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INTEGRATED SCIENCE SYLLABUS

Approved by the Board of Governors of the European Schools at its meeting in Brussels on 1 and 2 February 2005

Entry into force in September 2005: in years 1, 2 and 3 simultaneously.

This syllabus cancels and replaces the syllabus with the reference number 2000-D-405.

Revision of the Integrated Science syllabuses

Background.

The 'Integrated Science' Working Group, formed in 2003, had set itself a prime objective, namely the production of **worksheets**.
The teachers involved in the teaching of Integrated Science come from a variety of academic backgrounds, having studied different science subjects at university in their respective countries of origin, and cannot all be specialists in chemistry, physics and biology. Teachers newly seconded to the school are faced with a new and time-consuming task in preparing lab work sessions, perhaps teaching three different science subjects for the first time.
The availability of such worksheets will enable teachers to manage the preparation of their Integrated Science lessons more successfully and will lead to greater harmonisation of the teaching of this subject.

The Integrated Science **syllabuses** were revised several years ago.
At the group's first meetings, it emerged that the topics dealt with in the Integrated Science syllabuses for years 1, 2 and 3 match the scientific and pedagogical needs and requirements of secondary pupils in those year groups.
On the other hand, it was found that the internal distribution of the different sub-topics and subjects within the topics required revision.
The working group has just completed this revision work, which was carried out in close collaboration with the teachers in the different schools. The syllabuses as proposed are not very different from those currently in force but are distinguished by better structuring and more coherent distribution of the subjects across the 3 year groups in which Integrated Science is taught.

Proposal

It is proposed to introduce the restructured Integrated Science syllabuses for secondary years 1, 2 and 3 as from the 2005-2006 school year. For the reasons mentioned above, the simultaneous introduction of the new syllabuses for the three year groups is not expected to give rise to any problems.

Michel REULAND, Inspector

European Schools

Integrated Science Programme, years 1, 2 and 3.

Preamble.

1. Objectives.

1.1 General objectives.

The secondary section of the European Schools has the two objectives of providing formal, subject-based education and of encouraging pupils' personal development in a wider social and cultural context. Formal education involves the acquisition of knowledge and understanding, concepts and skills within each subject area. Pupils should learn to describe, interpret, judge, and apply their knowledge. Personal development involves an awareness of acceptable behaviour, understanding of the environment in which pupils work and live and a development of their individual identities.

1.2 Subject-specific objectives.

In the Integrated Science programme for years 1, 2 and 3 of the European Schools, the material is designed first to capture the interest of the pupils, and secondly to present subject-specific themes which form part of the curriculum in the schools.

The Integrated Science course offers an introduction that must provide a good basis for further study in years 4 and 5. Pupils must thus be introduced to the basic techniques and apparatus of science, and must learn to work in safety.

Data handling should form part of the teaching content. Particular emphasis should be placed upon issues such as the protection of the natural environment, the conservation of resources and the pollution of the environment by human agency. Pupils should also be introduced to the need to discuss ecological questions concerned with the implications of technological and scientific progress, and the opportunities and dangers these present for society and for the individual.

In working with the pupils, taking account of their particular interests and capacities, the teacher may also incorporate elements into the teaching elements chosen to nurture such interests. An important aim of the teaching is to develop the ability to work with others as a team.

The course is not merely about the acquisition of facts and of experimental results, but also the ability to plan and execute experiments to test hypotheses.

Properly presented experimental results should lead to suggestions of models of the scientific phenomena under consideration. Pupils should become familiar with an important basic notion: the careful observation of natural processes and of experiments, and the application of disciplined thought to these, is how scientific understanding begins and develops.
The planning of an experiment fosters more self-confidence, independence and maturity.

Pupils of this age can learn that a given set of experimental results can only be properly evaluated after reflecting on the implications of the method by which they were obtained.

2. Methodology.

2.1 Introduction.

The methodology of the course should follow the classical methodology of science, suitably adapted to the level and capacities of young pupils. The accent should therefore be on

- The carrying out of experiments
- The making and reporting of observations and measurements
- Where appropriate, the designing of follow up experiments.

