Middle Years Programme

Sciences guide

For use from September 2014/January 2015

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

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Published May 2014
Updated July 2014, September 2015, September 2017

Published on behalf of the International Baccalaureate Organization, a not-for-profit educational foundation of 15 Route des Morillons, 1218 Le Grand-Saconnex, Geneva, Switzerland by the

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The International Baccalaureate Organization (known as the IB) offers four high-quality and challenging educational programmes for a worldwide community of schools, aiming to create a better, more peaceful world. This publication is one of a range of materials produced to support these programmes.

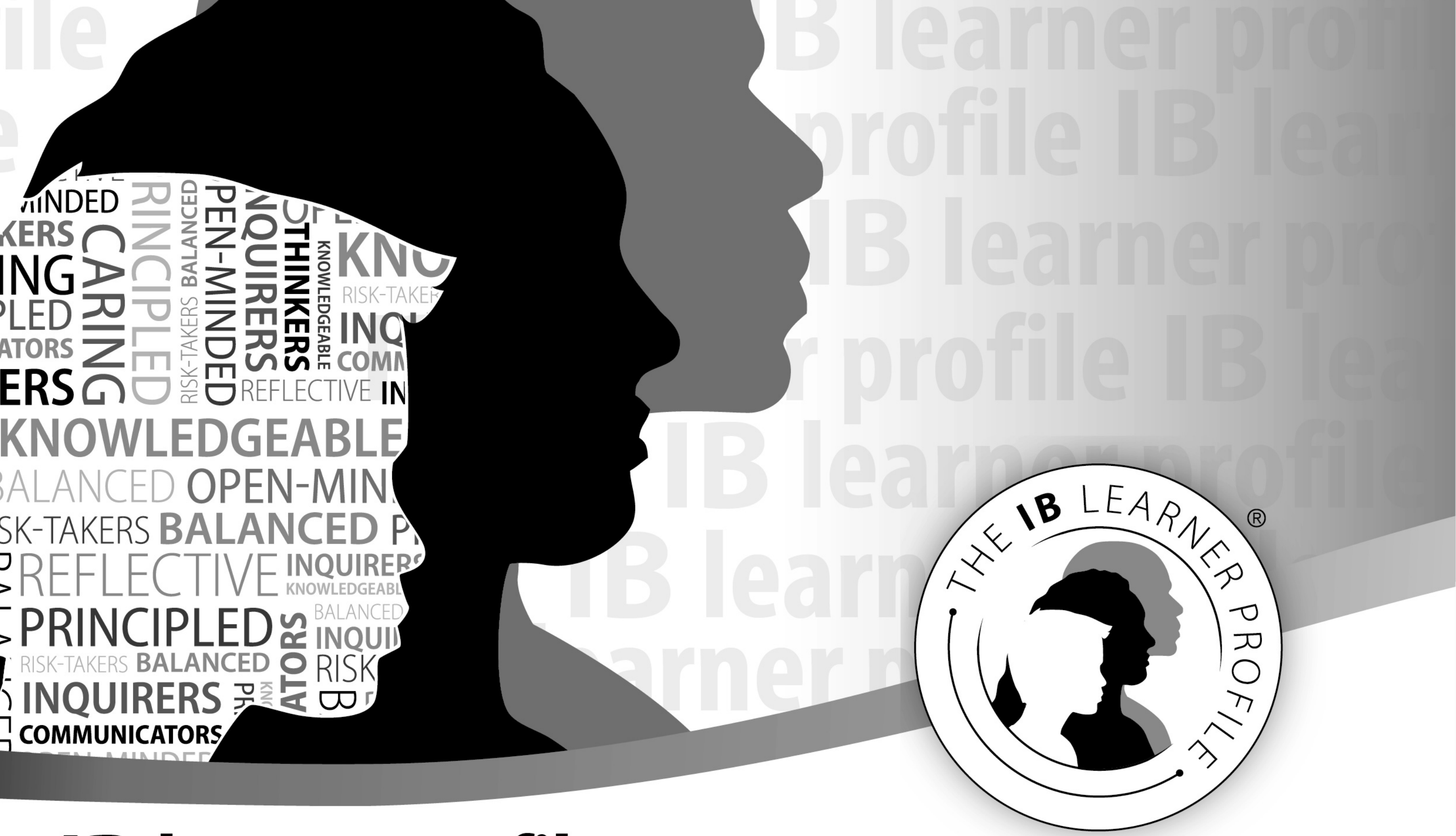
MYP320

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.

As IB learners we strive to be:

INQUIRERS
We nurture our curiosity, developing skills for inquiry and research. We know how to learn independently and with others. We learn with enthusiasm and sustain our love of learning throughout life.

KNOWLEDGEABLE
We develop and use conceptual understanding, exploring knowledge across a range of disciplines. We engage with issues and ideas that have local and global significance.

THINKERS
We use critical and creative thinking skills to analyse and take responsible action on complex problems. We exercise initiative in making reasoned, ethical decisions.

COMMUNICATORS
We express ourselves confidently and creatively in more than one language and in many ways. We collaborate effectively, listening carefully to the perspectives of other individuals and groups.

PRINCIPLED
We act with integrity and honesty, with a strong sense of fairness and justice, and with respect for the dignity and rights of people everywhere. We take responsibility for our actions and their consequences.

OPEN-MINDED
We critically appreciate our own cultures and personal histories, as well as the values and traditions of others. We seek and evaluate a range of points of view, and we are willing to grow from the experience.

CARING
We show empathy, compassion and respect. We have a commitment to service, and we act to make a positive difference in the lives of others and in the world around us.

RISK-TAKERS
We approach uncertainty with forethought and determination; we work independently and cooperatively to explore new ideas and innovative strategies. We are resourceful and resilient in the face of challenges and change.

BALANCED
We understand the importance of balancing different aspects of our lives—intellectual, physical, and emotional—to achieve well-being for ourselves and others. We recognize our interdependence with other people and with the world in which we live.

REFLECTIVE
We thoughtfully consider the world and our own ideas and experience. We work to understand our strengths and weaknesses in order to support our learning and personal development.

The IB learner profile represents 10 attributes valued by IB World Schools. We believe these attributes, and others like them, can help individuals and groups become responsible members of local, national and global communities.

Contents

Purpose of this guide

This guide is for use from September 2014 or January 2015, depending on the start of the school year.

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* (May 2014), which includes:

- general information about the programme
- the MYP unit planner, with guidance for developing the curriculum that is relevant for all subject groups
- detailed information about approaches to learning
- advice that supports access and inclusion (including accommodations for students with learning support requirements)
- a statement on academic honesty.

In MYP publications, requirements appear in a text box like this one.

Additional resources

Teacher support materials (TSMs) are available in the programme resource centre (https://resources.ibo.org). The TSM for sciences contains support for developing the written, taught and assessed curriculum. It provides examples of good practice, including subject-group overviews, assessment tasks and markschemes, as well as student work with teacher comments.

An optional process of external assessment can lead to **IB MYP course results** for sciences courses, and these results can contribute to the awarding of an **IB MYP certificate**. More information is available in the annual publication Middle Years Programme *Assessment procedures*.

A range of publications that support the MYP are available at the IB store (http://store.ibo.org).

Acknowledgments

The IB gratefully acknowledges the generous contributions of IB World Schools and a global community of educators who collaborate in the development of the Middle Years Programme.

Programme model

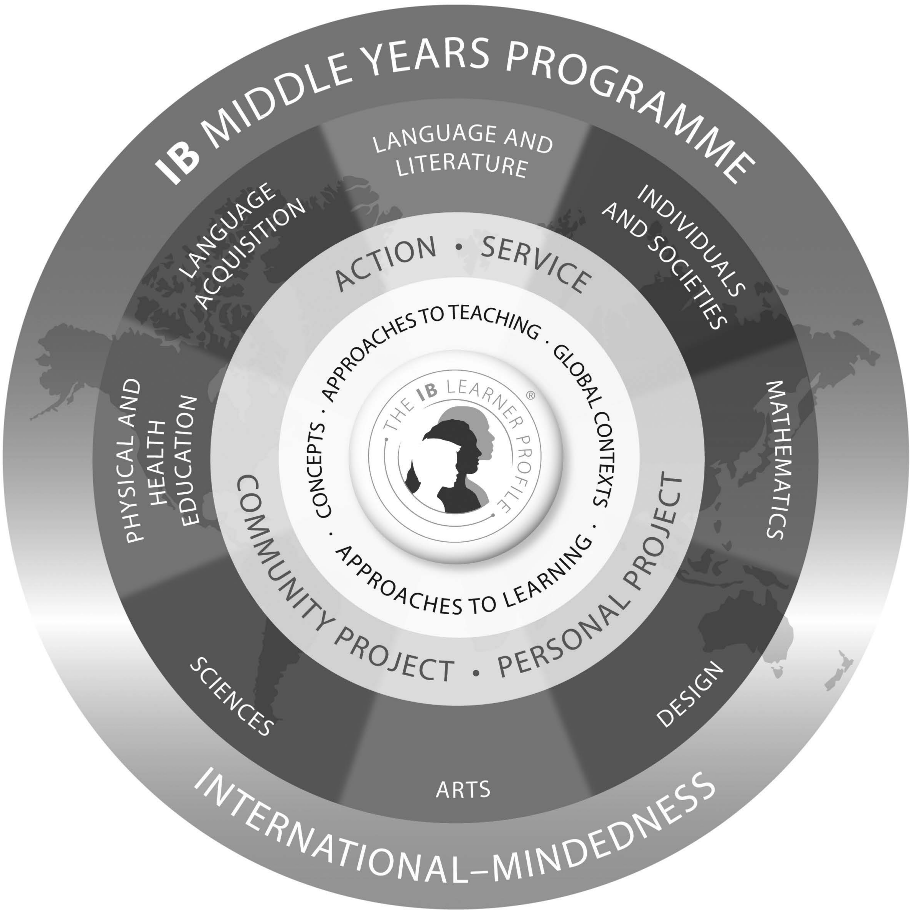


Figure 1

Middle Years Programme model

The MYP is designed for students aged 11 to 16. It provides a framework of learning that encourages students to become creative, critical and reflective thinkers. The MYP emphasizes intellectual challenge, encouraging students to make connections between their studies in traditional subjects and the real world. It fosters the development of skills for communication, intercultural understanding and global engagement—essential qualities for young people who are becoming global leaders.

The MYP is flexible enough to accommodate the demands of most national or local curriculums. It builds upon the knowledge, skills and attitudes developed in the IB Primary Years Programme (PYP) and prepares students to meet the academic challenges of the IB Diploma Programme (DP) and the IB Career-related Programme (CP).

The MYP:

- addresses holistically students' intellectual, social, emotional and physical **well-being**
- provides students opportunities to develop the **knowledge, attitudes and skills** they need in order to manage complexity, and take responsible action for the future

- ensures breadth and depth of understanding through study in **eight subject groups**
- requires the study of at least **two languages** to support students in understanding their own cultures and those of others
- empowers students to participate in **service with the community**
- helps to prepare students for **further education**, the **workplace** and a **lifetime of learning**.

Nature of sciences

> The scientific mind does not so much provide the right answers as asks the right questions.
>
> Claude Lévi-Strauss

With inquiry at the core, the MYP sciences framework aims to guide students to independently and collaboratively investigate issues through research, observation and experimentation. The MYP sciences curriculum must explore the connections between science and everyday life. As they investigate real examples of science applications, students will discover the tensions and dependencies between science and morality, ethics, culture, economics, politics, and the environment.

Scientific inquiry also fosters critical and creative thinking about research and design, as well as the identification of assumptions and alternative explanations. Students should learn to appreciate and respect the ideas of others, gain good ethical-reasoning skills and further develop their sense of responsibility as members of local and global communities.

Learning science involves more than simply learning technical terminology. The MYP considers all teachers to be language teachers and, thus, MYP sciences should enable students to access, use and communicate scientific knowledge correctly and confidently in oral, written and visual modes.

