



L-Università
ta' Malta

MATSEC
Examinations Board



School-based Assessment Exemplars

SEC06 CHEMISTRY

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Suggested non-exhaustive lists of activities suitable for LOs earmarked for coursework.

Subject Focus 1 Substances from the Earth: The Atmosphere	
Learning Outcome 2	I can describe and explain the properties of gases that may be found in air and how to prepare them in the lab.
	Prepare and perform chemical tests on gases safely by selecting and assembling appropriate apparatus. (<i>This experiment can be done for H₂, CO₂ and O₂ individually.</i>)
	Project: Analysis of the amount of certain gases and particulates in the environment and how they may increase due to combustion reactions and natural causes based on local or foreign data.
	Fieldwork: Determine the amount of certain gases and particulates in the environment which may increase due to combustion reactions and natural causes.
	Visit sites that are concerned with air quality and monitoring.
	Project: Interpret data regarding environmental effects of some pollutants and discuss methods for reducing emission of pollutants into the atmosphere.

Subject Focus 2 Substances from the Earth: Aquatic environments	
Learning Outcome 3	I can describe the solvent action of water including the impact of water hardness.
	Project: Water as a very precious resource in the world and a potential source of conflict.
	Produce crystals of salt from rock salt.
	Investigate the differences between hard and soft water.
	Project: Evaluation of desalination techniques that can be used to create demineralised water from sea water.
	Visit a reverse osmosis plant.
	Visit labs that ensure water quality.
	Fieldwork: Collect water from different fresh-water bodies (including natural lake-like reservoirs and potable water in constructed water reservoirs) and test for hardness.

Subject Focus 2 Substances from the Earth: Aquatic environments	
Learning Outcome 4	I can describe the chemical properties of acids, bases and salts.
	Prepare a soluble salt by one of the following methods: metal + acid; insoluble base + acid; insoluble carbonate + acid.
	Prepare any three insoluble salts by precipitation.
	Prepare a sodium or a potassium salt using the titration method.
	Visit sites that use acids/bases in their operations.
	Investigations related to the application of acid-base concepts in everyday life.
	Fieldwork: Collect soil samples from different strata of rock and investigate their pH.

Subject Focus 2	Substances from the Earth: Aquatic environments
Learning Outcome 5	I can describe the conduction of electricity through solutions and molten salts.

	Electrolysis of aqueous solutions. <i>(Dilute sulfuric acid, copper(II) sulfate solution using inert and active electrodes and concentrated sodium chloride solution.)</i>
	Visit sites where electrolysis and its applications are used.
	Fieldwork: Test samples collected from the sea vs freshwater for electrical conductivity. <i>(Distilled water can be used as a control.)</i>

Subject Focus 2	Substances from the Earth: Aquatic environments
Learning Outcome 7	I can describe how substances dissolved in water can be identified and how their concentration can be measured.

	Perform paper chromatography. <i>(Solvents limited to water and ethanol.)</i>
	Visit sites where qualitative analysis is used.
	An investigation involving the analysis of both the cation and anion in three unknown substances. <i>(The unknowns may be either supplied as solids or in solution.)</i>
	Fieldwork: Identify the presence of cations and anions in soil and/or aquatic environments.
	Prepare a standard solution. <i>(Limited to sodium carbonate.)</i>
	Conduct an acid/base titration to calculate the concentration of a given solution. <i>(Example hydrochloric acid, sulfuric acid, nitric acid, ethanoic acid with sodium hydroxide, potassium hydroxide and sodium carbonate.)</i>

Subject Focus 3	Substances from the Earth: The Land
Learning Outcome 8	I can describe how different rocks contain important substances, their extraction, chemical nature, responsible use and environmental impact.

