International Baccalaureate®
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Middle Years Programme

Sciences guide

For use from September 2010 or January 2011

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The International Baccalaureate (IB) offers three high quality and challenging educational programmes for a worldwide community of schools, aiming to create a better, more peaceful world.

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IB mission statement

The International Baccalaureate aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect.

To this end the organization works with schools, governments and international organizations to develop challenging programmes of international education and rigorous assessment.

These programmes encourage students across the world to become active, compassionate and lifelong learners who understand that other people, with their differences, can also be right.

IB learner profile

The aim of all IB programmes is to develop internationally minded people who, recognizing their common humanity and shared guardianship of the planet, help to create a better and more peaceful world.

IB learners strive to be:

Inquirers	They develop their natural curiosity. They acquire the skills necessary to conduct inquiry and research and show independence in learning. They actively enjoy learning and this love of learning will be sustained throughout their lives.
Knowledgeable	They explore concepts, ideas and issues that have local and global significance. In so doing, they acquire in-depth knowledge and develop understanding across a broad and balanced range of disciplines.
Thinkers	They exercise initiative in applying thinking skills critically and creatively to recognize and approach complex problems, and make reasoned, ethical decisions.
Communicators	They understand and express ideas and information confidently and creatively in more than one language and in a variety of modes of communication. They work effectively and willingly in collaboration with others.
Principled	They act with integrity and honesty, with a strong sense of fairness, justice and respect for the dignity of the individual, groups and communities. They take responsibility for their own actions and the consequences that accompany them.
Open-minded	They understand and appreciate their own cultures and personal histories, and are open to the perspectives, values and traditions of other individuals and communities. They are accustomed to seeking and evaluating a range of points of view, and are willing to grow from the experience.
Caring	They show empathy, compassion and respect towards the needs and feelings of others. They have a personal commitment to service, and act to make a positive difference to the lives of others and to the environment.
Risk-takers	They approach unfamiliar situations and uncertainty with courage and forethought, and have the independence of spirit to explore new roles, ideas and strategies. They are brave and articulate in defending their beliefs.
Balanced	They understand the importance of intellectual, physical and emotional balance to achieve personal well-being for themselves and others.
Reflective	They give thoughtful consideration to their own learning and experience. They are able to assess and understand their strengths and limitations in order to support their learning and personal development.

Contents

How to use this guide

This guide is for use from September 2010 or January 2011, depending on the start of the school year, and for first use in final assessment in June 2011 (northern hemisphere) and December 2011 (southern hemisphere).

This document provides the framework for teaching and learning in sciences in the Middle Years Programme (MYP) and must be read and used in conjunction with the document *MYP: From principles into practice* (August 2008).

Introduction to MYP sciences

The vision of MYP sciences is to contribute to the development of students as inquirers, scientifically literate, caring and responsible individuals who will think critically and creatively when solving problems and making decisions about aspects affecting themselves, others and their social and natural environments.

Science and its methods of investigation offer a way of learning that contributes to the development of an analytical and critical way of thinking. Inquiry is at the heart of MYP sciences and aims to support students' understanding of sciences by providing them with opportunities to independently investigate relevant issues through both research and experimentation.

Learning science relies on understanding and using the language of science, which involves more than simply learning technical scientific terminology. MYP sciences aims for students to become competent and confident when accessing, using and communicating scientific information. Students are expected to use scientific language correctly and select appropriate communication formats for oral and written communication.

MYP sciences aims to provide students with the opportunity to show their understanding of the main concepts and processes of science, by applying these to solve problems in familiar and unfamiliar situations. Students should demonstrate critical-thinking skills to analyse and evaluate information in order to make informed judgments in a variety of contexts.

The MYP sciences curriculum must be relevant to the interests of students, providing them with opportunities to explore the connections between science and everyday life. It is anticipated that students will become interested in and engaged with the role of science in the world. Through the investigation of real examples of the application of science, the "one world" objective allows students to gain insight into the tensions and dependencies between science and societal, environmental and ethical factors.

Students should also learn to appreciate and respect the ideas of others and further develop their sense of responsibility as individuals towards the natural, built and virtual environment. Their engagement, interest and enjoyment in science should foster a positive response to science and contribute to the development of opinion-forming, decision-making and ethical-reasoning skills.

To assist in achieving these broader goals, this guide provides both teachers and students with clear aims and objectives for MYP sciences as well as details on final assessment requirements. IB-produced teacher support material to complement this guide will be published shortly after the guide and will aid in the implementation of the subject within schools.

The IB sciences continuum

MYP sciences builds on experiences in science learning that students have gained during their time in the IB Primary Years Programme (PYP). The main approach to teaching and learning sciences in the PYP is through structured inquiry in the context of transdisciplinary units of inquiry. PYP students are encouraged to investigate science by formulating their own questions and finding the answers to those questions, including through research and experimentation. In turn, students construct meaning and create models of how the world works through the development of scientific knowledge, conceptual understanding and skills. Opportunities for the demonstration of positive attitudes and the taking of responsible action are also a feature of science learning in the PYP.

Scientific inquiry is central to teaching and learning science in the MYP. It enables students to develop a way of thinking and a set of skills and processes that, while allowing them to acquire knowledge and understanding, equips them with the capabilities to tackle with confidence the internal assessment component of Diploma Programme group 4 subjects.

Moreover, the MYP sciences objectives and assessment criteria A–F are aligned with the Diploma Programme group 4 objectives and internal assessment criteria and, as such, should support the smooth transition from the MYP to Diploma Programme. In particular, the "one world" objective is further developed in group 4 science (biology, chemistry, physics) where it is referenced to as aim 8—that is, to "raise awareness of the moral, ethical, social, economic and environmental implications of using science and technology". There are specific references to "one world" implications (aim 8) in assessment statements and teachers' notes in the syllabus details sections of all group 4 guides.

Aims and objectives

Aims

The aims of any MYP subject and of the personal project state in a general way what the teacher may expect to teach or do, and what the student may expect to experience or learn. In addition, they suggest how the student may be changed by the learning experience.

The aims of the teaching and study of MYP sciences are to encourage and enable students to:

1. develop curiosity, interest and enjoyment towards science and its methods of inquiry
2. acquire scientific knowledge and understanding
3. communicate scientific ideas, arguments and practical experiences effectively in a variety of ways
4. develop experimental and investigative skills to design and carry out scientific investigations and to evaluate evidence to draw a conclusion
5. develop critical, creative and inquiring minds that pose questions, solve problems, construct explanations, judge arguments and make informed decisions in scientific and other contexts
6. develop awareness of the possibilities and limitations of science and appreciate that scientific knowledge is evolving through collaborative activity locally and internationally
7. appreciate the relationship between science and technology and their role in society
8. develop awareness of the moral, ethical, social, economic, political, cultural and environmental implications of the practice and use of science and technology
9. observe safety rules and practices to ensure a safe working environment during scientific activities
10. engender an awareness of the need for and the value of effective collaboration during scientific activities.

Objectives

The objectives of any MYP subject and of the personal project state the specific targets that are set for learning in the subject. They define what the student will be able to accomplish as a result of studying the subject.

These objectives relate directly to the assessment criteria found in the "Sciences assessment criteria" section.

A One world

This objective refers to enabling students to gain a better understanding of the role of science in society. Students should be aware that science is a global endeavour and that its development and applications can have consequences for our lives.

One world should provide students with the opportunity to critically assess the implications of scientific developments and their applications to local and/or global issues.

At the end of the course, students should be able to:

- explain the ways in which science is applied and used to address specific problems or issues
- discuss the effectiveness of science and its application in solving problems or issues
- discuss and evaluate the moral, ethical, social, economic, political, cultural and environmental implications of the use of science and its application in solving specific problems or issues.

B Communication in science

This objective refers to enabling students to become competent and confident when communicating information in science. Students should be able to use scientific language correctly and a variety of communication modes and formats as appropriate. Students should be aware of the importance of acknowledging and appropriately referencing the work of others when communicating in science.

At the end of the course, students should be able to:

- use scientific language correctly
- use appropriate communication modes such as verbal (oral, written), visual (graphic, symbolic) and communication formats (laboratory reports, essays, presentations) to effectively communicate theories, ideas and findings in science
- acknowledge the work of others and the sources of information used by appropriately documenting them using a recognized referencing system.

C Knowledge and understanding of science

This objective refers to enabling students to understand scientific knowledge (facts, ideas, concepts, processes, laws, principles, models and theories) and to apply it to construct scientific explanations, solve problems and formulate scientifically supported arguments.

At the end of the course, students should be able to:

- recall scientific knowledge and use scientific understanding to construct scientific explanations
- apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations
- critically analyse and evaluate information to make judgments supported by scientific understanding.

D Scientific inquiry

While the scientific method may take on a wide variety of approaches, it is the emphasis on experimental work that characterizes MYP scientific inquiry.

This objective refers to enabling students to develop intellectual and practical skills to design and carry out scientific investigations independently and to evaluate the experimental design (method).

At the end of the course, students should be able to:

- state a focused problem or research question to be tested by a scientific investigation
- formulate a testable hypothesis and explain it using scientific reasoning
- design and carry out scientific investigations that include variables and controls, material and/or equipment needed, a method to be followed and the way in which the data is to be collected and processed
- evaluate the validity and reliability of the method

- judge the validity of a hypothesis based on the outcome of the investigation
- suggest improvements to the method or further inquiry, when relevant.

E Processing data

This objective refers to enabling students to collect, process and interpret sufficient qualitative and/or quantitative data to draw appropriate conclusions. Students are expected to develop analytical thinking skills to interpret data and judge the reliability of the data.

At the end of the course, students should be able to:

- collect and record data using units of measurement as and when appropriate
- organize, transform and present data using numerical and visual forms
- analyse and interpret data
- draw conclusions consistent with the data and supported by scientific reasoning.

F Attitudes in science

This objective refers to encouraging students to develop safe, responsible and collaborative working practices in practical science.

During the course, students should be able to:

- work safely and use material and equipment competently
- work responsibly with regards to the living and non-living environment
- work effectively as individuals and as part of a group by collaborating with others.

Requirements

MYP sciences is a compulsory component of the MYP in every year of the programme.

Teaching hours

It is essential that teachers are allowed the number of teaching hours necessary to meet the requirements of the MYP sciences course. Although the prescribed minimum teaching time in any given year for each subject group is 50 teaching hours, the IB recognizes that, in practice, more than 50 teaching hours per year will be necessary, not only to meet the programme requirements over the five years, but also to allow for the sustained, concurrent teaching of subjects that enables interdisciplinary study.

It is important that sufficient time is allocated for practical work because this provides students with hands-on opportunities to better understand scientific concepts and processes as well as the nature of scientific work.

Language of instruction

In schools where the language of instruction of science is not the mother tongue of some of the students taking the course, measures must be implemented to ensure that these students are not disadvantaged and have the full opportunity to meet the final objectives. These measures may include:

- teacher training
- differentiation of assessment tasks
- modification of language in materials
- parallel resources in students' mother tongues.

For further information, please refer to the document *Learning in a language other than mother tongue in IB programmes*.

Academic honesty

Academic honesty is the responsibility of schools, teachers and students in the MYP.

Teachers are encouraged to contribute to the development of academic honesty policies that show encouragement of honesty, guidelines on teaching students how to use all forms of resources adequately—including information and communication technologies (ICT)—and that also include information on procedures for when dishonesty is discovered. Academic honesty policies must apply throughout all years of IB programmes; this way, students will fully grasp the importance of being academically honest and will build on their skills from year to year.

Specific areas of academic honesty that can be focused on in sciences include:

- **personal skills**—discussions on integrity, confidence in one's own work, honesty in the collection and recording of experimental data, scientific honesty, willingness to work independently, self-evaluation skills
- **social skills**—discussions on how to work collaboratively, how to contribute to a team, how to acknowledge work by other team members, peer evaluation skills
- **technical skills**—recognition of when and why others' ideas should be acknowledged, which sources of information should be acknowledged and how to acknowledge them correctly, understanding plagiarism, how to construct a bibliography, how to reference correctly, familiarity with academic conventions.

MYP teachers should model academic honesty for students, for example, by ensuring that all learning materials given to students are properly referenced. School librarians can also play a role in promoting academic honesty, particularly with technical skills. Academic honesty can also be promoted by setting tasks that are difficult to complete through plagiarism or other forms of academic dishonesty. For example, if a task, such as a "one world" essay, requires students to give their own interpretation of the issue in question using scientifically supported arguments rather than asking for factual information, then it is more difficult to plagiarize other material. Tasks should be challenging, but not so difficult that students are tempted to use dishonest means to complete them, and support should be available when students require it.

For further information on IB policy on academic honesty, please see the publications *MYP: From principles into practice* and *Academic honesty*.

The IB does not prescribe any particular referencing convention. However, schools must adopt a recognized convention for students to use.

Resources

The choice of resources within a school will need to reflect the range of age and abilities within that school. Schools also need to ensure that there is an adequate supply of resources for teachers as well as students.

The school library has an essential role to play in this process. As well as providing up-to-date and appropriate resources both for teachers and students, the school library should provide opportunities for students to develop information literacy skills. The library staff should be consulted during the development of subject-specific and interdisciplinary units of work as they could be helpful during the planning stages.

Assessment tasks should be designed to measure the goals of a unit of work (whether students have grasped the significant concepts, unit question and area of interaction focus): resources must be carefully chosen and prepared so as to aid teaching and learning within a unit and to enable students to engage with the assessment tasks.

Information and communication technologies (ICT) should be used when appropriate as an important means of expanding students' knowledge of the world in which they live, gaining access to a broader range of resources and as a new channel for developing skills. Such technologies provide a range of resources and applications for teachers to explore and enhance the teaching and learning experience, both in sciences and in other subject groups. All teachers have the responsibility to teach students to use electronic media critically so that students are aware of the uses and limitations of the data.