Sciences across the IB continuum

The IB continuum of international education provides a progression of learning for students aged 3–19. In the PYP, science is viewed as the exploration of aspects of the natural world. Science within the IB programmes encourages inquiry, curiosity and ingenuity. Learners should develop an understanding of the resources of a rapidly-changing scientific and technological society and how to use those resources wisely. The MYP sciences curriculum aims to build on what students learn and do in the PYP and other student-centred programmes of primary education. There are no prior formal learning requirements.

The main approach to teaching and learning sciences is through structured inquiry in the context of interdisciplinary units. Students are encouraged to investigate science by formulating their own questions and finding answers to those questions, including through research and experimentation.

Scientific inquiry enables students to develop a way of thinking and a set of skills and processes that they can use to confidently tackle the internal assessment component of DP subjects in biology, chemistry and physics. Moreover, the MYP sciences objectives and assessment criteria A–D are aligned with the DP sciences objectives and internal assessment criteria, supporting the smooth transition from the MYP to the DP (see figures 2 and 3).

All IB programmes share common beliefs and values about teaching and learning science:

- **International dimension:** Students develop an appreciation that science requires open-mindedness and freedom of thought transcending gender, political, cultural, linguistic, national and religious boundaries.
- **Aesthetic dimension:** Students engage with the complexities, intricacies and beauty of science, which arouses their curiosity and heightens their learning.
- **Ethical dimension:** Students reflect on the ethical, social, economic, political, cultural and environmental implications of using science to solve specific problems. Students develop a personal, ethical stance on science-related issues.
- **Learning through investigation:** Students construct meaning by designing, conducting and reflecting on scientific investigations. The scientific process, which encourages hands-on experience, inquiry, and critical thinking, enables students to make informed and responsible decisions, not only in science but also in other areas of life.
- **Collaboration:** Students are provided opportunities to work individually and with their peers to learn about science within and beyond the classroom. They develop safe and responsible working habits in practical science.

The IB learner profile provides a strong foundation for teaching and learning science in IB programmes and is integral to its successful application.

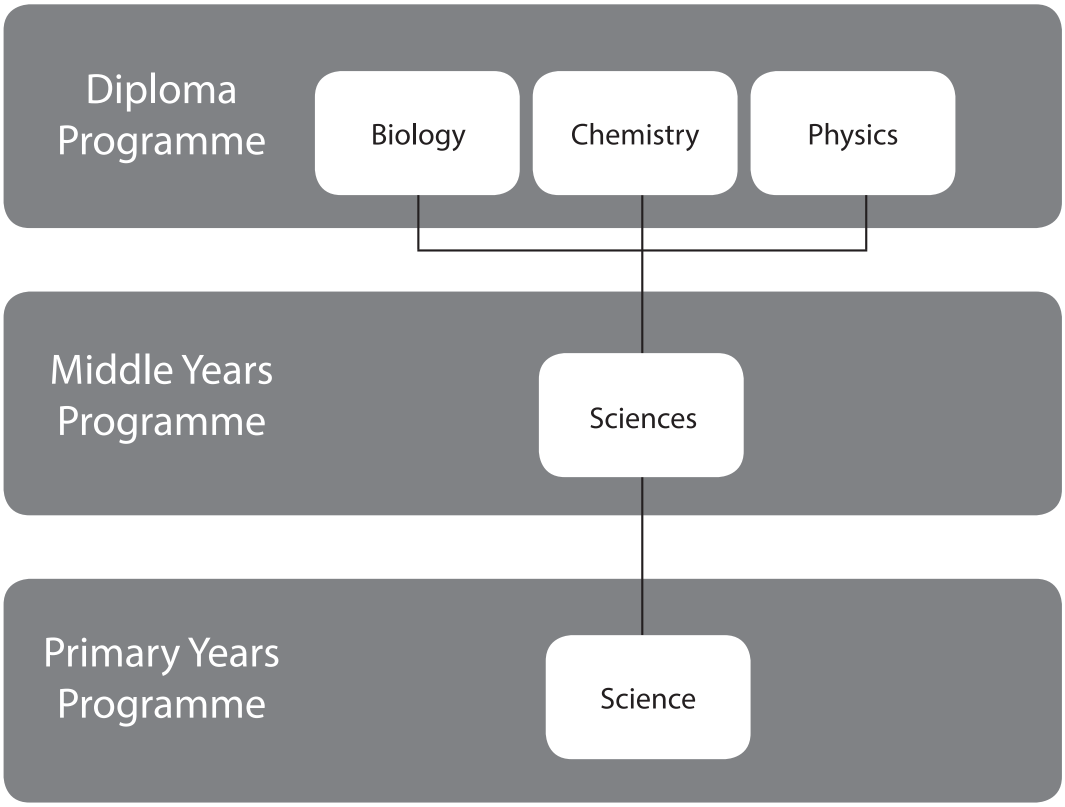


Figure 2

IB continuum pathway to Diploma Programme subjects—biology, chemistry and physics

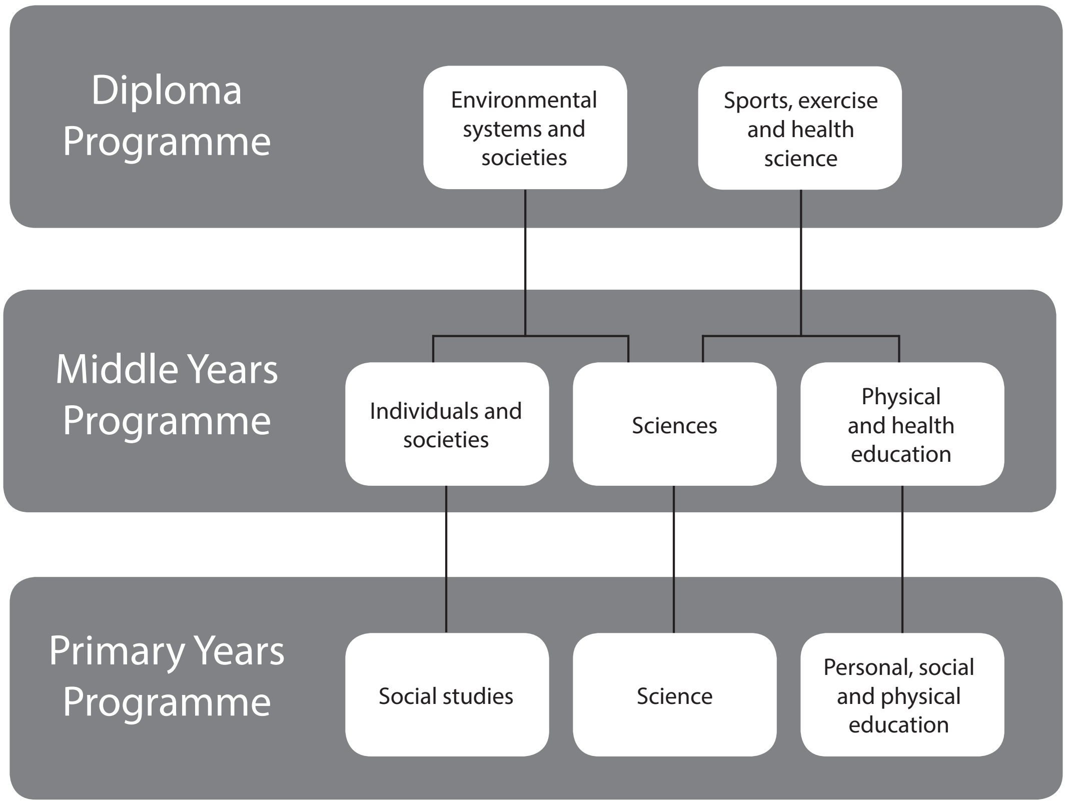


Figure 3

IB continuum pathway to Diploma Programme subjects—sports, exercise and health science and environmental systems and societies

MYP sciences also helps to prepare students for overall success in the IB Diploma Programme.

The knowledge, skills and attitudes that students develop in sciences courses provide a meaningful foundation for further study and help to prepare students for careers in academic and corporate research, as laboratory assistants and managers, in scientific consultancy for a range of companies and NGOs, in teaching, in fieldwork and journalism.

Aims

The aims of all MYP subjects state what a teacher may expect to teach and what a student may expect to experience and learn. These aims suggest how the student may be changed by the learning experience.

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

- understand and appreciate science and its implications
- consider science as a human endeavour with benefits and limitations
- cultivate analytical, inquiring and flexible minds that pose questions, solve problems, construct explanations and judge arguments
- develop skills to design and perform investigations, evaluate evidence and reach conclusions
- build an awareness of the need to effectively collaborate and communicate
- apply language skills and knowledge in a variety of real-life contexts
- develop sensitivity towards the living and non-living environments
- reflect on learning experiences and make informed choices.

Objectives

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

The objectives of MYP sciences encompass the factual, conceptual, procedural and metacognitive dimensions of knowledge.

Schools **must** use the objectives provided in this guide for years 1, 3 and 5 of the programme.

Each objective is elaborated by a number of **strands**; a strand is an aspect or indicator of the learning expectation.

Subject groups **must** address **all** strands of **all** four objectives **at least twice** in **each year** of the MYP.

These objectives relate directly to the assessment criteria found in the "Assessed curriculum" section of this guide.

Together these objectives reflect the holistic nature of science and the real-world work of scientists. They enable students to engage with all aspects of science, either through individual objectives or connected processes.

A Knowing and understanding

Students develop scientific knowledge (facts, ideas, concepts, processes, laws, principles, models and theories) and apply it to solve problems and express scientifically supported judgments.

Tests or exams must be assessed using this objective. To reach the highest level students must make scientifically supported judgments about the validity and/or quality of the information presented to them. Assessment tasks could include questions dealing with "scientific claims" presented in media articles, or the results and conclusions from experiments carried out by others, or any question that challenges students to analyse and examine the information and allows them to outline arguments about its validity and/or quality using their knowledge and understanding of science.

In order to reach the aims of sciences, students should be able to:

i. explain scientific knowledge

ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations

iii. analyse and evaluate information to make scientifically supported judgments.

B Inquiring and designing

Intellectual and practical skills are developed through designing, analysing and performing scientific investigations. Although the scientific method involves a wide variety of approaches, the MYP emphasizes experimental work and scientific inquiry.

When students design a scientific investigation they should develop a method that will allow them to collect sufficient data so that the problem or question can be answered. To enable students to design scientific investigations independently, teachers must provide an open-ended problem to investigate. An open-ended problem is one that has several independent variables appropriate for the investigation and has sufficient scope to identify both independent and controlled variables. In order to achieve the highest level for the strand in which students are asked to design a logical, complete and safe method, the student would include only the relevant information, correctly sequenced.

In order to reach the aims of sciences, students should be able to:

i. explain a problem or question to be tested by a scientific investigation

ii. formulate a testable hypothesis and explain it using scientific reasoning

iii. explain how to manipulate the variables, and explain how data will be collected

iv. design scientific investigations.

C Processing and evaluating

Students collect, process and interpret qualitative and/or quantitative data, and explain conclusions that have been appropriately reached. MYP sciences helps students to develop analytical thinking skills, which they can use to evaluate the method and discuss possible improvements or extensions.

In order to reach the aims of sciences, students should be able to:

i. present collected and transformed data

ii. interpret data and explain results using scientific reasoning

iii. evaluate the validity of a hypothesis based on the outcome of the scientific investigation

iv. evaluate the validity of the method

v. explain improvements or extensions to the method.

D Reflecting on the impacts of science

Students gain global understanding of science by evaluating the implications of scientific developments and their applications to a specific problem or issue. Varied scientific language will be applied in order to demonstrate understanding. Students are expected to become aware of the importance of documenting the work of others when communicating in science.

Students must reflect on the implications of using science, interacting with one of the following factors: moral, ethical, social, economic, political, cultural or environmental, as appropriate to the task. The student's chosen factor may be interrelated with other factors.