	Visit quarries and/or museums related to limestone.
	Project: Limestone and its use in Malta including the economic and environmental impact of open quarrying of stone.
	Investigate the simple physical and chemical properties of substances used in buildings and relate them to their use. <i>(E.g. Physical properties: density, heat and electrical conductivity and chemical properties: action of acids and water on limestone, concrete, wood, steel and aluminium.)</i>
	Investigate the conditions needed for iron to rust and the effectiveness of the various rust prevention techniques in different situations.
	Determine the position of an unknown metal (e.g. tin) with respect to other metals in the reactivity series from their reactions with water/steam and hydrochloric acid. <i>(Other metals limited to potassium, sodium, calcium, magnesium, aluminium, zinc, iron, lead, and copper.)</i>
	Determine metals' position in the reactivity series from displacement reactions. <i>(Metals limited to magnesium, aluminium, zinc, iron, lead, and copper.)</i>

	Visit a waste treatment plant to learn about the best course of action when considering the finite nature of many metals. (Reduce, reuse, recycle.)
	Project: The best course of action when considering the finite nature of many metals. (Reduce, reuse, recycle.)
	Fieldwork regarding the best course of action when considering the finite nature of many metals. (Reduce, reuse, recycle.)
	Fieldwork: Collect rock or sediment samples from a point or area which has different strata (ex: Għajn Tuffieħa) and analyse them (ex: pH, solubility in acid, etc.).
	Site visit along a bay (ex: marina) and an inland place to observe and compare implications and extent of rust.

Subject Focus 4 Making New Substances: How fast? How far? How much?

Learning Outcome 11	I can investigate why and how chemical reactions proceed at different rates.
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	Investigate how the rate of reaction may be affected by a chosen factor. (E.g. Surface area of reactants, concentration of reactants, temperature, light and the use of a catalyst.)
	Visit sites that deal with control of reaction rates.

Subject Focus 5 Carbon compounds from the Earth. Meeting our energy needs.

Learning Outcome 15	I can describe the energy changes accompanying chemical changes.
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	Determine the heat of combustion of ethanol.
	Determine the heat of combustion of different food samples.
	Measure the heat of neutralisation of the reaction between an acid and an alkali.
	Visit laboratories that are concerned with standards that determine the energy content of food and other substances.

School-based Assessment Exemplars

Exemplar 1: Experiment

Experiment																			
	<p>Practical work is a common element among the science subjects. Through experiments students develop experimental skills and techniques such as handling apparatus, performing tests or procedures, identifying variables to alter or control, conducting observations and measurements, and tabulating data. Furthermore, during data processing students can plot graphs, work out calculations, look for patterns and trends, analyse and interpret data observed, draw conclusions and link to scientific knowledge, principles and theory. Conducting experiments helps students to get a feel of the phenomena such as they can make the connections between observing concrete evidence and the more abstract ideas or theories.</p> <p>Each experiment should take around a double lesson to complete. Experiments may be carried out in groups of ideally not more than four. Each group should gather and interpret their own data but each student must present his/her own individual report.</p> <p>The following information shows the sections and respective notes that should be included in an experiment report. Third person past tense should be used when writing experimental reports.</p> <p>A rubric for marking experiments is presented at the end of this document.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Section</th> <th style="text-align: left;">Details</th> </tr> </thead> <tbody> <tr> <td>Date</td> <td>Write the date when the experiment was carried out in the lab.</td> </tr> <tr> <td>Title</td> <td>The title indicates the links to particular assessment criteria as outlined in the curriculum.