Some of the possible uses of ICT in the sciences might include using:

- databases and spreadsheets to log and process data, detect trends and patterns, make predictions and test hypotheses
- software to present and transform data and information in different ways (tables, graphs, charts, PowerPoint® presentations)
- simulation software to allow students to gain experience of phenomena and experiments
- modelling software to allow students to design models of phenomena and explore the relationships between variables
- data logging (microcomputer-based laboratories) for data analysis and interpretation (data logging uses electronic sensors to measure and process experimental data and to produce real-time graphical display of the results)
- the internet to access, collect and process relevant information
- multimedia, interactive CD-ROMs to access information or to engage students in virtual experiments, especially for hazardous laboratory practicals.

In addition, the online curriculum centre (OCC) is a valuable resource for teachers in the MYP. It contains discussion forums and resource banks, as well as official IB publications that can be downloaded. Please see your MYP coordinator for a school code and password.

Safety in practical work

Schools should follow the guidelines below to help ensure safety in practical work.

- Risk assessment of potential hazards should be identified and addressed.
- School science laboratories should be safe, well equipped and regularly maintained.
- Safety codes and procedures should be available and understood by everyone involved in practical work.
- Safety practices should be observed at all times when manipulating material, equipment and organisms during practical work.
- Class size and supervision of practical work should be considered to minimize potential risks and hazards.

While schools and teachers are responsible for following national or local guidelines for safety in practical work (which may differ from country to country), attention should be given to the mission statement below, which was developed by the International Council of Associations for Science Education (ICASE) Safety Committee.

ICASE Safety Committee

Mission statement

The mission of the ICASE Safety Committee is to promote good-quality, exciting practical science, which will stimulate students and motivate their teachers in a safe and healthy learning environment. In this way, all individuals (teachers, students, laboratory assistants, supervisors, visitors) involved in science education are entitled to work under the safest possible practicable conditions in science classrooms and laboratories. Every reasonable effort needs to be made by administrators to provide and maintain a safe and healthy learning environment and to establish and require safe methods and practices at all times. Safety rules and regulations need to be developed and enforced for the protection of those individuals carrying out their activities in science classrooms and laboratories, and experiences in the field. Alternative science activities are encouraged in the absence of sufficiently safe conditions.

It is a basic responsibility of everyone involved to make safety and health an ongoing commitment. Any advice given will acknowledge the need to respect the local context, the varying educational and cultural traditions, the financial constraints and the legal systems of differing countries.

Developing the curriculum

Introduction

The MYP sciences aims and objectives as published in this guide describe what is expected of students by the end of the programme. These aims and objectives are prescribed for all IB World Schools offering the MYP. Schools are responsible for developing the courses and structuring the science curriculum in accordance with these aims and objectives. The circumstances specific to individual schools and their local curricular requirements will determine how schools structure the curriculums and the courses that they can offer. However, schools must ensure that the curriculums and the courses developed provide students with enough opportunities to effectively meet the final aims and objectives of the subject group by the end of the programme.

Organizing the sciences curriculum in the school

MYP sciences encompasses the subjects of biology, chemistry and physics as the traditional science subjects offered by many schools. However, schools can also develop and offer other sciences courses as long as these allow students to meet the final aims and objectives of the subject group. Some of these courses include environmental sciences, life sciences, physical sciences, sport sciences, health sciences, life and earth sciences, among others.

The way in which schools structure the sciences curriculum throughout the five years of the programme varies from school to school. However, the courses should fall into one of the following options or a combination of options as shown below.

Throughout the five years of the programme schools could offer:

1. discrete science courses, generally represented by courses in the traditional sciences subjects of biology, chemistry and physics but could also include non-traditional sciences courses
2. a sciences course, encompassing elements (concepts, skills and processes) of the different science subjects
3. a combination of options 1 and 2 (discrete and sciences courses).

> Please note that the IB will moderate the internal assessment of the following science subjects only: biology, chemistry, physics and sciences. Please refer to the “Sciences: Moderation” section for more information on subject registration for moderation.

Planning for teaching and learning

Schools are expected to develop, map and document the curriculums they offer in each subject group, including sciences, to ensure that both the programme principles and the subject-specific requirements are met effectively. Through vertical and horizontal planning, teachers collaboratively design and sequence the teaching and learning experiences that should take place in every year of the programme. The curricular framework of the final aims and objectives of the subject group together with the **examples of interim objectives** published by the IB provide schools with guidance to scaffold the instruction from years 1–5, ensuring continuity and progression of learning.

By adopting or adapting the published examples of interim objectives for years 1 and 3 and using school-developed objectives for years 2 and 4, schools are provided with a five-year curriculum framework. This framework is flexible enough to allow a variety of teaching and learning approaches and to allow schools to select their subject-specific content.

Science teachers will determine the subject content for each year of the programme. However, it is important to consider that all objectives (A–F) must be developed during each year of the programme, at the appropriate level. The choice of the subject content will vary from school to school and may respond to local, national or state curriculum requirements.

To further support schools in determining the subject content, the MYP sciences guide provides the **framework for sciences**. This framework is organized into three main areas that cover scientific concepts, skills and processes, and personal attitudes. Although the use of this framework is not mandatory, its purpose is to guide teachers in the choice of concepts, skills, process and attitudes that could be explored through the development of unit plans to help students meet the final aims and objectives of MYP sciences.

To explore the subject content fully, teachers should use the **areas of interaction**. These provide meaningful contexts for learning and allow students to connect their learning with the real world and to connect their learning in one subject with that in another.

In developing the curriculum for the different years of the programme, teachers are encouraged to devise increasingly complex unit plans that will cover the entire scope of objectives. However, within these, discrete tasks or smaller units of work might concentrate on specific objectives.

In year 5 of the programme, the curriculum should provide students with the opportunity to achieve the highest descriptor levels in the final assessment criteria.

When devising a unit plan in science, teachers must ensure that:

- one area of interaction provides a context for learning, in addition to approaches to learning
- scientific concepts, skills, process and/or attitudes are being developed
- learning outcomes match the MYP objectives (see objectives in “Aims and objectives”)
- appropriate resources are selected from a range of sources
- differentiated teaching and learning methods are planned and used
- opportunities for scientific inquiry through practical work are provided
- student inquiry is supported and developed through the unit
- health, environmental and contemporary science issues are explored to support scientific understanding for informed decision making
- interdisciplinary teaching and learning are used when appropriate
- students are given clear information about how the work will be assessed, including which objectives are being developed
- in the final year of the programme, student achievement of the final objectives is measured against the published assessment criteria (see “Sciences assessment criteria”).

The document *MYP: From principles into practice* (August 2008) provides detailed information on organizing the written, taught and assessed curriculum, including the use of interim objectives, modified assessment criteria for years 1–4 of the programme and the planning of units of work.

Addressing the areas of interaction

The areas of interaction provide contexts through which teachers and students consider teaching and learning, approach the disciplines, and establish connections across disciplines. They are organizing elements that strengthen and extend student awareness and understanding through meaningful exploration of real-life issues. All teachers share the responsibility of using the areas of interaction as a focus for their units of work.

The process of inquiring into the subject content through the different perspectives or contexts of the areas of interaction enables students to develop a deeper understanding of the subject as well as the dimensions of the areas of interaction. Through this inquiry cycle of understanding and awareness, reflection and action, students engage in reflection and metacognition, which can lead them from academic knowledge to thoughtful action, helping to develop positive attitudes and a sense of personal and social responsibility.

The document *MYP: From principles into practice* (August 2008), in the section "The areas of interaction", provides further information relating to the dimensions of each area of interaction, the inquiry cycle, planning units of work, and focusing relevant content through these areas of interaction.

There are five areas of interaction:

- approaches to learning (ATL)
- community and service
- health and social education
- environments
- human ingenuity.

The following sections on the areas of interaction provide sample questions that might be used as **MYP unit questions** or **inquiry cycle questions**, depending on the content being taught. These particular questions are "content free", and when devising their own questions, teachers can relate them to the specific content that is being explored in a unit of work.

It is important to note that the areas of interaction are ways of looking at content: some of the examples that follow could easily fit into more than one area of interaction perspective, and also have the potential to be explored through subjects other than sciences.

The contexts that frame the content curriculum in sciences must be natural and meaningful. Often when designing a unit of work, the context for the content will emerge naturally. To provide meaningful learning experiences, teachers should ensure that the MYP unit question gives students scope for inquiry into the issues and themes within the content. The area of interaction will then give direction to teacher-directed and student-initiated inquiry.

Please note that any reference to "I" in the areas of interaction questions could also be interpreted as "we" where this is more appropriate to the social ethos of the school or location.

Approaches to learning

How do I learn best?
How do I know?
How do I communicate my understanding?

Approaches to learning (ATL) are central to all MYP subject groups and the personal project. Through ATL, schools provide students with the tools to enable them to take responsibility for their own learning. This involves articulating, organizing and teaching the skills, attitudes and practices that students require to become successful learners.

The MYP has identified seven groups of skills that encompass ATL: organization, collaboration, communication, information literacy, reflection, thinking and transfer. The school community will need to spend time defining the ATL attitudes, skills and practices that it considers important within these groups, both for an individual subject group and across subject groups.

Sample questions

- How can I learn best in science?
- What thinking skills and processes are specific to science?
- What does it mean to be scientifically literate?
- What is the value of scientific inquiry?
    - How do I formulate and test a hypothesis?
    - How do I design and carry out a scientific investigation?
    - How do I identify and manipulate relevant variables?
    - How do I plan to collect sufficient valid and reliable data?
    - How do I collect, record and communicate data?
    - How can I process data to draw reliable conclusions?
- How can I evaluate scientific information? How can my understanding of science allow me to challenge information and formulate supported arguments?
- How can I communicate my ideas and findings in an appropriate scientific manner?
- How do I acknowledge the work of others?
- How do I reflect on and evaluate my work in science?
- How can ICT support my learning in science?
- What are effective ways of working with my classmates? How can I ensure a safe working environment?

Community and service

How do we live in relation to each other?
How can I contribute to the community?
How can I help others?

The emphasis of community and service is on developing community awareness and a sense of belonging and responsibility towards the community so that students become engaged with, and feel empowered to act in response to, the needs of others.

Community and service starts in the classroom and extends beyond it, requiring students to discover the social reality of self, others and communities. This, in turn, may initiate involvement and service in the communities in which they live. Reflection on the needs of others and the development of students' ability to participate in and respond to these needs both contribute to the development of caring and responsible learners.

Students will explore the nature of past and present communities through sciences, as well as their place in their own communities. Incorporating community and service into the study of the sciences encourages responsible citizenship as students deepen their knowledge and understanding of the world around them.

Sample questions

- What is the role of science in a community and in the world?
- How does science shape communities and our lives?
- How is science communicated across time and cultures?
- How can my understanding of science contribute to my development as a citizen?
- How can I learn about communities through science?
- What are the uses and limitations of science in my community and in the world?
- To what extent do people and/or communities change through scientific experiences?
- How can science influence a community? How can communities influence science?
- What is my role in the community? How can I contribute to my community through science?
- What would the world be like without science?

Health and social education

How do I think and act?
How am I changing?
How can I look after myself and others?

This area of interaction is about how humanity is affected by a range of social issues (including health). It includes an appreciation of these effects in various cultural settings and at different times. It is concerned with physical, social and emotional health and intelligence—key aspects of development leading to a complete and balanced lifestyle.

Sample questions

- How does science impact on society, on individuals and on me?
- How can science be used to influence people and societies?
- To what extent can science contribute to the well-being of people and societies?
- How does science facilitate our understanding of ourselves and others?
- Is science a luxury or a necessity in societies?
- How important is science for personal and social development?
- How can my knowledge and understanding of science help me to make correct or healthy choices?
- What behaviours and attitudes will I seek to change in myself as a result of my experiences in science?
- What safety considerations are relevant for working in science?
- How can I use my knowledge and understanding of science to look after myself and others?

Environments

What are our environments?
What resources do we have or need?
What are my responsibilities?

This area of interaction considers environments to mean the totality of conditions surrounding us, natural, built and virtual. It focuses on the wider place of human beings in the world and how we create and affect our environments. It encourages students to question, to develop positive and responsible attitudes, and to gain the motivation, skills and commitment to contribute to their environments.

Sample questions

- How can science influence the natural, built and virtual environments?
- In what ways can environments influence science?
- What issues do natural, built and virtual environments present for science?
- In what ways do environments affect scientific development?
- How can my knowledge and understanding of science enable me to understand and contribute to different environments?
- How can science impact on the school environment?
- What are realistic changes that I can make that will impact positively on my environments?
- What are the uses and limitations of science in addressing issues of natural, built and virtual environments?
- What power and responsibility do scientists have in communicating environmental issues?
- How do my scientific understanding and skills enable me to understand and improve different environments?

Human ingenuity

Why and how do we create?
What are the consequences?

Human ingenuity looks at human contributions in the world both in their particular context and as part of a continuing process. It stresses the way humans can initiate change, whether for good or bad, and examines the consequences (intended and unintended). This area also emphasizes both the importance of researching the developments made by people across place, time and cultures, and the importance of taking time to reflect on these developments.

Sample questions

- What is science? Where does science come from? How has science evolved over time?
- What makes a scientist? What qualifies a person as a scientist?
- How is human ingenuity portrayed in sciences? How can science initiate change and challenge our thinking?
- In what ways have humans shaped science? In what ways has science shaped our lives?
- What would the world be like without science?
- What is the relationship between science and ethics?
- Who are the science pioneers in my time, and in earlier times? What makes them pioneers?
- What is the relationship between science and technology?
- In what way has technology influenced science? In what way has science influenced technology developments?
- How have my own views of science, and about how science works, changed?

Framework for sciences

The framework for sciences is organized into three domains:

- skills and processes
- concepts of science
- personal, social and global awareness (attitudes and beliefs).