In order to reach the aims of sciences, students should be able to:

i. explain the ways in which science is applied and used to address a specific problem or issue

ii. discuss and evaluate the various implications of the use of science and its application in solving a specific problem or issue

iii. apply scientific language effectively

iv. document the work of others and sources of information used.

Planning a progression of learning

Throughout the programme, students should engage with the curriculum and be expected to demonstrate their understanding at increasing levels of sophistication. The range of assessed skills, techniques, and concepts, as well as the complexity of their application, must increase as students progress through the programme.

Year 1 **In order to reach the aims of sciences, students should be able to:**	**Year 3** **In order to reach the aims of sciences, students should be able to:**	**Year 5** **In order to reach the aims of sciences, students should be able to:**
Objective A: Knowing and understanding		
i. outline scientific knowledge ii. apply scientific knowledge and understanding to solve problems set in familiar situations and suggest solutions to problems set in unfamiliar situations iii. interpret information to make scientifically supported judgments.	i. describe scientific knowledge ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations iii. analyse information to make scientifically supported judgments.	i. explain scientific knowledge ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations iii. analyse and evaluate information to make scientifically supported judgments.
Objective B: Inquiring and designing		
i. outline an appropriate problem or research question to be tested by a scientific investigation ii. outline a testable prediction using scientific reasoning iii. outline how to manipulate the variables, and outline how data will be collected iv. design scientific investigations.	i. describe a problem or question to be tested by a scientific investigation ii. outline a testable hypothesis and explain it using scientific reasoning iii. describe how to manipulate the variables, and describe how data will be collected iv. design scientific investigations.	i. explain a problem or question to be tested by a scientific investigation ii. formulate a testable hypothesis and explain it using scientific reasoning iii. explain how to manipulate the variables, and explain how data will be collected iv. design scientific investigations.

Year 1 In order to reach the aims of sciences, students should be able to:	Year 3 In order to reach the aims of sciences, students should be able to:	Year 5 In order to reach the aims of sciences, students should be able to:
Objective C: Processing and evaluating		
i. present collected and transformed data ii. interpret data and outline results using scientific reasoning iii. discuss the validity of a prediction based on the outcome of the scientific investigation iv. discuss the validity of the method v. describe improvements or extensions to the method.	i. present collected and transformed data ii. interpret data and describe results using scientific reasoning iii. discuss the validity of a hypothesis based on the outcome of the scientific investigation iv. discuss the validity of the method v. describe improvements or extensions to the method.	i. present collected and transformed data ii. interpret data and explain results using scientific reasoning iii. evaluate the validity of a hypothesis based on the outcome of the scientific investigation iv. evaluate the validity of the method v. explain improvements or extensions to the method.
Objective D: Reflecting on the impact of science		
i. summarize the ways in which science is applied and used to address a specific problem or issue ii. describe and summarize the various implications of the use of science and its application in solving a specific problem or issue iii. apply scientific language effectively iv. document the work of others and sources of information used.	i. describe the ways in which science is applied and used to address a specific problem or issue ii. discuss and analyse the various implications of the use of science and its application in solving a specific problem or issue iii. apply scientific language effectively iv. document the work of others and sources of information used.	i. explain the ways in which science is applied and used to address a specific problem or issue ii. discuss and evaluate the various implications of the use of science and its application in solving a specific problem or issue iii. apply scientific language effectively iv. document the work of others and sources of information used.

Visualizing the scientific process

The scientific process of inquiring, designing, processing and evaluating is represented by MYP sciences objectives B (inquiring and designing) and C (processing and evaluating). The visual representation in figure 4 shows the dynamic relationship between the four areas of experimental design and reporting.

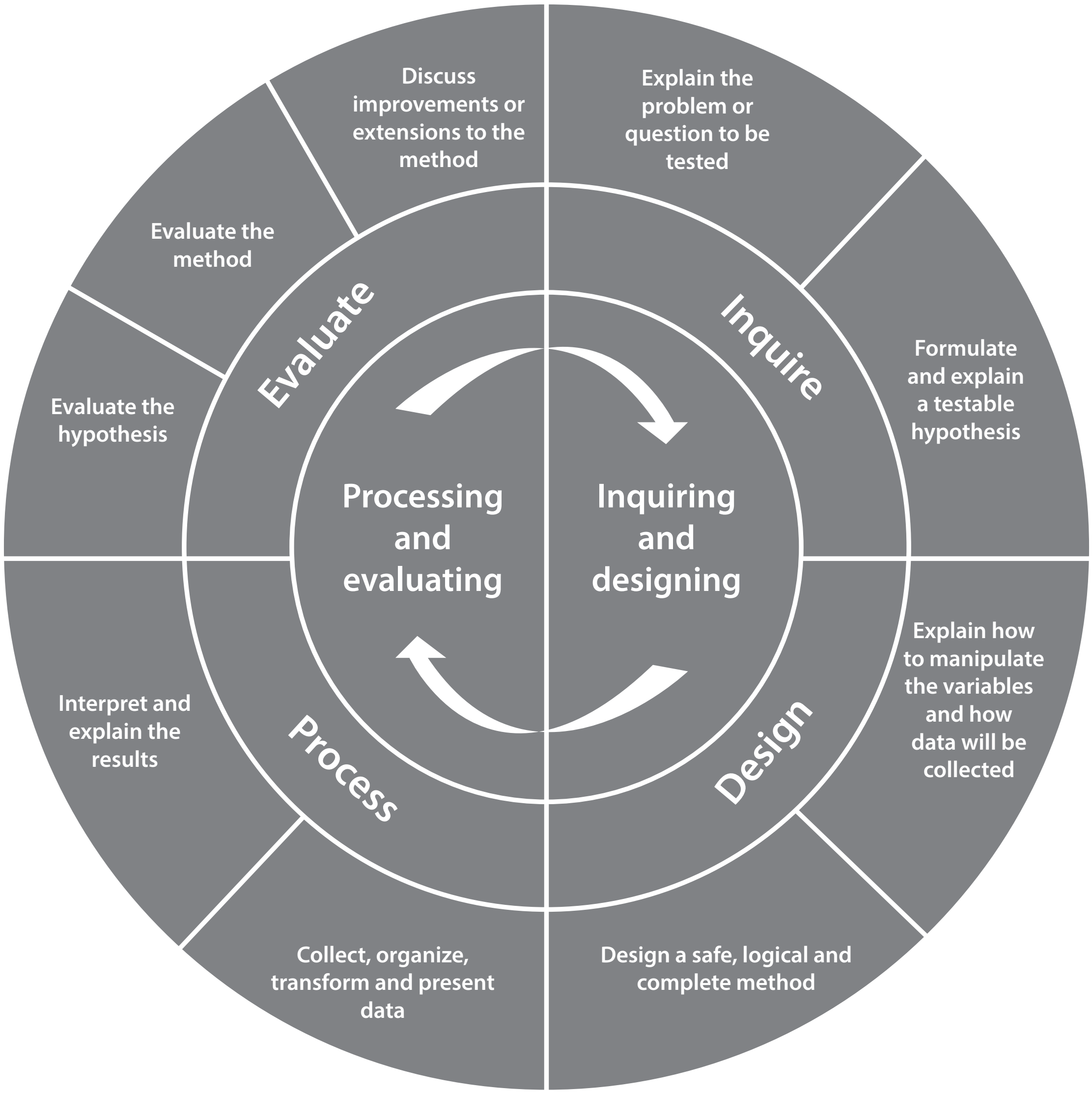


Figure 4

The experimental cycle

Interdisciplinary learning

Interdisciplinary teaching and learning is grounded in individual subject groups and disciplines, but extends disciplinary understanding in ways that are:

- **integrative—**bringing together concepts, methods or modes of communication from two or more subject groups, disciplines or established areas of expertise to develop new perspectives
- **purposeful**—connecting disciplines to solve real-world problems, create products or address complex issues in ways that would have been unlikely through a single approach.

Interdisciplinary teaching and learning builds a connected curriculum that addresses the developmental needs of students in the MYP. It prepares students for further academic (inter)disciplinary study and for life in an increasingly interconnected world.

The MYP uses concepts and contexts as starting points for meaningful integration and transfer of knowledge across subject groups and disciplines. *Fostering interdisciplinary teaching and learning in the MYP* (2014) contains more information, including a detailed process for planning and recording interdisciplinary units.

> MYP schools are responsible for engaging students in at least one collaboratively planned interdisciplinary unit for each year of the programme.

MYP sciences offer many opportunities for interdisciplinary teaching and learning. Possible interdisciplinary units in this subject group could include inquiries into:

- using mathematics to interpret and present data
- designing lighting and sound for arts productions using quantitative analysis
- investigating the properties of materials for design projects.

Interdisciplinary learning can take place through large- and small-scale learning engagements. Authentic interdisciplinary learning often requires critical reflection and detailed collaborative planning. However, teachers and students can also make interdisciplinary connections through spontaneous learning experiences and conversations.

> All MYP subject-group teachers are responsible for developing meaningful ongoing opportunities for interdisciplinary teaching and learning.

MYP projects

MYP projects

The MYP community project (for students in years 3 or 4) and MYP personal project (for students in year 5) aim to encourage and enable sustained inquiry within a global context that generates new insights and deeper understanding. In these culminating experiences, students develop confidence as principled, lifelong learners. They grow in their ability to consider their own learning, communicate effectively and take pride in their accomplishments.

Courses in sciences help students to develop key approaches to learning (ATL) that lead to success and enjoyment in the MYP projects. In this subject group, students have important opportunities to practise ATL skills, especially organizing and depicting information logically. Collaboration skills are an essential aspect of the scientific enterprise.

From their learning experiences in this subject group, students can find inspiration for their projects. Students' interest in the natural world and in technological innovation provides many points of entry into projects that involve science, technology, engineering and mathematics.

MYP sciences offers many opportunities for learning through action. Inspiration from sciences for community projects and personal projects might include inquiries into:

- scientific principles and natural phenomena of personal interest
- applications of science to solve practical problems
- individual, community or global challenges that require scientific understanding
- scientific literacy in local and national communities
- the impact of scientific developments and innovations.

Requirements

Teaching hours

Schools must allocate the teaching hours necessary to meet the requirements of MYP sciences.

> The MYP requires at least 50 hours of teaching time for each subject group in each year of the programme.

In practice, more time is often necessary to meet subject-group aims and objectives and to provide for the sustained, concurrent teaching that enables interdisciplinary study.

For students pursuing IB MYP course results that can contribute to the awarding of the IB MYP certificate, the recommended sciences courses should include at least 70 teaching hours in each of the final two years of the programme (MYP year 4 and MYP year 5).

Organizing sciences in the school

MYP sciences courses usually include biology, chemistry and physics, but schools may develop and offer other sciences courses as long as students can meet the aims and objectives of the IB subject group. Additional courses could include environmental sciences, life sciences, physical sciences, sport sciences, health sciences and earth sciences.

Although schools may vary the structure of the sciences curriculum throughout the five years of the programme, they should offer either discrete or modular science courses:

Discrete sciences courses generally encompass biology, chemistry and physics, but may include other science disciplines. Discrete science courses can include interdisciplinary science units that explore concepts, skills and processes from two or more science disciplines, provided that teachers

- use related concepts from the course's disciplinary focus
- devote at least fifty per cent (50%) of guided learning hours in the course to its disciplinary focus.

Modular sciences courses include two or more discrete sciences taught in rotation. This structure can also include interdisciplinary science units, provided that schools

- clearly identify student achievement of MYP sciences objectives for each discipline
- provide a balanced selection of science disciplines.

> In **every year** of MYP sciences, all students must independently complete a **scientific investigation** that is assessed against **criterion B** (inquiring and designing) and **criterion C** (processing and evaluating).

Planning the sciences curriculum

IB World Schools are responsible for developing and structuring MYP sciences courses that provide opportunities for students to meet the aims and objectives of the programme. Each school's circumstances, including local and national curriculum requirements, determine the organization of the sciences within the school.

MYP standards and practices require schools to facilitate and promote collaborative planning for the purpose of curriculum development and review.