</td> </tr> <tr> <td>Aim</td> <td>The purpose of the experiment is clearly stated.</td> </tr> <tr> <td>Apparatus</td> <td>A list of apparatus and materials/chemicals used during the experiment.</td> </tr> <tr> <td>Diagram</td> <td>Clear diagram/s of the experimental setup are to be drawn and labelled in pencil. Diagrams should not be too small nor too large.</td> </tr> <tr> <td>Procedure</td> <td>This section will be given to the students.</td> </tr> <tr> <td>Variables (if applicable)</td> <td>A variables grid should be included specifying the independent variable (the one which is changed during the experiment) and the dependent variable (the one which is measured for a change in the independent variable). Other variables which are kept constant, to ensure fair testing, should be included.</td> </tr> <tr> <td>Precautions</td> <td>A list of precautions taken to improve the accuracy of the experiment. Each precaution needs to be supported with reason/s explaining why such precautions are taken.</td> </tr> </tbody> </table>	Section	Details	Date	Write the date when the experiment was carried out in the lab.	Title	The title indicates the links to particular assessment criteria as outlined in the curriculum.	Aim	The purpose of the experiment is clearly stated.	Apparatus	A list of apparatus and materials/chemicals used during the experiment.	Diagram	Clear diagram/s of the experimental setup are to be drawn and labelled in pencil. Diagrams should not be too small nor too large.	Procedure	This section will be given to the students.	Variables (if applicable)	A variables grid should be included specifying the independent variable (the one which is changed during the experiment) and the dependent variable (the one which is measured for a change in the independent variable). Other variables which are kept constant, to ensure fair testing, should be included.	Precautions	A list of precautions taken to improve the accuracy of the experiment. Each precaution needs to be supported with reason/s explaining why such precautions are taken.
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	<p>Safety Considerations (if applicable) A short paragraph/list that identifies safety considerations associated with the preparation and implementation of the experiments to prevent any accidents.</p>
	<p>Results and Observations Depending on the nature and type of the experiment:</p> <ul style="list-style-type: none"> • Observations can be written in paragraphs or in tables. Observations are to be written in a sequential order as noted during the different stages of the experiment. • Numerical results should be tabulated. <ul style="list-style-type: none"> ○ Write the name of the measurement and its units in the column headers of the table of results. ○ Repeated readings should be taken when possible and recorded in the table. ○ Numerical values should be given to the same number of significant figures appropriate to the measuring device.
	<p>Processing data</p> <ul style="list-style-type: none"> • Graphs are a pictorial way of looking at a table of results. Patterns can be observed and anomalous results can be identified. • Line graphs should include at least 5 data points. • Suitable scales should be chosen which makes it easy to plot data. At least 2/3 of the graph paper should be used. • Each axis should be labelled with the name and unit of the quantity being plotted. • The data points should be clearly marked and the points are joined to have a line of best fit or a smooth curve. • The line must go through the origin for quantities which are directly proportional. • Data can also be presented in the form of bar graphs. • Gradient of line graphs are calculated and answers are given with the appropriate units. • Show all steps in the calculations. • In working calculations, the answer should have the same number of significant figures as the measurements used in the calculation. • Avoid excessive rounding especially in calculations involving moles.
	<p>Discussion and Conclusion</p> <p>Include the following points as applicable to the nature of the experiment.</p> <ul style="list-style-type: none"> • A summary of the findings of the experiments and relate them clearly to the aim of the experiment. • A discussion of any patterns or trends in the data.