These domains represent key scientific concepts, skills, process and attitudes identified by the MYP as relevant for developing the sciences curriculum. The components of the domains and the examples selected are neither restrictive nor exhaustive. Schools are encouraged to expand and enrich these domains as they feel appropriate. The use of the framework itself is **not a mandatory requirement** of the MYP; its role is to assist teachers in developing their own school-specific science curriculum and to provide them with ideas to explore and expand through the units of work in science.

Skills and processes

Learning science gives students the opportunity to develop scientific ways of knowing and working. Working scientifically involves students acquiring both practical and intellectual skills that will enable them to understand the main scientific ideas and the way science and scientists work.

Groups of skills taken together, or sometimes single skills, make up the process by which scientific understanding has developed and progressed. Therefore, the process of scientific inquiry requires the use of multiple skills, both practical and intellectual.

This domain is also clearly articulated with approaches to learning and contributes to the development of general transferable skills common to other subjects, as well as science-specific skills.

The following table presents a summary of some of the skills and processes developed in science; they should become part of the students' experience in the classroom and of their participation in practical work.

Skills and processes	Explanation	Key words
Analysing	Examining and breaking information into parts; identifying patterns, relationships, causes, main ideas and errors	Compare, contrast, examine, infer, conclude
Classifying	Ordering according to properties, characteristics or relationships	Sort, group, identify, decide, label, compare, order, collect data, record

Skills and processes	Explanation	Key words
Communicating	Expressing information in a variety of forms: oral, written accounts, visual representations such as graphs, diagrams, equations, tables, presentations using ICT applications, and so on	Record, present findings, demonstrate, describe, explain, report, show, outline
Controlling variables	Manipulating variables: changing one factor that may affect the outcome while the other factors remain constant	Experiment, fair test, control
Defining	Giving the precise meaning of a word, phrase or physical quantity	Define, state. It can involve factors such as appearance and function
Evaluating	Assessing the validity of information or quality of the work based on criteria	Judge, assess, decide, prove, support, appraise, defend, conclude
Experimenting	Demonstrating a theoretical concept, testing a hypothesis (at the core of scientific investigation)	Explore, discover, check, identify and control variables, investigate, try, verify
Hypothesizing	Stating a problem in the form of a statement, question, prediction or scientific explanation that can be verified by a process of experimentation	Question, observe, predict, infer
Inferring	Making judgments based on observations and past experience	Predict, explore, refine, discuss
Inquiring	Formulating questions to clarify issues and understand meaning	Define problems, research, question, ask questions, discuss
Interpreting data	Observing information and offering explanations, organizing data, drawing conclusions and predictions	Explain, interpret, predict, conclude, revise
Measuring	Using appropriate instruments and techniques to collect and record data on weight, mass, temperature, time, volume, and so on	Compare, match, estimate, determine

Skills and processes	Explanation	Key words
Modelling	Describing and explaining relationships between ideas using simplified, often mathematical or diagrammatical, representation	Produce a model, provide a physical, verbal or mental representation of an idea (for example, atomic model, DNA model, solar system model)
Observing	Using the senses and instruments to focus the perception on some phenomenon, object or process	Distinguish, recognize, look, feel, touch
Predicting	Offering statements, suggestions or hypotheses based on observations, experience and knowledge to anticipate the outcome of a situation	Interpret, construe, deduce, infer
Recognizing patterns	Articulating interrelationships between parts and components	Analyse, compare, contrast, categorize, distinguish relationships, examine, discover
Recording	Collecting, showing and presenting data, findings and conclusions	Record, present, construct, organize, draw
Synthesizing	Combining information in a different way to construct meaning	Combine, create, propose, adapt, develop, infer, predict, elaborate, restructure, improve
Using numbers	Quantifying measurements, comparisons and classifications	Count, divide, graph
Using time–space relationships	Describing spatial relationships as affected by time	Motion, direction, sequence, symmetry

Concepts of science

Concepts are powerful ideas that have relevance within and across disciplines. Students must develop an understanding of the following science concepts over the five years of the programme at increasing levels of sophistication.

- The concept of change
- The concept of energy
- The concept of structures, patterns and systems

The concept of change

Students can explore the concepts of constancy and equilibrium in order to understand change. The following content areas are suggested examples.

- Chemical and physical change: substances can undergo physical and chemical changes that will affect their properties. These changes occur in both living and non-living systems and are influenced by the same factors.
- Forces: forces hold the universe and us together. Unbalanced forces give rise to changes in shape, size or motion. The concept of conservation of momentum and Newton's laws of motion can be explored as well as the effect of electrical, magnetic and gravitational forces.
- Constancy and change in life forms: living organisms reproduce and maintain constancy of structures and functions by passing genetic information from one generation to the next. The value of change, mutation and variation should be explored as a means to explain diversity and evolution.
- Natural cycles: the occurrence of natural cycles—seasons, life cycles, geological cycles, nutrient cycles—can be explored to develop the idea of regularity and constancy.
- Homeostasis: the maintenance of a constant internal environment and the role of corrective feedback mechanisms to achieve equilibrium can be explored in different organisms and systems.

The concept of energy

Energy is central to science and provides one of the most fundamental laws of science—the law of conservation of energy—along with the conservation of mass and the conservation of momentum. Students can explore the multiplicity of energy transformations within and between living and non-living systems, different means of energy storage and the uses made of energy.

Students should realize that energy can be manifested in different ways, such as heat, chemical energy, potential energy, kinetic energy, electrical energy, nuclear energy, light and sound.

The following content areas are suggested as examples for exploring the concept of **transformation of energy**.

- Energy in cells (photosynthesis and respiration)
- Energy flow in an ecosystem
- Chemical reactions
- Conversion between potential and kinetic, heat, and mechanical energy
- Conversions in electrical circuits

The following content areas are suggested as examples for exploring the concept of **transport and transfer of energy**.

- Heat conduction, convection and radiation
- Wave phenomena
- Distribution of electricity
- Living systems

The following content areas are suggested as examples for exploring the **uses of energy**.

- Effect of atmosphere heating and its link to climate change
- Fuels and energy production
- Use of electricity in the chemical industry
- Propulsion methods (motors, heat engines, rockets and jet engines)

The concept of structures, patterns and systems

The concept of structures, patterns and systems can be developed through a number of content areas that range from the subatomic level in the organization of matter to the macro level in the organization of organisms in populations, communities, on Earth and in the universe.

Science explores the structure of atoms, subatomic particles, simple and complex molecules, compounds and crystals, cells, the complex nature of individual organs, organisms, groups of organisms, Earth and the universe. At all these levels of organization, structures and patterns become evident, which help explain natural phenomena and behaviour and which may be used to predict and interpret new experiences.

The concept of structures, patterns and systems can be explored through the study of the following content areas.

Structure of matter

Atomic theory powerfully explains many phenomena in science. However, due to its complexity and abstraction, it requires teachers to use evidence and explanations from several stories to gradually develop the concept. The idea that all matter is made up of atoms that are invisible, and that the number of subatomic particles and their structure determine the properties of materials, could be developed. The distinction between atoms, subatomic particles, elements, molecules and compounds, as well as the attractive forces between them such as intermolecular and intramolecular bonding, could be explored in order to understand the structure and properties of matter.

The following content areas are suggested as examples.

- Atomic model and the concept of the particulate nature of matter
- States of matter and arrangements of particles
- Changes of state and forces between particles; intermolecular forces
- Gas properties
- Physical and chemical reactions, atomic arrangement of reactants and products, and chemical equations
- Compounds, elements and solubility rules
- Chemical substances and reactions in everyday life and their environmental significance
- Safe use of chemicals in the laboratory and in everyday life
- The idea of conservation of mass

Living systems

Cells are the structural and functional units of all living things, and all the instructions necessary to direct their activities are contained in their DNA (deoxyribonucleic acid). The DNA from all organisms shares similar chemical and physical properties. The differential expression of this information will result in different cells having specific structure and function. Students could explore the pattern of differentiation in cells, tissues, organs, systems and organisms in order to understand the great diversity of life on Earth.

The following content areas are suggested as examples.

- Chemical composition of nucleic acids (DNA, RNA) and their role in the genome
- Structure and function of plant and animal cells
- Classification of organisms—criteria
- Biological diversity within and across species
- Similarities in DNA sequences between organisms

- Evolution—molecular DNA evidence supports anatomical evidence
- The theory of natural selection as a mechanism for evolution—the origin of new hereditable characteristics in organisms and their selective advantage for survival

Students can develop a sophisticated understanding of how living organisms function, develop and evolve. Some teachers may choose to focus on the human body and physical health.

Earth and space

Students could develop an understanding of the architecture of the universe and the place of Earth in the cosmos. They could become aware of the scientific aspects of the origin and structure of the universe. Explanations of day and night, and the phases of the moon and the seasons, could be developed and clarified.

The following content areas are suggested as examples.

- The solar system, its composition and the role of gravity
- The theories about the origin of the universe
- The sun as a star in the solar system
- Evolution of Earth as a planet
- Structure of Earth and the conditions for life
- Atmospheric phenomena, heat energy and the water cycle, and their effect on global climate
- Conditions for life on Earth including gravitational force, the atmosphere, sun radiation and the water cycle

Personal, social and global awareness

This domain summarizes three aspects of the development of students: as individuals, as members of their community and as global citizens. Therefore, emphasis should be placed on providing opportunities for students to progress in each of these areas. The development of students as informed, responsible and caring individuals is key to their personal well-being and to their role as members of society and the wider world.

The global dimension of science offers students opportunities to develop global awareness by exploring real issues and understanding the interactions between science and social, economic, political, environmental, cultural and ethical factors.

This domain provides an opportunity to raise questions and discuss ethical issues so that students become more critical when interpreting, communicating and making choices about scientific issues. Confronting students with ethical dilemmas will encourage them to develop opinion-forming skills based on critical reasoning, which can contribute to their development as informed and responsible citizens when having to make decisions or take action in their own lives.

Environments, health and social education, and community and service provide the context for students to develop these attitudes.

The following content areas are suggested as examples.

- The concept of sustainable development and the capacity of human society to maintain the delicate balance between man and the natural environment
- The use and management of natural resources (air, water, soil and solar energy), and their transformation into human capital, goods, tools and machines

- The role and responsibilities of individuals and societies in the sustainable use and exploitation of natural resources
- The analysis of social, economic, political, cultural and ethical aspects in relation to sustainable development initiatives
- Health-related issues such as nutrition, alcohol, tobacco and drug abuse, and their impact on individuals and society as a whole
- Health care and preventive care in developed and developing countries
- Controversial science issues*, such as climate change, genetic transfer between species, genetically modified organisms, DNA profiling, stem cell research, karyotyping of unborn fetuses, IVF (in vitro fertilization) cloning, MMR (measles, mumps, rubella) vaccination, and pandemics and their social, economic, political, environmental, cultural and ethical implications
- The role of science in society and its relationship with technology through specific examples in developed and developing countries

*Note: These examples seem relevant at the time of writing; teachers should select examples that are pertinent to their local and current environment.

Assessment in the MYP

There is no external assessment provided by the IB for the MYP and therefore no formal externally set or marked examinations. All assessment in the MYP is carried out by teachers in participating schools and relies on their professional expertise in making qualitative judgments, as they do every day in the classroom. In line with the general IB assessment philosophy, a norm-referenced approach to assessment is not appropriate to the MYP. Instead, MYP schools must follow a criterion-related approach. This means that students' work must be assessed against defined assessment criteria and not against the work of other students.

The IB moderation and monitoring of assessment procedures ensure that the final judgments made by these teachers all conform to an agreed scale of measurement on common criteria.

It is expected that the procedures for assessment and the MYP assessment criteria are shared with both students and parents as an aid to the learning process.

Using the assessment criteria

The assessment criteria published in this guide correspond to the objectives of this subject group. The achievement levels described have been written with year 5 final assessment in mind.

All schools **must** use the assessment criteria published in this guide for final assessment, although local or national requirements may involve other assessment models and criteria as well.

In years 1–4, schools may modify the descriptors of the achievement levels for each criterion according to the progression of learning organized by them and guided by the interim objectives. These modified criteria must be based on the MYP principles of assessment and must provide for a coherent approach to assessment practices over the entire programme. Schools may add other criteria, in addition to the MYP criteria, in response to national requirements and report on these internally to parents and students.

Clarifying published criteria in year 5

During the final year of the programme, the final assessment criteria as published in each subject-group guide must be used when awarding levels. However, specific expectations of students for a given task must still be defined.

Teachers will need to clarify the expectations of any given task with direct reference to the published assessment criteria. For example, in sciences, teachers would need to clarify exactly what "communicates scientific information effectively" means in the context of a given assessment task. This might be in the form of:

- a task-specific clarification of the criteria, using the published criteria but with some wording changed to match the task
- an oral discussion of the expectations
- a task sheet that explains the expectations.

It is important that teachers specify the expected outcomes at the beginning of each individual task so that students are fully aware of what is required.

When clarifying expectations for students, teachers must ensure that they do not alter the standard expected in the published criteria, nor introduce new aspects. When awarding final levels in year 5, teachers should always use the published criteria.

Please also see the “Sciences: Moderation” section for guidance on what is required as part of background information.

The “best-fit” approach

The descriptors for each criterion are hierarchical. When assessing a student’s work, teachers should read the descriptors (starting with level 0) until they reach a descriptor that describes an achievement level that the work being assessed has **not** attained. The work is therefore best described by the preceding descriptor.

Where it is not clearly evident which level descriptor should apply, teachers must use their judgment to select the descriptor that best matches the student’s work overall. The “best-fit” approach allows teachers to select the achievement level that best describes the piece of work being assessed.

If the work is a strong example of achievement in a band, the teacher should give it the higher achievement level in the band. If the work is a weak example of achievement in that band, the teacher should give it the lower achievement level in the band.

Further guidance

Only whole numbers should be recorded; partial levels, fractions and decimals are not acceptable.

