

Purpose of internal assessment

Internal assessment is an integral part of the course and is compulsory for SL students. It enables students to demonstrate the application of their skills and knowledge, and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations. The internal assessment should, as far as possible, be woven into normal classroom teaching and not be a separate activity conducted after a course has been taught.

Time allocation

Internal assessment is an integral part of the astronomy course, contributing 20% to the final assessment in the SL course. This weighting should be reflected in the time that is allocated to teaching the knowledge, skills and understanding required to undertake the work, as well as the total time allocated to carry out the work.

It is recommended that a total of approximately 10 hours of teaching time should be allocated to the work. This should include:

- time for the teacher to explain to students the requirements of the internal assessment
- class time for students to work on the internal assessment component and ask questions
- time for consultation between the teacher and each student
- time to review and monitor progress, and to check authenticity

Guidance and authenticity

The individual investigation submitted for internal assessment must be the student's own work. However, it is not the intention that students should decide upon a title or topic and be left to work on the internal assessment component without any further support from the teacher. The teacher should play an important role during both the planning stage and the period when the student is working on the internally assessed work. It is the responsibility of the teacher to ensure that students are familiar with:

- the requirements of the type of work to be internally assessed
- the assessment criteria; students must understand that the work submitted for assessment must address these criteria effectively.

Teachers and students must discuss the internally assessed work. Students should be encouraged to initiate discussions with the teacher to obtain advice and information, and students must not be penalized for seeking guidance. As part of the learning process, teachers should read and give advice to students on one draft of the work. The teacher should provide oral or written advice on how the work could be improved, but not edit the draft. The next version handed to the teacher must be the final version for submission.

It is the responsibility of teachers to ensure that all students understand the basic meaning and significance of concepts that relate to academic honesty, especially authenticity and intellectual property. Teachers must ensure that all student work for assessment is prepared according to the requirements and must explain clearly to students that the internally assessed work must be entirely their own. Where collaboration between students is permitted, it must be clear to all students what the difference is between collaboration and collusion.

All work submitted to the IB for moderation or assessment must be authenticated by a teacher, and must not include any known instances of suspected or confirmed academic misconduct. Each student

must confirm that the work is his or her authentic work and constitutes the final version of that work. Once a student has officially submitted the final version of the work it cannot be retracted. The requirement to confirm the authenticity of work applies to the work of all students, not just the sample work that will be submitted to the IB for the purpose of moderation. For further details refer to the IB publication *Academic honesty, The Diploma Programme: From principles into practice* and the relevant articles in *General regulations: Diploma Programme*.

Authenticity may be checked by discussion with the student on the content of the work, and scrutiny of one or more of the following:

- the student's initial proposal
- the first draft of the written work
- the references cited
- the style of writing compared with work known to be that of the student
- the analysis of the work by a web-based plagiarism detection service.

The same piece of work cannot be submitted to meet the requirements of both the internal assessment and the extended essay.

Group work

Group work may not be undertaken by students as part of the individual investigation (IA). Each investigation is an individual piece of work based on different data collected or measurements generated. Ideally, students should work on their own when collecting data.

It should be made clear to students that all work connected with the investigation should be their own. It is therefore helpful if teachers try to encourage in students a sense of responsibility for their own learning so that they accept a degree of ownership and take pride in their own work.

Group work is encouraged for all other practical work.

Safety requirements and recommendations

While teachers are responsible for following national or local guidelines, which may differ from country to country, attention should be given to the guidelines below, which were developed for the International Council of Associations for Science Education (ICASE) Safety Committee by The Laboratory Safety Institute (LSI).

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

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 program 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 OSHA 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 prior knowledge of a staff member.
16. Extend the safety program 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. When 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:
 - "Safety in School Science Labs", Clair Wood, 1994, Kaufman & Associates, 101 Oak Street, Wellesley, MA 02482
 - "The Laboratory Safety Pocket Guide", 1996, Genium Publisher, One Genium Plaza, Schnectady, NY
 - "Safety in Academic Chemistry Laboratories", ACS, 1155 Sixteenth Street NW, Washington, DC 20036
 - "Manual of Safety and Health Hazards in The School Science Laboratory", "Safety in the School Science Laboratory", "School Science Laboratories: A guide to Some Hazardous Substances" Council of State Science Supervisors (now available only from LSI.)
 - "Handbook of Laboratory Safety", 4th Edition, CRC Press, 2000 Corporate Boulevard NW, Boca Raton, FL 33431
 - "Fire Protection Guide on Hazardous Materials", National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
 - "Prudent Practices in the Laboratory: Handling and Disposal of Hazardous Chemicals", 2nd Edition, 1995
 - "Biosafety in the Laboratory", National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418
 - "Learning By Accident", Volumes 1-3, 1997-2000, The Laboratory Safety Institute, Natick, MA 01760

