[Reference Only]

Annex 10

The Requirements of Basic Academic Attainments for Junior Secondary Natural Science

I. Basic rationale

Natural science is the general term for science in the fields of substances, life, the Earth and the Universe, etc. Through long-term development, natural science has not only established a knowledge system about human and nature, but also formed a unique way of perceiving the world, nurturing the scientific spirit and ethic, making great influence on all aspects of human social life. Being in the era of rapid scientific development, the current junior secondary school students, the future citizens, should have a basic understanding of scientific knowledge, methods, spirit as well as the relationship between science and society, no matter what kind of profession they will be engaged in. The Junior Secondary Natural Science curriculum can be conducted in different subjects or one integrated subject. Whichever it is, cultivating students' science literacy should be the core objective of Natural Science Education at this education level. On these grounds, the Requirements of Basic Academic Attainments for Junior Secondary Natural Science should comply with the following fundamental principles:

1. Paying attention to the individual differences of students, elevating their level of science literacy

Natural Science curriculum should allow all students to be able to enhance their learning effectiveness and equip them with the science literacy needed for adapting to modern life and the development of future society. The individual differences of students, the uniqueness of their learning style, interests and capacity should be concerned about; starting from students' previous knowledge and experience, gradually guide them to learn scientific knowledge, essential skills and methods, and develop their emotional attitudes and values.

2. Taking notice of the interdisciplinary connections, guiding students to understand the relationship between science, technology, society and environment

Natural Science curriculum should enable students to understand the unity of nature and the relationship between nature and human civilisation, take notice of the connection and infiltration between different subjects in natural science, and pay attention to the latest development of scientific technology as well as its positive and negative influence on human society. It should also focus on combining the actual situations of the community where the students are and the Macao society, guiding students to understand the relationship between scientific technology and society, and care about issues of ecology, resources and environment in Macao.

3. Advocating scientific inquiry and attaching importance to the diversification of teaching methods.

In science teaching, it is advocated to adopt exploratory teaching methods to allow students to experience the process of exploration, learn different scientific methods, nurture their curiosity, craving for knowledge and practical skills and ultimately form the habit of constant thinking. According to the teaching objectives, contents and resources, diverse teaching methods should be adopted flexibly, such as lectures, inquiries, discussions, exchange of ideas and autonomous exploration; attention should be attached to guiding students to participate actively in the learning process. Applying information technology reasonably in science teaching is encouraged.

II. Curriculum Goals

1. Maintain and develop students' curiosity and craving for knowledge about natural phenomena; reinforce their interests in and passion for learning science.
2. Allow students to understand basic scientific knowledge; be able to explain common natural phenomena by using relevant scientific concepts and principles.
3. Help students master some basic scientific methods and skills; guide them to solve practical problems related to natural science.
4. Lead students to realise the significance and basic process of scientific inquiry; enhance their experience in and develop their primary ability of scientific inquiry.
5. Enable students to gradually cultivate such scientific spirit as constant thinking, daring to question, being rigorous in searching for the truth, willing to practice and being good at cooperating with others.
6. Guide students to comprehend the relationship between science, technology, society and environment; pay attention to science-related social issues to allow them to initially form the awareness of actively participating in the discussion of social issues.

7. Lead students to understand the nature of science, nurturing their awareness of applying scientific knowledge, methods, and attitude in viewing and solving personal and social issues.

III. The Requirements of Basic Academic Attainments in different learning domains

Explanation of coding:

(1) The capital English letters represent the requirements of basic academic attainments in different learning domains; A – Scientific inquiry, B – Physical science, C - Life science, D – The Earth and space science;

(2) The first number following the English letter represents the serial number of learning categories in the learning domains.

(3) The second number following the English letter represents the serial number of the requirements of basic academic attainments in the respective learning category.

Learning domain A: Scientific inquiry

Learning category A-1: Comprehension of scientific inquiry

A-1-1 Realise that scientific inquiry is an important way for people to acquire scientific knowledge and understand the natural world.

A-1-2 Understand that scientific inquiry should follow the basic process of identifying the problem, establishing a hypothesis, formulating a research plan, implementing the research plan, drawing the conclusion, presenting and discussing the findings.

A-1-3 Primarily understand that scientific inquiry focuses on facts and evidence; which involves observation, experiment, investigation and many other methods.