The levels attributed to the descriptors must not be considered as fixed percentages, nor should it be assumed that there are arithmetical relationships between descriptors. For example, a level 4 performance is not necessarily twice as good as a level 2 performance.

Teachers should not think in terms of a pass or fail boundary for each criterion, or make comparisons with, or conversions to, the IB 1–7 grade scale, but should concentrate on identifying the appropriate descriptor for each assessment criterion.

The highest descriptors do not imply faultless performance, but should be achievable by students at the end of the programme. Teachers should therefore not hesitate to use the highest and lowest levels if they are appropriate descriptors for the work being assessed.

A student who attains a high achievement level for one criterion will not necessarily reach high achievement levels for the other criteria. Similarly, a student who attains a low achievement level for one criterion will not necessarily attain low achievement levels for the other criteria.

Teachers should not assume that the results of a group of students being assessed will follow any particular distribution plan.

Further information on MYP assessment can be found in the document *MYP: From principles into practice* (August 2008) in the section “Assessment”.

Sciences assessment criteria

Please note that the assessment criteria in this guide are for first use in **final assessment** in June 2011 for northern hemisphere schools and December 2011 for southern hemisphere schools.

The following assessment criteria have been established by the IB for sciences in the MYP. All final assessment in the final year of the MYP must be based on these assessment criteria even if schools are not registering students for IB-validated grades and certification.

Criterion A	One world	Maximum 6
Criterion B	Communication in science	Maximum 6
Criterion C	Knowledge and understanding of science	Maximum 6
Criterion D	Scientific inquiry	Maximum 6
Criterion E	Processing data	Maximum 6
Criterion F	Attitudes in science	Maximum 6

For each assessment criterion, a number of band descriptors are defined. These describe a range of achievement levels with the lowest represented as 0.

The descriptors concentrate on positive achievement, although failure to achieve may be included in the description for the lower levels.

Criterion A: One world

Maximum: 6

One world enables students to gain a better understanding of the role of science in society and allows them to explore how scientific developments and applications are applied and used to address specific problems or issues in local and global contexts.

Students should be able to:

- explain the ways in which science is applied and used to address **a specific** problem or issue
- discuss the effectiveness of science and its application in solving the problem or issue
- discuss and evaluate the moral, ethical, social, economic, political, cultural and environmental implications of the use of science and its application in solving specific problems or issues.

Assessment tasks should give students the opportunity to explore how science is used to address **a specific** problem or issue. Students are required to critically discuss and evaluate the implications associated with the use and application of science by considering moral, ethical, social, economic, political, cultural and environmental factors.

Suitable assessment tasks for criterion A include written pieces of work, essays, case studies and research projects, as well as debates, oral and multimedia presentations.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1–2	The student **states** how science is applied and how it may be used to address a specific problem or issue in a local or global context. The student **states** the effectiveness of science and its application in solving the problem or issue.
3–4	The student **describes** how science is applied and how it may be used to address a specific problem or issue in a local or global context. The student **describes** the effectiveness of science and its application in solving the problem or issue. The student **describes** the implications of the use and application of science interacting with **at least one** of the following factors: moral, ethical, social, economic, political, cultural and environmental.
5–6	The student **explains** how science is applied and how it may be used to address a specific problem or issue in a local or global context. The student **discusses** the effectiveness of science and its application in solving the problem or issue. The student **discusses and evaluates** the implications of the use and application of science interacting with **at least two** of the following factors: moral, ethical, social, economic, political, cultural and environmental.

Describe: to give a detailed account.

Discuss: to give an account including, where possible, a range of arguments for and against the relative importance of various factors and comparisons of alternative hypotheses.

Evaluate: to assess the implications and limitations.

Explain: to give a clear account, including causes and reasons or mechanisms.

State: to give a specific name, value or other brief answer without explanation or calculation.

Criterion B: Communication in science

Maximum: 6

Communication in science enables students to develop the communication skills to become competent and confident when communicating information in science.

Students should be able to use different communication modes, including verbal (oral, written) and visual (graphic, symbolic), as well as appropriate communication formats (laboratory reports, essays, and multimedia presentations) to effectively communicate scientific ideas, theories, findings and arguments in science.

Students should be able to:

- use scientific language correctly
- use appropriate communication modes and formats
- acknowledge the work of others and the sources of information used by appropriately documenting them using a recognized referencing system.

Suitable assessment tasks for criterion B include scientific investigation reports, research essays, case studies, written responses, debates and multimedia presentations among others.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1–2	The student uses a **limited range** of scientific language **correctly**. The student communicates scientific information with **limited effectiveness**. When appropriate to the task, the student **makes little attempt** to document sources of information.
3–4	The student uses **some** scientific language correctly. The student communicates scientific information with **some effectiveness**. When appropriate to the task, the student **partially documents** sources of information.
5–6	The student uses **sufficient** scientific language correctly. The student communicates scientific information **effectively**. When appropriate to the task, the student **fully documents** sources of information **correctly**.

Document: to credit fully all sources of information used by referencing (or citing), following one recognized referencing system. References should be included in the text and also at the end of the piece of work in a reference list or bibliography.

Notes

- The first strand of the criterion requires students to use scientific language correctly. Teachers are expected to determine within the context of the task what constitutes acceptable evidence for "limited range", "some" and "sufficient" scientific language and communicate this to students.
- Effective communication in this context implies that the work achieves what it intends to, including being successful and convincing, well structured and presented in a logical sequence, and supported by evidence as appropriate. It involves the use of appropriate communication modes and formats to communicate scientific ideas, theories or findings to a particular audience in a successful way.
- Criterion B can be used with a range of tasks such as written pieces of work as well as oral and multimedia presentations. In all cases students are expected to acknowledge the work of others and the sources of information used by referencing (or citing). The IB does not prescribe any particular referencing system. Schools are allowed to follow a recognized referencing system of their choice in a consistent manner.
- The statement "when appropriate to the task" means that, depending on the nature of the tasks (and generally for written pieces of work), students are required to fully document the sources used.

Criterion C: Knowledge and understanding of science

Maximum: 6

Knowledge and understanding of science enables students to demonstrate their understanding of science by applying scientific knowledge to construct scientific explanations, solve problems and formulate scientifically supported arguments.

Students should be able to:

- recall scientific knowledge and use scientific understanding to construct scientific explanations
- apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations
- critically analyse and evaluate information to make judgments supported by scientific understanding.

Suitable assessment tasks for criterion C include tests, examinations, case studies, written responses and other assignments that combine a range of problems of different complexity, and opportunities for students to makes scientifically supported judgments.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1–2	The student **recalls some** scientific ideas, concepts and/or processes. The student applies scientific understanding to solve **simple problems**.
3–4	The student **describes** scientific ideas, concepts and/or processes. The student applies scientific understanding to solve **complex problems in familiar situations**. The student **analyses** scientific information by identifying parts, relationships or causes.
5–6	The student **uses** scientific ideas, concepts and/or processes **correctly** to **construct scientific explanations**. The student applies scientific understanding to solve complex problems **including** those in **unfamiliar situations**. The student **analyses** and **evaluates** scientific information and **makes judgments supported by scientific understanding**.

Analyse: to identify parts and relationships and to interpret information to reach a conclusion.

Complex problems: refers to problems that are set in a familiar or unfamiliar context and require analysis. These problems can often be broken down into sub-problems or stages, each of which requires the selection and application of the appropriate principle, rule, equation or method.

Evaluate: to assess the implications and limitations; to make judgments about the value of ideas, works, solutions and methods in relation to selected criteria.

Simple problems: refers to straightforward problems that are clearly stated and set in a familiar context, and require the student to apply the appropriate principle, rule, equation or method.

Unfamiliar situation: refers to a problem or situation in which the context or the application is modified so that it is considered unfamiliar for the student.

Notes

- The first strand of the criterion refers to students using scientific knowledge. It requires students to "recall/describe/use scientific ideas, concepts and/or processes". However, this list is not exclusive and may also include scientific models, laws, principles and theories as appropriate to the task.
- To reach the highest level of the criterion, students are required to make scientifically supported judgments about the validity and/or quality of the information presented to them. For this purpose assessment tasks could include questions dealing with "scientific claims" presented in media articles (newspapers, television, the internet, and so on), or the results and conclusions from experiments carried out by others, or any question that challenges students to critically analyse and evaluate the information and that allows them to formulate arguments about its validity and/or quality using their knowledge and understanding of science.

Criterion D: Scientific inquiry

Maximum: 6

This criterion enables students to design and carry out scientific investigations independently.

Students should be able to:

- state a focused problem or research question to be tested by a scientific investigation
- formulate a testable hypothesis and explain it using scientific reasoning
- design and carry out scientific investigations that include variables and controls, material and/or equipment needed, a method to be followed, and the way in which the data is to be collected and processed
- evaluate the validity and reliability of the method
- judge the validity of the hypothesis based on the outcome of the investigation
- suggest improvements to the method or further inquiry, when relevant.

Suitable assessment tasks for criterion D should provide students with the opportunity to design and carry out a scientific investigation independently. Some of the possible types of suitable practical work include laboratory experiments, investigations and field studies among others.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1–2	The student **attempts to state** a focused problem or research question. The method suggested **is incomplete**. The student **attempts to evaluate** the method and respond to the focused problem or research question.
3–4	The student **states** a focused problem or research question and **makes a hypothesis** but **does not explain it** using scientific reasoning. The student selects **appropriate** materials and equipment and writes a **mostly complete** method, mentioning **some of the variables** involved and how to manipulate them. The student **partially evaluates** the method. The student **comments** on the validity of the hypothesis based on the outcome of the investigation. The student **suggests some** improvements to the method or makes suggestions for further inquiry when relevant.

Achievement level	Level descriptor
5–6	The student states a **clear** focused problem or research question, **formulates a testable hypothesis** and **explains** the hypothesis using scientific reasoning. The student selects appropriate materials and equipment and writes a **clear**, **logical** method, mentioning **all of the relevant variables** involved and how to control and manipulate them, and describing how the data will be collected and processed. The student **evaluates** the method, commenting on its **reliability** and **validity**. The student comments on the validity of the hypothesis based on the outcome of the investigation. The student suggests **realistic** improvements to the method and makes suggestions for further inquiry when relevant.

Explain: to give a detailed account of causes, reasons or mechanisms.

Reliability of the method: refers to whether the method allows for the collection of sufficient reliable data to answer the question. This depends upon the selection of the measuring instrument, the precision and accuracy of the measurements, errors associated with the measurement instrument, the size of the sample, the sampling techniques used and the number of readings.

Validity of the method: refers to whether the method allows for the collection of sufficient valid data to answer the question. This includes factors such as whether the measuring instrument measures what it is supposed to measure, the conditions of the experiment and the manipulation of variables (fair testing).

Notes

- To explain the hypothesis using scientific reasoning requires students to include in their explanations the scientific concepts, theories or understanding that support their thinking of why or how something might happen the way they have hypothesized or predicted.
- When designing a scientific investigation, students should develop a method that will allow them to collect sufficient data so that the research question can be answered and the reliability of the data evaluated.
- To allow students to develop scientific investigations independently teachers must ensure that they provide students with an open-ended problem to investigate. An open-ended problem is one that has several independent variables from which students can/could choose one as a suitable basis for the investigation. This should ensure that students formulate a range of plans and that there is sufficient scope to identify both independent and controlled variables. To ensure that the task is appropriate for the assessment of criterion D, teachers should not give students closed or very directed experiments, where the focused problem or research question and relevant variables are given.

Criterion E: Processing data

Maximum: 6

Processing data refers to enabling students to organize, process and interpret quantitative and qualitative data.

Students should be able to:

- collect and record data using units of measurement as and when appropriate
- organize, transform and present data using numerical and visual forms
- analyse and interpret the data
- draw conclusions consistent with the data and supported by scientific reasoning.

Suitable assessment tasks for criterion E include scientific investigations carried out by students, as well as laboratory reports and studies that provide students with sufficient raw data for processing and further analysis.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1–2	The student **collects some** data and **attempts to record** it in a suitable format. The student **organizes and presents** data using **simple** numerical **or** visual forms. The student **attempts to identify** a trend, pattern or relationship in the data. The student attempts to draw a conclusion but this is **not consistent with** the interpretation of the data.
3–4	The student collects **sufficient** relevant data and **records** it in a suitable format. The student organizes, **transforms** and presents data in numerical and/or visual forms, **with a few errors or omissions**. The student **states** a trend, pattern or relationship shown in the data. The student draws **a conclusion consistent with** the interpretation of the data.
5–6	The student collects sufficient relevant data and records it in a suitable format. The student organizes, transforms and presents data in numerical and/or visual forms **logically** and **correctly**. The student **describes** a trend, pattern or relationship in the data and comments on the reliability of the data. The student draws a **clear** conclusion **based on** the **correct interpretation** of the data and **explains it** using scientific reasoning.

Numerical forms: may include mathematical calculations such as averaging, or determining values from a graph or table.

Qualitative data: refers to non-numerical data or information that it is difficult to measure in a numerical way.

Quantitative data: refers to numerical measurements of the variables associated with the investigation.

Transforming data: involves processing raw data into a form suitable for visual representation. This process may involve, for example, combining and manipulating raw data to determine the value of a physical quantity (such as adding, subtracting, squaring or dividing), and taking the average of several measurements. It might be that the data collected is already in a form suitable for visual representation, for example, distance travelled by a woodlouse. If the raw data is represented in this way and a best-fit line graph is drawn, the raw data has been processed.

Suitable format: may include tables with appropriate headings and units, large clearly labelled diagrams or concisely worded observations.

Visual forms: may include drawing graphs of various types appropriate to the kind of data being displayed (line graphs, bar graphs, histograms, pie charts, and so on).