	<ul style="list-style-type: none">• State any relationships discovered or confirmed between variables being tested in the experiment• Compare numerical results with known values from data books and suggest any reasons for any differences.• A complete analysis or interpretation of observations noted in the experiment (including balanced chemical equations and ionic equations where appropriate)• Draw a conclusion based on experimental evidence and relate it to scientific knowledge, laws, and theory. <p>Evaluation</p> <ul style="list-style-type: none">• Identify and comment on any sources of error in the experiment.• Discuss any difficulties encountered in carrying out the experiment and any precautions taken to achieve accuracy.• Suggest way/s of improving the experimental set-up and or results. Suggest any other experiments which can be done to support the conclusions.
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Exemplar 2: Investigation

Investigation					
	<p>Gott & Duggan (1995) define investigations as "... a specific type of problem solving which allow pupils a varying degree of autonomy and which are problems to which the solution is not obvious." Investigations should allow freedom, allowing students to be creative and choose their own methods to investigate the given problem.</p> <p>Students must be allowed time (at least one lesson) to solve the problem and design an experiment to check their solution. The students' plan must be checked by the teacher for health and safety concerns only. Otherwise, the plan must be unchanged, and students must be allowed to carry out the investigation that they designed which should take approximately a double lesson.</p> <p>The notes below contain information, definitions, and requirements that are important when carrying out an investigation. The following guidelines are designed to ensure that teachers can carry out valid and consistent assessment.</p> <p>It is suggested that informal feedback is given to students after the investigation has been planned to ensure safety of the experiment.</p> <p>Investigations may be carried out in groups of ideally not more than four. Each group should gather and interpret their own data but each student must present his/her own individual report.</p> <p>The following information shows the sections and respective notes that should be included in an investigation report.</p> <table border="1" style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="background-color: #e0e0e0;">Section</th> <th style="background-color: #e0e0e0;">Details</th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top;">Investigation Outline</td> <td> <p>This section should contain an outline of the procedure that will be devised in the investigation together with scientific theory required to understand the investigation.</p> <p>The plan should be concise and written in the future tense.</p> <p>This section should include:</p> <ul style="list-style-type: none"> • The title. • A short statement of the problem to be investigated. • The aim of the investigation. • A brief description of the scientific procedure. • A list of materials and apparatus. • Any pre-experiment work. • A variables grid may be presented to highlight all the variables in the investigation (where applicable). Variables should be identified as independent and dependent variables. Other significant/relevant variables should be noted including the way they are controlled for results to be more reliable. • Any background theory/research where applicable is given. • The hypothesis section (where applicable) should give an outline of what may happen and why. <p><i>(Note: Students are to be made aware that no marks will be lost if the hypothesis is disproved.)</i></p> </td> </tr> </tbody> </table>	Section	Details	Investigation Outline	<p>This section should contain an outline of the procedure that will be devised in the investigation together with scientific theory required to understand the investigation.</p> <p>The plan should be concise and written in the future tense.</p> <p>This section should include:</p> <ul style="list-style-type: none"> • The title. • A short statement of the problem to be investigated. • The aim of the investigation. • A brief description of the scientific procedure. • A list of materials and apparatus. • Any pre-experiment work. • A variables grid may be presented to highlight all the variables in the investigation (where applicable). Variables should be identified as independent and dependent variables. Other significant/relevant variables should be noted including the way they are controlled for results to be more reliable. • Any background theory/research where applicable is given. • The hypothesis section (where applicable) should give an outline of what may happen and why. <p><i>(Note: Students are to be made aware that no marks will be lost if the hypothesis is disproved.)</i></p>
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	Precautions and safety considerations	<p>This section should include:</p> <ul style="list-style-type: none"> Any precautions taken to achieve a more accurate result and improve the outcome of the investigation. Safety considerations associated with the preparation and implementation of the investigation to prevent any accidents.
	Procedure Followed	<p>This section should include:</p> <p>A detailed account of the procedure followed. All the steps involved to perform the experiment including any modifications made to the plan and any additional materials and apparatus used should be stated. The method should include measurements used, diagrams, and photos, where applicable.</p> <p>Note:</p> <ul style="list-style-type: none"> Results should not be included in this section. Third person past tense should be used. Any concentrations, measurements, amounts, times, and temperatures should be quantified. The procedure should be written in such a way that an independent person could repeat the experiment without referring to the person writing the report.
	Results and observations	<p>This section should include:</p> <ul style="list-style-type: none"> All observations and/or measurements should be presented in an organised form. Any calculated data should be presented showing all steps. Graphical representations should be used to display data when possible. <p>Note:</p> <ul style="list-style-type: none"> Tables may be the best way of presenting data. Tables should have headings and units. An adequate number of readings should be taken especially if a graph has to be plotted. Results should not be interpreted in this section. Third person past tense should be used to describe any observations.
	Discussion and Conclusion	<p>This section should include:</p> <ul style="list-style-type: none"> A brief summary of the aim of the investigation. A summary of the most important findings including trends and patterns emerging from analysis of the results. An explanation why calculations were used if any, and their link to the investigation. A very brief description stating whether the investigation has supported/falsified the hypothesis.

	<ul style="list-style-type: none">• A description and an explanation of how the results relate to the expectations based on laws, theories, relationships, patterns and models studied.• This section should be concluded by a closure of all findings.
	<p>Evaluation and references</p> <p>This section should include:</p> <ul style="list-style-type: none">• A list of procedural/sources of errors that may have affected the result.• A list of improvements and any other experiments which can be done to support the conclusions. <p>All sources cited in the text should be listed in full. A basic format should be used when listing the sources.</p>