Sciences objectives for years 1 to 5 of the curriculum provide continuity and outline a progression of learning. These objectives guide teachers in making decisions about developmentally appropriate learning experiences, including formative and summative assessments.

As they develop the vertical articulation of sciences over the years of the programme, teachers should plan increasingly complex units of work that encompass multiple objectives. However, within these units, discrete tasks or smaller units of work might concentrate on specific objectives or individual strands.

Sciences courses offer many opportunities to build interdisciplinary connections across the curriculum. Horizontal articulation for each year of the programme should coordinate teaching and learning across courses in sciences, as well as identify shared conceptual understandings and approaches to learning (ATL) that span multiple subject groups and help to create a coherent learning experience for students throughout the year.

Teaching and learning through inquiry

Inquiry, in the broadest sense, is the process that is used to move to deeper levels of understanding. Inquiry involves speculating, exploring, questioning and connecting. In all IB programmes, inquiry develops curiosity and promotes critical and creative thinking.

The MYP structures sustained inquiry in sciences by developing **conceptual understanding** in **global contexts**. Teachers and students develop a **statement of inquiry** and use **inquiry questions** to explore the subject. Through their inquiry, students develop specific interdisciplinary and disciplinary **approaches to learning** skills.

Conceptual understanding

A concept is a "big idea"—a principle or notion that is enduring, the significance of which goes beyond particular origins, subject matter, or place in time. Concepts represent the vehicle for students' inquiry into the issues and ideas of personal, local and global significance, providing the means by which they can explore the essence of the sciences.

Concepts have an important place in the structure of knowledge that requires students and teachers to think with increasing complexity as they organize and relate facts and topics.

Concepts express understanding that students take with them into lifelong adventures of learning. They help students to develop principles, generalizations and theories. Students use conceptual understanding as they solve problems, analyse issues, and evaluate decisions that can have an impact on themselves, their communities and the wider world.

> In the MYP, conceptual understanding is framed by prescribed key and related concepts. Teachers must use these concepts to develop the curriculum. Schools may identify and develop additional concepts to meet local circumstances and curriculum requirements.

Key concepts

Key concepts promote the development of a broad curriculum. They represent big ideas that are both relevant within and across disciplines and subjects. Inquiry into key concepts can facilitate connections between and among:

- courses within the sciences subject group (intra-disciplinary learning)
- other subject groups (interdisciplinary learning).

Table 1 lists the key concepts to be explored across the MYP. The key concepts contributed by the study of sciences are **change**, **relationships** and **systems**.

Aesthetics	**Change**	Communication	Communities
Connections	Creativity	Culture	Development
Form	Global interactions	Identity	Logic
Perspective	**Relationships**	**Systems**	Time, place and space

Table 1
MYP key concepts

These key concepts provide a framework for sciences, informing units of work and helping to organize teaching and learning.

Change

Change is a conversion, transformation or movement from one form, state or value to another. Inquiry into the concept of change involves understanding and evaluating causes, processes and consequences.

In sciences, change is viewed as the difference in a system's state when observed at different times. This change could be qualitative (such as differences in structure, behaviour, or level) or quantitative (such as a numerical variable or a rate). Change can be irreversible, reversible or self-perpetuating.

Relationships

Relationships are the connections and associations between properties, objects, people and ideas—including the human community's connections with the world in which we live. Any change in relationship brings consequences—some of which may occur on a small scale, while others may be far reaching, affecting large networks and systems such as human societies and the planetary ecosystem.

Relationships in sciences indicate the connections found among variables through observation or experimentation. These relationships also can be tested through experimentation. Scientists often search for the connections between form and function. Modelling is also used to represent relationships where factors such as scale, volume of data, or time make other methods impractical.

Systems

Systems are sets of interacting or interdependent components. Systems provide structure and order in human, natural and built environments. Systems can be static or dynamic, simple or complex.

Systems in sciences describe sets of components that function due to their interdependence or complementary nature. Common systems in science are closed systems, where resources are not removed or replaced, and open systems, where necessary resources are renewed regularly. Modelling often uses closed systems to simplify or limit variables.

Other key concepts can also be important in sciences. For example, development is an important aspect in the continual growth through change that epitomizes scientific knowledge. Science offers important perspectives on the definition, measurement and meaning of time, place and space. Creativity is always important for scientists working together to extend the limits of human understanding.

Related concepts

Related concepts promote deep learning. They are grounded in specific disciplines and are useful for exploring key concepts in greater detail. Inquiry into related concepts helps students develop more complex and sophisticated conceptual understanding. Related concepts may arise from the subject matter of a unit or the craft of a subject—its features and processes.

The following tables list related concepts for the study of sciences. Teachers are not limited to the related concepts listed in this chart and may choose others when planning units, including from other subject groups.

Related concepts in biology		
Balance	Consequences	Energy
Environment	Evidence	Form
Function	Interaction	Models
Movement	Patterns	Transformation

Table 2a
Related concepts in biology

Related concepts in chemistry		
Balance	Conditions	Consequences
Energy	Evidence	Form
Function	Interaction	Models
Movement	Patterns	Transfer

Table 2b
Related concepts in chemistry

Related concepts in physics		
Consequences	Development	Energy
Environment	Evidence	Form
Function	Interaction	Models
Movement	Patterns	Transformation

Table 2c
Related concepts in physics

Related concepts for modular sciences courses		
Balance	Consequences	Energy
Environment	Evidence	Form
Function	Interaction	Models
Movement	Patterns	Transformation

Table 2d
Related concepts for modular sciences courses

The appendix contains a glossary of these related concepts for sciences.

Global contexts for teaching and learning

Global contexts direct learning toward independent and shared inquiry into our common humanity and shared guardianship of the planet. Using the world as the broadest context for learning, MYP sciences can develop meaningful explorations of

- identities and relationships
- orientation in space and time
- personal and cultural expression
- scientific and technical innovation
- globalization and sustainability
- fairness and development.

> Teachers must identify a global context for teaching and learning, or develop additional contexts that help students explore the relevance of their inquiry (why it matters).

Many inquiries into sciences concepts naturally focus on scientific and technical innovation. However, courses in this subject group should, over time, offer students multiple opportunities to explore all MYP global contexts in relation to the aims and objectives of the subject group.

Statements of inquiry

Statements of inquiry set conceptual understanding in a global context in order to frame classroom inquiry and direct purposeful learning. They establish the unit's purpose within a specific, relevant and engaging exploration of a global context. Table 3 shows some possible statements of inquiry for possible units of work in MYP sciences.

Statement of inquiry	Key concept Related concepts Global context (exploration to develop)	Possible topic or area of study
Societies must consider the consequences of change made possible by the biological revolution's technological innovations.	• change • consequences, function • scientific and technical innovation (the biological revolution)	Biology: biotechnology Physical chemistry: nanotechnology
Models help people visualize the relationship between the structures and functions that shape human identity.	• relationships • function, models • identities and relationships (identity formation)	Biology: evolution (DNA and genetics)
Energy is distributed within a system, and can be transferred between a system and its environment.	• systems • energy, environment, transfer • scientific and technical innovation—exploring the natural world and its laws (products, processes and solutions)	Biology: interaction between organisms Physics: energy transfer and transformation Chemistry: bonding
Health is a function of interactions between individuals and societies.	• relationships • conditions, interaction • identities and relationships (health and well-being, lifestyle choices)	Biology: interactions with environment Chemistry: food science
Pioneering discoveries can challenge conventional wisdom and open pathways toward deeper understanding.	• change • evidence, development, patterns • orientation in space and time—discoveries and turning points (evolution, constraints and adaptation)	Chemistry: periodic table (trends, groups and periods) Nature of science and science-based ways of knowing
Scientists discern patterns and use them to construct systems with rules and conventions that help to explain how the world works.	• systems • models, patterns • personal and cultural expression (social constructions of reality; history of ideas, fields and disciplines; analysis and argument)	Chemistry: organic chemistry; types of chemical reactions; chemical nomenclature

Statement of inquiry	Key concept Related concepts Global context (exploration to develop)	Possible topic or area of study
In order to meet growing demands for energy, societies often turn to new technologies that interact with the natural world.	• change • consequences, energy, interaction • fairness and development (imagining a hopeful future)	Physics: electromagnetism (generation and transmission of electricity); forces and energy (pressure, work and power); atomic physics (uses and dangers)
Technological innovations often alter the relationships people have with their local and global environments.	• relationships • development, environment • globalization and sustainability (consumption, conservation, natural resources and public goods)	Physics: forces and energy (fuels and environmental impact)
Innovative devices transform matter and energy to satisfy human needs and desires.	• creativity • form, function, transformation • personal and cultural expression (entrepreneurship, practice and competency)	Physics: heat, light and sound; waves (electromagnetic spectrum, imaging and applications)

Table 3

Example statements of inquiry

Inquiry questions

Teachers and students use statements of inquiry to help them identify factual, conceptual and debatable inquiry questions. Inquiry questions give direction to teaching and learning, and they help to organize and sequence learning experiences.

Table 4 shows some possible inquiry questions for MYP sciences units.

Factual questions: Remembering facts and topics	**Conceptual questions: Analysing big ideas**	**Debatable questions: Evaluating perspectives and developing theories**
• What do cells look like? • How do scientists measure chemical molecules and compounds? • Which technologies are available for producing electrical energy at an industrial scale?	• How is the universe structured? • How do models evolve and transform? • What is the relationship between microbiology and natural selection?	• Who should have the power to modify and control genetic material? • What are the social and economic consequences of nuclear energy? • What are the limits of scientific understanding?

Table 4
Examples of factual, conceptual and debatable questions

Approaches to learning

All MYP units of work offer opportunities for students to develop and practise approaches to learning (ATL) skills. These skills provide valuable support for students working to meet the subject group's aims and objectives.

ATL skills are grouped into five categories that span the IB continuum of international education. IB programmes identify discrete skills in each category that can be introduced, practised and consolidated in the classroom and beyond.

While ATL skills are relevant across all MYP subject groups, teachers may also identify ATL skill indicators especially relevant for, or unique to, a particular subject group or course.

Table 5 suggests some of the indicators that can be important in sciences.

Category	**Skill indicator**
Thinking skills	Interpret data gained from scientific investigations.
Social skills	Practise giving feedback on the design of experimental methods.
Communication skills	Use appropriate visual representations of data based on purpose and audience.
Self-management skills	Structure information appropriately in laboratory investigation reports.
Research skills	Make connections between scientific research and related moral, ethical, social, economic, political, cultural or environmental factors.

Table 5
Examples of sciences-specific skill indicators

Well-designed learning engagements and assessments provide rich opportunities for students to practise and demonstrate ATL skills. Each MYP unit explicitly identifies ATL skills around which teaching and learning can focus, and through which students can authentically demonstrate what they are able to do. Formative assessments provide important feedback for developing discrete skills, and many ATL skills support students as they demonstrate their achievements in summative assessments of subject-group objectives.

Table 6 lists some specific ATL skills that students can demonstrate through performances of understanding in sciences.

Approaches to learning
Thinking (or critical thinking): Draw justifiable conclusions based on processing, interpreting and evaluating data gained from scientific investigations. **Communication (or interaction):** Use appropriate scientific terminology, data tables and graphs to make the meaning of your findings clear to an audience of your peers.

Table 6
Examples of sciences demonstrations of ATL skills

Subject-specific guidance

Mathematical requirements

Throughout the MYP sciences students should have regular exposure to the mathematical skills developed in MYP mathematics and used by scientists. By the end of the MYP sciences course, students should be able to:

- perform the basic arithmetic functions: addition, subtraction, multiplication and division
- use calculations involving means, decimals, fractions, percentages, ratios, approximations and reciprocals
- express numbers in standard form (scientific notation), that is $a \times 10^k$ where $1 \leq a \leq 10$ and $k \in \mathbb{Z}$
- use direct and inverse proportion
- solve simple algebraic equations
- solve linear simultaneous equations
- plot graphs (with suitable scales and axes), including two variables that show linear and non-linear relationships
- interpret graphs, including the significance of gradients, changes in gradients, intercepts and areas
- draw lines (either curves or linear) of best fit on a scatter plot graph
- interpret data presented in various forms (for example, bar charts, histograms and pie charts)
- represent arithmetic mean using x-bar notation (for example, $\overline{x}$)

Safety in practical work

Because IB science courses emphasize inquiry and experimentation, schools need to provide many field experiences and laboratory work for students. Schools should follow these guidelines to help ensure safety in practical work.

