GUIDELINES FOR THE SCHOOL-BASED ASSESSMENT

RATIONALE

School-Based Assessment (SBA) is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills and attitudes that are critical to the subject. The activities for the School-Based Assessment are linked to the “Suggested Practical Activities” and should form part of the learning activities to enable the student to achieve the objectives of the syllabus.

During the course of study of the subject, students obtain marks for the competence they develop and demonstrate in undertaking their SBA assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

The guidelines provided in this syllabus for selecting appropriate tasks are intended to assist teachers and students in selecting assignments that are valid for the purpose of the SBA. These guidelines are also intended to assist teachers in awarding marks according to the degree of achievement in the SBA component of the course. In order to ensure that the scores awarded by teachers are not out of line with the CXC standards, the Council undertakes the moderation of a sample of SBA assignments marked by the teacher.

School-Based Assessment provides an opportunity to individualise a part of the curriculum to meet the needs of students. It facilitates feedback to the students at various stages of the experience. This helps to build the self-confidence of the students as they proceed with their studies. School-Based Assessment further facilitates the development of essential investigative and practical skills that allow the students to function more effectively in their chosen vocation and everyday life. School-Based Assessment therefore, makes a significant and unique contribution to the development of relevant skills of the students. It also provides an instrument for testing them and rewarding them for their achievements.

PROCEDURES FOR CONDUCTING SBA

SBA assessments should be made in the context of normal practical coursework exercises. It is expected that the exercises would provide authentic learning experiences. Assessments should only be made after candidates have been taught the skills and given enough opportunity to develop them. Sixteen practicals over the two-year period would be considered the minimum number for candidates to develop their skills and on which to base realistic assessments. These practicals MUST include all of the following:

1. separation techniques;
2. acids, bases and salts;
3. redox reactions and electrolysis;
4. qualitative analysis;
5. volumetric analysis;
6. rates of reaction;
7. energetics;
8. saturated and unsaturated hydrocarbons.
Each skill must be assessed at least three times over the two-year period. Candidates should be encouraged to do corrections so that misconceptions will not persist. As the assessment of certain skills, especially those requiring on-the-spot observation or involve looking at several behaviours or criteria, teachers are advised to select not more than two skills to be assessed in any activity. The practical exercises selected to be used for assessment should make adequate demands on the candidates and the skills assessed should be appropriate for the exercises done. For the assessment of written work, the practical selected should be one that can be completed in the time allotted for the class and the notebooks should be collected at the end of the period.

Candidates who have not been assessed over the two-year period will be deemed absent from the whole examination. Under special circumstances, candidates who have not been assessed at all points may, at the discretion of CXC, have their marks pro-rated (adjusted proportionately).

1. In preparation for an SBA practical, the teacher should:
   
   (a) select tasks which must be chosen from the eight (8) topics on page 42 and should be related to a given syllabus objective. These tasks may be chosen from the “Suggested Practical Activities” and should fit in with the normal work being done in that class;
   
   (b) list the materials including quantities and equipment that will be needed for each student;
   
   (c) carry out the experiment beforehand, if possible, to ascertain the suitability of materials and the kind of results (observations, readings) which will be obtained, noting especially any unusual or unexpected results;
   
   (d) list the steps which will be required by the candidates in performing the experiment. From this it will be clear to the teacher how the candidates should be arranged in the laboratory, whether any sharing of equipment or materials is necessary, the skills which can be assessed from the practical, and the instructions to be given;
   
   (e) list the skills that may be assessed (for example, observation/recording/reporting, analysis and interpretation). No more than two practical skills should be assessed from any one activity;
   
   (f) select the skills to be assessed on this occasion. Skills other than those required for that year should also be included for teaching purposes;
   
   (g) work out the criteria for assessing each skill. This will form the basis of a mark scheme and a checklist.

2. The teacher should carry out the assessment and record the marks.

   This is the most critical step in the assessment process. For a teacher to produce marks that are reliable, the marking must be consistent for all candidates and the marks should reflect the standard of performance at the level. The teacher must be able to justify the marks, and this occurs when there is a fixed set of conditions, factors or criteria for which the teacher looks. Marks should be submitted electronically to CXC on the SBA form provided. The forms should be dispatched through the Local Registrar by the Moderator to reach CXC by 30 April in the year of the examination.
ASSESSMENT OF PRACTICAL SKILLS

School-Based Assessment will assess skills under the profiles Experimental Skills and Use of Knowledge (Analysis and Interpretation only).

The assessment will be conducted during Terms 1 - 5 of the two-year period following the programme indicated in the Table below.

SBA SKILLS TO BE ASSESSED FOR CXC MODERATION

<table>
<thead>
<tr>
<th>PROFILE</th>
<th>SKILLS</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO. OF TIMES SKILLS TO BE ASSESSED</td>
<td>MARKS</td>
<td>NO. OF TIMES SKILLS TO BE ASSESSED</td>
<td>MARKS</td>
</tr>
<tr>
<td>XS</td>
<td>Manipulation/Measurement</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Observation/Recording/Reporting</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Planning and Designing*</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>UK</td>
<td>Analysis and Interpretation</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

*Weighted mark

Investigative project to be done in Year 2.

The investigative project would be assessed for two skills, Planning and Design and Analysis and Interpretation.

Students who are pursuing two or more of the single science subjects (Biology, Chemistry, Physics) may opt to carry out ONE investigation* only from any of these subjects.