Exemplar 3: Fieldwork

Fieldwork							
	<p>Fieldwork in science is an important complementary approach to learning outside the classroom. It permits first-hand experience of the practical uses and applications of Chemistry in industry and in everyday life. Fieldwork is understood as an investigation which happens outside of the usual laboratory setting. It can be an experiment or an investigation which contains a significant portion of work done outside school, followed by a session in the laboratory (e.g. sample analysis). Fieldwork helps students understand scientific theories, integrate knowledge and develop important scientific, intra and interpersonal skills.</p> <p>Fieldwork should be well planned before the actual activity. The teacher should pay a site visit, a few days prior to the activity to recognise and set clear learning objectives. Students should be prepared in advance in detailing the theoretical knowledge and informed of site conditions that may affect the outcome of the fieldwork.</p> <p>Students should be well informed of site-specific information so as not to disrupt the site whether it is an urban or natural setting. They should also be informed of all relevant hazard/s which might be present on the site and to follow the instructions of their guide at all times.</p> <p>Visits to sites should be coordinated (including applying for permits) with the relevant authority or company responsible for the management of the site. This includes the Environment and Resources Authority or various Non-Governmental Organisations in the case of certain open-air sites. Consent forms from the students' parents/guardians should also be obtained prior to the fieldwork visit. The following shows the relevant sections to be included in the fieldwork report. There is no minimum word limit, however the notes accompanying the sections give a clear indication of the work that is expected.</p> <p>A rubric for marking fieldwork is presented at the end of this document.</p> <table border="1" style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="width: 20%;">Section</th> <th>Details</th> </tr> </thead> <tbody> <tr> <td>Title</td> <td>The title should contain the keywords describing the work presented. It should be short and unambiguous but with an adequate description of the work. Keywords can include type of fieldwork, location and date.</td> </tr> <tr> <td>Overview</td> <td> <p>Describe the location of where the fieldwork took place (include a map of the area where necessary)</p> <p>Explain whether fieldwork was performed as a single outdoor session or whether it was followed up by a laboratory session.</p> <p>Discuss which aspects of chemistry are relevant to the fieldwork carried out.</p> <p>Describe the main features being observed or investigated</p> <p>Discuss the rationale behind sampling techniques and other fieldwork methods being used.</p> <p>Identify any human impact on the location (if applicable).</p> </td> </tr> </tbody> </table>	Section	Details	Title	The title should contain the keywords describing the work presented. It should be short and unambiguous but with an adequate description of the work. Keywords can include type of fieldwork, location and date.	Overview	<p>Describe the location of where the fieldwork took place (include a map of the area where necessary)</p> <p>Explain whether fieldwork was performed as a single outdoor session or whether it was followed up by a laboratory session.</p> <p>Discuss which aspects of chemistry are relevant to the fieldwork carried out.</p> <p>Describe the main features being observed or investigated</p> <p>Discuss the rationale behind sampling techniques and other fieldwork methods being used.</p> <p>Identify any human impact on the location (if applicable).</p>
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	<p>Precautions and Safety considerations This section should contain all relevant hazard/s which might be present on the site and precautionary measures taken to reduce these hazards/risks (including physical hazards, man-made hazards and health issues). The majority of these can be identified and discussed prior to the fieldwork</p>
	<p>Field Activities This section should include reports regarding a number of hands-on fieldwork activities performed by students that were carried out on site and/or in the laboratory. Each activity should be reported using the following format:</p> <p>(A) Title and aim of activity – This should be short and to the point and outline the scope of the exercise (e.g.: To identify, compare and contrast ..., analyse the presence of).</p> <p>(B) Equipment required – This should include a list of materials and equipment, kits and chemicals needed for this specific activity (e.g.: chemical test kits, test tubes etc.).</p> <p>(C) Procedure – A sequence of instructions and/or protocols (including any pre-experiment work) stating the steps involved to perform the particular activity. This component can include specific measurement, diagrams and photos if applicable. Third person past tense should be used in writing the procedure.</p> <p>(D) Precautions – A list of experimental precautions taken e.g. when collecting samples from site and other precautions to ensure accuracy.</p>
	<p>Results and Observations This section should convey the results in a clear and accurate visual manner. Data should be represented in this section under an appropriate heading for each activity by including:</p> <ul style="list-style-type: none"> • Quantitative data can be presented using tables. • Observations can be presented in paragraph or in tables. • Presentation of results should be without interpretation.
	<p>Processing results Results can be processed by using calculations, pie and bar charts, histograms, and line graphs. The type of process used should reflect the data taken. Pie and bar charts are used for categorical variables while histograms and line graphs indicate continuous variables.</p>
	<p>Discussion and Evaluation This section should include an analysis and an evaluation of the results by including:</p> <ul style="list-style-type: none"> • Discussion and interpretation of the results obtained. Discussion of the relationships, patterns or trends of the results obtained. • Description and explanation of how the results relate to the expectations and literature. Laws, theories and model studies should be referred to. • Reference to possible sources of errors arising from the use of measuring instruments and/or chemical kits.
	<p>Conclusion Briefly evaluate data collected from the activity and draw scientific conclusions.</p>
	<p>References All sources cited in the report should be listed in full. A basic format should be used when listing the sources.</p>