- Assess and manage the risk of potential hazards
- Maintain school science laboratories and ensure that they are safe and well equipped
- Ensure that everyone involved in practical work knows the correct safety codes and procedures to follow
- Use appropriate class size and supervision of practical work to limit potential risks and hazards

It is a basic responsibility of everyone involved in MYP sciences to make safety and health an ongoing commitment within the context of local requirements, educational and cultural traditions, financial constraints and national legal systems. Teachers can use these guidelines developed by the International Council of Associations for Science Education (ICASE) Safety Committee by The Laboratory Safety Institute (LSI).

The Laboratory Safety Institute's Laboratory Safety Guidelines

40 suggestions for a safer lab

Steps requiring minimal expense

1. Have a written health, safety and environmental affairs (HS&E) policy statement.
2. Organize a departmental HS&E committee of employees, management, faculty, staff and students that will meet regularly to discuss HS&E issues.
3. Develop an HS&E orientation for all new employees and students.
4. Encourage employees and students to care about their health and safety and that of others.
5. Involve every employee and student in some aspect of the safety programme and give each specific responsibilities.
6. Provide incentives to employees and students for safety performance.
7. Require all employees to read the appropriate safety manual. Require students to read the institution's laboratory safety rules. Have both groups sign a statement that they have done so, understand the contents, and agree to follow the procedures and practices. Keep these statements on file in the department office.
8. Conduct periodic, unannounced laboratory inspections to identify and correct hazardous conditions and unsafe practices. Involve students and employees in simulated health and safety inspections.
9. Make learning how to be safe an integral and important part of science education, your work and your life.
10. Schedule regular departmental safety meetings for all students and employees to discuss the results of inspections and aspects of laboratory safety.
11. When conducting experiments with hazards or potential hazards, ask yourself these questions.
    - What are the hazards?
    - What are the worst possible things that could go wrong?
    - How will I deal with them?
    - What are the prudent practices, protective facilities and equipment necessary to minimize the risk of exposure to the hazards?
12. Require that all accidents (incidents) be reported, evaluated by the departmental safety committee, and discussed at departmental safety meetings.
13. Require every pre-lab/pre-experiment discussion to include consideration of the health and safety aspects.
14. Don't allow experiments to run unattended unless they are failsafe.
15. Forbid working alone in any laboratory and working without the prior knowledge of a staff member.
16. Extend the safety programme beyond the laboratory to the automobile and the home.
17. Allow only minimum amounts of flammable liquids in each laboratory.
18. Forbid smoking, eating and drinking in the laboratory.
19. Do not allow food to be stored in chemical refrigerators.
20. Develop plans and conduct drills for dealing with emergencies such as fire, explosion, poisoning, chemical spill or vapour release, electric shock, bleeding and personal contamination.
21. Require good housekeeping practices in all work areas.

22. Display the phone numbers of the fire department, police department and local ambulance either on or immediately next to every phone.
23. Store acids and bases separately. Store fuels and oxidizers separately.
24. Maintain a chemical inventory to avoid purchasing unnecessary quantities of chemicals.
25. Use warning signs to designate particular hazards.
26. Develop specific work practices for individual experiments, such as those that should be conducted only in a ventilated hood or involve particularly hazardous materials. Whenever possible, most hazardous experiments should be done in a hood.

Steps requiring moderate expense

27. Allocate a portion of the departmental budget to safety.
28. Require the use of appropriate eye protection at all times in laboratories and areas where chemicals are transported.
29. Provide adequate supplies of personal protective equipment—safety glasses, goggles, face shields, gloves, lab coats and bench-top shields.
30. Provide fire extinguishers, safety showers, eye wash fountains, first aid kits, fire blankets and fume hoods in each laboratory and test or check monthly.
31. Provide guards on all vacuum pumps and secure all compressed gas cylinders.
32. Provide an appropriate supply of first-aid equipment and instruction on its proper use.
33. Provide fireproof cabinets for storage of flammable chemicals.
34. Maintain a centrally located departmental safety library.
35. Remove all electrical connections from inside chemical refrigerators and require magnetic closures.
36. Require grounded plugs on all electrical equipment and install ground fault interrupters (GFIs), where appropriate.
37. Label all chemicals to show the name of the material, the nature and degree of hazard, the appropriate precautions, and the name of the person responsible for the container.
38. Develop a programme for dating stored chemicals and for recertifying or discarding them after predetermined maximum periods of storage.
39. Develop a system for the legal, safe and ecologically acceptable disposal of chemical wastes.
40. Provide secure, adequately spaced, well-ventilated storage of chemicals.

Alignment of objectives and assessment criteria

In the MYP, assessment is closely aligned with the written and taught curriculum. Each strand from MYP sciences has a corresponding strand in the assessment criteria for this subject group. Figure 5 illustrates this alignment and the increasingly complex demands for student performance at higher achievement levels.

C Processing and evaluating

At the end of year 5, students should be able to:

i. present collected and transformed data

ii. interpret data and explain results using scientific reasoning

iii. evaluate the validity of a hypothesis based on the outcome of the scientific investigation

iv. evaluate the validity of the method

v. explain improvements or extensions to the method.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. collect and **present** data in numerical and/or visual forms ii. **interpret** data iii. **state** the validity of a hypothesis based on the outcome of a scientific investigation iv. **state** the validity of the method based on the outcome of a scientific investigation v. **state** improvements or extensions to the method.
3–4	The student is able to: i. correctly collect and **present** data in numerical and/or visual forms ii. accurately **interpret** data and **explain** results iii. **outline** the validity of a hypothesis based on the outcome of a scientific investigation iv. **outline** the validity of the method based on the outcome of a scientific investigation v. **outline** improvements or extensions to the method that would benefit the scientific investigation.
5–6	The student is able to: i. correctly collect, organize and **present** data in numerical and/or visual forms ii. accurately **interpret** data and **explain** results using scientific reasoning iii. **discuss** the validity of a hypothesis based on the outcome of a scientific investigation iv. **discuss** the validity of the method based on the outcome of a scientific investigation v. **describe** improvements or extensions to the method that would benefit the scientific investigation.
7–8	The student is able to: i. correctly collect, organize, transform and **present** data in numerical and/or visual forms ii. accurately **interpret** data and **explain** results using correct scientific reasoning iii. **evaluate** the validity of a hypothesis based on the outcome of a scientific investigation iv. **evaluate** the validity of the method based on the outcome of a scientific investigation v. **explain** improvements or extensions to the method that would benefit the scientific investigation.

Figure 5

Sciences objectives and criteria alignment

Assessment criteria overview

Assessment for sciences courses in all years of the programme is criterion-related, based on four equally weighted assessment criteria:

Criterion A	Knowing and understanding	Maximum 8
Criterion B	Inquiring and designing	Maximum 8
Criterion C	Processing and evaluating	Maximum 8
Criterion D	Reflecting on the impacts of science	Maximum 8

Subject groups **must** assess **all** strands of **all** four assessment criteria **at least twice** in **each year** of the MYP.

In the MYP, subject-group objectives correspond to assessment criteria. Each criterion has eight possible achievement levels (1–8), divided into four bands that generally represent limited (1–2); adequate (3–4); substantial (5–6); and excellent (7–8) performance. Each band has its own unique descriptor that teachers use to make "best-fit" judgments about students' progress and achievement.

This guide provides the **required assessment criteria** for years 1, 3 and 5 of MYP sciences. In response to national or local requirements, schools may add criteria and use additional models of assessment. Schools must use the appropriate assessment criteria as published in this guide to report students' final achievement in the programme.

Teachers clarify the expectations for each summative assessment task with direct reference to these assessment criteria. Task-specific clarifications should clearly explain what students are expected to know and do. They could be in the form of:

- a task-specific version of the required assessment criteria
- a face-to-face or virtual classroom discussion
- a detailed task sheet or assignment.

Sciences assessment criteria: Year 1

Criterion A: Knowing and understanding

Maximum: 8

At the end of year 1, students should be able to:

i. outline scientific knowledge

ii. apply scientific knowledge and understanding to solve problems set in familiar situations and suggest solutions to problems set in unfamiliar situations

iii. interpret information to make 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 is able to: i. **select** scientific knowledge ii. **select** scientific knowledge and understanding to **suggest solutions** to problems set in **familiar situations** iii. **apply** information to **make judgments**, **with limited success**.
3–4	The student is able to: i. **recall** scientific knowledge ii. **apply** scientific knowledge and understanding to **suggest solutions** to problems set in **familiar situations** iii. **apply** information to **make judgments**.
5–6	The student is able to: i. **state** scientific knowledge ii. **apply** scientific knowledge and understanding to **solve problems** set in **familiar situations** iii. **apply** information to **make scientifically supported judgments**.
7–8	The student is able to: i. **outline** scientific knowledge ii. **apply** scientific knowledge and understanding to **solve problems** set in **familiar situations** and **suggest solutions** to problems set in **unfamiliar situations** iii. **interpret** information to **make scientifically supported judgments**.

Criterion B: Inquiring and designing

Maximum: 8

At the end of year 1, students should be able to:

i. outline an appropriate problem or research question to be tested by a scientific investigation

ii. outline a testable prediction using scientific reasoning

iii. outline how to manipulate the variables, and outline how data will be collected

iv. design scientific investigations.

Achievement level	Level descriptor
0	The student **does not** reach a standard described by any of the descriptors below.
1–2	The student is able to: i. **select** a problem or question to be tested by a scientific investigation ii. **select** a testable prediction iii. **state** a variable iv. design a **method with limited success**.
3–4	The student is able to: i. **state** a problem or question to be tested by a scientific investigation ii. **state** a testable prediction iii. **state** how to manipulate the variables, and **state** how **data** will be collected iv. design a **safe method** in which he or she **selects materials and equipment**.
5–6	The student is able to: i. **state** a problem or question to be tested by a scientific investigation ii. **outline** a testable prediction iii. **outline** how to manipulate the variables, and **state** how **relevant data** will be collected iv. design a **complete and safe method** in which he or she **selects appropriate materials and equipment**.
7–8	The student is able to: i. **outline** a problem or question to be tested by a scientific investigation ii. **outline** a testable prediction **using scientific reasoning** iii. **outline** how to manipulate the variables, and **outline** how **sufficient, relevant data** will be collected iv. design a **logical, complete and safe method** in which he or she **selects appropriate materials and equipment**.

Criterion C: Processing and evaluating

Maximum: 8

At the end of year 1, students should be able to:

i. present collected and transformed data

ii. interpret data and outline results using scientific reasoning

iii. discuss the validity of a prediction based on the outcome of the scientific investigation

iv. discuss the validity of the method

v. describe improvements or extensions to the method.

Achievement level	Level descriptor
0	The student **does not** reach a standard described by any of the descriptors below.
1–2	The student is able to: i. **collect and present** data in numerical and/or visual forms ii. **interpret** data iii. **state** the validity of a prediction based on the outcome of a scientific investigation, **with limited success** iv. **state** the validity of the method based on the outcome of a scientific investigation, **with limited success** v. **state** improvements or extensions to the method that would benefit the scientific investigation, **with limited success**.
3–4	The student is able to: i. **correctly collect and present** data in numerical and/or visual forms ii. **accurately interpret** data and **outline** results iii. **state** the validity of a prediction based on the outcome of a scientific investigation iv. **state** the validity of the method based on the outcome of a scientific investigation v. **state** improvements or extensions to the method that would benefit the scientific investigation.
5–6	The student is able to: i. **correctly collect, organize and present** data in numerical and/or visual forms ii. **accurately interpret** data and **outline** results **using scientific reasoning** iii. **outline** the validity of a prediction based on the outcome of a scientific investigation iv. **outline** the validity of the method based on the outcome of a scientific investigation v. **outline** improvements or extensions to the method that would benefit the scientific investigation.