[ONLY the marks for the investigation can be transferred across subjects.]
**Assessment of Investigation Skills**

**Proposal (Planning and Design)**

The maximum marks available for the Proposal is **10 marks**

The format for this part is shown below:

- Observation/Problem/Research question stated
- Hypothesis: 2 marks
- Aim: 1 mark
- Materials and Apparatus: 1 mark
- Method: 2 marks
- Controlled variables: 1 mark
- Expected Results: 2 marks
- Assumptions, Precautions/ Limitations: 1 mark

**TOTAL** **10 marks**

**Implementation (Analysis and Interpretation)**

The maximum marks available for the Implementation is **20 marks**

The format for this part is shown below:

- Method: 1 mark
- Results: 4 marks
- Discussion: 5 marks
- Limitation: 3 marks
- Reflection: 5 marks
- Conclusion: 2 marks

**TOTAL** **20 marks**
REPORTING FORMAT OF INVESTIGATION

PART A THE PROPOSAL (Planning and Design)

Statement of the Problem – Can be an observation, a problem
Hypothesis
Aim – Should be related to the hypothesis
Materials and Apparatus
Method – Should also include variables
Assumptions/Precautions
Expected Results

PART B THE IMPLEMENTATION (Analysis and Interpretation)

Method - Linked to Part A (change of tense)
Results
Discussion – Explanations/Interpretations/Trends
Limitations
Reflections
Conclusion

CRITERIA FOR ASSESSING INVESTIGATIVE SKILLS

A. PLANNING AND DESIGN

HYPOTHESIS 2
- Clearly stated 1
- Testable 1

AIM 1
- Related to hypothesis 1

MATERIALS AND APPARATUS 1
- Appropriate materials and apparatus 1

METHOD 2
- Suitable 1
- At least one manipulated or responding variable 1

CONTROLLED VARIABLE 1
- Controlled variable stated 1

EXPECTED RESULTS 2
- Reasonable 1
- Link with method 1

ASSUMPTIONS/PRECAUTIONS/POSSIBLE SOURCES OF ERRORS 1
- Any one stated 1

TOTAL (10)
B. ANALYSIS AND INTERPRETATION

METHOD
Linked to Proposal, Change of tense

RESULTS
- Correct formulae and equations: 2
  Accurate (2)
  Acceptable (1)

- Accuracy of data: 2
  Accurate (2)
  Acceptable (1)

DISCUSSION
- Explanation 2
  Development of points:
  Thorough (2)
  Partial (1)

- Interpretation 2
  Fully supported by data (2)
  Partially supported by data (1)

- Trends 1
  Stated

LIMITATIONS
- Sources of error identified 1
- Precautions stated 1
- Limitation stated 1

REFLECTIONS
- Relevance between the experiment and real life 1
  (Self, Society or Environment)

- Impact of knowledge gain from experiment on self 1
- Justification for any adjustment made during experiment 1
- Communication of information 2
  (Use of appropriate scientific language, grammar and clarity of expression all of the time (2); some of the time (1)

CONCLUSION
- Stated 1
- Related to the aim 1

TOTAL (20)
EXAMPLAR OF INVESTIGATIVE PRACTICAL

EXAMPLAR 1

Part A  THE PROPOSAL

Observation

Whenever an uncovered carbonated beverage is left exposed at room temperature the beverage goes ‘flat’ (that is, loses its fizz) within a few hours but when an uncovered carbonated beverage is stored in a refrigerator it remains fizzy for much longer.

Hypothesis: The higher the temperature of an uncovered carbonated drink the faster the drink will lose carbon dioxide gas.

Aim: To determine if increasing the temperature causes an uncovered carbonated beverage to lose carbon dioxide gas at a higher rate.

Materials/Apparatus: A sealed bottle of a carbonated beverage, cold water, 3 boiling tubes, 3 delivery tubes with rubber bungs, three test tube racks, a 60 °C water bath, an ice-bath, 3 thermometers, three measuring cylinder, three retort stands with clamps, 3 graduated syringes and a timing device.

Method

1. All apparatus will be cleaned and dried before beginning the experiment.

2. Label each boiling tube as follows: R- for room temperature, C- for cold and H- for hot. Measure 20 cm³ of the carbonated beverage and pour slowly into each boiling tube.

3. Leave the uncovered boiling tube labeled R on the counter at room temperature. Place the uncovered tube labeled C into an ice-bath and the uncovered tube labeled H into a 60°C water bath. Record the temperature of each beverage in a table and leave each tube undisturbed for 30 minutes.

4. After the 30 minutes has passed for each beverage, securely fit the tube with a rubber bung and delivery tube. Keep the shaking of the tube to a minimum during this set-up process. The open end of the delivery tube will be attached to a graduated syringe and the boiling tube shaken for two minutes. Record the volume reached by the gas in a suitable table. Repeat the same procedure for each tube.

Precaution: Carbonated beverage was poured slowly down the sides of the boiling tube to minimise loss of gas.

Expected Results

It is expected that the carbonated beverage labeled H will produce the least volume of gas, beverage R will produce more gas than H but less than C and beverage C will produce the highest volume of gas.
PART B- THE IMPLEMENTATION

Introduction

Whenever an uncovered carbonated beverage is left exposed at room temperature the beverage goes ‘flat’ (that is, loses its fizz) within a few hours but when an uncovered carbonated beverage is stored in a refrigerator it remains fizzy for much longer.

The gas responsible for the fizz of a carbonated drink is carbon dioxide and the lower the carbon dioxide content of a drink the ‘flatter’ the drink will be.

In this experiment the relationship between the temperature and the carbon dioxide content of a carbonated drink will be explored so as to offer an explanation to the observation made.

Method

1. All apparatus was cleaned and dried before beginning the experiment.
2. Each boiling tube was labeled as follows: R- for room temperature, C- for cold and H- for hot.
3. 20 cm\(^3\) of the carbonated beverage was measured and poured slowly into each boiling tube.
4. The uncovered boiling tube labeled R was left on the counter at room temperature, the uncovered tube labeled C was placed into an ice-bath and the uncovered tube labeled H was placed into a 60°C water bath. The temperature of each beverage was recorded in a table and each tube was left undisturbed for 30 minutes.
5. After 30 minutes had passed for each beverage, the tube was securely fitted with a rubber bung and delivery tube. Shaking of the tube was kept to a minimum during this set-up process. The open end of the delivery tube was attached to a graduated syringe and the boiling tube was shaken for two minutes. The volume reached by the gas was recorded in a suitable table. The same procedure was repeated for each tube.