Notes

- Suitable assessment tasks can include scientific investigations carried out by students where students collect and record raw data for themselves, as well as data from investigations carried out by others (generally data from scientific articles in journals, books or the internet). When students are provided with the data by the teacher, the first strand (sentence) of the descriptor that refers to data collection should not be considered for assessment. Also, students are not expected to comment on the reliability of the data because they would not have enough information to make judgments about the uncertainties incurred during the experiment (such as the choice of measuring instrument, precision and accuracy of the measurements, errors associated with the measurements, number of readings, size of the sample, sampling techniques used and so on).
- Assessment tasks where the data is provided in preformatted tables with columns, headings and units of measurement are unlikely to allow students to reach the highest level of achievement for this criterion.

Criterion F: Attitudes in science

Maximum: 6

Attitudes in science encourages students to develop safe, responsible and collaborative working practices when carrying out experimental work in science.

During the course students are expected to:

- work safely and use material and equipment competently
- work responsibly with regards to the living and non-living environment
- work effectively as individuals and as part of a group by collaborating with others.

Evidence of performance for this criterion should be collected from the observation of students when working individually and in groups. This criterion should be internally assessed but is not externally moderated.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1–2	The student **requires some guidance** to work safely and **some assistance** when using material and equipment. The student requires **some guidance** to work responsibly with regards to the living and non-living environment. When working as part of a group, the student needs **frequent reminders to cooperate with others**.
3–4	The student **requires little guidance** to work safely and **little assistance** when using material and equipment. The student **works responsibly** with regards to the living and non-living environment. When working as part of a group the student **cooperates with others on most occasions**.
5–6	The student **requires no guidance** to work safely and uses material and equipment **competently**. The student works responsibly with regards to the living and non-living environment. When working as part of a group, the student **cooperates with others**.

Determining the final grade

This section explains the process by which a student's overall achievement level (in terms of the assessment criteria) is converted to a single grade.

1. Collecting the information

Teachers will use assessment tasks to make judgments of their students' performance against the assessment criteria at intervals during the final year in the subject. Many of the assessment tasks will allow judgments of levels to be made with regard to more than one criterion.

For the purposes of final assessment, teachers **must** ensure that, for each student, they make **several judgments against each criterion**. This can be achieved by using some kinds of assessment task more than once, or by incorporating other types of assessment activity. MYP sciences has six criteria and so **at least** twelve judgments (two per criterion) must be made for each student in the final year for the purposes of final assessment. However, as more-complex tasks will allow students to be assessed against several criteria, final assessment may rest on a limited number of tasks.

Important: If more than one teacher is involved in one subject for a single year group, the school must ensure **internal standardization** is used to provide a common system for the application of the assessment criteria to each student. In joint assessment, internal standardization is best achieved by:

- the use of common assessment tasks
- shared assessment between the teachers
- regular contact between the teachers.

In certain schools, students may be grouped according to ability within the same subject. In such cases, the teachers' final assessment of student performance across all groups must be based on a **consistent application of the assessment criteria to all students**. A different standard should not be applied to different groups.

2. Making a final judgment for each criterion

When the judgments on the various tasks have been made, teachers will be in a position to establish a final profile of achievement for each student by determining the **single most appropriate level for each criterion**. Where the judgments for a criterion differ for specific assessment tasks, the teacher must decide which level best represents the student's final standard of achievement.

Important: Teachers should not average the levels gained in year 5 for any given criterion. Students can develop academically right up to the end of the programme, and teachers must make a professional judgment (that is also supported by work completed) as to which level best corresponds to a student's general level of performance for each of the criteria towards the end of the programme.

3. Determining the final criterion levels total

The final levels for each criterion must then be added together to give a **final criterion levels total** for sciences for each student. In sciences, students have the opportunity to gain a maximum level of 6 for each criterion. Therefore, the maximum final criterion levels total for sciences will be 36.

The final criterion levels total is the total that will be submitted to the IB via IBIS (IB information system) for those schools that have registered students to receive IB-validated grades.

4. Determining the final grade for sciences

Grade boundaries must be applied to the criterion levels totals to decide the final grade for each student.

Please see the *MYP coordinator's handbook* for the table of grade boundaries for sciences.

All MYP subjects receive final grades in the range from 1 (lowest) to 7 (highest) on the IB record of achievement, where students have been registered for IB-validated grades. The general MYP grade descriptors describe the achievement required for the award of the subject grade. After using the conversion table to determine a student's final sciences grade, teachers should check the general grade descriptor table to ensure that the description equally reflects the student's achievement.

Schools requiring **IB-validated grades** are required to use **only** the published MYP subject-specific criteria as a basis for the final results that they submit to the IB (both for moderation and as final assessment for certification).

Other schools (those not requiring IB-validated grades) will use the published criteria together with any additional criteria that they have developed independently, and report internally to students and parents. These schools may decide on their own grade boundaries (if using published and additional criteria), or use the boundaries published by the IB.

Sciences: Moderation

The following details apply **only** to schools that request **IB-validated grades**.

Please ensure that you also refer to the section "Assessment in the MYP".

Purpose of moderation

The external moderation procedure in all MYP subjects and the personal project exists to ensure that students from different schools and different countries receive comparable grades for comparable work, and that the same standards apply from year to year.

All MYP assessment is carried out by the students' own teachers (or by the supervisors in the case of the personal project). The IB moderation procedures ensure that the final tasks set by those teachers are appropriate and that the final judgments made by these teachers all conform to an agreed scale of measurement on common criteria.

To ensure this comparability and conformity, moderation samples submitted to the IB **must** be assessed using the assessment criteria and achievement levels listed in this guide.

The submission date for moderation samples is before the end of a school's academic year. Tasks submitted for moderation are not absolutely final tasks. Schools must continue to make further assessments of students' work after moderation samples have been submitted, as these later tasks will also contribute towards the student's final criterion levels total.

For general information on moderation, please see *MYP: From principles into practice* (August 2008), section "Moderation".

Teachers should note that there are three distinct phases to the moderation process.

- Phase 1: Submission of moderation samples
- Phase 2: Submission of criterion levels totals
- Phase 3: Award of MYP grades

Phase 1: Submission of moderation samples

Schools that request IB-validated grades for their students must register these students following the guidelines in the *MYP coordinator's handbook*. This includes students who are only eligible for the record of achievement along with those who are also eligible for the MYP certificate.

Each moderation sample must include **eight folders of students' work** with each folder representing the work of a single student. The selection of student work should be representative of a range of abilities within the final year group, comprising two comparatively good folders, four folders showing average ability and two comparatively weak folders. Only the work of students registered for IB-validated grades should be submitted. If there are fewer than eight students registered, the sample will therefore have fewer than eight folders.

Schools that have had minimal adjustments to their results over a two-year period have been instructed to send only four folders of student work instead of eight in the relevant subjects. "Minimal adjustments" means differences between teachers' and moderators' totals of within plus or minus 3. This does not mean that there will be no changes to final grades, as some students' totals will still cross grade boundaries even though the differences, and therefore the moderation factors applied, are small. Schools are advised via the moderation reports whether they can send four folders the following year. The situation is monitored annually and applies only to the subjects that have been identified in the moderation reports. For further information, please contact your MYP coordinator.

Prescribed minimum tasks

There must be **two** judgments **only** for each sciences criterion (A, B, C, D, E and F) entered on the moderation coversheet contained in each student folder.

- A **scientific investigation** designed and carried out independently by the student. Criteria **D and F** must be used to assess this task and, depending on the nature of the task, criterion **E** could also be used.
- An end-of-unit or end-of-term **test or examination**. Criterion **C** must be one of the criteria used to assess this task.
- A **piece of writing** by the student of approximately 700–1,200 words in length (or 1,000–1,500 characters for those written in Chinese). Criteria **A and B** must be used to assess this task.

Notes

- The work in the moderation sample should be taken from the same unit(s) of work for all students, as far as possible.
- Student work submitted for moderation should reflect the types of tasks used for final assessment and must be devised to give students the opportunity to reach the highest descriptors of each criterion.
- In order to help schools with the timing of the preparation of moderation samples, work from the end of year 4 of the programme can be included, provided the final year assessment criteria have been used. The sample must also include work produced in year 5.
- Where students are engaged in collaborative work, they must record their contribution and be assessed on an individual basis; their individual contribution to the task should be clearly identifiable in the work submitted.
- In law, students retain copyright in work they create themselves, and the school probably retains copyright in the tasks created by teachers. However, when the school submits this work to the IB, students and schools are deemed to be granting the IB a non-exclusive worldwide licence to use the work. Please see the *MYP coordinator's handbook*, sections F1 and F3 for further information on how this work may be used, and section F4 for the *Student claim of exclusive copyright* form if needed.

Sciences-specific information

Important: The piece of writing generally referred to as the **"one world assignment" or "one world essay" could take the form of a presentation** (oral, PowerPoint® or multimedia) provided the task allows students to effectively reach the highest level of criterion A. For the submission of oral and multimedia presentations to be acceptable, a **written transcript** of the presentation must accompany the work.

A **common assessment task** (such as a single piece of writing or one world essay, or a scientific investigation) can be presented **for moderation** for **more than one science subject within the subject group** (for example, for physics, chemistry and/or biology) provided the following conditions are met.

- Teachers of the different science subjects involved work collaboratively in the design of the task.
- The task allows students to develop the knowledge, skills, concepts and understanding expected from the sciences subjects involved.
- Teachers ensure that internal standardization is used to provide a common system for the application of the assessment criteria.
- Teachers make a note in the background information folder of the use of a common task and include copies of the task in the moderation samples of the respective science subjects.

In the sample of work submitted for moderation, at least **one** of the tasks to be assessed against **criterion B** should provide evidence of the acknowledgment and referencing of sources.

Subject registration options

The IB can only moderate the internal assessment in the following subjects: biology, chemistry, physics and sciences.

Schools should register students under **sciences** if, during the last two years of the programme, they offer a course in which collaborative planning by the school has seen the development of **units of work covering different discrete science subjects that are intertwined in terms of objectives set, content covered and learning outcomes reached**.

Samples sent for moderation in **sciences** must provide documentation that shows evidence of:

- collaborative planning between teachers within the subject group (in the form of curriculum maps or course outlines)
- student achievement against concepts and skills and the objectives of the subject group as stated in the relevant guide.

Schools should submit separate subject moderation samples in **biology, chemistry** and/or **physics** as appropriate if, during the last two years of the programme, they offer a course consisting of separate sciences subjects taught concurrently or in a rotation or modular fashion, where the subjects remain as discrete "modules" within that course and there is occasional or no real intertwining of subjects.

For non-traditional sciences courses not covered by the current registration options, such as earth sciences, environmental sciences or physical and chemical sciences, among others, schools should contact the IB curriculum and assessment centre for specific guidance on registration options and supporting documentation required.

Practical organization of the moderation sample

- The coversheet *Form F3.1* must be used to record the judgments for each criterion in each student's folder.
- Background information should be compiled in an additional folder to the students' folders. It should document details that will be useful to the moderators:
  - the context and expected outcomes of the unit of work
  - time allocation
  - the degree of teacher support
  - the conditions under which the work was completed
  - information about the application of the assessment criteria.

  Unit planners must be included in the background information in order to give moderators an idea of the context in which the task was set. The moderator will not make comments about the unit planner.
- Clear and legible copies of work should be submitted in the sample. Original work may be submitted but it is not returned to schools.
- Students are expected to reference sources they use for their work as a matter of course.
- If teachers and students use third-party material as stimuli and/or as part of their tasks, this material must be fully referenced. This will include the title of the source, the author, the publication date, the publisher and, for books only, the ISBN. Examples of third-party material include newspaper and magazine articles, cartoons, videos, movie excerpts, extracts from books, pictures (please check the acknowledgments in the original publication for the original sources), diagrams, graphs, tables, statistics, materials from websites, and so on.

If schools wish to do so, they are encouraged to send all of the documents listed above on CD-ROM instead of on paper. It is important that all background information and student work on the CD-ROM is clearly organized and easy to navigate, as is required in a paper sample. In the long term, the IB will work towards the submission of online samples without the need to send any materials through the post to moderators. Moving towards submitting moderation samples on CD-ROM should help to facilitate this long-term objective.

Phase 2: Submission of criterion levels totals

Phase 1 of the moderation process takes place before the end of most schools' academic year. After submitting moderation samples, teachers should continue to assess students' work until **final assessment**.

After final assessment, teachers should use the procedure described in "Determining the final grade" to arrive at a **criterion levels total** for each student registered for certification.

The MYP coordinator will then enter each registered student's criterion levels total on **IBIS**, and submit this to the IB.

Phase 3: Award of MYP grades

Following moderation in each subject, the IB may, where appropriate, apply a moderation factor to the criterion levels totals submitted by a school. Final grades will then be determined by applying grade boundaries to these moderated totals.

Schools will receive notification of the final grades for their students and the IB will also provide a general and a school-specific moderation report for each subject in which students were registered.

The *MYP coordinator's handbook* provides further guidelines on submitting criterion levels totals in each subject.

Sciences: Monitoring of assessment

The following details apply to schools **not** requesting IB-validated grades.

Please ensure that you also refer to the sections "Assessment in the MYP" and "Sciences: Moderation".

Definition

Monitoring of assessment is a service available to IB World Schools offering the MYP, whereby schools can send samples of assessed student work to the IB to receive feedback from an experienced MYP moderator in the form of a report. This service is subject to a fee.

Monitoring of assessment is aimed at providing support and guidance in the implementation and development of the programme with regard to internal assessment procedures and practices. It is not linked to validation of students' grades, and therefore differs from the process of external moderation.

Samples for monitoring of assessment in sciences must be submitted in English, French or Spanish, although these may be translations into one of these languages.

Details on registering for monitoring of assessment and fees, as well as the latest updated versions of the coversheets, are available in the *MYP coordinator's handbook*.

Further information on monitoring of assessment can be found in the document *MYP: From principles into practice* (August 2008), in the section "Monitoring of assessment". Brief information follows here.