Achievement level	Level descriptor
7–8	The student is able to: i. **correctly collect, organize, transform and present** data in numerical and/ or visual forms ii. **accurately interpret data** and **outline** results **using correct scientific reasoning** iii. **discuss** the validity of a prediction based on the outcome of a scientific investigation iv. **discuss** the validity of the method based on the outcome of a scientific investigation v. **describe** improvements or extensions to the method that would benefit the scientific investigation.

Criterion D: Reflecting on the impacts of science

Maximum: 8

At the end of year 1, students should be able to:

i. summarize the ways in which science is applied and used to address a specific problem or issue

ii. describe and summarize the various implications of using science and its application in solving a specific problem or issue

iii. apply scientific language effectively

iv. document the work of others and sources of information used.

Achievement level	Level descriptor
0	The student **does not** reach a standard described by any of the descriptors below.
1–2	The student is able to, **with limited success**: i. **state** the ways in which science is used to address a specific problem or issue ii. **state** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **apply** scientific language to communicate understanding iv. document sources.
3–4	The student is able to: i. **state** the ways in which science is used to address a specific problem or issue ii. **state** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **sometimes apply** scientific language to communicate understanding iv. **sometimes** document sources correctly.
5–6	The student is able to: i. **outline** the ways in which science is used to address a specific problem or issue ii. **outline** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **usually apply** scientific language to communicate understanding **clearly and precisely** iv. **usually** document sources correctly.
7–8	The student is able to: i. **summarize** the ways in which science is applied and used to address a specific problem or issue ii. **describe and summarize** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **consistently apply** scientific language to communicate understanding **clearly and precisely** iv. document sources **completely**.

Sciences assessment criteria: Year 3

Criterion A: Knowing and understanding

Maximum: 8

At the end of year 3, students should be able to:

i. describe scientific knowledge

ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations

iii. analyse information to make scientifically supported judgments.

Achievement level	Level descriptor
0	The student **does not** reach a standard indicated by any of the descriptors below.
1–2	The student is able to: i. **recall** scientific knowledge ii. apply scientific knowledge and understanding to **suggest solutions** to problems set in **familiar situations** iii. **apply** information to make **judgments**.
3–4	The student is able to: i. **state** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar situations** iii. **apply** information to make **scientifically supported judgments**.
5–6	The student is able to: i. **outline** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar situations** and **suggest solutions** to problems set in **unfamiliar situations** iii. **interpret** information to make **scientifically supported judgments**.
7–8	The student is able to: i. **describe** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar and unfamiliar situations** iii. **analyse** information to make **scientifically supported judgments**.

Criterion B: Inquiring and designing

Maximum: 8

At the end of year 3, students should be able to:

i. describe a problem or question to be tested by a scientific investigation

ii. outline a testable hypothesis and explain it using scientific reasoning

iii. describe how to manipulate the variables, and describe how data will be collected

iv. design scientific investigations.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **state** a problem or question to be tested by a scientific investigation, with **limited success** ii. **state** a testable hypothesis iii. **state** the variables iv. design **a method, with limited success**.
3–4	The student is able to: i. **state** a problem or question to be tested by a scientific investigation ii. **outline** a testable hypothesis **using scientific reasoning** iii. **outline** how to manipulate the variables, and **state** how **relevant data** will be collected iv. design a **safe method** in which he or she **selects materials and equipment**.
5–6	The student is able to: i. **outline** a problem or question to be tested by a scientific investigation ii. **outline and explain** a testable hypothesis **using scientific reasoning** iii. **outline** how to manipulate the variables, and **outline** how **sufficient, relevant data** will be collected iv. design **a complete and safe method** in which he or she **selects appropriate materials and equipment**.
7–8	The student is able to: i. **describe** a problem or question to be tested by a scientific investigation ii. **outline and explain** a testable hypothesis **using correct scientific reasoning** iii. **describe** how to manipulate the variables, and **describe** how **sufficient, relevant** data will be collected iv. design a **logical, complete and safe method** in which he or she **selects appropriate materials and equipment**.

Criterion C: Processing and evaluating

Maximum: 8

At the end of year 3, students should be able to:

i. present collected and transformed data

ii. interpret data and describe results using scientific reasoning

iii. discuss the validity of a hypothesis based on the outcome of the scientific investigation

iv. discuss the validity of the method

v. describe improvements or extensions to the method.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **collect and present** data in numerical and/or visual forms ii. **accurately interpret** data iii. **state** the validity of a hypothesis **with limited reference** to a scientific investigation iv. **state** the validity of the method **with limited reference** to a scientific investigation v. **state limited** improvements or extensions to the method.
3–4	The student is able to: i. **correctly collect and present** data in numerical and/or visual forms ii. **accurately interpret** data and **describe** results iii. **state** the validity of a hypothesis based on the outcome of a scientific investigation iv. **state** the validity of the method based on the outcome of a scientific investigation v. **state** improvements or extensions to the method that would benefit the scientific investigation.
5–6	The student is able to: i. **correctly collect, organize and present** data in numerical and/or visual forms ii. **accurately interpret** data and **describe** results **using scientific reasoning** iii. **outline** the validity of a hypothesis based on the outcome of a scientific investigation iv. **outline** the validity of the method based on the outcome of a scientific investigation v. **outline** improvements or extensions to the method that would benefit the scientific investigation.

Achievement level	Level descriptor
7–8	The student is able to: i. **correctly collect, organize, transform and present** data in numerical and/ or visual forms ii. **accurately interpret data** and **describe** results **using correct scientific reasoning** iii. **discuss** the validity of a hypothesis based on the outcome of a scientific investigation iv. **discuss** the validity of the method based on the outcome of a scientific investigation v. **describe** improvements or extensions to the method that would benefit the scientific investigation.

Criterion D: Reflecting on the impacts of science

Maximum: 8

At the end of year 3, students should be able to:

i. describe the ways in which science is applied and used to address a specific problem or issue

ii. discuss and analyse the various implications of using science and its application in solving a specific problem or issue

iii. apply scientific language effectively

iv. document the work of others and sources of information used.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **state** the ways in which science is used to address a specific problem or issue ii. **state** the implications of the use of science to solve a specific problem or issue, interacting with a factor iii. **apply** scientific language to communicate understanding but does so **with limited success** iv. document sources, **with limited success**.
3–4	The student is able to: i. **outline** the ways in which science is used to address a specific problem or issue ii. **outline** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **sometimes apply** scientific language to communicate understanding iv. **sometimes** document sources **correctly**.
5–6	The student is able to: i. **summarize** the ways in which science is applied and used to address a specific problem or issue ii. **describe** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **usually apply** scientific language to communicate understanding **clearly and precisely** iv. **usually** document sources **correctly**.

Achievement level	Level descriptor
7–8	The student is able to: i. **describe** the ways in which science is applied and used to address a specific problem or issue ii. **discuss and analyse** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **consistently apply** scientific language to communicate understanding **clearly and precisely** iv. document sources **completely**.

Sciences assessment criteria: Year 5

Criterion A: Knowing and understanding

Maximum: 8

At the end of year 5, students should be able to:

i. explain scientific knowledge

ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations

iii. analyse and evaluate information to make scientifically supported judgments.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **state** scientific knowledge ii. apply scientific knowledge and understanding to **suggest solutions** to problems set in **familiar situations** iii. **interpret** information to make **judgments**.
3–4	The student is able to: i. **outline** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar situations** iii. **interpret** information to make **scientifically supported judgments**.
5–6	The student is able to: i. **describe** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar situations** and **suggest solutions** to problems set in **unfamiliar situations** iii. **analyse** information to make **scientifically supported judgments**.
7–8	The student is able to: i. **explain** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar and unfamiliar situations** iii. **analyse** and **evaluate** information to make **scientifically supported judgments**.

Criterion B: Inquiring and designing

Maximum: 8

At the end of year 5, students should be able to:

i. explain a problem or question to be tested by a scientific investigation

ii. formulate a testable hypothesis and explain it using scientific reasoning

iii. explain how to manipulate the variables, and explain how data will be collected

iv. design scientific investigations.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **state** a problem or question to be tested by a scientific investigation ii. **outline** a testable hypothesis iii. **outline** the variables iv. **design** a method, **with limited success**.
3–4	The student is able to: i. **outline** a problem or question to be tested by a scientific investigation ii. **formulate** a testable hypothesis **using scientific reasoning** iii. **outline** how to manipulate the variables, and **outline** how **relevant data** will be collected iv. design a **safe method** in which he or she **selects materials and equipment**.
5–6	The student is able to: i. **describe** a problem or question to be tested by a scientific investigation ii. **formulate and explain** a testable hypothesis **using scientific reasoning** iii. **describe** how to manipulate the variables, and **describe** how **sufficient, relevant data** will be collected iv. design a **complete and safe method** in which he or she selects **appropriate materials and equipment**.
7–8	The student is able to: i. **explain** a problem or question to be tested by a scientific investigation ii. **formulate and explain** a testable hypothesis **using correct scientific reasoning** iii. **explain** how to manipulate the variables, and **explain** how **sufficient, relevant data** will be collected iv. **design** a **logical, complete and safe method** in which he or she **selects appropriate materials and equipment**.

Criterion C: Processing and evaluating

Maximum: 8

At the end of year 5, students should be able to:

i. present collected and transformed data

ii. interpret data and explain results using scientific reasoning

iii. evaluate the validity of a hypothesis based on the outcome of the scientific investigation

iv. evaluate the validity of the method

v. explain improvements or extensions to the method.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **collect and present** data in numerical and/or visual forms ii. **interpret** data iii. **state** the validity of a hypothesis based on the outcome of a scientific investigation iv. **state** the validity of the method based on the outcome of a scientific investigation v. **state** improvements or extensions to the method.
3–4	The student is able to: i. **correctly collect and present** data in numerical and/or visual forms ii. **accurately interpret** data and **explain** results iii. **outline** the validity of a hypothesis based on the outcome of a scientific investigation iv. **outline** the validity of the method based on the outcome of a scientific investigation v. **outline** improvements or extensions to the method that would benefit the scientific investigation.
5–6	The student is able to: i. **correctly collect, organize and present** data in numerical and/or visual forms ii. **accurately interpret** data and **explain** results **using scientific reasoning** iii. **discuss** the validity of a hypothesis based on the outcome of a scientific investigation iv. **discuss** the validity of the method based on the outcome of a scientific investigation v. **describe** improvements or extensions to the method that would benefit the scientific investigation.

Achievement level	Level descriptor
7–8	The student is able to: i. **correctly collect, organize, transform and present** data in numerical and/or visual forms ii. **accurately interpret** data and **explain** results **using correct scientific reasoning** iii. **evaluate** the validity of a hypothesis based on the outcome of a scientific investigation iv. **evaluate** the validity of the method based on the outcome of a scientific investigation v. **explain** improvements or extensions to the method that would benefit the scientific investigation.

Criterion D: Reflecting on the impacts of science

Maximum: 8

At the end of year 5, students should be able to:

i. explain the ways in which science is applied and used to address a specific problem or issue

ii. discuss and evaluate the various implications of using science and its application to solve a specific problem or issue

iii. apply scientific language effectively

iv. document the work of others and sources of information used.

Achievement level	Level descriptor
0	The student **does not** reach a standard identified by any of the descriptors below.
1–2	The student is able to: i. **outline** the ways in which science is used to address a specific problem or issue ii. **outline** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **apply** scientific language to communicate understanding but does so **with limited success** iv. document sources, with **limited success**.
3–4	The student is able to: i. **summarize** the ways in which science is applied and used to address a specific problem or issue ii. **describe** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **sometimes apply** scientific language to communicate understanding iv. **sometimes** document sources correctly.
5–6	The student is able to: i. **describe** the ways in which science is applied and used to address a specific problem or issue ii. **discuss** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **usually apply** scientific language to communicate understanding clearly and precisely iv. **usually** document sources correctly.