Learning category A-2: Capacity for scientific inquiry

A-2-1 Be able to learn to use concise, accurate and clear language to present the scientific problems explored.

A-2-2 Be able to initially try to adopt such methods as variable control and control experiment to design research proposals.

A-2-3 Be able to learn to acquire research evidence through such research methods as observation, survey, experiment, etc.

A-2-4 Acquire a preliminary knowledge on data classification and collation, and use scientific jargons to make a presentation.

A-2-5 Be able to initially use various forms like words and charts, etc. to write simple research reports.

Learning domain B: Physical Science

Learning category B – 1: Substances in everyday life

B-1-1 Recognise the composition of water and its main properties.

B-1-2 Understand the methods of water purification such as adsorption, precipitation, filtration, distillation, etc.

B-1-3 Understand the concept of solution; and be able to describe the meaning of saturated solution and solubility.

B-1-4 Be able to point out the main components of air, and illustrate the main properties and uses of oxygen (O_2) and carbon dioxide (CO_2).

B-1-5 Master the experimental techniques and test methods for oxygen and carbon dioxide extraction.

B-1-6 Be able to briefly explain the Oxygen Cycle and Carbon Cycle in the natural world.

B-1-7 Be able to enumerate the main sources of air pollution and the measures for air pollution reduction.

B-1-8 Be able to illustrate the function of the ozone layer in the atmosphere as well as the need for its protection.

B-1-9 Be able to briefly explain the cause of greenhouse effect and its impact on global environment.

B-1-10 Be able to tell the definition of air quality index, and understand the air quality condition in Macao.

B-1-11 Be able to name the main properties and application of common metals like copper, iron, aluminum; and briefly explain the impact of metal smelting on human civilisation.

B-1-12 Be able to list the reaction of common metals with oxygen, and understand the simple ways to prevent metal rust and corrosion.

B-1-13 Understand the environmental pollution caused by metal disposal, and realise the importance of metal recycling.

B-1-14 Be able to describe the main properties and uses of acid and base, and list the common acids, bases and salts in daily life.

B-1-15 Be able to use indicator and pH test paper to measure the acidity or alkalinity of a solution.

B-1-16 Be able to describe the characteristics of neutralisation reaction.

B-1-17 Be able to briefly explain the cause of acid rain and its impact on the environment.

Learning category B-2: Material properties and structures

B-2-1 Be able to distinguish between pure substance and mixture, simple substance and compound.

B-2-2 Master the basic techniques of separation of mixtures.

B-2-3 Be able to describe the significance of melting point and boiling point.

B-2-4 Have a preliminary understanding of the phenomena of crystal and crystallisation.

B-2-5 Be able to describe the elasticity, hardness, thermal conductivity, electrical conductivity and other physical properties of substances and their application in daily life.

B-2-6 Have a preliminary understanding of the concept of mass and be able to measure the mass of solid and liquid.

B-2-7 Understand the concept of density; and be able to apply the knowledge of density to explain some physical phenomena in life.

B-2-8 Know the microscopic particles that constitute substances, understand the basic concept of particle theory, be able to use the particle theory to explain the phenomena of atmospheric pressure, thermal expansion and contraction, etc.

B-2-9 Have an elementary understanding of the structure of atom and the composition of atomic nucleus, as well as the function of extranuclear electrons in chemical reactions.

B-2-10 Be able to generally describe the development history of the models of atomic structure, and have a basic understanding of scientific models.

B-2-11 Be able to enumerate the names and symbols of some common elements such as hydrogen, carbon, oxygen, nitrogen; and have a basic understanding of the periodic table of elements.

B-2-12 Know the valency of a few common elements; and be able to use chemical formulae to represent the composition of some common substances.

B-2-13 Be able to calculate the relative molecular weight of simple compounds.

B-2-14 Be able to write simple chemical reaction equations correctly and make basic calculation based on such chemical reaction equations.

Learning category B-3: Movement and interaction of substances

B-3-1 Be able to state the basic characteristics of chemical changes; and the differences between chemical and physical changes.

B-3-2 Be able to state the conditions of combustion, and general self-rescue techniques in case of fire.

B-3-3 Basically understand the important function of a catalyst in a chemical reaction.

B-3-4 Understand the reducibility and flammability of hydrogen and carbon monoxide; be able to state the primary first-aid procedures for carbon monoxide poisoning.