(All are available from LSI.)
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 program 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.

Using assessment criteria for internal assessment

For internal assessment, a number of assessment criteria have been identified. Each assessment criterion has level descriptors describing specific achievement levels, together with an appropriate range of marks. The level descriptors concentrate on positive achievement, although for the lower levels failure to achieve may be included in the description.

Teachers must judge the internally assessed work against the criteria using the level descriptors.

- The aim is to find, for each criterion, the descriptor that conveys most accurately the level attained by the student, using the best-fit model. A best-fit approach means that compensation should be made when a piece of work matches different aspects of a criterion at different levels. The mark awarded should be one that most fairly reflects the balance of achievement against the criterion. It is not necessary for every single aspect of a level descriptor to be met for that mark to be awarded.
- When assessing a student's work, teachers should read the level descriptors for each criterion until they reach a descriptor that most appropriately describes the level of the work being assessed. If a piece of work seems to fall between two descriptors, both descriptors should be read again and the one that more appropriately describes the student's work should be chosen.
- Where there are two or more marks available within a level, teachers should award the upper marks if the student's work demonstrates the qualities described to a great extent; the work may be close to achieving marks in the level above. Teachers should award the lower marks if the student's work demonstrates the qualities described to a lesser extent; the work may be close to achieving marks in the level below.
- Only whole numbers should be recorded; partial marks, (fractions and decimals) are not acceptable.
- Teachers should not think in terms of a pass or fail boundary, but should concentrate on identifying the appropriate descriptor for each assessment criterion.
- The highest level descriptors do not imply faultless performance but should be achievable by a student. Teachers should not hesitate to use the extremes if they are appropriate descriptions of the work being assessed.
- A student who attains a high achievement level in relation to one criterion will not necessarily attain high achievement levels in relation to the other criteria. Similarly, a student who attains a low achievement level for one criterion will not necessarily attain low achievement levels for the other criteria. Teachers should not assume that the overall assessment of the students will produce any particular distribution of marks.
- It is recommended that the assessment criteria be made available to students.

Practical work and internal assessment

General introduction

The internal assessment, worth 20% of the final assessment, consists of one scientific investigation. The individual investigation should cover a topic that is commensurate with the level of the course of study.

Student work is internally assessed by the teacher and externally moderated by the IB. The performance in internal assessment at SL is marked against assessment criteria, with a total mark out of 24.

Note: Any investigation that is to be used to assess students should be specifically designed to match the relevant assessment criteria.

The internal assessment task will be one scientific investigation taking about 10 hours and the write-up should be about 6 to 12 pages long. Investigations exceeding this length will be penalized in the communication criterion as lacking in conciseness.

The practical investigation, with generic criteria, will allow a wide range of practical activities satisfying the varying needs of group 4 subjects. The investigation addresses many of the learner profile attributes well. See section on "Approaches to teaching and learning" for further links.

The task produced should be complex and commensurate with the level of the course. It should require a purposeful research question and the scientific rationale for it. The marked exemplar material in the teacher support material will demonstrate that the assessment will be rigorous and of the same standard as the assessment in the previous courses.

Some of the possible tasks include:

- a hands-on laboratory investigation
- using a spreadsheet for analysis and modelling
- extracting data from a database and analysing it graphically
- producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
- using a simulation provided it is interactive and open-ended.

Some tasks may consist of relevant and appropriate qualitative work combined with quantitative work.

The tasks include the traditional hands-on practical investigations as in the previous course. The depth of treatment required for hands-on practical investigations is unchanged from the previous internal assessment and will be shown in detail in the teacher support materials. In addition, detailed assessment of specific aspects of hands-on practical work will be assessed in the written papers as detailed in the relevant topic(s) in the "Syllabus content" section of the guide.