2.2 Carrying out experiments.

2.2.1 The activity of practical science fosters the assimilation of concepts which, if taught through formal lectures, would be very difficult for children to absorb and make their own.

2.2.2 The Integrated Science courses should be laboratory based. It is not always possible to present the entire course using only experiments performed by pupils; occasional demonstrations and some formal class teaching are inevitable.

2.2.3 Such activities also provide for bringing the senses to bear on the phenomena, which should engender more complete and more pleasurable understanding.

2.2.4 Practical science classes foster the development of manipulative skills. Working with equipment, taking measurements and constructing apparatus all help with this goal.

2.3 The making of observations and the reporting of experiments.

2.3.1 The process of reporting not only helps the growth of language skills, but also requires that pupils examine and question their own understanding of the phenomena.

2.3.2 The demands made in this respect will evolve in length and complexity as the course progresses from year 1 to year 3.

2.3.3 The use of modern methods of observing and recording data, including those calling on information technology for data capture and processing, should be encouraged, but traditional methods and instruments (where still in current use) should not be neglected.

2.4 Development and application of mathematical skills.

2.4.1 Opportunities should be exploited to progressively develop mathematical skills such as using formulae, estimation, use of the standard form, percentage, proportions.

2.4.2 Use of graphs.

2.4.3 Collection, processing, presentation and interpretation of data.

3 Continuity of teaching

3.1 To preserve the integrated nature of the course it is highly recommended that one teacher be assigned to teach all periods in a particular year.

3.2 To achieve a balance it is recommended that teachers from the three sciences contribute to the teaching of the course over the three years.

3.3 Two of the 4 periods should be scheduled as a double period.

3.4 The sensitive, appropriate and discriminating use of internet resources.

4. Assessment of learning outcomes.

4.1 Functions and principles of assessment.

Assessment is both a formative and a summative process.

Formative assessment is an ongoing process providing information about pupils' learning. It should also be a basis for pupils' further development and plays an important rôle in the provision of educational guidance for pupils, parents or guardians and for the school. Assessment need not always involve the award of a mark, and it should not be punitive, but should evaluate performance. For teachers, assessment of learning outcomes provides an opportunity to review the objectives, methods and results of their teaching.

Summative assessment provides a clear statement of the knowledge and skills possessed by a pupil at a particular point in time. The following general principles of assessment of learning outcomes should be observed:
- Performance should be assessed against all the objectives relating to knowledge and skills set out in the syllabus.

- All types of work done by the pupil on the course should be a part of the assessment process, e.g. oral and written contribution, class tests, practical work.
- Pupils should be aware of the work to be done and the standards to be achieved in order to attain each level in the assessment scale.
- Teachers should do everything reasonable to harmonise their assessment of pupils within and across sections.

4.2. Participation in class.

The formative assessment is an ongoing process during the year which reflects predominantly on the development and the acquisition of attitudes related to science.

- Do pupils show some respect for life, for material of the school, and for the work of others pupils?
- Do they listen to the opinions of others, and respect other opinions?
- Are they able to execute practical work in a group?
- Do they acquire through science some sense of responsibility and are they able to

reflect on their rôle in society?

The summative assessment examines the progress in knowledge and skills.During lessons, the pupil can be evaluated by assessing

- their ability to answer questions
- their contribution to discussions
- their skill in recording and copying data and information in notebooks
- their ability to draw sensible conclusions.
- their ability to do practical work.

4.3. Written work and tests.

Assessment can be done by "end of topic" tests. A pupil should be able to obtain a pass mark by the demonstration of basic knowledge and skills. Higher marks require a demonstration of more sophisticated knowledge, skills and reasoning.

Further evaluation is possible by setting homework, including

- short essays on specific topics using scientific vocabulary (collecting data from books, newspaper, and electronic information)
- handling and presenting information obtained in class (graphs, collages, writing descriptions)
- completing structured questions (preformatted text, exercise to fill in)
- making scientific reports

General Introduction.

The syllabus is **divided** into 3 columns, Program Headings (the main themes), Materials, Ideas and Experiments (the details), and Notes.