Results

<table>
<thead>
<tr>
<th>Boiling Tube</th>
<th>Temperature (°C)</th>
<th>Volume of CO(_2) gas (cm(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

From this experiment, it was determined that as the temperature increased the carbon dioxide content of the drink decreased. The drink which was kept at the highest temperature lost the most gas in the allotted time period.

When a carbonated drink is left uncovered, the decrease in pressure causes the gas particles to leave the solution at the surface faster. Also, increasing the temperature gives the gas particles more kinetic energy and increases the rate at which these particles leave the drink’s surface.
Particles possess more kinetic energy at higher temperatures than at lower temperatures. Hence, more gaseous particles will leave the surface of a drink at room temperature than at a lower temperature. Therefore it is clear that when the carbonated drink was left at room temperature the loss of CO₂ would have occurred more readily than if the same drink was kept in a refrigerator and as a result the drink at room temperature would become flat much sooner than one stored at colder temperatures.

**Limitations**

Every effort was made to reduce experimental error as much as possible. Shaking of the beverage during measuring was minimized and the temperatures were monitored strictly. However, the following situations may have contributed to experimental error:

1. Loss of gas as an undetermined amount of gas was lost during the pouring of the beverage into the measuring cylinder.
2. Loss of gas occurred during the assembling of the delivery tube to the graduated syringe.

**Reflections**

Whenever an uncovered carbonated beverage is left exposed at room temperature, the beverage goes flat (it loses its fizz) within a few hours but when an uncovered carbonated beverage is stored in a refrigerator it remains fizzy for much longer.

From the experiment, I have learnt that the reason carbonated drinks go flat faster at room temperature is because of the higher temperature which gives the gas particles enough energy to leave the drink’s surface faster. Therefore, based on scientific fact it is better to store a carbonated drink at low temperatures as this will preserve its CO₂ content for much longer.

This experiment was carried out as designed in the plan.

**Conclusion**

Increasing the temperature of an uncovered carbonated drink causes the drink to lose carbon dioxide faster.

**Exemplar 2**

**Part A  THE PROPOSAL**

**Observation**

While on a field trip to the local Botanical Gardens, an observation was made that the all the rocks in the river which flowed through this garden had shiny, rusty-brown surfaces. The villagers claim that the water flowing through the gardens contains iron compounds and that the rocks had these compounds deposited from the water on their surfaces.

**Hypothesis:** The rusty brown solid on the rock surfaces is a compound of iron.

**Aim:** To determine if the deposit on the surfaces of the river rocks is a compound of iron.
Materials/Apparatus: A sample of the rock from the river bed, a sample of rock from the river shore, knife, test tube and test tube rack, 2 M H₂SO₄ solution, sodium hydroxide solution, measuring cylinder and a teat pipette.

Method

1. All apparatus will be cleaned and dried before beginning the experiment.

2. The knife will be used to remove some of the deposit from the surface of the river rock. The deposit will be placed into a test tube. 4 cm³ of acid will be added to the test tube and the tube will be shaken. The mixture will be decanted to isolate any undissolved particles. To the filtrate, sodium hydroxide solution will be added dropwise until in excess. Repeat the experiment using the sample of rock from the river shore.

3. All observations will be recorded and tabulated.

Assumption: There is enough iron compound in the rock deposit to react with the acid.

Expected Results

It is expected that if an iron compound is present, the iron compound from the deposit will react in the acid to give a pale yellow solution. When the solution is tested with the sodium hydroxide dropwise, a rusty-brown precipitate will form which will be insoluble in excess.

PART B - THE IMPLEMENTATION

Introduction

While on a field trip to the local Botanical Gardens, an observation was made that all the rocks in the river which flowed through this garden had shiny, rusty-brown surfaces. The villagers claim that the water flowing through the gardens contain compounds of iron and that the rocks had iron compounds deposited from the water on their surfaces.

Fe³⁺ ions which are present in iron compounds will precipitate out as iron (III) oxide which is rusty brown in colour. This compound coats the rocks, making them appear as shiny rusty brown surfaces.

It is suspected that the water contains iron (III) ions which will form a rusty brown deposit. The purpose of this experiment is to determine if this is the case.

Method

All pieces of apparatus were cleaned and dried before beginning the experiment.

The knife was used to remove some of the deposit from the surface of the river rock. The deposit was placed into a test tube. 4 cm³ of acid was added to the test tube and the tube was shaken to dissolve as much of the deposit as possible. The mixture was filtered to isolate any undissolved particles. To the filtrate, sodium hydroxide solution was added dropwise until in excess.

All observations were recorded and tabulated.
Results

TABLE SHOWING THE OBSERVATIONS WHEN SODIUM HYDROXIDE SOLUTION WAS ADDED DROPWISE AND IN EXCESS

<table>
<thead>
<tr>
<th>OBSERVATION WITH DILUTE NaOH (aq)</th>
<th>Dropwise</th>
<th>Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>A rusty-brown precipitate formed.</td>
<td>The rusty-brown precipitate remained insoluble.</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Mineral water is obtained from a mineral spring and contains various minerals such as salts and even compounds of sulfur. Other compounds found in mineral water are iron compounds, the levels of which may vary depending on the time of year and the pH of the water. During certain times of the year the river water becomes more acidic and this causes an increase in the amount of iron salts from the soil dissolved in the river water. Some of those salts can then precipitate unto the river rocks and change the regular appearance of the rocks’ surfaces.