The task will have the same assessment criteria for SL and HL. The five assessment criteria are personal engagement, exploration, analysis, evaluation and communication.

Internal assessment details

Internal assessment component

Duration: 10 hours

Weighting: 20%

- Individual investigation.
- This investigation covers assessment objectives 1, 2, 3 and 4.

Internal assessment criteria

The new assessment model uses five criteria to assess the final report of the individual investigation with the following raw marks and weightings assigned:

| Personal engagement | Exploration | Analysis | Evaluation | Communication | Total |
|---------------------|-------------|----------|------------|---------------|-----------|
| 2 (8%) | 6 (25%) | 6 (25%) | 6 (25%) | 4 (17%) | 24 (100%) |

Levels of performance are described using multiple indicators per level. In many cases the indicators occur together in a specific level, but not always. Also, not all indicators are always present. This means that a candidate can demonstrate performances that fit into different levels. To accommodate this, the IB assessment models use markbands and advise examiners and teachers to use a **best-fit approach** in deciding the appropriate mark for a particular criterion.

Teachers should read the guidance on using markbands shown above in the section called “Using assessment criteria for internal assessment” before starting to mark. It is also essential to be fully acquainted with the marking of the exemplars in the teacher support material. The precise meaning of the command terms used in the criteria can be found in the glossary of the subject guides.

Personal engagement

This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These could include addressing personal interests or showing evidence of independent thinking, creativity or initiative in the designing, implementation or presentation of the investigation.

| Mark | Descriptor |
|------|--|
| 0 | The student's report does not reach a standard described by the descriptors below. |
| 1 | <p>The evidence of personal engagement with the exploration is limited with little independent thinking, initiative or insight.</p> <p>The justification given for choosing the research question and/or the topic under investigation does not demonstrate personal significance, interest or curiosity.</p> <p>There is little evidence of personal input and initiative in the designing, implementation or presentation of the investigation.</p> |
| 2 | <p>The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or insight.</p> <p>The justification given for choosing the research question and/or the topic under investigation demonstrates personal significance, interest or curiosity.</p> <p>There is evidence of personal input and initiative in the designing, implementation or presentation of the investigation.</p> |

Exploration

This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the Diploma Programme level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

| Mark | Descriptor |
|------|---|
| 0 | The student's report does not reach a standard described by the descriptors below. |
| 1–2 | <p>The topic of the investigation is identified and a research question of some relevance is stated but it is not focused.</p> <p>The background information provided for the investigation is superficial or of limited relevance and does not aid the understanding of the context of the investigation.</p> <p>The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.</p> <p>The report shows evidence of limited awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation*.</p> |
| 3–4 | <p>The topic of the investigation is identified and a relevant but not fully focused research question is described.</p> <p>The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation.</p> <p>The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.</p> <p>The report shows evidence of some awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation*.</p> |
| 5–6 | <p>The topic of the investigation is identified and a relevant and fully focused research question is clearly described.</p> <p>The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation.</p> <p>The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.</p> <p>The report shows evidence of full awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation*.</p> |

* This indicator should only be applied when appropriate to the investigation.

Analysis

This criterion assesses the extent to which the student's report provides evidence that the student has selected, recorded, processed and **interpreted** the data in ways that are relevant to the research question and can support a conclusion.

| Mark | Descriptor |
|------|--|
| 0 | The student's report does not reach a standard described by the descriptors below. |
| 1–2 | <p>The report includes insufficient relevant raw data to support a valid conclusion to the research question.</p> <p>Some basic data processing is carried out but is either too inaccurate or too insufficient to lead to a valid conclusion.</p> <p>The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis.</p> <p>The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.</p> |
| 3–4 | <p>The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question.</p> <p>Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing.</p> <p>The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis.</p> <p>The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced.</p> |
| 5–6 | <p>The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question.</p> <p>Appropriate and sufficient data processing is carried out with the accuracy required to enable a conclusion to the research question to be drawn that is fully consistent with the experimental data.</p> <p>The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis.</p> <p>The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.</p> |