The material printed in bold is explicitly required for a successful beginning to the 4th year programmes in Biology, Chemistry and Physics, and if pupils have not studied this material they will be handicapped. This is not to devalue the rest of the programme, which remains compulsory for study, and provides for the pupil experiencing and learning a great deal of science; but it may be of help to specialist Physics, Chemistry and Biology teachers who are less well acquainted with the 4th year programmes of all the sciences. The numbers [1,2…] refer to notes in the third column, which expand some of these points slightly, again for the benefit of non-specialists.

The programme as laid out here is not a teaching order, and the numbering in the first column is not intended to assemble units of work that should all be done together. The order and organization of this presentation is not intended therefore to dictate an order and an organization to teachers, who may organize the work, in each year block, in a way which suits them, their circumstances and the apparatus and resources available.

A series of dedicated worksheets has been produced by colleagues from all the European schools for use by other colleagues. These worksheets are examples of what should be done in Integrated Science. They are a basic framework and each teacher should adapt them to his style of teaching and add others to complete the syllabus. These worksheets are posted on the internet and teachers should see their subject coordinators for the address, password and instructions for the use of the site. It is envisaged that this database of worksheets will be a dynamic resource with old one being adapted or replaced with new ones and a series of supplementary worksheets offered.

Reference should be made where appropriate to **environmental, social and ethical** matters that are related to the material.

Scientific vocabulary and safety considerations should likewise be made a general part of the pupils' learning experience.

Pupils should be taught safety procedures, proper care and efficiency in distribution of all equipment, and the importance of giving equipment back tidily and in good condition. In this connection, staff and - particularly - coordinators should ensure that they are familiar with local laws, which will vary from country to country, concerning issues such as attitudes towards the limits on the use of animals in the laboratory, and the substances that pupils may be permitted to handle.

Throughout the course, teachers should exploit opportunities to develop an understanding of how “science is done”. This theme would include discussions concerning desire for accuracy and precision (but their limitations); the design of investigations; the handling, presentation and interpretation of data and evidence. Some of the proposed worksheets are specific to this.

Programme Heading	Material, Ideas and Experiments	Notes
First Year.	**First Year.**	
	Pupils' written work in this year, while remaining an essential part of their learning, might sometimes use preformatted sheets where they can fill in spaces, so as to limit the need for heavy demands on limited reporting skills.	
1.1 Measurement.	**Measurements need units and techniques** In principle, SI units should be taught and used; however, common practical units may be introduced. **Length, volume of regular and irregular bodies and of liquids** [1]. **Mass, temperature, time. Density presented as grams per cm^3.**[2] Speed in m/s. Collecting and treating results. Introduction to graphs and histograms. Simple calculations concerning measurements (length, area, volume)	[1] Metre, cm, mm, litre, cm^3, g/cm^3, g, kg and their relationships. Work should consist of practical measurements on solids, liquids and gases Elementary weather observations and measurements can be used as an example [2] there may be a problem in French, English and possibly in other languages, concerning the terms "density" and "densité" which are not equivalent. Care will be needed in translating worksheets.
1.2 Air.	**Solids, Liquids and Gases; definition of characteristics.** **Mass of 1 litre of air** [1]. **Informal introduction to air pressure** [2]. **First introduction to the particle model.** Diffusion of gases and liquids. **Testing gases. Composition of air. Breathing** [3]: exhaled air is weaker in oxygen than inhaled air and stronger in CO_2. **The respiratory system** [4]. Burning food; formation of CO_2. Smoking. Respiration in plants.	[1] The mass per litre of air is used for comparison with other gases. [2]Experiments with the U-tube manometer for an informal introduction to the notion of pressure. The pascal and the explicit notion of force per unit area are not required. [3] Investigation of the gases entering and leaving the body during the breathing process. [4] Respiratory system; only common names required.