Purpose

There are three reasons why schools send in a monitoring of assessment sample:

1. as a requirement for the school's programme evaluation visit
2. as a pre-check before sending in samples for moderation
3. to receive guidance on a particular subject.

Choice of tasks for monitoring of assessment

For evaluation visit and general advice

Schools can decide on the types of task they wish to submit for monitoring of assessment for the evaluation visit or for general advice. However, they are recommended to consider the prescribed minimum tasks detailed in the "Sciences: Moderation" section, as this is designed to give an even spread over the sciences assessment criteria.

Prior to moderation

If the school is requesting monitoring of assessment in preparation for future moderation, the tasks in the following list **must** be included in the sample of assessed student work. These are the required minimum tasks listed in the "Sciences: Moderation" section.

- A **scientific investigation** designed and carried out independently by the student. Criteria **D and F** must be used to assess this task and, depending on the nature of the task, criterion **E** could also be used.
- An end-of-unit or end-of-term **test or examination**. Criterion **C** must be one of the criteria used to assess this task.
- A **piece of writing** by the student of approximately 700–1,200 words in length (or 1,000–1,500 characters for those written in Chinese). Criteria **A and B** must be used to assess this task.

Please see the "Sciences: Moderation" section for further notes and information.

MYP sciences frequently asked questions

General

Can a school offer a sciences course instead of discrete science subjects such as biology, chemistry and physics?

Yes. MYP sciences provides a curriculum framework with aims and objectives to be met by the end of the programme. The flexible nature of this framework allows schools to design and structure their sciences curriculums and offer the science courses that would best suit their local requirements and preferences while complying with the philosophy of the MYP and meeting the requirements, aims and objectives prescribed by the subject group.

Schools can opt to structure and teach MYP sciences as a "sciences" course or as discrete sciences disciplines (biology, chemistry, physics, others) or as a combination of both approaches throughout the duration of the five-year programme. However, it is important to remember that the courses offered as part of the sciences curriculum must provide students with plenty of opportunities to meet the final aims and objectives of the subject group by the end of the programme.

Does the MYP allow for non-traditional science courses, such as environmental sciences, sports sciences and health sciences?

Yes. The MYP is flexible and allows for creativity in the design of the science curriculum. A school can opt to offer a non-traditional sciences course as long as the course is structured in a way that allows students to meet the final aims and objectives of MYP sciences. The choice of the course will reflect specific local resources, curricular requirements and preferences. For example, a school may decide to offer environmental sciences to provide a foundation for further studies in environment. (For guidance on the moderation of non-traditional science courses, please refer to the section "Sciences: Moderation" in this guide.)

Why does the MYP not supply a detailed syllabus for the sciences as some other educational providers do?

The MYP provides a curriculum framework rather than a detailed syllabus. This is because of the international nature of the programme. It would be impossible to provide a detailed syllabus for a five-year programme that covered all international, cultural and educational perspectives and needs. However, a common framework has been defined for MYP sciences. This framework prescribes domains of the skills, concepts, processes and attitudes that must be addressed in any MYP sciences course.

Do I need to stick to the contents of the framework for sciences to develop the sciences curriculum in my school?

No. The framework is not a mandatory requirement of MYP sciences. Nonetheless, the domains of the framework represent basic scientific concepts, skills, process and attitudes that should be addressed by students in most 11–16 science curriculums.

When developing the science curriculum, schools would have to respond to specific local (national, state, provincial) curricular requirements for content in science. Therefore, the purpose of the MYP framework for science is to offer guidance, to support teachers in developing the science curriculum and to provide them with ideas of concepts and skills to explore through the units of work.

What is the best MYP sciences textbook?

The IB does not specify any textbooks for the MYP. This would not be sensible as the curriculum framework allows different schools to have different content as part of their curriculum. Therefore, a range of different textbooks as well as a wide range of other resources will be necessary. A useful source of documentation would be the OCC, where resources posted by other teachers and discussion forums might bring some good ideas to light.

How can I detect plagiarism? How can I avoid it in the first place?

If you suspect that work has been plagiarized, one way to check is to conduct an internet search. Using a major search engine, type in a selection of the work in inverted commas (one sentence should be sufficient). If the work has been taken directly from a website, it will be detected. Your school may also subscribe to a plagiarism detection site. Plagiarism from other sources can be more difficult to detect, depending on how familiar the teacher is with all the resources available to the students.

The best solution is to avoid setting tasks that are easy to complete through plagiarism, or other forms of academic dishonesty. For example, if a task requires students to discuss the safety of mobile phones, it is important that students are challenged to differentiate between scientific evidence and interpretation of the information.

Tasks should also be challenging, but not so difficult that students are tempted to use dishonest means to complete them, and support should be available when students require it.

Does the IB mandate a particular referencing convention?

There is no set style for referencing in the MYP. Schools need to decide on one or more recognized styles of referencing that suit the needs of the students and the school.

Assessment

Can we use the test students take at the end of the semester as one of the tasks to be assessed using criterion C?

The task you choose should provide students with the opportunities to show knowledge and understanding of scientific ideas by applying these to solve problems in familiar and unfamiliar situations. However, in order to allow students to reach the maximum level descriptor, the task must include questions that challenge students to analyse and evaluate scientific information by making scientifically supported arguments.

Misconceptions of scientific concepts can be used to derive arguments, as well as observations of scientific investigations and theories. Students could be asked to analyse scientific information presented in various sources, such as the media (for example, newspaper articles, television interviews, internet), and construct scientifically supported arguments to assess the credibility of the information presented.

Why do we have to assess communication in science?

Communication is one of the fundamental concepts of the MYP. Learning science relies on understanding and using the language of science. The language of science involves more than learning technical scientific vocabulary. Students should demonstrate understanding when using scientific words. They should be able to use the appropriate scientific vocabulary and language when communicating scientific ideas in both oral and written communication.

The way science is communicated involves using a range of communication modes (oral and written, visual, graphical and symbolic) that are specific to science, as well as precise communication genres such as laboratory reports, explanations, argumentative essays and oral expositions to present arguments, to mention some.

I want to assess my students in a variety of ways without being restricted to the choice of a "piece of writing", an "end-of-unit test" or a "scientific investigation". Can I assess in other ways as well?

Yes. The "piece of writing", "end-of-unit test" and "scientific investigation" are compulsory for moderation, and should reflect the types of tasks used later in the last year for final assessment. However, the prescribed minimum tasks are only a snapshot of what is assessed in schools. Teachers are reminded that a wide range of assessment tasks should be used in all years of the MYP.

We teach biology, chemistry and physics as separate courses in a modular/rotational scheme during the last two years of the programme. Can we register students for moderation under "sciences" and include in the moderation sample work from the different science courses?

No. What is effectively being described in this query is a situation of separate sciences subjects being taught as separate courses. In this case, the school should register students under biology, chemistry and/or physics as appropriate. To register a course under "sciences", the course should provide evidence of collaborative planning in the development of the course curriculum outline, and units of work that show how the different science subjects are intertwined in terms of the objectives set, content covered and learning outcomes reached. Moderation samples for "sciences" must provide documentation that shows evidence of:

- collaborative planning between teachers within the subject group in the form of curriculum maps or course outlines
- student achievement against concepts and skills and the objectives of the subject group as stated in the relevant guide.

(For more information please refer to the section "Developing the curriculum" in this guide.)

My students cannot achieve the objectives in years 1–4. It's hard to assess years 1–4 against the criteria. What can I do?

The science objectives are designed in such a way that students should be able to achieve them by the end of five years of study in the MYP. It is not expected that students in the earlier years of the programme will be able to achieve them, but it is expected that they will be working towards achieving them.

Schools should consult the sciences interim objectives for years 1 and 3 on the OCC for examples of modified objectives.

My students have difficulty understanding the descriptors. What can I do?

In years 1–4, schools may modify the descriptors of the achievement levels for each criterion according to the progression of learning organized by them and guided by the interim objectives. These modified criteria must be based on the MYP principles of assessment and must provide for a coherent approach to assessment practices over the entire programme. Schools may add other criteria, in addition to the MYP criteria, in response to national requirements and report on these internally to parents and students.

Can I clarify the criteria in year 5 to be task specific?

Yes. Clarifying the criteria in any year level is of great help to the students in defining what is expected of them in given tasks. When clarifying expectations for students, teachers must ensure that they do not alter the standard expected in the published criteria, nor introduce new aspects.

Can I modify the assessment criteria for my students who are accessing the curriculum in their second language?

The assessment criteria may be modified in years 1–4 either in terms of difficulty, language, or both. In the final year of the MYP, students need to be assessed against the criteria as published, although students may have a personal copy of the criteria written in more accessible language. The document *Second-language acquisition and mother-tongue development: A guide for schools* gives further information on how schools can provide programmes to ensure second-language students have the opportunity to achieve all objectives at the highest levels in all subjects.

Can I modify the assessment criteria for my students who are designated as having special educational needs?

Modified criteria should be developed for each particular stage of learning for all students, as described in *MYP: From principles into practice* (August 2008). The assessment criteria may be modified in years 1–4 either in terms of requirements, difficulty, language, or a combination of the three, according to the needs of the student. In the final year of the MYP, students need to be assessed against the criteria as published. If a diagnosed special need makes assessment of some science objectives impossible, the MYP coordinator should follow the guidelines in the "Special cases" section of the *MYP coordinator's handbook* so that the student is not disadvantaged when registering and submitting the levels or grade for certification.

What is the connection between the criterion levels and the final grade?

A criterion level only gives a partial assessment of MYP sciences. For example, a level for criterion C only shows the student's achievement in "Knowledge and understanding of science" in a specific situation or when solving a specific problem. More than one assessment task will be needed to make a final judgment of the student's final achievement for a particular criterion.

To work out a student's final grade, a teacher must take into account levels from all of the criteria, giving a balanced final result. In summary, the final grade is an overall view of the student's achievement in the subject; the criterion levels show student achievement in components of the subject.

	Criterion A (/6)	Criterion B (/6)	Criterion C (/6)	Criterion D (/6)	Criterion E (/6)	Criterion F (/6)	Levels total (/36)	Final grade
Student 1	4	5	4	4	5	4	26	5
Student 2	2	3	5	5	5	5	25	5
Student 3	5	6	5	4	4	4	28	5

Moderation

What is "background information"? What should I include?

Background information is the information provided in a moderation or monitoring of assessment sample that tells the moderator details of the tasks, what the expectations were and under what conditions the tasks were completed. Examples of background information include worksheets, instructions or notes given to students, information on time allocation or length of preparation, the degree of teacher or peer support allowed, blank copies of tasks, tests or examination papers used and the teacher's corrected versions, and relevant markschemes and comments on student work. In sciences, it is important that background information indicates the degree of assistance the students received for their scientific inquiry and, in the case of the test, teachers should indicate which problems or questions are unfamiliar to the students.

If the sample differs from the stated requirements in any way, this should also be explained in the background information.

In my school we teach biology, chemistry and physics. Can we send a combined sample including student work in biology, chemistry and physics for moderation?

No. In order to moderate the internal assessment of a school, the moderation team needs to see what is effectively happening in the school. Therefore, the moderation sample should provide evidence of how the subject is taught and assessed in the school. In other words, if sciences is taught as discrete subjects then the moderation should apply to single subjects. Conversely, if the subject is taught in an integrated way, it is appropriate to submit a sample that shows how the school has managed to integrate and apply the concepts and skills to an integrated course.

If the school teaches discrete sciences disciplines (biology, physics and chemistry as discrete courses), it is appropriate to moderate the internal assessment of the discrete courses and register students accordingly.

For moderation in sciences, could a school opt to register students for another non-traditional subject such as environmental systems or nutrition? Can they be moderated in this?

If a school is interested in implementing a non-traditional sciences course, they should contact the IB curriculum and assessment centre to seek guidance on the registration options and documentation required.

I can never find students who are, for example, "average" in all tasks. What do I do for moderation?

The aim of moderation is to check that teachers are setting appropriate tasks and that they are assessing the work appropriately—that average work is awarded an average level and good work is awarded a good level.

Often, students do not fit into one "category", so when submitting samples, teachers will need to tick the "comparatively good", "average" or "comparatively weak" boxes using the principle of best fit. For example, a student with two excellent pieces of work and one average piece of work may be designated "comparatively good"; a student with one excellent, two average and one poor piece of work may be designated "average". The important thing is to ensure that there is a range of abilities displayed; the moderator can then check that good work is awarded a good level, poor work is awarded a low level, and so on.

It is hard to get samples of good year 5 level work when I have to send moderation samples so early in the school year. Are students penalized by this?

No. The moderation process checks that teachers are assigning appropriate levels to student work. Moderators take into account that most of the work sent is from the first half of the final year of the MYP.

Could we present an assessment plan early in the course for feedback rather than find out during moderation that something is not appropriate?

Yes. Schools that wish to have feedback on their courses or assessment procedures as a check before moderation are welcome to apply for monitoring of assessment. Monitoring of assessment reports will give schools this type of feedback; any changes in criterion levels as a result are for feedback purposes only and do not affect the final grades of the students. (Fees for monitoring of assessment are listed in the *MYP coordinator's handbook*.)

What can I do if my questions are not answered here?

Your MYP coordinator may be able to answer your questions. If not, posting a message on the OCC can often prompt answers from other teachers in the MYP world. Alternatively, your coordinator may pass your query on to be answered by your regional office or IB Cardiff.