The rusty brown solid is likely to be iron(III) oxide which reacts with the sulfuric acid forming a soluble iron(III) salt which is a pale yellow solution. By performing qualitative analysis on a sample of the deposit it was determined that the rusty-brown deposit on the rock contained iron(III) ions due to the presence of an iron(III) salt. Iron(III) salt solutions form the rusty-brown, insoluble iron (III) hydroxide precipitate with sodium hydroxide solution. As shown by the equation below:

\[
Fe^{3+}(aq) + 3 OH^{-}(aq) \rightarrow Fe(OH)_3(s)
\]

Limitations

The reaction between the iron compound and the acid produced a small amount of iron (III) ion solution. Iron compounds will react with sulfuric acid to form soluble salts which can then be tested using aqueous sodium hydroxide. If small amounts of the iron (III) ions are produced in the reaction between the acid and the deposit, then the resulting solution may not have sufficient iron(III) ions to produce a visible precipitate with sodium hydroxide.

Reflections

Mineral springs produce water which contains a number of dissolved salts, one of which is a compound of iron. The rusty brown deposits on the rocks are likely to be iron(III) oxide which will react with acids to produce iron(III) ion solutions.

It is believed that mineral water has medicinal properties because of the presence of some compounds such as compounds of iron.

Knowledge of the iron content of water allows decisions to be made as to the benefits of using this water for health purposes.

It was decided that filtration would replace decantation as suggested in the proposal to ensure that the suspended particles were completely removed.
**Conclusion**

Iron compounds were found to be deposited on the river rocks. The results of the test support the villagers’ claims. Iron compounds are indeed present in the river water.

**RECORD KEEPING**

Each candidate is required to keep a practical workbook containing all practicals done over the two-year period prior to the examination. Those assessed for CXC will be used to determine the standard of marking by the teacher. **A mark scheme must be provided for each practical assessed for CXC.** All practicals should be dated and an index made by the candidates of the practicals done. Those assessed for CXC should be clearly indicated along with the marks awarded for each skill. **This must include the identity of unknowns and expected readings.**

Candidates’ workbooks should be durable and neatness should be encouraged. The pages should be numbered and all exercises should be dated. The workbook should contain a contents page providing the following information concerning the practicals:

1. page number;
2. date;
3. aim of practical;
4. an indication using an asterisk, of which practicals were assessed for CXC;
5. the skills assessed.

A possible format is given below:

<table>
<thead>
<tr>
<th>Page No.</th>
<th>Date</th>
<th>Aim of Practical</th>
<th>Skills Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2013-10-02</td>
<td>Separation of mixtures- oils and water, dyes in screened methyl orange, ammonium chloride and sodium chloride</td>
<td></td>
</tr>
<tr>
<td>*9</td>
<td>2013-10-23</td>
<td>To observe the effect of heat on nitrates</td>
<td>Man./Meas.</td>
</tr>
</tbody>
</table>

Note: The asterisk (*) indicates practical assessed for CXC.

A breakdown of the skills assessed and the marks awarded should be given at the end of the report for each SBA practical (for example):

- Manipulation and Measurement (mm) 6/10
- Observation, Recording, Reporting (ORR) 8/10

CXC will require a sample of practical workbooks for moderation. Teachers are reminded that **the marks awarded for each practical skill should be in the candidate’s workbook** and that accuracy in recording marks on CXC mark sheets is essential.

Additional workbooks may be requested. The school should therefore retain all other practical workbooks until at least three (3) months after the publication of examination results. Candidates’ workbooks should show evidence of conducting test some of the experiments, which they have planned and designed.
Moderation of School-Based Assessment

The reliability (consistency) of the marks awarded by teachers on the School-Based Assessment is an important characteristic of high quality assessment. To assist in this process, the Council undertakes on-site moderation of the School-Based Assessment conducted by visiting external Moderators.

The Moderator will make a first visit in Term 3 of Year 1. Teachers must make available to the Moderator ALL Assessment Sheets (Record of Marks, Mark Schemes and the proposal for the Investigation).

During the Term 2 of Year 2, the Moderator will make a second visit. Teachers must make available to the Moderator ALL Assessment Sheets (Record of Marks, Mark Schemes and the report on the Investigation). Teachers are NOT required to submit to CXC samples of candidates’ work, unless specifically requested to do so by the Council BUT will be required to submit the candidates’ marks electronically.

The Moderator will remark the skills, and investigation reports for a sample of five candidates, who are selected using the guidelines listed below.

1. Candidates’ total marks on the SBA are arranged in descending order (highest to lowest).
2. The sample comprises the work of the candidates scoring the:
   (a) highest Total mark;
   (b) middle Total mark;
   (c) lowest Total mark;
   (d) mark midway between the highest and middle Total mark;
   (e) mark midway between the middle and lowest Total mark;
3. The candidates selected above may be required to demonstrate some practical skills.

Teachers’ marks may be adjusted as a result of the moderation and feedback will be provided by the Moderator to the teachers.

The Moderator may re-mark the assignments of additional candidates. Where the total number of candidates is five or fewer, the Moderator will remark ALL.

On the first visit, the Moderator will re-mark a sample of the Year 1 candidates. A copy of this report must be retained by the teacher, and be made available to the Moderator during Term 2 of Year 2.

The Moderator will submit the Assessment Sheets, moderation of SBA Sample and the moderation reports to the Local Registrar by April 30 of the year of the examination. A copy of the Assessment Sheets and candidates’ work must be retained by the school for three months after the examination results are published by CXC.

School-Based Assessment Record Sheets are available online via the CXC’s website www.cxc.org.

All School-Based Assessment Record of marks must be submitted online using the SBA data capture module of the Online Registration System (ORS).
EXAMPLE OF A POSSIBLE SBA PRACTICAL

Aim: Finding the end of a neutralisation reaction by measuring temperature changes.