Programme Heading	Material, Ideas and Experiments	Notes
1.3 Classification in everyday life.	Introduction: classification of everyday objects showing hierarchical relationships, e.g books, waste for recycling... Distinction between non-living and living things. **Metals and non-metals** [2];**conductors and insulators; magnetic metals and non-magnetic metals**. Permanent magnets; elementary experiments. **Classification of living organisms using simple keys** [1]. Recognition of common plants and animals, especially those to be found locally, and their habitats. Five kingdoms[3], vertebrates and invertebrates.	[1] Construction *and* use of simple keys. Names and basic characteristics of vertebrate classes should be included. Names and one example each of invertebrate phyla and plant phyla. [2] The characteristics of a metal (shiny, conductive, ductile). [3] Bacteria, protists, fungi, plants, animals
1.4 Water and solutions.	Purification of water. Filtration and distillation. Centrifugation. **Water cycle,** water supply. Use of water. Cleaning products. Thermal expansion and contraction of water and other substances (qualitative). **Ideas of concentration and solubility. Solutions, solvents, emulsions, suspensions.** Chromatography. Crystalline substances. Growing large crystals. Water and the human body; water input/output	
1.5 Elementary electric circuits.	**Elementary experiments with bulbs and switches. Necessity for a complete circuit.** The "short circuit" and the necessity to avoid it. **Elementary circuit diagrams** [1]. **Simple series and parallel circuits**.	[1] Pupils should be able to make simple circuits **and** to draw the circuit diagrams (symbols limited to bulb, battery, switch and fuse).
1.6 Reproduction and development.	Levels of organization: cells, tissue, organs, system, organism [1]. Experiments on asexual reproduction. **Introduction to the use of the microscope** [2]. Cell division [3]: microscopic organism [4]. Simple comparisons of vertebrate reproductive methods. **Flowering plants**: the flower, pollination, fruit, dispersal of seeds, germination. **Human reproduction**: anatomy, conception, introduction to contraception, foetal development, birth, growth, puberty.	[1] Description and one example. [2] Including drawings of observations with the microscope. [3] Mitosis and meiosis are not required. [4] Elodea, paramecium, daphnia, etc

Programme Heading	Material, Ideas and Experiments	Notes
Second Year.	**Second Year**	
2.1 Elements and compounds (**I**).	**Elements, mixtures, compounds.** **Conditions for combustion. Products of combustion**. Respiration occurs in cells. **Introduction to transport within the body** [1]. **Burning of hydrogen to water, and of carbon to carbon dioxide.** Extinguishing fires [2]. Air pollution and contamination. Rusting [3]**:** combination with atmospheric oxygen. Extraction of metals. Electrolysis [4] of water and other substances.	[1] Heart, arteries, veins; transport of gases, nutrients, waste [2] Fire extinguishers; link with safety in the lab [3] Only the reaction of iron and oxygen is required. [4] Basic idea and practical work.
2.2 Force.	**Observation of forces** [1]. Forces due to magnets, viscous resistance (qualitative), elasticity, gravity. The normal "contact" force. The friction force and its dependence upon contact force and nature of surface. Lubrication. Homemade force meter, spring. [2] Electrostatic forces.	[1] Pupils should know that forces are pushes and pulls, measured in newtons. They should be able to estimate forces. [2] Graphing.
2.3 Energy.	Informal identification of energy. **Distinction between force and energy**. **Results of using fuel: heat, movement, light, gravitational potential energy, electricity**... Sources and origins of ~~fuel~~ Fossil fuel, sunlight. Conservation. Energy in the home: the electricity bill. **Conversions of one sort of energy to another**. Food as fuel [1]. Diet. Digestion [2], dentition. Transport of heat by conduction, convection and radiation. Insulation. Relevance of convection to the freezing of ponds etc.	[1] Food as fuel; main nutrients (carbohydrates, fats, proteins). No chemical formulae. [2] Digestive system; only common names required and limited to the main steps

Programme Heading	Material, Ideas and Experiments	Notes
2.4 Senses.	**Sight**. Binocular vision, stereoscopic vision, light intensity and pupil change, perspective, optical illusions. Fields of view of different animals. Colour: RGB and CMYB, primary and secondary colours. Colour blindness. Persistence of vision. Hearing: sound and vibrations. Frequency range of the **human** ear. The speed of sound. Intensity of sound; health implications. Smell and taste. Confusion of the senses when smelling one food but tasting another. Touch. Sensitivity depends on number of touch receptors per unit area.	Perception and the brain. Nerves: reaction time.
2.5 Equilibrium in nature.	**Photosynthesis** [1]. Testing for starch in leaves. Oxygen/carbon dioxide balance[2]. Further consideration of Pollution. **Primary role of plants** in food, fuel and usable energy production; **food chains, food webs.** Simple inventory of a small biotope: ecological relations. Conservation of ecosystems (oceans, forests…).	[1] Pupils must be able to describe what happens in photosynthesis. All organisms depend ultimately on this process. [2] cf. respiration from unit 1.2
2.6 Earth and Space.	The Solar System. Planets, stars, moons. Phases of the Moon. Shadows. Eclipses. Gravity, **the distinction between mass and weight**. Seasons. The magnetic compass.	

