation of AC (AC voltage, AC, frequency, phase, angular frequency), AC flowing through a resistor, effective values

(4) AC circuits

Reactance of coil and phase difference, reactance of capacitor and phase difference, electric power consumption, impedance of AC circuits, resonant circuit, oscillation circuit

(5) Electromagnetic waves

Electromagnetic wave, generation of electromagnetic wave, properties of electromagnetic waves, classification of electromagnetic waves

V Atoms

1. Electrons and light

(1) Electrons

Discharge, cathode ray, electrons, specific charge, elementary electric charge

(2) Wave-particle duality

Photoelectric effect, photon, X-ray, Compton effect, Bragg reflection, matter wave, interference and diffraction of electron beam

2. Atoms and nuclei

(1) Structure of atoms

Nucleus, spectrum of hydrogen atom, Bohr's model of atoms, energy level

(2) Nuclei

Compositions of nuclei, isotope, atomic mass unit, atomic weight, nuclear decay, radiation, radioactivity, half-life, nuclear reaction, nuclear energy

(3) Elementary particles

Elementary particles, four fundamental types of forces