Apparatus: 2 mol dm$^{-3}$ sodium hydroxide solution.
2 mol dm$^{-3}$ hydrochloric acid solution.
Thermometer (0-110°C, 1°C gradations).
Styrofoam cup.
25 cm$^3$ or 20 cm$^3$ pipette. (Measuring cylinder can be used if pipettes are unavailable)
Burette (Test tube calibrated to measure 5 cm$^3$ or syringe or any other suitable measuring container).

Procedure: 1. Pipette 25 cm$^3$ of the sodium hydroxide solution into the Styrofoam cup. Measure and record the temperature of this solution.
2. Fill the burette to the 0 mark with the acid and deliver 5 cm$^3$ of acid into the alkali all at once. Stir with the thermometer and record the highest temperature reached. WITHOUT DELAY, add a second 5 cm$^3$ of the acid, stir and record the highest temperature reached. Repeat the procedure until a total of 40 cm$^3$ of acid has been added.
3. Record your readings in an appropriate table.

Activities:
1. Plot a graph of total volume of acid added (x-axis) against the temperature (y-axis) and draw two best-fit lines.
2. Account for the shape of the graph you have obtained.
3. Use your graph to determine the total volume of acid needed to neutralise exactly 25 cm$^3$ of alkali.
4. Determine likely sources of error in this procedure for determining the end-point of a neutralisation reaction.
5. Write the ionic equation for the neutralisation reaction.

MARK SCHEME

Skills assessed: Observation/Recording/Reporting, Analysis and Interpretation.

Temperature change during neutralisation

1. Observation/Recording/Reporting
   Table
   (a) Neatly enclosed table. 1
   (b) Headings with units. 1
   (c) Data written correctly to a consistent number of decimal places. 1
(d) Graph.
  (i) Labelling of axes with units             2
  (ii) Selecting a suitable scale for x and y axes.  2
  (iii) Plotting accurately.    2
  (iv) Drawing best fit intersecting lines.        1

10 Marks

2. Analysis and Interpretation

(a) Deducing that for the portion of the graph sloping upwards:
  (i) reaction is incomplete;  1
  (ii) amount of heat given off increases as more reactant (acid) is available.  1

(b) Deducing that for the portion of graph sloping downwards:
  (i) reaction is complete;  1
  (ii) temperature falls as more reactant is added.  1

(c) Deducing that reaction is complete when highest temperature is reached, hence peak in graph.  1

(d) Reading off volume of acid corresponding to highest temperature reached.  2

(e) Two likely sources or error (for example, heat loss to surroundings, incomplete transfer of acid).  2

(f) Ionic equation
   \[ \text{H}^+_{\text{aq}} + \text{OH}^-_{\text{aq}} \rightarrow \text{H}_2\text{O(l)} + \text{heat}. \]  1

10 Marks

Manipulation and Measurement

Aim: To investigate how the solubility of potassium nitrate crystals varies with temperature.

Apparatus and Materials: Boiling tube, test tube holder, Bunsen burner, glass rod, measuring cylinder, thermometer, matches, potassium nitrate, distilled water, tap water, ice.

Procedure:

1. Place 5 g of KNO₃ crystals into a boiling tube.
2. Using a measuring cylinder, pour 3.0 cm³ of distilled water into the KNO₃.
3. Heat the contents of the boiling tube carefully over Bunsen flame while stirring until all the solid dissolves.
4. Remove the boiling tube carefully from the flame. Place the thermometer in the boiling tube. Allow the boiling tube to cool and record the temperature at which the crystals first appear.
5. Add to the contents of the boiling tube a further 3.0 cm³ of distilled water and repeat the above procedure, noting the temperature at which crystals first appear.
6. Repeat the procedure adding a further 3.0 cm³ portions of water to obtain a total volume of 15 cm³.
Results: Record the results in a table with the following headings (include appropriate units).

<table>
<thead>
<tr>
<th>Volume of H₂O Added to 5 g KNO₃</th>
<th>Temperature at Which Crystals Appear</th>
<th>Mass of KNO₃ dissolved in 100 g of H₂O (Solubility)</th>
</tr>
</thead>
</table>

Analysis of Results:

Calculate the solubility of KNO₃ at for each volume of water using the equation below.

3.0 cm³ of H₂O dissolves 5 g of KNO₃

100 cm³ of H₂O dissolves \( \frac{5 \times 100}{100} = 166.6 \) g

Plot graph of temperature at which crystals form (x-axis) vs solubility in 100 g of water (y-axis) and draw the best-fit curve.

Use your graph to determine:

1. the solubility of KNO₃ at 45°C;
2. the mass of KNO₃ that would crystallize when a solution of KNO₃ cools from 65°C to 35°C.

Discussion:

Define solubility.

Account for the shape of the graph you have obtained.

MARK SCHEME

NB. This lab may be assessed for ORR and AI.

Skill Assessed: Manipulation and Measurement

(a) Correct use of balance (scale). 1
(b) Placing measuring cylinder on flat surface. 1
(c) Taking reading at eye level. 1
(d) Correctly lighting Bunsen burner. (closing air hole, striking match, turning on gas, lighting burner, opening air hole, adjusting gas to control height of flame). 4
(e) Carefully heating contents of boiling tube with stirring by holding tube away from self and others. 1
(f) Holding thermometer upright for reading. 1
(g) Making sure that the bulb of the thermometer is submerged and not touching the walls of the container. 1

10 Marks

Planning and Design

Problem:
In a café, sugar is provided in a single package cube. Each customer is given one package per order. Each cube contains 5 g of sugar. The manager notices that there is sugar left in the bottom of many of the used iced tea cups but not in the bottom of the hot tea cups.

