

## Syllabus for EJU Subject Examinations (Basic Scholastic Ability)

### < Science > ( with relation to MEXT\* curriculum guidelines )

\*Ministry of Education, Culture, Sports, Science and Technology

#### Purpose of the Examination

The purpose of this examination is to test whether students from other countries have the basic scholastic ability in science considered necessary for studying at the undergraduate level at a Japanese university.

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

The questions are classified according to each of these three subjects; each subject section has questions and a list of relevant terminology.

#### Physics

##### Mechanics

#### 1 . Motion and force ... (1) "Projectile motion" : Physics , others : Physics

##### (1) Description of motion

Velocity and acceleration, 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, Systems of units and dimensions

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

Static friction force, Kinetic friction force, Air resistance and terminal velocity

#### 2 . Energy and momentum ... (1) (2) (3) : Physics , (4) (5) : Physics

##### (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

##### (5) Collision and fission

Coefficient of restitution, Elastic collision, Inelastic collision

#### 3 . Various forces and motion ... Physics

##### (1) Circular motion

Angular velocity, Period and rotational frequency, Acceleration and centripetal force,  
General circular motion

##### (2) Inertial force

Inertial force, Centrifugal force

##### (3) Simple harmonic oscillation

Spring pendulum, Energy of simple harmonic motion, Simple pendulum

##### (4) Universal gravitation

Planetary motion (Kepler's law), Universal gravitation and gravity, Conservation of energy

## Thermodynamics

### 1 . Temperature and heat ... Physics

#### (1) Temperature and heat

Temperature, Heat quantity and heat capacity, Specific heat, Conservation of heat quantity

#### (2) Internal energy

Melting point, Boiling point, Heat of fusion, Heat of evaporation, Latent heat, Heat and work,  
The first law of thermodynamics

### 2 . Properties of gas ... (1) “ Boyle’s law, Charles’ law ” : Physics , others : Physics (optional topics)

#### (1) Laws of gas

Boyle’s law, Charles’ law

Boyle-Charles' law, Equation of state of ideal gas

#### (2) Kinetic theory of gas

Pressure and molecule motion, Absolute temperature, Internal energy of ideal gas,  
Molar heat capacity

#### (3) Change of state of gases

Isochoric change, Isobaric change, Adiabatic change, Isothermal change

### 3 . Heat engine and irreversible change ... Physics

#### (1) Conversion and conservation of various energy

Conversion and conservation of energy , Irreversible change, Efficiency of heat engine

## Waves ... Physics

### 1 . Properties of wave

#### (1) Propagation of wave

Medium , Wave source , Waveform , Period , Amplitude , Wave length , Wave velocity ,  
Transverse and longitudinal waves

#### (2) Superposition principle and interference

Superposition principle, Interference, Standing and traveling waves

#### (3) Reflection, refraction, and diffraction of waves

Huygens’ principle, Law of reflection, Law of refraction, Refractive index, Diffraction

### 2 . Sound

#### (1) Propagation of sound

Sound speed, Reflection, Refraction, Diffraction, Interference, Beat

#### (2) Vibrations of sounding body and resonance

Vibration of string, Vibration of air column, Resonance

#### (3) Doppler effect

Case of moving sound source, Case of moving observer

### 3 . Light

#### (1) Properties of light

Various lights ( visible light, white light, monochromatic light, light and color ) , Speed of light,  
Wavelength

#### (2) Reflection and refraction of light

Reflection and refraction, Total reflection, Scattering of light, Lenses, Real and virtual images

#### (3) Diffraction and interference of light

Diffraction ,Young’s experiment( interference fringes, bright and dark lines ), Diffraction grating ,  
Thin-film interference

#### (4) Dispersion and polarization of light

Dispersion of light, Spectrum, Polarized light

## Electromagnetism

### 1 . Electric field ... Physics

#### (1) Electrostatic force

Electric charge (electric quantity), Coulomb’s law, Law of electric charge conservation

- (2) Electric field
  - Electric field, Electric field of a point charge, Superposition principle of electric field, Electric lines of force
- (3) Electric potential
  - Electric potential and voltage, Equipotential surfaces, Electrostatic potential energy
- (4) Matter in electric fields
  - Electrostatic induction, Electrostatic shielding, Dielectric polarization
- (5) Capacitor
  - Capacitance of a parallel-plate capacitor and connection of capacitors, Energy of electric field and dielectrics
- 2 . Electric current ... (1) : Physics , (2) : Physics
  - (1) Electric current
    - Electric current and electrons, Resistance, Ohm's law, Joule's heat, Electric power, Electric energy, Series and parallel connections of resistors, Ammeter, Voltmeter
  - (2) Direct current circuit
    - Kirchhoff's rules, Temperature dependence of resistivity, Measurement of resistance, Internal resistance (and electromotive force) of battery, Circuit with capacitors
- 3 . Current and magnetic field ... Physics
  - (1) Magnetic field
    - Magnets and magnetic materials, Magnetic poles, Magnetic field, Magnetic lines of force, Magnetization, Magnetic flux density and intensity of magnetic field (permeability)
  - (2) Magnetic fields generated by currents
    - Magnetic fields of currents in a long straight wire, a circular loop, and a solenoid
  - (3) Magnetic forces on currents
    - Magnetic force on a direct current, Force between parallel currents
  - (4) The Lorentz force
    - the Lorentz force, Cyclotron motion and specific charge, Forces on currents, The Hall effect
- 4 . Electromagnetic induction and electromagnetic wave ... Physics
  - (1) Laws of induction
    - Electromagnetic induction, Lenz's law, Faraday's law of induction, Induced electromotive force in a conductor crossing magnetic field (the Lorentz force and induced electromotive force)
  - (2) Mutual induction , Self-induction
    - Mutual inductances, Self-inductances, Magnetic energy stored by an inductor
  - (3) Alternating current (AC)
    - Generation of AC (AC voltage, AC, phase, angular frequency), AC flowing through a resistor, Effective values
  - (4) AC circuit
    - Reactance of inductors, Reactance of capacitors, Electric power consumption, Electric transformer and the energy conservation, Resonant circuit, Oscillation circuit
  - (5) Electromagnetic waves
    - Generation and properties of electromagnetic waves, Radiation from high-temperature objects