B-3-5 Basically understand some common combination reactions, decomposition reactions and replacement reactions.

B-3-6 Be able to describe the meaning of speed and average speed.

B-3-7 Be able to name common forces in daily life such as gravity, friction, elasticity, and state their effects.

B-3-8 Know the relationship between mass and gravity, and be able to do basic calculation.

B-3-9 Be able to specify the conditions for the balance between two forces.

B-3-10 Understand that force is the cause of change in the state of object motion; and be able to explain some common phenomena with the concept of inertia.

B-3-11 Basically understand the concept of pressure, and the methods to change the pressure.

B-3-12 Be able to describe the characteristics of liquid pressure; and explain the Archimedes' principle and the conditions of floating and sinking.

B-3-13 Know the measurement of air pressure, and understand the change of air pressure as well as its effects on daily life.

B-3-14 Understand the three elements of sound, condition for the production and spreading of sound; be able to state the hazards of noise and methods of noise abatement.

B-3-15 Be able to briefly state the characteristics of light propagation in the same homogeneous medium.

B-3-16 Recognise the laws of reflection and refraction of light, and be able to illustrate their practical application.

B-3-17 Be able to draw simple light path diagrams of light reflection and refraction.

B-3-18 Understand dispersion of light and the mixture of coloured lights.

B-3-19 Understand the basic structure of a circuit; be able to make a series circuit and a parallel circuit, as well as draw the circuit diagrams.

B-3-20 Know how to use the ammeter and voltmeter.

B-3-21 Understand the Ohm's law, and be able to do simple calculations.

B-3-22 Be able to briefly describe the heating effect of electric current and the application of fuses.

B-3-23 Understand semiconductors and superconductors as well as the impact of their application on society.

B-3-24 Be able to illustrate the relationship between electric power, current and voltage.

B-3-25 Be able to distinguish between the rated power and actual power of an electrical appliance.

B-3-26 Be able to indicate the polarity of the magnet, and be able to draw common magnetic induction lines to indicate the magnetic field.

B-3-27 Have a preliminary understanding of the magnetic field around the energised conductor, and the characteristics of the magnetic field around the energised solenoid.

B-3-28 Be able to describe the application of electromagnetic wave, and its influence on human life and social development.

Learning category B-4: Energy and energy source

B-4-1 Understand energy and its diverse forms of existence; know energy transfer and energy conversion, and be able to enumerate simple energy conversion devices such as battery, motor and generator.

B-4-2 Be able to describe the significance of work and power, and know the process of work is the process of energy conversion or energy transfer.

B-4-3 Understand the concepts of kinetic energy and potential energy, and be able to name the factors that affect the amount of them.

B-4-4 Briefly describe the history of the discovery of the Law of Conservation of Energy, and be able to analyse physical phenomena using the view of energy conversion as well as the law of conservation of energy.

B-4-5 Be able to state the classification and characteristics of different energy resources; briefly describe the relationship between energy resources and human existence as well as social development.

Learning domain C: Life science

Learning category C-1: The structure of organisms

C-1-1 Be able to state the basic structure and functions of an optical microscope, and know how to use it to observe slide specimens of different biological materials.

C-1-2 Be able to make a simple temporary slide and draw a simple diagram of the structure of a cell.

C-1-3 Be able to explain the role of observation tools in knowing the world of life by making use of the discovery of cells.

C-1-4 Be able to describe the basic structure and main function ~~s~~ of cells, as well as indicate the similarities and differences in the structure of animal cells and plant cells.

C-1-5 Be able to explain that cells are the basic structural and functional units of organisms.

C-1-6 Be able to express the basic processes of cell growth, cell division and cell differentiation as well as their results.

C-1-7 Be able to state the structural characteristics of unicellular organisms; as well as their relationship with human beings.

C-1-8 Recognise the main tissues and organs of animals and plants, as well as animal systems.

Learning category C-2: Vital activities of organisms

C-2-1 Be able to state the main process of seed germination, and explore the necessary conditions for seed germination.

C-2-2 Be able to observe and describe the structure of flowers and seeds, and describe the process of fruit and seed formation.

C-2-3 Be able to enumerate the application of the modes of reproduction in animals and plants during the process of production.

C-2-4 Be able to describe the absorption and transport of water and inorganic salt, as well as transpiration in plants.