Propose an hypothesis to explain this observation. Plan and design an experiment to test this hypothesis.
Skills Assessed: Planning and Design

**Hypothesis:** Clearly stated with ONE variable, testable.  
2

**Aim:** Related to hypothesis and problem statement, method to be used specified  
2

**Apparatus and Materials:** All essential ones stated.  
2

**Procedure:** Logical sequence of steps, written in present or future tense, workable or feasible to test hypothesis.  
4

**Variables:** (Manipulated, controlled and responding): Clearly stated or implied  
3

**Data to be collected:** Observations, measurements or qualitative data which will prove or disprove hypothesis.  
2

**Treatment/Interpretation of data:** Shows link between how data to be collected proves or disproves hypothesis.  
2

**Assumptions, Limitations, Precautions.**  
3

20 marks (scale to 10)

Conversion of marks to the 11-point scale

The 11-point scale ranges from 0 to 10 thus the maximum mark for each skill at any assessment point is 10. Always marking out of 10 or multiples of 10 makes conversion easy but this is not necessary, as this may be readily calculated. Conversion of the scale can be done for each assessment but this is not the only possibility. The raw marks out of the totals used must be recorded and these marks totalled for each skill and the conversion done only when their submission to CXC is required.

The following hypothetical result for the assessment of a student on a particular skill may be used as an example. If the marks obtained for observation/recording/reporting are:

5/7, 4/6, 5/5, 7/9, 6/8

The total marks are out of a possible 35 marks. This may be converted by calculations as follows:

\[
\frac{27 \times 10}{35} = 7.71 \text{ (approximately)} \\
\frac{35}{8} = 8 \text{ for CXC purposes.}
\]

VALIDITY AND RELIABILITY OF TEACHERS’ MARKS

The reliability of marks awarded is a significant factor in SBA and has far-reaching implications for the candidate's final grade. Teachers are asked to note the following:

1. The criteria for assessing a skill should be clearly identified. A mark scheme must be submitted with the sample of books sent for moderation. Failure to do this could result in the candidates being unavoidably penalised.
2. The relationship between the SBA marks in the practical workbooks and those submitted to CXC on the SBA forms must be clearly shown. It is important that the marks awarded reflect the degree of mastery of the skills assessed.

3. Workbooks should contain all practical work and those exercises used for SBA marks should be clearly identified. At least eight exercises should be undertaken.

4. The standard of marking must be consistent, hence the need for a mark scheme.

5. Collaboration among teachers especially in the same centre is urged to minimise the discrepancy in the standard of assessment among teachers.

STRATEGIES FOR ASSESSING THE PLANNING AND DESIGN SKILL

The Planning and Designing skill is intended to test students’ ability to develop hypotheses and devise means of carrying out investigations to test them, plan experimental procedures and operations in appropriate sequence, identify variables, state expected results and identify precautions and possible sources of error. It is expected that some activities related to the planning and designing skill will be carried out. However, the reports of these activities are no longer plans and cannot be assessed as planning and design (PD). They can be marked for other skills, for example, observation, recording and reporting (ORR).

The assessing of Planning and Designing is not intended to test the students’ research ability but rather their ability to use known procedures in a novel situation, or to make a novel use of a known procedure. Developing this skill to a good standard requires an understanding of the concepts involved. It requires much practice before it is assessed.

The following steps are recommended to ensure that this important skill is developed by students and properly tested by the teacher (See Guidelines for the School-Based Assessment for further details):

1. The problem selected should preferably be one which allows for different feasible routes to a solution, and should give opportunities for resourcefulness.

2. Less than full instructions should be given for typical experiments. The fewer the instructions the greater the test of the student’s ability to plan and design.

3. Allow candidates to plan the sequence of steps in the identification of unknown substances. For example, candidates could be given test tubes of substances labelled A, B, C and so on, and be required to decide from a separate list of the names of the substances (not given in the correct order) the identity of each one using only the substances given in the test tubes, or a given set of reagents.

They should be required to prepare a clear logical plan of the procedure before carrying out the investigation. This should include a list of requirements, precautions necessary, and the significance of each step proposed. They should then be required to explain how the results will be interpreted, including the relevant equations.
### CARIBBEAN EXAMINATIONS COUNCIL

**SCHOOL-BASED ASSESSMENT IN CHEMISTRY**

**NAME OF SCHOOL:** __________________________

**SCHOOL CODE:** __________

**YEAR OF FINAL EXAMINATION:** __________________________

**NAME OF TEACHER:** __________________________

**TERRITORY:** __________________________

<table>
<thead>
<tr>
<th>REGISTRATION NUMBER</th>
<th>CANDIDATES NAME</th>
<th>YEAR 1</th>
<th>TOTAL</th>
<th>YEAR 2</th>
<th>TOTAL</th>
<th>TOTAL</th>
<th>PROFILE</th>
<th>OVERALL</th>
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<tr>
<td></td>
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<td>XS</td>
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<td>XS</td>
<td>KS</td>
<td>KS</td>
<td>XS</td>
<td>UK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P3 (10)</td>
<td>P3 (10)</td>
<td>P3 (20)</td>
<td>P2 (20)</td>
<td>60</td>
<td>P3 (20)</td>
<td>P3 (20)</td>
</tr>
</tbody>
</table>

**TEACHER’S SIGNATURE:** __________________________

**PRINCIPAL’S NAME:** __________________________

**DATE:** __________________________

**PRINCIPAL’S SIGNATURE:** __________________________
LIST OF SUGGESTED CHEMICALS

1. Aluminium foil.
2. Aluminium powder.
3. Aluminium Ammonium Sulfate.
4. Aqueous Ammonia, 3 mol dm$^{-3}$.
5. Ammonium Chloride or Ammonium Carbonate.
6. Ammonium Nitrate.
7. Barium Chloride or Barium Nitrate 0.25 mol dm$^{-3}$.
8. Bromine.
9. Calcium.
10. Calcium Carbonate, (powdered or precipitated).
11. Calcium Chloride, anhydrous.
12. Calcium Hydroxide saturated solution (filtered).
13. Calcium Nitrate.
15. Copper (turnings or powder).
16. Copper, thick wire or strips.
19. Copper (II) Oxide.
20. Copper (II) Sulfate.
22. Hydrochloric Acid 2 mol dm$^{-3}$, 6 mol dm$^{-3}$.
LIST OF SUGGESTED CHEMICALS (cont’d)

