

Practical work and internal assessment

General introduction

The internal assessment requirements are the same for biology, chemistry and physics. 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 both SL and HL is marked against common 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 biology, chemistry and physics. 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 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 mark bands 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	Clarifications
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>	<p>The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or insight.</p> <p>State the local and global context in an INTRODUCTION. Give local data or examples ie newspaper or articles</p> <p>The INTRODUCTION identifies the personal reasons why the research question and/or the topic under investigation is important (to you)</p> <p>Find other researchers work that is associated with the Research Question (RQ) Describes how you have adapted or modified or further explored that work in:</p> <ul style="list-style-type: none"> ● Designing the method ● Analysing and presenting the data ● Evaluating the data and method ● Revisit your initial reasons for interest and show how the findings apply to your introduction <p>RQ is not readily found in a book or on the internet</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	Clarifications
0	<p>The student's report does not reach a standard described by the descriptors below.</p>	
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>	

<p>5-6</p>	<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>State the Research Topic in a title for the investigation. This should summarise the purpose of the investigation and include the DV and local or global context.</p> <p>AND SEPARATELY STATE the Research Question (RQ):</p> <p>Formulates a focused research question (RQ) that explicitly states :</p> <ul style="list-style-type: none"> ● Dependent Variable (DV) with correct units ● Dependent Variable (DV) measurement technique ● Independent Variable (IV) with correct units ● Independent Variable (IV) with range ● Species or Subject being studied <p>Question is comprehensible. Make sure this work is answerable within the 10 hour limit for the IA.</p> <p>(Helpful hint: Go to news articles. The headlines will help with setting the topic. Using Journals will help set the RQ)</p> <p>INTRODUCTION has the BACKGROUND INFORMATION to the investigation which includes:</p> <ul style="list-style-type: none"> ● Subject specific related information ie use your course text ● Introduction gives a detailed account of the science related to the IV ie why is this variable of interest and use science to explain the variable ● Introduction includes scientific reasoning why the IV was chosen ie use supporting journals or news articles <p>Hypothesis , where used, includes:</p> <ul style="list-style-type: none"> ● correct scientific reasoning to show how the IV affects the DV using mathematical terminology (eg directly proportional), ● a sketch graph, with no errors or omissions. HINT Include ... using the work of ... I predict that the general trend will look like ... ALSO include another author's graph to support your idea <p>Designing the Method:</p> <ul style="list-style-type: none"> ● Describe how to manipulate the IV, including details of range and referenced protocols ● IV Range is appropriate for the task; minimum of 5 increments over a suitable range ● Describes how to measure the DV using referenced protocols ● Identifies how qualitative DV data will be collected and processed ● Identifies how quantitative DV data will be collected and processed ● Simple method protocols have been combined to make a more complex and challenging method for manipulating the IV and measuring the DV ● Describes how the DV data will be further manipulated ie %increase not just a mean calculated ● Replicates are sufficient for the task ie if completing a t-test 10 samples per group ● Annotated photo of equipment or set-up ● Suitable equipment and materials lists. ● Method is clearly presented in a stepwise format ● Explain why they have chosen the equipment to measure the DV and IV <p>Controlling the Variables:</p>
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- *Identifies all variables that could impact on the DV (called controlled variables, CV)*
- *Describes how they will manipulate all key CVs*
- *Explains why the CV's will be manipulated*
- *Identifies the impact on the results ie use a scale to indicate impact*
- *Identifies uncertainty of tools, apparatus and equipment*
- *include pretesting as justification for DV and IV*

Planning Data Collection and Processing

Relevant means:

- Qualitative data that is related to the the DV ie if a colorimeter is used then subjectively describe the colours observed
- Quantitative data collected for the DV directly measures the effect of the IV
- How will/What graphs be presented?

Appropriate and sufficient :

- means the DV data will be further manipulated ie %increase, MAP is a good example, so beyond simply a mean
- Mean is calculated
- SD/SEM is calculated
- A parametric test such as t-test or non-parametric test such as Mann Whitney is used on the DV processed data

The report shows evidence of full awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation***.

Safety and ethics sections of the method address the experimentation policy in the subject guide ie consent forms and Risk Assessment section

*This indicator should only be applied when appropriate to the investigation. See exemplars in TSM.

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	Clarifications
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

The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question.

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.

The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis.

The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.