MYP sciences glossary

Analyse	To identify parts or relationships and to interpret information to reach a conclusion.
Bibliography	A list of all the sources used and referred to in the text, plus those consulted.
Communication format	Refers to the different genres, styles and conventions used to communicate scientific information to different audiences in sciences. These include experimental accounts, laboratory reports, essays, oral and multimedia presentations.
Communication mode	Refers to the different channels of communication such as verbal (oral, written) or visual (graphic, symbolic).
Complex problems	Refers to problems that are set in a familiar or unfamiliar context and require analysis. These problems can often be broken down into sub-problems or stages, each of which requires the selection and application of the appropriate principle, rule, equation or method.
Data	Measurement of a parameter that can be quantitative (volume, temperature, PH, and so on) or qualitative (colour, shape, texture, and so on).
Dependent variable	The variable in which values are measured in the experiment.
Describe	To give a detailed account.
Discuss	To give an account including, where possible, a range of arguments for and against the relative importance of various factors and comparisons of alternative hypotheses.
Document	To credit fully all sources of information used by referencing (or citing), following one recognized referencing system. References should be included in the text and also at the end of the piece of work in a reference list or bibliography.
Ethics	The process of rational inquiry to decide on issues as right (good) or wrong (bad) as applied to the people and their actions.
Evaluate	To assess the implications and limitations; to make judgments about the value of ideas, works, solutions or methods in relation to selected criteria.
Explain	To give a clear account, including causes and reasons or mechanisms.

Hypothesis	A tentative explanation for an observation or phenomenon that requires experimental confirmation. It can take the form of a question or a statement.
Independent variable	The variable that is selected and manipulated by the investigator in an experiment.
Investigation	Complex problem-solving activities that attempt to determine the relationship between variables or between data. Investigations can take different forms such as laboratory-based experiments, data analyses and field studies among others.
Numerical forms	May include mathematical calculations such as averaging or determining values from a graph or table.
Qualitative data	Refers to non-numerical data or information that is difficult to measure in a numerical way.
Quantitative data	Refers to numerical measurements of the variables associated with the investigation.
Reference list	A list of all the sources of information referred to in the piece of work.
Reliability of the method	Refers to whether the method allows for the collection of sufficient reliable data to answer the question. This depends upon the selection of the measuring instrument, the precision and accuracy of the measurements, errors associated with the measurement instrument, the size of the sample, the sampling techniques used, and the number of readings.
Scientific language	Includes vocabulary, terminology, conventions, symbols and units of measurement used to communicate in science.
Simple problems	Refers to straightforward problems that are clearly stated and set in a familiar context, and which require the student to apply the appropriate principle, rule, equation or method.
State	To give a specific name, value or other brief answer without explanation or calculation.
Suitable format	May include tables with appropriate headings and units, large clearly labelled diagrams or concisely worded observations.
Transforming data	Involves processing raw data into a form suitable for visual representation. This process may involve, for example, combining and manipulating raw data to determine the value of a physical quantity (such as adding, subtracting, squaring or dividing), and taking the average of several measurements. It might be that the data collected is already in a form suitable for visual representation, for example, distance travelled by a woodlouse. If the raw data is represented in this way and a best-fit line graph is drawn, the raw data has been processed.

Unfamiliar situation	Refers to a problem or situation in which the context or the application is modified so that it is considered unfamiliar for the student.
Validity of the method	Refers to whether the method allows for the collection of sufficient valid data to answer the question. This includes factors such as whether the measuring instrument measures what it is supposed to measure, the conditions of the experiment and the manipulation of variables (fair testing).
Visual forms	May include drawing graphs of various types appropriate to the kind of data being displayed (for example, line graphs, bar graphs, histograms or pie charts).
Visual representation	Refers to the drawings, diagrams, tables, graphs, charts, models, and so on, which students use when communicating their scientific understanding of science.

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Middle Years Programme

Sciences teacher support material
Example interim objectives

For use with the *Sciences guide* (February 2010)

Objectives for years 1, 3 and 5 of the Middle Years Programme

Year 5 objectives

The sciences objectives for year 5 of the Middle Years Programme (MYP) can be found in the *Sciences guide* (February 2010). This set of **prescribed** objectives forms the basis for the **assessment criteria**, published in the guide, which must be used for final assessment of students' work during year 5.

Example interim objectives

Example interim objectives for years 1 and 3 of the MYP appear in the tables that follow. They have been developed in order to:

- promote articulation between the MYP and the Primary Years Programme (PYP)
- support individual schools in developing a coherent curriculum across the five years of the programme (or however many years a school is authorized to offer)
- emphasize the need to introduce students to the required knowledge, understanding, skills and attitudes from the first year of the programme
- provide examples of possible learning activities and assessment tasks that will allow students to work towards meeting the final objectives for year 5
- support schools that are authorized to offer the first three years of the MYP in designing appropriate assessment tasks for the end of the third year.

> Unlike the objectives for year 5, the interim objectives for years 1 and 3 are not prescribed, although the IB recommends that all schools use them. Schools may choose to adopt the objectives contained in this document or develop their own.

If choosing to develop their own interim objectives, schools must start with the prescribed objectives for year 5 and modify each one by taking into account the age, prior knowledge and stage of development of students in an earlier year of the programme. Each year 5 objective will then correspond directly to a modified objective in a preceding year of the programme. **No objectives should be omitted** from an earlier year as it is vital to ensure a coherent progression of learning across all five years of the programme.

Tables of objectives

Where the objectives in the tables that follow are the same for different years of the programme, there is a natural assumption that the student will gain more knowledge, understanding and skills, and become more mature as the course progresses. The units of work are therefore likely to become more complex and the underlying concepts to become more sophisticated as the student progresses from one year to the next.

A One world

This objective refers to enabling students to gain a better understanding of the role of science in society. Students should be aware that science is a global endeavour and that its development and applications can have consequences for our lives.

One world should provide students with the opportunity to critically assess the implications of scientific developments and their applications to local and/or global issues.

Year 1	Year 3	Year 5
Objectives		
At the end of the first year, students should be able to:	At the end of the third year, students should be able to:	At the end of the course, students should be able to:
• give examples and make comments on the ways in which science is applied and used to address specific problems or issues	• describe the ways in which science is applied and used to address specific problems or issues	• explain the ways in which science is applied and used to address specific problems or issues
• make comments on the effectiveness of science and its application in solving problems or issues	• describe the effectiveness of science and its application in solving problems or issues	• discuss the effectiveness of science and its application in solving problems or issues
• make comments on how science and its application interact with life, society and the world.	• describe how science and its application interact with some of the following factors: moral, ethical, social, economic, political, cultural and environmental.	• discuss and evaluate the moral, ethical, social, economic, political, cultural and environmental implications of the use of science and its application in solving specific problems or issues.

B Communication in science

This objective refers to enabling students to become competent and confident when communicating information in science. Students should be able to use scientific language correctly and a variety of communication modes and formats as appropriate. Students should be aware of the importance of acknowledging and appropriately referencing the work of others when communicating in science.

Year 1	Year 3	Year 5
Objectives		
At the end of the first year, students should be able to:	At the end of the third year, students should be able to:	At the end of the course, students should be able to:
• use scientific language correctly, consistent with the level of complexity of the units of work covered	• use scientific language correctly, consistent with the level of complexity of the units of work covered	• use scientific language correctly
• with guidance, use appropriate communication modes, such as verbal (oral, written), visual (graphic, symbolic) and communication formats (laboratory reports, essays, presentations), consistent with the level of complexity of the units of work covered	• use appropriate communication modes, such as verbal (oral, written), visual (graphic, symbolic) and communication formats (laboratory reports, essays, presentations), consistent with the level of complexity of the units of work covered, to effectively communicate theories, ideas and findings in science	• use appropriate communication modes, such as verbal (oral, written), visual (graphic, symbolic) and communication formats (laboratory reports, essays, presentations) to effectively communicate theories, ideas and findings in science
• with guidance, acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.	• acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.	• acknowledge the work of others and the sources of information used by appropriately documenting them using a recognized referencing system.

C Knowledge and understanding of science

This objective refers to enabling students to understand scientific knowledge (facts, ideas, concepts, processes, laws, principles, models and theories) and to apply it to construct scientific explanations, solve problems and formulate scientifically supported arguments.

Year 1	Year 3	Year 5
Objectives		
At the end of the first year, students should be able to:	At the end of the third year, students should be able to:	At the end of the course, students should be able to:
• with guidance, recall scientific knowledge and use scientific understanding to construct scientific explanations, consistent with the level of complexity of the units of work covered	• recall scientific knowledge and use scientific understanding to construct scientific explanations, consistent with the level of complexity of the units of work covered	• recall scientific knowledge and use scientific understanding to construct scientific explanations
• apply scientific knowledge and understanding to solve problems in familiar and, with guidance, in unfamiliar situations, consistent with the level of complexity of the units of work covered	• apply scientific knowledge and understanding to solve problems in familiar and unfamiliar situations, consistent with the level of complexity of the units of work covered	• apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations
• analyse scientific information by identifying components, relationships and patterns and, with guidance, make comments on the validity and quality of the information.	• analyse and evaluate information critically and make comments on the validity and quality of the information supported by scientific understanding.	• analyse and evaluate information critically to make judgments supported by scientific understanding.

D Scientific inquiry

While the scientific method may take on a wide variety of approaches, it is the emphasis on experimental work that characterizes MYP scientific inquiry.

This objective refers to enabling students to develop intellectual and practical skills to design and carry out scientific investigations independently and to evaluate the experimental design (method).

Year 1	Year 3	Year 5
Objectives		
At the end of the first year, students should be able to:	At the end of the third year, students should be able to:	At the end of the course, students should be able to:
• with guidance, articulate the problem or research question to be tested by a scientific investigation, consistent with the level of complexity of the units of work covered	• state a focused problem or research question to be tested by a scientific investigation, consistent with the level of complexity of the units of work covered	• state a focused problem or research question to be tested by a scientific investigation
• ask questions of the type: "What will happen if?", "Why does this happen when?" and make predictions ("If I do this, then this will happen … "), consistent with the level of complexity of the units of work covered	• formulate a testable hypothesis and explain it using scientific reasoning ("If I do this, then this will happen because … "), consistent with the level of complexity of the units of work covered	• formulate a testable hypothesis and explain it using scientific reasoning
• carry out investigations, consistent with the level of complexity of the units of work covered, and, with guidance, identify the variables that can be measured (dependent variables), the variables that can be manipulated (independent variables) and those that must remain constant (control variables); identify the materials and/or equipment needed; describe a simple method	• design and carry out scientific investigations that include variables and controls, materials and/or equipment needed, a method to be followed and the way in which the data is to be collected, consistent with the level of complexity of the units of work covered	• design and carry out scientific investigations that include variables and controls, material and/or equipment needed, a method to be followed and the way in which the data is to be collected and processed

• with guidance, make comments on the method and the quality of the data collected; ask questions of the type: “Is the method effective/workable/ feasible?”, “Is the data accurate/reliable?”	• make comments on the method, and the accuracy and precision of the data	• evaluate the validity and reliability of the method
• with guidance, make comments on how the outcome of the investigation helps to answer the research question; ask questions of the type: “Is my hypothesis/research question supported by the data?”, “Does the outcome of the investigation support the research question?”	• make comments on the how the hypothesis is supported or not by the data/outcome of the investigation	• judge the validity of a hypothesis based on the outcome of the investigation
• with guidance, suggest improvements to the method, consistent with the level of complexity of the units of work covered.	• when relevant, suggest improvements to the method, consistent with the level of complexity of the units of work covered.	• when relevant, suggest improvements to the method or further inquiry.

E Processing data

This objective refers to enabling students to collect, process and interpret sufficient qualitative and/or quantitative data to draw appropriate conclusions. Students are expected to develop analytical thinking skills to interpret data and judge the reliability of the data.

Year 1	Year 3	Year 5
Objectives		
At the end of the first year, students should be able to:	At the end of the third year, students should be able to:	At the end of the course, students should be able to:
• with guidance, collect and record data using units of measurement as and when appropriate	• collect and record data using units of measurement as and when appropriate	• collect and record data using units of measurement as and when appropriate
• with guidance, organize, transform and present data using simple numerical forms (including mathematical calculations) and visual forms (tables, graphs and charts)	• organize transform and present data using numerical (including mathematical calculations) and visual forms (tables, graphs and charts)	• organize, transform and present data using numerical and visual forms
• with guidance, analyse data/information to identify trends, patterns and relationships, and use the data to convey understanding/ interpretation	• analyse data/information to identify trends, patterns and relationships, and use the data to convey understanding/ interpretation	• analyse and interpret data
• with guidance, draw conclusions based on the analysis and interpretation of the data; ask questions of the type: "What might have caused….?", "How can we explain what happened using what we know about science…?".	• draw conclusions consistent with the analysis and interpretation of the data that are supported by scientific reasoning.	• draw conclusions consistent with the data and supported by scientific reasoning.

F Attitudes in science

This objective refers to encouraging students to develop safe, responsible and collaborative working practices in practical science.

Year 1	Year 3	Year 5
Objectives		
During the course, students should:	During the course, students should:	During the course, students should:
• work safely and use material and equipment competently	• work safely and use material and equipment competently	• work safely and use material and equipment competently
• work responsibly with regard to the living and non-living environment	• work responsibly with regard to the living and non-living environment	• work responsibly with regard to the living and non-living environment
• work effectively as individuals and as part of a group by collaborating with others.	• work effectively as individuals and as part of a group by collaborating with others.	• work effectively as individuals and as part of a group by collaborating with others.

MYP units of work

Examples of possible learning activities and assessment tasks are provided in the tables that follow. Each learning activity is intended to form part of a larger unit of work designed to address a central question or theme, known as the **MYP unit question**. More information about MYP units of work can be found in the section on "Planning for teaching and learning" in *MYP: From principles into practice* (August 2008).

Within each unit of work, the **context for learning**, **significant concept(s)** and **assessment tasks** are defined in relation to the MYP unit question. The areas of interaction provide the context for learning while the significant concepts refer to the underlying concepts that define the principal goal of the unit. Assessment tasks are designed to address the levels of students' engagement with the MYP unit question and the aligned objectives.