Exemplar 4: Site Visit

Site Visit											
<p>100 marks</p> <p>internally-assessed</p> <p>externally-moderated</p>	<p>Site visits offer opportunities to observe the actual world and relate the theory learned in class to a contextualised setting giving an authentic picture of science, its relevance to everyday life and its social purposes. During a site visit, students are exposed to multiple stimuli, thus attracting students of different learning styles, learning abilities and backgrounds. Such contextualised settings drive students to explore and discover new environments and become involved in the activity. In fact, it is a symbiosis of intrinsic motivation to learn and an engaging environment that promotes significant learning gains for the students. Research shows that sites of scientific interest help the students consolidate the work carried out in class, allow them to apply theory to the actual world, introduce the students to the world of work, help them take actions in their real life as they increase awareness about issues discussed and contribute to less compartmentalisation among subjects.</p> <p>For a site-visit experience to be valuable, prior work is required. This involves preparation such as planning ahead of time to compliment work carried out in class, carrying out risk assessment of the site and showing pictures to familiarise the students with the premises thus reducing the novelty effect that can hinder the commencement of cognitive tasks. Prior to the students' visit, communication with the guide on the premises is essential to determine the learning objectives. However, one should be aware that the learning that occurs during a site visit is not exclusive to knowledge and facts. Learning outcomes set must be achieved during the site visit.</p> <p>The following shows the relevant sections in the site visit report. There is no established word limit, however the guidelines accompanying each section give a clear indication of the amount of work expected. Each student should present an individual report. This may include various forms such as text, photographs with captions, labelled diagrams/drawings and tables with information.</p> <p>A rubric for marking a site visit report is presented at the end of this document.</p> <table border="1"> <thead> <tr> <th>Section</th> <th>Details</th> </tr> </thead> <tbody> <tr> <td>Date</td> <td>Date of site visit</td> </tr> <tr> <td>Title</td> <td>The title should include the name of the site where the visit is being carried out.</td> </tr> <tr> <td>Aim</td> <td>The aim should consist of a brief note stating the aim/s and objectives of the visit.</td> </tr> <tr> <td>Preparatory activities</td> <td> This section should include: <ul style="list-style-type: none"> • background information about the scientific aspects relevant to the site visit; • questions the students would be asking the relevant practitioner/s; • an outline of any activities to be carried out. </td> </tr> </tbody> </table>	Section	Details	Date	Date of site visit	Title	The title should include the name of the site where the visit is being carried out.	Aim	The aim should consist of a brief note stating the aim/s and objectives of the visit.	Preparatory activities	This section should include: <ul style="list-style-type: none"> • background information about the scientific aspects relevant to the site visit; • questions the students would be asking the relevant practitioner/s; • an outline of any activities to be carried out.
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	Site details	<p>This section should include:</p> <ul style="list-style-type: none"> • a brief history of the site (where applicable). • a description of the location where the site visit took place.
	Precautions and Safety Considerations	<p>This section should contain potential hazard/s and the precautionary measures taken to reduce them. Potential hazards are to include physical, chemical and biological hazards as applicable.</p>
	Site Activities	<p>This section should include a description of the activities carried out on site. Each activity should be reported in the third person past tense.</p>
	Communication of outcomes	<p>This section should include the answers to the questions prepared by the students prior to the visit and any other information collected during the visit.</p>
	Discussion, Evaluation, Reflection and References	<p>This section should include a discussion, evaluation and/or interpretation of the outcomes achieved or information collected with respect to the aim/s set out for the site visit. This section should also include the students' self-reflection/s on their experience of the site visit, related to good practices, possible improvements and alternative activities that could have been carried out during the visit. All sources cited in the report should be listed in full. A consistent format should be used when listing the sources.</p>