C-2-5 Be able to describe the main process of photosynthesis in green plants and its significance; and enumerate the actual application of photosynthesis in agricultural production.

C-2-6 Be able to describe the main process and significance of plant respiration.

C-2-7 Be able to briefly describe the functions of digestion, respiration, nutrient transport and waste discharge in higher animals, as well as their physiological structures.

C-2-8 Be able to enumerate and describe the phenomenon of irritability in plants, as well as the function of auxin.

C-2-9 Be able to describe the structures and functions of the motor system and nervous system of animals.

C-2-10 Be able to enumerate the phenomena of heredity and mutation in organisms,

and briefly explain the reasons thereof.

Learning category C-3: Human body and health

C-3-1 Be able to describe the structure of the motor system, nervous system, respiratory system, circulatory system, digestive system, reproductive system, urinary system and endocrine system in human body, and their physiological functions.

C-3-2 Be able to tell the human growth and development process from birth to death.

C-3-3 Pay attention to the physical and mental health during puberty, and form correct sexual morality.

C-3-4 Be able to state the main nutrients necessary for human body and the important functions thereof. Acknowledge the importance of a balanced diet as well as food safety.

C-3-5 Be able to enumerate the main types of human infectious diseases; tell the common means of transmission and the preventive measures against the common infectious diseases.

C-3-6 Be able to state the types of immunity and their differences, and acknowledge the significance of planned immunisation.

C-3-7 Be able to describe the discovery of penicillin and its significance.

C-3-8 Be able to state the main characteristics and prevention of genetic diseases.

C-3-9 Be able to state the harmful effects of drugs, alcohol and smoking on human physiological function.

C-3-10 Understand the relationship between blood type and blood transfusion; as well as the importance of blood donation in saving lives.

Learning category C-4: Ecology and evolution

C-4-1 Be able to describe the meaning, structure and function of ecosystem.

C-4-2 Be able to enumerate the main types of ecosystems and the interrelationship among them; as well as describe the concept of biosphere.

C-4- 3 Realise the role of green plants in ecosystems.

C-4-4 Be able to describe the basic methods of classifying organisms and state the meaning and significance of biodiversity.

C-4-5 Be able to state the main characteristics of bacteria, fungi and viruses; as well as their relationship with human beings.

C-4-6 Be able to briefly illustrate the main groups of animals and plants; as well as

their relationship with human beings.

C-4-7 Be able to describe the transmission of harmful substances in the food chain, and enumerate the reasons for the destruction of ecosystems.

C-4-8 Be able to realise the ecological environment in Macao and their protective measures.

C-4-9 Be able to describe the basic process of life arising from non-living matter.

C-4-10 Be able to enumerate the phenomena of biological evolution, and realise the basic viewpoints of biological evolution.

Learning domain D: The Earth and Space Science

Learning category D-1: Our Earth

D-1-1 Be able to describe the shape, the size and the structure of the Earth's internal layers.

D-1-2 Know that volcanos and earthquakes are manifestation of movements of the Earth's crust; and point out the distribution of volcanic seismic zones in the world.

D-1-3 Be able to exemplify the constant activities and changes of the oceans and land on the surface of the Earth; and understand the theory of Plate Tectonics.

D-1-4 Be concerned about satellite remote sensing technology and the application of global positioning system.

D-1-5 Be able to enumerate the classification of bodies of water on Earth and their proportion, as well as to indicate the main stages of the natural water cycle.

D-1-6 Be able to illustrate the basic situation of freshwater resources in Macao, and propose feasible measures for preventing and controlling water pollution in Macao.

Learning category D-2:Composition of the Universe

D-2-1 Be able to describe the general situation of the Sun and the Moon; and know the relationship between the Sun, the Moon and the Earth.

D-2-2 Be able to describe the major components of the Solar System.

D-2-3 Understand the history of human space exploration as well as the new achievements of aerospace science and technology in China.

D-2-4 Be able to describe the composition, size and shape of the Milky Way Galaxy; state the location of the Solar System in the Milky Way Galaxy.

D-2-5 Understand that the Universe is composed of a large number of galaxies;

and know the origin, expansion and evolution of the Universe.

D-2-6 Comprehend the developmental history of Geocentric Theory and Heliocentric Theory, and understand that scientific knowledge is ever developing.