Achievement level	Level descriptor
7–8	The student is able to: i. **explain** the ways in which science is applied and used to address a specific problem or issue ii. **discuss and evaluate** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **consistently apply** scientific language to communicate understanding **clearly and precisely** iv. document sources **completely**.

MYP eAssessment

Students seeking **IB MYP course results** for MYP sciences complete an on-screen examination in which they can demonstrate their achievement of subject-group objectives. Successful results can contribute to students' attainment of the **IB MYP certificate**.

Optional eAssessment in sciences is offered in biology, chemistry, physics and integrated sciences (biology, chemistry and physics) and is assessed by on-screen examination. This verification of learning assures accurate and consistently applied standards.

Topic lists for sciences

For the purpose of external assessment, the MYP identifies a range of subject-specific topics that constitute one of the variables that authors consider when they create on-screen examinations. These topics are at a lower level of specification than the formal syllabus of a similar subject in the IB Diploma Programme, and they leave considerable leeway for schools to develop their own written curriculum according to MYP requirements.

These topics define the examinable subject matter for MYP on-screen examinations. In their local development of the MYP curriculum, schools are not limited to these topics. This list does not constitute an exclusive IB-approved curriculum for MYP years 4–5.

Biology

- Cells (tissues, organs, systems, structure and function; factors affecting human health; physiology; vaccination)
- Organisms (habitat, ecosystems, interdependency, unity and diversity in life forms; energy transfer and cycles [including nutrient, carbon, nitrogen]; classification)
- Processes (photosynthesis, cell respiration, aerobic and anaerobic, word and chemical equations)
- Metabolism (nutrition, digestion, biochemistry and enzymes; movement and transport, diffusion; osmosis; gas exchange; circulation, transpiration and translocation; homeostasis)
- Evolution (life cycles, natural selection; cell division, mitosis, meiosis; reproduction; biodiversity; inheritance and variation, DNA and genetics)
- Interactions with environment (tropism, senses, nervous system, receptors and hormones)
- Interactions between organisms (pathogens/parasites, predator/prey, food chains and webs; competition, speciation and extinction)
- Human interactions with environments (human influences, habitat change or destruction, pollution/ conservation; overexploitation, mitigation of adverse effects)
- Biotechnology (genetic modification, cloning; ethical implications, genome mapping and application, 3D tissue and organ printing)

Chemistry

- Periodic table (metals and non-metals; transition metals, noble gases, trends, periods, groups)
- International Union of Pure and Applied Chemistry (IUPAC naming and classification of: alkanes, alkenes, alcohols, carboxylic acids and esters; structural formulas)
- The atmosphere (characteristics of gases; atmospheric composition, testing and treatment; extraction, emission and environmental implications)
- Matter (states and properties of matter; particle/kinetic theory, diffusion; atomic structure [including isotopes]; electron configuration and valency)
- Pure and impure substances (types of mixtures [solutions, oils, alloys, emulsions]; separation techniques, including: filtration, distillation [including crude oil], chromatography)
- Bonding (structure and bonding, properties, chemical formulas, chemical reactions and the conservation of mass; balancing equations, the mole concept and chemical calculations; reaction kinetics [rates, and factors affecting rates/collision theory]; equilibria/reversible reactions; energy changes in reactions, endo- and exothermicity; combustion of fuels)
- Types of chemical reaction (acids and bases, neutral solutions, acid/base reactions, pH and indicators, formation of salts, uses of salts; redox reactions, reactivity series; extraction of metals, and corrosion, electrochemical cells)

Physics

- Forces and energy (measurement in science; states and properties of matter, kinetic theory, density; forces and effects of forces; forces and motion, speed, motion graphs, Newton's laws; pressure; work and power, efficiency; gravity and gravitational fields; energy sources and resources, fuels and environmental impact; energy transfer and transformation, conservation of energy)
- Electromagnetism (magnetism, electric and magnetic fields; static electricity; electromagnetic forces and induction, AC and DC; current, voltage, power, generation and transmission of electricity; electric circuits)
- Astrophysics (the solar system, planets and satellites, the Big Bang theory)
- Heat, light and sound (thermal physics; heat transfer, condensation and evaporation)
- Waves (longitudinal and transverse waves, sound waves; wave phenomena including reflection, refraction, diffraction; wave equation; electromagnetic spectrum, imaging and applications)
- Atomic physics (atomic structure, particles, charges and masses; radioactivity, decay and half-life, forms of radiation; uses and dangers)

Integrated sciences

- Atoms (atomic structure and electron configuration)
- Bonding (word and chemical reactions and formulas; acids, bases and pH)
- Cells (tissues, organs and systems; cell division; reproduction)
- Electromagnetism (magnetism, magnetic fields; electric circuits)
- Forces and energy (motion, motion graphs, Newton's laws; energy transfer and transformation)
- Fuels (combustion)
- Interactions between organisms (food chains and webs)
- Matter (particles and kinetic theory)
- Metabolism (digestion, gas exchange)

- Periodic table (trends, periods, groups)
- Systems (photosynthesis and respiration)

Sciences examination blueprint

MYP on-screen examinations are constructed as a series of tasks that sample, simulate or replicate internal assessment practices. The assessments follow an agreed structure that provides a clear framework for developing each examination. The distribution of marks within each eAssessment may vary by no more than three marks from those displayed in the blueprint.

As part of an ethical assessment model, these assessment blueprints ensure consistency and transparency, and they guarantee a balanced approach in measuring students' achievement with respect to MYP objectives. MYP on-screen examination blueprints document the close connection of large-scale assessment with subject-group objectives, classroom learning engagements and the programme's rigorous internal assessment requirements.

These blueprints enable teachers and students to review the nature and purpose of MYP eAssessment. They provide an important resource for helping students to prepare for on-screen examinations, focusing attention on subject-group criteria and assessment strategies in each subject group.

Overview

The following table illustrates how on-screen examinations in the sciences assessment are structured.

Task	Marks	Main criteria assessed	Criterion marks
Knowing and understanding	25	A	25
Investigation skills	50	B	25
		C	25
Applying science	25	D	25
	100		

Examination sources, tools and tasks

Sources

A variety of sources feature in each assessment and could include the following.

- Data tables
- Static images
- Videos
- Animations
- Simulations
- Graphs

Tools

A variety of response tools are available to students, including but not limited to an on-screen calculator, a measuring tool, drawing canvases, a graph plotter and a table drawing tool.

Students will be able to access an age-appropriate interactive version of the IUPAC periodic table used in Diploma Programme examinations. With the exceptions of copper and chlorine, the relative atomic masses of all elements will be rounded to the nearest whole number.

1	2											3	4	5	6	7	0
H			Copper **Cu**														He
Li	Be		**Atomic number:** 29									B	C	N	O	F	Ne
Na	Mg		**Relative atomic mass:** 63.5									Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La†	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac‡	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							

Table 7

IUPAC periodic table

Any other data required will be provided within questions.

Tasks

Knowing and understanding

The first task assesses students' knowledge and understanding of science; however, marks may be awarded against the other criteria when appropriate to the skills used in answering a question. For example, a question assessing knowledge and understanding may also involve interpretation of data. In this situation marks are awarded against criteria A and C.

Investigation skills

The second task assesses the skills needed in scientific investigations (criteria B and C). The task may involve a single investigation or it may assess specific skills in a number of discrete scenarios. A variety of rich media will be used to present different challenges. Students should expect to formulate hypotheses, plan investigations, collect data from simulations, present data appropriately and interpret and evaluate data and hypotheses.

Applying science

The third task requires students to explain how science is used to address a real-life issue. This task will be assessed against criterion D, but there may be occasions when marks are also awarded against the other three criteria when this is appropriate for the question. Students should expect to write extended responses, which consider one or more of the factors indicated in the subject guide.

Conventions for on-screen examinations in MYP sciences

Standardized symbols, notation and terminology for the sciences

MYP eAssessments will use the standards adopted by the IB from a system of notation based on ISO 80000 (International Organization for Standardization, 2009). Students are expected to recognize this notation in science disciplines, and teachers should introduce this notation as a regular part of MYP courses as appropriate.

For on-screen examinations in the sciences, symbols, units and equations—where appropriate—will be provided to ensure consistent usage and authentic age-appropriate scientific communication. If an examination question requires additional symbols or notations, they will be defined and explained within the context of the relevant task.

Candidates must always use correct mathematical notation, not calculator notation. Candidates should be familiar with scientific notation, also referred to as standard form, as follows:

$a \times 10^k$ where $1 \le a \le 10$ and $k \in \mathbb{Z}$

Answers will require an appropriate use of significant figures or decimal places based on the demands of the question. Unless otherwise indicated, final answers are to be given correct to three significant figures. Estimation is to be completed by rounding; truncation will not be rewarded.

Correct use of subscript and superscript is expected in all relevant scientific and mathematical contexts.

Candidates are expected to use the on-screen tools to present chemical formulas appropriately. Chemical formulas with missing subscripts and superscripts are incorrect and will not be rewarded.

In the sciences, numerical values usually relate to physical quantities and will therefore have associated units; candidates are expected to include appropriate units in their answers. Units used for measurement and calculation will refer to the SI units (*Système international d'unités*) where possible. Candidates must also be familiar with metric (SI) multipliers and more demanding derived units (mol dm^{-3}, J g^{-1} °C^{-1}, $kJmol^{-1}$, gdm^{-3}, ms^{-1}, ms^{-2}).

Exceptions:

- Mass is measured in kg but may also be given in g, particularly in laboratory conditions. The tonne (t), which is equivalent to 1000 kg, will be used for larger masses.
- Volume is measured in dm^3 but also in cm^3, particularly in laboratory conditions.
- Temperature is measured in °C.
- Pressure is measured in Pa (Pascal).

For the purposes of eAssessment, the updated CLP hazard symbols used will be taken from www.unece.org.

Metric multipliers

The following information about metric multipliers will be provided in the on-screen examination for all sciences subjects.

Prefix	Abbreviation	Value
tera	T	10^{12}
giga	G	10^{9}

Prefix	Abbreviation	Value
mega	M	10^6
kilo	k	10^3
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

MYP physics formula sheet

Density	$\text{density} = \frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
Force	$\text{force} = \text{mass} \times \text{acceleration}$	$F = ma$
Motion	$\text{final velocity} = \text{initial velocity} + (\text{acceleration} \times \text{time})$	$v = u + at$
	$\text{distance} = (\text{initial velocity} \times \text{time}) + \frac{1}{2} \times \text{acceleration} \times (\text{time})^2$	$s = ut + \frac{1}{2}at^2$
	$(\text{final velocity})^2 = (\text{initial velocity})^2 + 2 \times \text{acceleration} \times \text{distance}$	$v^2 = u^2 + 2as$
	$\text{distance} = \frac{(\text{final velocity} + \text{initial velocity}) \times \text{time}}{2}$	$s = \frac{(v+u)t}{2}$
Momentum	$\text{momemtum} = \text{mass} \times \text{velocity}$	$p = mv$
Pressure	$\text{pressure} = \frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
Work	$\text{work} = \text{force} \times \text{distance}$	$W = Fs$
Kinetic energy	$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times (\text{velocity})^2$	$E_k = \frac{1}{2}mv^2$
Gravitational field strength	$\text{gravitational field strength} = \frac{\text{force}}{\text{mass}}$	$g = \frac{F}{m}$
Gravitational potential energy	$\text{change in gravitational potential energy} = \text{mass} \times g \times \text{change in height}$	$\Delta E_p = mg\,\Delta h$