24. Distilled water.
25. Iodine (resublimed).
26. Iodine solution.
27. Iron nails.
31. Lead foil.
32. Lead (II) Bromide of Lead(II)Iodide.
33. Lead Ethanoate.
34. Lead (II) Nitrate.
35. Lead (II) Oxide.
36. Litmus paper, blue and red.
37. Magnesium ribbon.
38. Manganese (IV) Oxide.
40. Methyl orange or screened methyl orange.
41. Nitric Acid 2 dm$^{-3}$.
42. Phenolphthalein.
43. Potassium Bromide or Sodium Bromide.
44. Potassium Carbonate.
LIST OF SUGGESTED CHEMICALS (cont’d)

45. Potassium Iodide 0.5 mol dm$^{-3}$.  
46. Potassium Nitrate.  
47. Potassium Permanganate (manganate (VII)).  
48. Silver Nitrate 0.1 mol dm$^{-3}$.  
49. Sodium.  
50. Sodium Carbonate.  
51. Sodium Carbonate hydrated (washing soda).  
52. Sodium Chloride.  
53. Sodium Hydrogen Carbonate.  
54. Sodium Hydroxide 2 mol dm$^{-3}$, pellets.  
55. Sodium Sulfate.  
56. Sodium Sulfite.  
57. Sodium Thiosulfate.  
58. Steel wool.  
59. Sulfuric Acid 3 mol dm$^{-3}$, 6 mol dm$^{-3}$.  
60. Universal indicator paper.  
61. Universal indicator solution.  
62. Zinc granulated or powdered.  
63. Zinc Carbonate.  
64. Zinc Oxide.  
65. Zinc Nitrate.  
66. Zinc Sulfate.  
67. Ethanol.  
68. Sulfur powder.
SUGGESTED EQUIPMENT LIST

1. Balance (+ 0.1g).
2. Beakers (100 cm³, 250 cm³, 400 cm³).
4. Bunsen burners.
5. Burettes (50 cm³).
7. Burette clamps or clips.
8. Capillary tubes (melting point tubes).
9. Conical flasks (250 cm³).
10. Crucible tongs.
11. Distillation apparatus *(simple and fractional)*
12. Dropper or teat pipettes.
15. Filter paper.
16. First Aid kit (1 per lab.).
17. *Fire Extinguisher (1 per lab) *
18. Gas syringes (100 cm³).
19. Glass rods.
20. Glass tubing.
21. Measuring cylinders (20 cm³, 100 cm³) (1000 cm³ for teachers use only).
22. *Pipette fillers.*
23. Pipettes (25 cm³, (20 cm³).
SUGGESTED EQUIPMENT LIST (cont’d)

25. Retort stands.
26. Rubber tubing.
27. Separating funnel.
28. Simple electrolysis apparatus (electrodes, cells, wire).
29. Spatulas.
30. Stoppers or Bungs.
31. Test tubes (125 mm x 15 mm).
32. Test tube brushes.
33. Test tube holder.
34. Test tube racks.
35. Thermometers (1°C grad.).
36. Tripods.
37. Volumetric flasks (250 cm³, 1dm³, 2dm³, - for teacher's use).
38. Wash bottles.
39. Watch glasses.
40. Wire gauzes.
41. Delivery tubes.
42. Boss heads.
43. Crucibles.
44. Stop watches.
45. Gas jars.
46. Splints.
47. Pneumatic trough.
48. Beehive shelf.
RESOURCES

Chapman, S., Luttig, D., Murray, J., Ritchie, E. and Tindale, A.  

Clarke, J. and Oliver, R.  

Nazir, Joanne  

Taylor, M. and Chung-Harris, T.  