Exemplar 5: Project

Project	
	<p>A project is an interdisciplinary approach that involves tasks based on challenging questions and / or problems, culminating in realistic tangible products. The project should help enhance the student creativity and interest in the subject whilst improving knowledge and attitude towards science. A project gives the students the opportunity to apply and enhance a range of skills (e.g. cognitive, technical, physical, creative). Projects are of particular importance in science classes because they give students the opportunity to work like scientists. Furthermore, '<i>A growing body of evidence suggests that inquiry-based instruction resulting from project work results in significantly higher student achievement with respect to content knowledge, reasoning, and argumentation skills.</i>' (Abdi 2014; Riga et al. 2017).</p> <p>The project in the Chemistry laboratory/classroom assesses how students apply their knowledge to work on a solution to a single task, situation and/or scenario which the students propose, based upon the theme/s indicated by the teacher. A project should consist of ONE of components A, B, or C in addition to component D as outlined below.</p> <ul style="list-style-type: none"> A. Written: students use written language to communicate ideas and information supported, where applicable, by data, tables, flow charts, diagrams, referenced research, etc.; (e.g. a report, an article for a journal/magazine, leaflet, chart, script for a role play, infographic, etc. (about 500 words)) OR B. Product: using a range of skills students create a product (e.g. a model or digital presentation) OR C. Demonstration: students will make an actual demonstration in class/laboratory of an innovative/creative way how to represent a scientific situation or concept AND D. Spoken: students use spoken language to explain the written, product, or demonstration component, to confirm their understanding of scientific concepts involved in the project as well as the authenticity of the project (e.g. oral presentation, interview by the teacher (2 - 3 minutes)). <p>It is being suggested that the students work individually on the project. The whole project should take around 6 lessons, which might not be consecutive, and include all the steps indicated in the guidelines below. Students should be given some continuous class time to develop their project. They can continue their work on the project at home.</p> <p>The following steps related to the implementation of the project in a classroom setting, are being suggested:</p> <ol style="list-style-type: none"> 1. The teacher indicates the theme/s for the project based on one or more Learning Outcomes/ Assessment Criteria. The student is to be made aware of the types of projects which can be submitted, keeping in mind the scientific merit of the project as explained in the attached rubric. It is important that students are allowed to choose their own project format, based on their interests, and the most suitable way to present it. The student should be encouraged to research the area under study to help determine the project that is to be carried out. 2. The student selects an appropriate project and presents a plan of action that would lead to the final product. 3. It is suggested that the teacher gives feedback to the student about the plan. The student can revise the plan based on the feedback received. 4. The project is carried out over a period of time established by the teacher. 5. The project is submitted together with the journal and is presented to the class. This might take the form of a 2 - 3-minute oral presentation followed by questions from the teacher or an interview by the teacher. Additional resources (e.g. visual aids etc.) may be used to assist the student in the presentation. The student may also answer questions from the rest of the class.

The Project Guidelines	
Section	Details
Title and Plan	<p>This section should include:</p> <ul style="list-style-type: none"> • An appropriate title. • The aim/s of the project. • A brief description (short paragraph) of what the project will consist of including the related scientific concepts
Written or Product or Demonstration Component	<p>The student will present the chosen Project component to the teacher:</p> <p>A: Written OR B: Product OR C: Demonstration</p>
The Learning Journal	<p>The journal should include:</p> <ul style="list-style-type: none"> • The plan of the project. • A step-by-step log of the procedure involved in creating the project. • The relevant research, diagrams, photographic evidence of the process, etc. required for the project development. <p>Reflections related to the process by which the project was realised including any suggested improvements.</p>
Spoken Component	<p>In this section the student needs to explain:</p> <ul style="list-style-type: none"> • The aim of the project. • The steps involved in developing the project. • What was learnt/concluded from the project.
	<p>The student answers questions to show:</p> <ul style="list-style-type: none"> • mastery of the scientific concepts covered by the project; • involvement in the actual build-up of the project itself.