Efficiency	$\text{efficiency} = \dfrac{\text{useful energy out}}{\text{total energy in}} \times 100$	
Power	$\text{power} = \dfrac{\text{work done}}{\text{time}}$	$P = \dfrac{W}{t}$
Current	$\text{current} = \dfrac{\text{flow of charge}}{\text{time}}$	$I = \dfrac{\Delta Q}{t}$
Power	$\text{power} = \text{voltage} \times \text{current}$	$P = IV$
Voltage	$\text{voltage} = \text{current} \times \text{resistance}$	$V = IR$
Transformers	$\dfrac{\text{primary voltage}}{\text{secondary voltage}} = \dfrac{\text{turns on primary coil}}{\text{turns on secondary coil}}$	$\dfrac{V_p}{V_s} = \dfrac{V_p}{N_s}$
Wave speed	$\text{wave speed} = \text{frequency} \times \text{wavelength}$	$v = f\lambda$
Time period	$\text{time period} = \dfrac{1}{\text{frequency}}$	$T = \dfrac{1}{f}$

MYP integrated sciences formula sheet

Density	$\text{density} = \dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
Force	$\text{force} = \text{mass} \times \text{acceleration}$	$F = ma$
Motion	$\text{final velocity} = \text{initial velocity} + (\text{acceleration} \times \text{time})$	$v = u + at$
	$\text{distance} = (\text{initial velocity} \times \text{time}) + \dfrac{1}{2} \times \text{acceleration} \times (\text{time})^2$	$s = ut + \dfrac{1}{2}at^2$
	$(\text{final velocity})^2 = (\text{initial velocity})^2 + 2 \times \text{acceleration} \times \text{distance}$	$v^2 = u^2 + 2as$
	$\text{distance} = \dfrac{(\text{final velocity} + \text{initial velocity}) \times \text{time}}{2}$	$s = \dfrac{(v+u)t}{2}$
Momentum	$\text{momemtum} = \text{mass} \times \text{velocity}$	$p = mv$
Kinetic energy	$\text{kinetic energy} = \dfrac{1}{2} \times \text{mass} \times (\text{velocity})^2$	$E_k = \dfrac{1}{2}mv^2$
Gravitational field strength	$\text{gravitational field strength} = \dfrac{\text{force}}{\text{mass}}$	$g = \dfrac{F}{m}$
Gravitational potential energy	$\text{change in gravitational potential energy} = \text{mass} \times g \times \text{change in height}$	$\Delta E_p = mg\,\Delta h$
Current	$\text{current} = \dfrac{\text{flow of charge}}{\text{time}}$	$I = \dfrac{\Delta Q}{t}$
Power	$\text{power} = \text{voltage} \times \text{current}$	$P = IV$
Voltage	$\text{voltage} = \text{current} \times \text{resistance}$	$V = IR$
Transformers	$\dfrac{\text{primary voltage}}{\text{secondary voltage}} = \dfrac{\text{turns on primary coil}}{\text{turns on secondary coil}}$	$\dfrac{V_p}{V_s} = \dfrac{V_p}{N_s}$

Sciences subject-specific grade descriptors

Subject-specific grade descriptors serve as an important reference in the assessment process. Through careful analysis of subject-group criteria and the general grade descriptors, they have been written to capture and describe in a single descriptor the performance of students at each grade for each MYP subject group.

For on-screen examination subjects, teachers are required to submit predicted grades. When considering predicted grades, teachers should consider their own assessment of students during MYP 4 and the first part of MYP 5 and allowing for subsequent academic development, teachers are asked to predict the outcome of eAssessment for their students with reference to the subject-specific grade descriptors. This prediction helps the IB to check the alignment between teachers' expectations and the IB's assessment outcome and, as such, forms an essential strategy for ensuring reliable results.

Subject-specific grade descriptors are also the main reference used to select grade boundaries for each discipline in each assessment session. During this process, the grade award team compares student performance against descriptors of achievement at grades 2 and 3; 3 and 4; and 6 and 7 (other boundaries are set at equal intervals between these key transitions). The grade award process is able to compensate for variations in challenge between examinations and in standards applied to marking (both between subjects and for a particular subject across sessions) by setting boundaries for each discipline and examination session, with reference to real student work.

Subject-specific grade descriptors tie eAssessment to criterion-related assessment and to MYP assessment criteria and level descriptors, which put the programme's criterion-related assessment philosophy into practice.

Grade	Descriptor
7	Produces high-quality work with frequent insightful scientific discussion that is fully justified. Communicates comprehensive, nuanced understanding of concepts and contexts demonstrating proficient use of scientific and technical communication modes. Consistently demonstrates sophisticated analytical thinking and critical evaluation to make scientifically supported judgments. Frequently transfers scientific knowledge and applies scientific skills, with independence and expertise, in complex classroom and real-world situations.
6	Produces high-quality work with occasionally insightful scientific discussion and justification. Communicates extensive understanding of concepts and contexts demonstrating proficient use of scientific and technical communication modes. Demonstrates analytical thinking and critical evaluations to make scientifically supported judgments, frequently with sophistication. Transfers scientific knowledge and applies scientific skills, often with independence, in classroom and real-world situations.
5	Produces generally high-quality work with scientific discussion and justification. Communicates good understanding of concepts and contexts demonstrating proficient use of scientific and technical communication modes. Demonstrates analytical thinking and critical evaluations to make scientifically supported judgments, sometimes with sophistication. Usually transfers scientific knowledge and applies scientific skills, with some independence, in classroom and real-world situations.
4	Produces good-quality work with some evidence of scientific discussion and justification. Communicates basic understanding of most concepts and contexts with evidence of appropriate scientific and technical communication modes, with few misunderstandings and minor gaps. Often demonstrates analytical thinking to make scientifically supported judgments. Transfers some scientific knowledge and applies some scientific skills in classroom and real-world situations, but requires support in unfamiliar situations.

Grade	Descriptor
3	Produces work of an acceptable quality with occasional evidence of scientific description. Communicates basic understanding of many concepts and contexts, with occasional significant misunderstandings or gaps. Begins to demonstrate some analytical thinking and begins to make scientifically supported judgments. Begins to transfer scientific knowledge and apply skills, requiring support even in familiar classroom situations.
2	Produces work of limited quality. Communicates limited understanding of some concepts and contexts with significant gaps in understanding. Demonstrates limited evidence of scientific thinking. Limited evidence of transfer of scientific knowledge and application of skills.
1	Produces work of a very limited quality. Conveys many significant misunderstandings or lacks understanding of most concepts and contexts. Very rarely demonstrates evidence of scientific thinking. Very inflexible, rarely shows evidence of knowledge or skills.

Related concepts in sciences

Related concept	Definition
Balance: biology specific	The dynamic equilibrium that exists among members of a stable natural community; the regulation of the internal environment of an organism.
Balance: chemistry specific	A state of equilibrium or stable distribution.
Conditions: chemistry specific	The environment, both physical and chemical, of a reaction or process; factors which contribute to an interaction including temperature, pressure, concentration, pH and the absence or presence of a catalyst.
Consequences	The observable or quantifiable effects, results, or outcomes correlated with an earlier event or events.
Development: physics specific	The process of applying theory to data and observations in order to improve, progress, or further scientific understanding.
Energy	The capacity of an object to do work or transfer heat.
Environment: biology specific	All of the biotic and abiotic factors that act on an organism, population or community and influence its survival, evolution and development.
Environment: physics specific	A description of the universe or a closed system through the application of the laws of physics; the complex of physical conditions or climate affecting a habitat or community.
Evidence	Support for a proposition derived from observation and interpretation of data.
Form	The features of an object that can be observed, identified, described, classified and categorized.
Function	A purpose, a role or a way of behaving that can be investigated; a mathematical relationship between variables.
Interaction	The effect or effects two or more systems, bodies, substances or organisms have on one another, so that the overall result is not simply the sum of the separate effects.
Models	Representations used for testing scientific theories or proposals that can be accurately repeated and validated; simulations used for explaining or predicting processes which may not be observable or to understand the dynamics of multiple underlying phenomena of a complex system.
Movement	The act, process, or result of displacing from one location or position to another within a defined frame of reference.
Patterns	The distribution of variables in time or space; sequences of events or features.

Related concept	Definition
Transfer: chemistry specific	The net movement of matter or particles from one location to another.
Transformation: biology specific	Differentiation of a cell; change of energy form, including at a molecular level; alteration of molecules and metabolism and/or genetic make-up of an organism or species and consequently a community, relative to external factors.
Transformation: physics specific	A change from one well-defined state to another well-defined state; an alteration in form or condition, including energy and particle nature.

Sciences glossary

Term	Definition
Cultural	Patterns of knowledge, behaviour, beliefs, shared attitudes, values, goals and practices that characterize groups of people.
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.
Economic	Production, distribution, and use of income, wealth, and commodities.
Environmental	Circumstances, objects, or conditions by which one is surrounded.
Ethical	Process of rational inquiry to decide on issues as right or wrong, as applied to the people and their actions.
Extensions to the method	Developments for further inquiry as related to the outcome of the investigation.
Hypothesis	A tentative explanation for an observation or phenomenon that requires experimental confirmation; 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.
Moral	Principles of right or wrong behaviour derived from a particular society.
Numerical forms	May include mathematical calculations such as averaging or determining values from a graph or table.
Political	Relates to government or public affairs.
Prediction	Give an expected result of an upcoming action or event.
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.
Social	Interactions between groups of people involving issues such as welfare, safety, rights, justice or class.

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

MYP command terms for sciences

Command term	Definition
Analyse	Break down in order to bring out the essential elements or structure. (To identify parts and relationships, and to interpret information to reach conclusions.)
Annotate	Add brief notes to a diagram or graph.
Apply	Use knowledge and understanding in response to a given situation or real circumstances. Use an idea, equation, principle, theory or law in relation to a given problem or issue.
Calculate	Obtain a numerical answer showing the relevant stages in the working.
Classify	Arrange or order by class or category.
Comment	Give a judgment based on a given statement or result of a calculation.
Construct	Display information in a diagrammatic or logical form.
Define	Give the precise meaning of a word, phrase, concept or physical quantity.
Demonstrate	Make clear by reasoning or evidence, illustrating with examples or practical application.
Describe	Give a detailed account or picture of a situation, event, pattern or process.
Design	Produce a plan, simulation or model.
Determine	Obtain the only possible answer.
Discuss	Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.
Document	Credit 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.
Draw	Represent by means of a labelled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines. Diagrams should be drawn to scale. Graphs should have points correctly plotted (if appropriate) and joined in a straight line or smooth curve.
Estimate	Obtain an approximate value for an unknown quantity.
Evaluate	Make an appraisal by weighing up the strengths and limitations.
Explain	Give a detailed account including reasons and causes. (See also "Justify".)
Find	Obtain an answer showing relevant stages in the working.

Command term	Definition
Formulate	Express precisely and systematically the relevant concept(s) or argument(s).
Identify	Provide an answer from a number of possibilities. Recognize and state briefly a distinguishing fact or feature.
Interpret	Use knowledge and understanding to recognize trends and draw conclusions from given information.
Justify	Give valid reasons or evidence to support an answer or conclusion. (See also "Explain").
Label	Add title, labels or brief explanation(s) to a diagram or graph.
List	Give a sequence of brief answers with no explanation.
Measure	Obtain a value for a quantity.
Organize	Put ideas and information into a proper or systematic order.
Outline	Give a brief account or summary.
Plot	Mark the position of points on a diagram.
Present	Offer for display, observation, examination or consideration.
Recall	Remember or recognize from prior learning experiences.
Select	Choose from a list or group.
Show	Give the steps in a calculation or derivation.
Sketch	Represent by means of a diagram or graph (labelled as appropriate). The sketch should give a general idea of the required shape or relationship, and should include relevant features.
Solve	Obtain the answer(s) using appropriate methods.
State	Give a specific name, value or other brief answer without explanation or calculation.
Suggest	Propose a solution, hypothesis or other possible answer.
Summarize	Abstract a general theme or major point(s).
Verify	Provide evidence that validates the result.
Write down	Obtain the answer(s), usually by extracting information. Little or no calculation is required. Working does not need to be shown.

On-screen examinations in sciences will draw from the full list of MYP command terms that is available in *MYP: From principles into practice*.

Selected reading

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