Context for learning

Every MYP unit of work has an approaches to learning (ATL) component: a shared and agreed set of skills that all teachers develop with their students throughout the entire programme. The context that frames a particular unit of work is generally derived from one of the other four areas of interaction, although ATL might be the specific context on some occasions. Some of the examples of assessment tasks listed in the tables that follow have an obvious connection to one of the areas of interaction, for example, "How can humans protect and improve the environment?" Others may not, initially, show any clear connection. However, it should be possible to integrate many different types of assessment tasks and learning activities into a single unit of work.

Planning an interdisciplinary unit in collaboration with other subject teachers is also a possibility and several of the examples listed offer this possibility.

Assessment tasks

One of the first stages in planning a unit of work is to design **summative assessment tasks**, linked to the MYP unit question, that provide varied opportunities for students to demonstrate their knowledge, understanding, skills and attitudes. It is also important to include ongoing **formative assessment tasks** within a unit of work as these provide valuable insights into the extent of student learning as the unit of work progresses. Examples of possible assessment tasks have been included in the tables that follow. Each assessment task is intended to be integrated into a unit of work and may therefore be regarded as a formative or summative assessment task depending on the MYP unit question being explored.

MYP year 1	
Examples of possible assessment tasks	**Examples of possible learning activities**
Objectives A and B	
"The way we use energy matters: can we stop using fossil fuels?" Using a question as a prompt, students investigate an issue and express an opinion, supported by scientific reasoning. Students communicate their findings and opinions through the creation of a web page, a poster or another form of visual presentation. Students support their creation with a written reflection.	Teachers design learning activities that provide students with opportunities to: • carry out research into the use of energy sourced by fossil fuel combustion and the current requirements for energy produced this way • identify methods that could meet current requirements for energy using alternative energy sources • explain, using scientific terminology, how science and technology are involved in providing solutions to the problem • investigate how these solutions may affect their lives • investigate how different societies may have needs that conflict with these solutions • make comments on the way science is used to solve the problem of using fossil fuels to produce energy • make comments on how science and its application can provide alternative, greener energy sources and how these can affect their lives and the future of the planet • with guidance, acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.

"How can humans protect and improve the environment?" Students give a written response focusing on how humans and their activities have an impact on their environment, and the ways in which science and technology can either support or damage the balance of a particular ecosystem.	Teachers design learning activities that provide students with opportunities to: • carry out research into human activities that affect their local environment • identify the biotic and abiotic factors in their ecosystem • investigate possible solutions to mitigate the impact of human activities on the environment • discuss how these solutions may affect their lives and those of others • discover how different societies may have needs that conflict with the solutions • make comments on how science and its application can provide solutions • make use of scientific language • become familiar with the structure of essay writing • with guidance, acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.
Objective B	
"How are plant cells constructed?" Students create a three-dimensional model of a plant cell that is designed to be accurate in form, structure and relative proportions.	Teachers design learning activities that provide students with opportunities to: • convert text-based descriptions of a plant cell (from a variety of sources) into a three-dimensional model • work out scale factors for representing structures respecting relative proportions • develop a meaningful annotated key • make use of scientific language • acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.

Objective C	
"How can organisms be classified?" Students create a visual presentation showing how fruits, seeds or shells can be classified according to a self-developed dichotomous key. They also write a summary of the processes they followed and include details of any problems they solved during the process.	Teachers design learning activities that provide students with opportunities to: • collect a wide variety of specimens from the natural world to classify, for example, tree leaves, fruits, seeds, shells • research into leaf structure using scientific language • identify patterns and relationships in the leaf structures • develop a dichotomous key • identify, through evaluation of individual keys, successful strategies employed in the development of the keys • acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.
"To what extent can carbon dioxide emissions be managed and reduced?" Students express an informed opinion by answering a series of structured questions that guide them into identifying scientific information and allow them to demonstrate their knowledge, skills and attitudes.	Students are presented with information about carbon dioxide emissions from at least two different sources (for example, an extract from a renowned science journal and one from a dubious media source). They answer a structured question that guides them towards: • identifying the scientific information contained in each source • analysing and making comparisons between the scientific components of both sources • looking for relationships and patterns • making comments on the validity and quality of the information • expressing an informed opinion based on their scientific understanding of the issue.
Objectives B and E	
"How do populations grow?" Students use scientific language to write an account of the processes they followed in observing the growth of a population, as well as identifying and explaining the patterns and trends they observed.	Teachers design learning activities that provide students with opportunities to: • grow a culture on bread • regularly measure the growth of the culture over a period of time • create a graphic representation of the growth process • express the area of growth as a percentage of the whole and present data in the form of a pie chart or bar graph • acknowledge the work of others and the sources of information used by documenting them using a recognized referencing system.

Objectives D, E and F	
Investigations Students produce written laboratory reports that provide details of their investigations into one or more of the following: • how different solutes might change the boiling point of water • how a change in temperature affects the solubility of a solute • the cooling of paraffin wax.	Teachers design learning activities that provide students with opportunities to carry out investigations by: • writing an aim or research question • identifying experimental variables and at least one control variable • making a simple prediction • designing an experiment using appropriate materials and equipment • providing a simple evaluation of their method and at least one improvement • carrying out the experiment and recording data in a table • collecting and recording data • organizing and transforming numerical data into graphs, histograms or pie charts • drawing a conclusion with reference to the data.
Objective F	
Attitudes and behaviour Students are assessed according to their ability to: • take into account their own safety and that of others • work cooperatively in different groups • clean up their space in the laboratory • select appropriate equipment • set up equipment correctly • use and dispose of materials responsibly • share data with partners or their group.	Teachers design learning activities that provide students with opportunities to: • produce health and safety codes for working in the sciences class • confront issues of safety • reflect upon the health and hazard of irresponsible work • work in different groups • look after their space in the laboratory • select, set up and handle equipment safely • use materials safely and responsibly • collect data.

<table>
<tr><th colspan="2">MYP year 3</th></tr>
<tr><th>Examples of possible assessment tasks</th><th>Examples of possible learning activities</th></tr>
<tr><th colspan="2">Objectives A and B</th></tr>
<tr><td>“Can we reach zero population growth?”

Using a question as a prompt, students investigate an issue, express their opinions and make judgments, supported by scientific knowledge and reasoning. Students communicate their findings, opinions and judgments through the creation of a web page, a poster or another form of visual presentation. Students support their creation with a written reflection.</td><td>Teachers design learning activities that provide students with opportunities to carry out research into:
• problems relating to an increasing global population
• the need (or otherwise) to control growth and ways in which this could or could not be achieved.
Students should carry out their research using an appropriate range of sources. When writing up the results of their research, they should include:
• descriptions of measures, decisions and technologies that could be used to control population growth
• explanations supported by their scientific understanding of ways in which science is involved in possible solutions to the problem and ways in which possible solutions might affect our lives
• descriptions of how possible solutions may be interpreted by different societies and cultures
• descriptions of the effectiveness of science and its application in providing solutions to the problem
• acknowledgments of the sources of information used, documented using a recognized referencing system.</td></tr>
<tr><td>“Has malnutrition developed into a global issue?”

Students investigate malnutrition in relation to a specific macro- or micro-nutrient in a particular area of the world. Students write an essay and discuss the scope of the problem, its causes, consequences and possible ways for eradication.</td><td>Teachers design learning activities that provide students with opportunities to carry out research into this topic by:
• identifying the nutrient and associated diseases connected with malnutrition
• describing how science and/or technology could be used to alleviate malnutrition
• presenting information in different forms (maps, graphs and charts)
• determining how the cause and possible solutions are affected by societal factors
• finding out how the possible solutions may be interpreted by different societies
• using an appropriate range of sources and acknowledging these sources using a recognized referencing system.</td></tr>
</table>

Objective B	
"How does the human digestive system work?" Students design a T-shirt that shows a stylized design of the digestive system, correctly labelled and scientifically accurate, using appropriate technologies.	Teachers design learning activities that provide students with opportunities to convert a text-based description of the digestive system into a diagram and then into a stylized design. The design must: • be accurate both in structure and in the relationship of organs to each other • have all parts labelled correctly. A complete bibliography should be included on the back of the T-shirt.
Objective C	
"Are genetically modified foods safe for us and the environment?" Students express an informed opinion based on scientific reasoning by answering a series of structured questions that guide them into identifying scientific information and commenting on its credibility.	Students are presented with at least three sources of information about genetically modified foods, one of which is of dubious quality. Teachers design learning activities that provide students with opportunities to answer structured questions, requiring them to: • identify and describe the scientific information contained in each source • use appropriate scientific language • analyse and make comparisons between the scientific components of the sources • look for relationships and patterns • express an informed opinion based on their understanding of the sciences behind the issue • comment on the credibility of each source based on their understanding of sciences and how the different sources have been selected and presented, and acknowledge the sources of the information.

<table>
<tr><th colspan="2">Objectives D, E and F</th></tr>
<tr><td>Investigations

Students produce a written laboratory report of their investigations into:
• factors affecting the rate of a reaction, for example, the rate of solubility
• determining the percentage composition of a mixture
• the rate of evaporation for different liquids
• measuring personal power (in a vertical direction).</td><td>Teachers design learning activities that provide students with opportunities to carry out investigations by:
• writing a research question
• identifying dependent and independent variables and suitable control variables
• making a simple hypothesis and supporting it with a scientific explanation
• designing a simple experiment using appropriate equipment
• identifying the data to be collected and the way of recording it
• writing an evaluation of their method and including at least one improvement
• commenting on the reliability of their data
• carrying out the experiment
• recording data in an appropriate form (for example, a table), using an appropriate degree of accuracy that takes into account the precision of their measuring instruments and the accuracy of the readings
• transforming numerical data into a graph, histogram and/or pie chart
• arriving at a conclusion and supporting it with the interpretation of the data.</td></tr>
<tr><th colspan="2">Objective F</th></tr>
<tr><td>Attitudes and behaviour

Students are assessed according to their ability to:
• take into account their own safety and that of others
• work cooperatively in different groups
• clean up their space in the laboratory
• select appropriate equipment
• set up equipment correctly
• use and dispose of materials responsibly
• share data with partners or their group.</td><td>Teachers design learning activities that provide students with opportunities to:
• confront issues of safety
• work in different groups
• look after their space in the laboratory
• select, set up and use equipment safely and responsibly
• use materials safely and responsibly
• collect data.</td></tr>
</table>

<table>
<tr><th colspan="2">MYP year 5</th></tr>
<tr><th>Examples of possible assessment tasks</th><th>Examples of possible learning activities</th></tr>
<tr><td colspan="2">Objectives A and B</td></tr>
<tr><td>“How have electricity and electronics changed our lives?”

Using a question as a prompt, students investigate an issue, express their opinions and make judgments, supported by scientific knowledge and reasoning. Students communicate their findings, judgments and opinions through the creation of an essay, supported by a range of visual representations.</td><td>Teachers design learning activities that provide students with opportunities to conduct their own research by:
• finding out how science is applied and used to solve specific issues related to energy and electricity
• explaining their findings using scientific language
• selecting the most appropriate communication mode and preparing suitable visual material to support their explanation
• discussing the effectiveness of science and its application in solving the issue
• exploring the influence of at least two societal factors on the application of science in this context
• using an appropriate range of sources and acknowledging these sources using a recognized referencing system.</td></tr>
<tr><td>“What is happening to the ozone layer?”

Students write an essay focusing on the effect of chlorofluorocarbons (CFCs) on the ozone layer.</td><td>Teachers design learning activities that provide students with opportunities to take part in a focused discussion on the effects of CFCs on the ozone layer and then conduct research, using a range of resources, that enables them to:
• appreciate that ozone depletion is a consequence of our modern living
• use scientific language to explain the effect of CFCs (and other atmospheric gases) on the ozone layer
• explain how sciences and technology are applied to solve the problem in this situation
• explore the influence of at least two societal factors on ozone depletion
• explain how technology can be a cause but also part of a solution to this problem
• use appropriate scientific language including chemical symbols
• use appropriate visual representation such as diagrams, graphs, maps and charts to communicate effectively
• acknowledge all sources of information accurately using a recognized referencing system.</td></tr>
</table>

Objective C	
"Does the use of mobile phones pose health risks?" Students express an informed opinion and make a judgment based on scientific reasoning by answering a series of structured questions that guide them into identifying scientific information and assessing its credibility.	Teachers design learning activities that allow students to: • collect articles presented in the media (internet, science journals, newspapers, magazines) about mobile phones • identify the scientific information contained in each article • discuss, analyse and evaluate each component of scientific information • assess the credibility of their sources based on their scientific understanding of the issues • demonstrate the ability to transfer knowledge from one situation to another.
Objectives D, E and F	
Investigations Students produce a written laboratory report of their investigations into: • determining the best material to keep a liquid hot • exploring the threshold of taste • determining the factors that affect the solubility of an organic liquid • comparing the elasticity of different types of plastic bags • comparing the efficiency of a ball's bounce.	Teachers design learning activities that provide students with opportunities to carry out investigations by: • writing a research question • identifying the experimental variables and a suitable number of control variables • making a hypothesis and supporting it with scientific explanation • designing an experiment using appropriate equipment • identifying the data to be collected and how it is to be recorded and analysed • writing an evaluation of their method by commenting on its validity in relation to the hypothesis, citing improvements and discussing the reliability of the method • recording data in a table to an appropriate degree of accuracy by recognizing the levels of precision offered by their equipment • transforming numerical data into a graph, histogram and/or pie chart • explaining patterns in their data using scientific reasoning • drawing a conclusion with reference to the data.

Objective F	
Attitudes and behaviour Students are assessed according to their ability to: • take into account their own safety and that of others • work cooperatively in different groups • clean up their space in the laboratory • select appropriate equipment • set up equipment correctly • use and dispose of materials responsibly • share data with partners or their group.	Teachers design learning activities that provide students with opportunities to: • confront issues of safety • work in different groups • look after their space in the laboratory • select, set up and use equipment safely and responsibly • use materials safely and responsibly • collect data.