Remy C. Mason, L.  
<table>
<thead>
<tr>
<th>WORD/TERM</th>
<th>DEFINITION/MEANINGS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>annotate</td>
<td>add a brief note to a label</td>
<td>{simple phrase of a few words}</td>
</tr>
<tr>
<td>apply</td>
<td>use knowledge and principles to solve problems</td>
<td>{make inferences and conclusions; UK}</td>
</tr>
<tr>
<td>assess</td>
<td>present reasons for the importance of particular structures, relationships or processes</td>
<td>{compare the advantages and disadvantages or the merits and demerits of a particular structure, relationship or process; UK}</td>
</tr>
<tr>
<td>calculate</td>
<td>arrive at the solution to numerical problem</td>
<td>{steps should be shown; units must be included; UK}</td>
</tr>
<tr>
<td>cite</td>
<td>quote or refer to</td>
<td>{KC}</td>
</tr>
<tr>
<td>classify</td>
<td>divide into groups according to observable characteristics</td>
<td>{UK}</td>
</tr>
<tr>
<td>comment</td>
<td>state opinion or view with supporting reasons</td>
<td>{UK}</td>
</tr>
<tr>
<td>compare</td>
<td>state similarities and differences</td>
<td>{an explanation of the significance of each similarity and difference stated may be required for comparisons which are other than structural; UK}</td>
</tr>
<tr>
<td>construct</td>
<td>use a specific format to make or draw a graph, histogram, pie chart or other representation using data or material provided or drawn from practical investigations, build (for example, a model) draw scale diagram</td>
<td>{such representation should normally bear a title, appropriate headings and legend; UK}</td>
</tr>
<tr>
<td>deduce</td>
<td>make a logical connection between two or more pieces of information; use data to arrive at a conclusion</td>
<td>{UK}</td>
</tr>
<tr>
<td>define</td>
<td>state concisely the meaning of a word or term</td>
<td>{this should include the defining equation or formula where relevant; KC}</td>
</tr>
<tr>
<td>demonstrate</td>
<td>show, direct attention to...</td>
<td>{KC}</td>
</tr>
<tr>
<td>derive</td>
<td>to deduce, determine or extract from data by a set of logical steps some relationship, formula or result</td>
<td>{this relationship etc. may be general or specific; KC}</td>
</tr>
<tr>
<td>WORD/TERM</td>
<td>DEFINITION/Meanings</td>
<td>NOTES</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>describe</td>
<td>provide detailed factual information on the appearance or arrangement of a specific structure or the sequence of a specific process</td>
<td>{descriptions may be in words, drawings or diagrams or any appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary; KC}</td>
</tr>
<tr>
<td>determine</td>
<td>find the value of a physical quality</td>
<td>{UK}</td>
</tr>
<tr>
<td>design</td>
<td>plan and present, with appropriate practical detail</td>
<td>{where hypotheses are stated or when tests are to be conducted, possible outcomes should be clearly stated the way in which data will be analyzed and presented; XS}</td>
</tr>
<tr>
<td>develop</td>
<td>expand or elaborate on an idea or argument with supporting reasons</td>
<td>{KC/UK}</td>
</tr>
<tr>
<td>differentiate or distinguish (between or among)</td>
<td>state or explain briefly those differences between or among items which can be used to define the items or place them into separate categories</td>
<td>{KC}</td>
</tr>
<tr>
<td>discuss</td>
<td>present reasoned argument; consider points both for and against; explain the relative merits of a case</td>
<td>{UK}</td>
</tr>
<tr>
<td>draw</td>
<td>make a line representation of apparatus which shows accurate relationship between the parts</td>
<td>{A diagram is a simplified representation showing the relationship between components; KC/UK}</td>
</tr>
<tr>
<td>estimate</td>
<td>make an approximate quantitative judgement</td>
<td>{UK}</td>
</tr>
<tr>
<td>evaluate</td>
<td>weigh evidence and make judgements based on given criteria</td>
<td>{the use of logical supporting reasons for a particular point of view is more important than the view held; usually both sides of an argument should be considered; UK}</td>
</tr>
<tr>
<td>explain</td>
<td>give reasons, based on recall, to account for</td>
<td>{KC}</td>
</tr>
<tr>
<td>find</td>
<td>locate a feature or obtain as from a graph</td>
<td>{UK}</td>
</tr>
<tr>
<td>formulate</td>
<td>devise a hypothesis</td>
<td>{UK}</td>
</tr>
<tr>
<td>identify</td>
<td>name or point out specific components or features</td>
<td>{KC}</td>
</tr>
<tr>
<td>WORD/TERM</td>
<td>DEFINITION/MEANINGS</td>
<td>NOTES</td>
</tr>
<tr>
<td>-----------</td>
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<td>-------</td>
</tr>
<tr>
<td>illustrate</td>
<td>show clearly by using appropriate examples or diagrams, sketches</td>
<td>{KC/UK}</td>
</tr>
<tr>
<td>investigate</td>
<td>use simple systematic procedures to observe, record data and draw logical conclusions</td>
<td>{XS}</td>
</tr>
<tr>
<td>label</td>
<td>add names to identify structures or parts indicated by pointers</td>
<td>{KC}</td>
</tr>
<tr>
<td>list</td>
<td>itemise without detail</td>
<td>{KC}</td>
</tr>
<tr>
<td>measure</td>
<td>take accurate quantitative readings using appropriate instruments</td>
<td>{XS}</td>
</tr>
<tr>
<td>name</td>
<td>give only the name of</td>
<td>{no additional information is required; KC}</td>
</tr>
<tr>
<td>note</td>
<td>write down observations</td>
<td>{XS}</td>
</tr>
<tr>
<td>observe</td>
<td>pay attention to details which characterise reaction or change taking place; to examine and note scientifically</td>
<td>{observations may involve all the senses or extensions of them but would normally exclude the sense of taste; XS}</td>
</tr>
<tr>
<td>plan</td>
<td>prepare to conduct an exercise</td>
<td>{XS}</td>
</tr>
<tr>
<td>predict</td>
<td>use information provided to arrive at a likely conclusion or suggestion possible outcome</td>
<td>{UK}</td>
</tr>
<tr>
<td>record</td>
<td>write an accurate description of the full range of observations made during a given procedure</td>
<td>{this includes the values for any variable being investigated; where appropriate, recorded data may be depicted in graphs, histograms or tables; XS}</td>
</tr>
<tr>
<td>relate</td>
<td>show connections between; explain how one set of facts or data depend on others or are determined by them</td>
<td>{UK}</td>
</tr>
<tr>
<td>sketch</td>
<td>Make a simple freehand diagram showing relevant proportions and any important details</td>
<td>{KC}</td>
</tr>
<tr>
<td>state</td>
<td>provide factual information in concise terms omitting explanations</td>
<td>{KC}</td>
</tr>
<tr>
<td>WORD/TERM</td>
<td>DEFINITION/MEANINGS</td>
<td>NOTES</td>
</tr>
<tr>
<td>-----------</td>
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<td>-------</td>
</tr>
<tr>
<td>suggest</td>
<td>offer an explanation deduced from information provided or previous knowledge. (... an hypothesis; provide a generalisation which offers a likely explanation for a set of data or observations.)</td>
<td>{no correct or incorrect solution is presumed but suggestions must be acceptable within the limits of scientific knowledge; UK}</td>
</tr>
<tr>
<td>test</td>
<td>to find out following set procedures</td>
<td>{XS}</td>
</tr>
</tbody>
</table>

**KEY TO ABBREVIATIONS**

KC - Knowledge and Comprehension  
UK - Use of Knowledge  
XS - Experimental Skills