Programme Heading	Material, Ideas and Experiments	Notes
Third Year.	**Third Year.**	
3.1 Elements and compounds (**II**).	**Acids, alkalis:** taste, feel [1]. Safety. **Indicators**; home made, from red cabbage and other plant materials. **Litmus. Universal indicator. Practical use of the pH scale**. Testing cleaning products and cosmetics. **Neutralisation. Production of salts from acids and alkalis.** Acid rain, environmental considerations. **Combination and decomposition** [2]. **"Word equations"; link with the particle model. Distinction between an atom and a molecule** [3]. **Reaction of metals with water and acids; introduction of the reactivity series** [4].	[1] Of natural products only! e.g. lemon juice [2] A + B → **AB**, e.g. copper with oxygen. **AB** → A + B e.g. mercury (II) oxide. [3] Simple introduction to the periodic table; some examples of formulas of molecules [4] e.g. reaction of Mg, Al, Fe, Cu with oxygen and with water/acids (gas evolution and heat)
3.2 The microscopic world.	Small organisms in pond water. Further observation with the microscope. **Bacteria and fungi**; bread, wine, beer and cheese. *Penicillin.*	
3.3 Health education.	Disease. Antibiotics [1]. Viruses. Vaccination. Principles of hygiene. Contraceptive methods and their association with sexually transmitted diseases (AIDS etc). Mental health, eating disorders, substance abuse, etc	[1] Culturing of microorganisms, and use in the food industry and in medicine. Microorganisms can be dangerous – correct manipulation and disposal is essential.
3.4 The Soil.	Common soil types: formation, recognition, characteristics and organisms. Capillarity. pH of soils; soil pollution: effects of agriculture.	

Programme Heading	Material, Ideas and Experiments	Notes
3.5 Light, images and vision.	Behaviour of light. Rays, reflection. The pinhole camera. Bending of light by refraction on entering glass, water, plastic.... Nature of a real and virtual image. Image formation by reflection and by refraction [1]. Action of lenses [2]. Model of the eye. The image on the retina is inverted. Image formation by a convex lens; focal length. Common vision defects and their correction (not astigmatism). Decomposition of light into colours with a prism. Recombination.	[1] Optical instruments. [2] Ray diagrams.
3.6 Work and machines.	Mechanical work . **The joule - moving 1 metre against a force of 1 newton**. Moments. Machines: simple experiments with levers and pulleys (simple calculations). The trading of force for distance and vice versa [1]. Power introduced as the work done every second (the watt). **Muscles and the skeleton** [2]: overview of important muscles and antagonist muscle pairs, and of important bones. Care and proper use of the skeleton. Composition of bone.	[1] A machine can magnify force, but only at the expense of distance. The work got out from machine cannot exceed the work put into it. [2] Mineral component for hardness; organic component for tensile strength.
3.7 Electricity.	**Measurement of electric current** with different batteries, different circuits: the ammeter. The series and parallel circuits [1]. Advantages of the parallel circuit. Qualitative idea of resistance. Electrical safety. **The correct connection and use of the voltmeter**. Its use to measure the "push" of a battery [2], i.e. the battery's ability to supply current. Batteries in series. The water analogy. Simple electromagnets. The electric motor. **Electric charge. Charging things by friction. Attraction and repulsion. Different sorts of charge** [3].	[1] Construct, identify and draw simple series and parallel circuits. Use the ammeter correctly to measure currents at various points in such circuits. [2] Pupils should know how to connect a voltmeter correctly, and that adding batteries in series increases the voltage in a circuit. [3] Charged bodies can attract and repel both each other and uncharged bodies. Two sorts of charge exist (positive and negative).