Evaluation

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

| Mark | Descriptor |
|------|---|
| 0 | The student's report does not reach a standard described by the descriptors below. |
| 1–2 | <p>A conclusion is outlined which is not relevant to the research question or is not supported by the data presented.</p> <p>The conclusion makes superficial comparison to the accepted scientific context.</p> <p>Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are outlined but are restricted to an account of the practical or procedural issues faced.</p> <p>The student has outlined very few realistic and relevant suggestions for the improvement and extension of the investigation.</p> |
| 3–4 | <p>A conclusion is described which is relevant to the research question and supported by the data presented.</p> <p>A conclusion is described which makes some relevant comparison to the accepted scientific context.</p> <p>Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are described and provide evidence of some awareness of the methodological issues* involved in establishing the conclusion.</p> <p>The student has described some realistic and relevant suggestions for the improvement and extension of the investigation.</p> |
| 5–6 | <p>A detailed conclusion is described and justified which is entirely relevant to the research question and fully supported by the data presented.</p> <p>A conclusion is correctly described and justified through relevant comparison to the accepted scientific context.</p> <p>Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are discussed and provide evidence of a clear understanding of the methodological issues* involved in establishing the conclusion.</p> <p>The student has discussed realistic and relevant suggestions for the improvement and extension of the investigation.</p> |

Communication

This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

| Mark | Descriptor |
|------|--|
| 0 | The student's report does not reach a standard described by the descriptors below. |
| 1–2 | <p>The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.</p> <p>The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way.</p> <p>The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information.</p> <p>There are many errors in the use of subject-specific terminology and conventions*.</p> |
| 3–4 | <p>The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.</p> <p>The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way.</p> <p>The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation.</p> <p>The use of subject-specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.</p> |

*For example, incorrect/missing labelling of graphs, tables, images; use of units, decimal places. For issues of referencing and citations refer to the "Academic honesty" section.

Rationale for practical work

Although the requirements for IA are centred on the investigation, the different types of practical activities that a student may engage in serve other purposes, including:

- illustrating, teaching and reinforcing theoretical concepts
- developing an appreciation of the essential hands-on nature of much scientific work
- developing an appreciation of scientists' use of secondary data from databases
- developing an appreciation of scientists' use of modelling
- developing an appreciation of the benefits and limitations of scientific methodology.

Practical scheme of work

The practical scheme of work (PSOW) is the practical course planned by the teacher and acts as a summary of all the investigative activities carried out by a student.

Syllabus coverage

The range of practical work carried out should reflect the breadth and depth of the subject syllabus at each level, but it is not necessary to carry out an investigation for every syllabus topic. However, all students must participate in the group 4 project and the IA investigation.

Planning your practical scheme of work

Teachers are free to formulate their own practical schemes of work by choosing practical activities according to the requirements outlined. Their choices should be based on:

- the needs of their students
- available resources
- teaching styles.

Each scheme must include some complex experiments that make greater conceptual demands on students. A scheme made up entirely of simple experiments, such as ticking boxes or exercises involving filling in tables, will not provide an adequate range of experience for students.

Teachers are encouraged to share ideas about possible practical activities. A Basecamp group with a discussion forum will be created for astronomy teachers, where resources can also be uploaded for others to view. It is to be hoped that teachers will take advantage of this resource.

Flexibility

The practical programme is flexible enough to allow a wide variety of practical activities to be carried out. These could include:

- short labs or projects extending over several weeks
- computer simulations
- using databases for secondary data
- developing and using models
- data-gathering exercises such as questionnaires, user trials and surveys
- data-analysis exercises
- fieldwork.

Practical work documentation

Details of the practical scheme of work are recorded on *Form 4/PSOWAS* provided in the *Handbook of Procedures*. A copy of the class *4/PSOWAS* form must be included with any sample set sent for moderation.

Time allocation for practical work

The recommended teaching times for all Diploma Programme courses are 150 hours at SL and 240 hours at HL. Students at SL are required to spend 40 hours, and students at HL 60 hours, on practical activities (excluding time spent writing up work). These times include 10 hours for the group 4 project and 10 hours for the internal assessment investigation. (Only 2–3 hours of investigative work can be carried out after the deadline for submitting work to the moderator and still be counted in the total number of hours for the practical scheme of work.)