Sufficient means:

- IV Range is appropriate for the task; minimum of 5 increments over a suitable range
- Replicates are sufficient for the task ie if completing a t-test 10 samples per group otherwise a minimum of 5 replicates

Relevant means:

- Qualitative data that is related to the the DV ie if a colorimeter is used then subjectively describe the colours observed
- Quantitative data collected for the DV directly measures the effect of the IV

Appropriate and sufficient :

- means the DV data will be further manipulated ie %increase so beyond simply a mean
- Mean is calculated
- SD/SEM is calculated
- A parametric test such as t-test or non-parametric test such as Mann Whitney is used on the DV processed data

Accuracy:

- 3 Significant figures and/or dp are consistent with the raw data ie has same level of precision as raw data
- Calculations are carried out without errors or omissions

Consistent:

- The parametric /non-parametric test result are correctly calculated
- Random Sample selected and reference to normal distribution

(Identifies uncertainty of tools, apparatus and equipment in method)

Uncertainties are adjusted, where necessary

Treatment of uncertainties and errors in the processed data

The parametric /non-parametric test result is accurately described. This is not a conclusion! Describe all data, including highlighting where anomalies occur

Table fulfills DUHUGIT:

- Decimal places consistent
- Units
- Headings
- Uncertainties (Treatment of the Uncertainty, adding equipment uncertainties)
- Gridlines
- Independent variable forms first column of table
- Title introducing the Graph

Graph fulfills PLAATES:

- Plots are correct and clearly identifiable
- Line of Best fit is included where required
- Axis have IV on X axis and DV on y axis
- Axis include uncertainties
- Type of graph is correct
- Error bars are included and state in a legend that they represent SD
- Scale is appropriate

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	Clarifications
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>	

<p>5-6</p>	<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>	<p>Concluding:</p> <ul style="list-style-type: none"> ● Observations, trends and patterns revealed by the data ● Comparison with a literature value referenced ● States a conclusion with justification ● Include a scientific explanation for the conclusion ● Associated qualitative data is used to give supporting evidence for the conclusion ● Appropriate language such as 'supports my hypothesis' is used ● Sources cited correctly <p>Evaluating procedure:</p> <ul style="list-style-type: none"> ● Evaluation of the data/hypothesis and methodology ● Reference to error bars with regard to reliability of the results ● Explanation of reliability of the results ● Validity statement based on the data being sufficient to answer the RQ (https://explorable.com/validity-and-reliability or https://www.uni.edu/chfasoa/reliabilityandvalidity.htm) ● Comment suggesting if the IV data range was appropriate to answer the RQ ● Identify and explain any anomalies ● Qualitative data is discussed and used to suggest any limitations or implications of the data ● Refers to errors and suggest how much this impacted upon the data collected. <p>For the following the student refers to possible effect on the data and scales the impact on the data; this can be tabulated:</p> <ul style="list-style-type: none"> ● Evaluate random biological variation ● Evaluate measurement/instrument errors or limitations ● Evaluate systematic (method) errors ● The focus is on the investigation rather than time management or human errors <p>Improving the investigation:</p> <ul style="list-style-type: none"> ● Suggests improvements, linked to aspect 2, and gives advantages and limitations of each improvement ● Suggested improvements focus on modifications to experimental technique ● Modifications realistic and clearly specified
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*See exemplars in TSM for clarification.

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	Clarifications
0	The student's report does not reach a standard described by the descriptors below.	N/A
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>Figure title, paragraph title, and page number</p> <p>Table fulfills DUHUGIT:</p> <ul style="list-style-type: none"> ● Decimal places consistent ● Units ● Headings ● Uncertainties ● Gridlines ● Independent variable forms first column of table ● Title introducing the Graph ● Records all quantitative data correctly in a table <p>Graph fulfills PLAATES:</p> <ul style="list-style-type: none"> ● Plots are correct and clearly identifiable ● Line of Best fit is included where required ● Axis have IV on X axis and DV on y axis ● Axis include uncertainties ● Type of graph is correct ● Error bars are included ● Error bars have a legend to identify the source ● Scale is appropriate <p>3 Significant figures and/or dp are consistent in raw data</p> <p>The report includes:</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>	<ul style="list-style-type: none"> ● Title ● RQ ● Introduction ● Background Information ● Aim/Hypothesis ● Variables ● Methodology ● Results ● Discussion /Data Analysis ● Conclusion ● Evaluation ● Bibliography <p>The report is structured logically</p> <p>Calculation examples of working out shown Calculation steps are clearly stated</p> <p>Descriptions and Explanations are giving a lot of information clearly and in as few words possible; brief but comprehensive Descriptions and Explanations are giving a lot of information clearly and link directly to the RQ or findings</p> <p>Consistently apply scientific language to communicate understanding clearly and precisely: 0 or more key scientific terms are used in strand one above.</p> <p>All key scientific terms are relevant and used correctly</p> <p>Uses only recognised standard abbreviations</p> <p>Document sources completely: A variety of valid sources are used (3 different text types)</p> <p>Correctly formatted (MLA) in-text references are always used when necessary</p> <p>A correctly formatted bibliography (MLA format) that includes all in-text references</p>
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*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.