

Practical Booklet 2

Testing for biological molecules

Cambridge International AS & A Level

Biology 9700

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Introduction

Practical work is an essential part of science. Scientists use evidence gained from prior observations and experiments to build models and theories. Their predictions are tested with practical work to check that they are consistent with the behaviour of the real world. Learners who are well trained and experienced in practical skills will be more confident in their own abilities. The skills developed through practical work provide a good foundation for those wishing to pursue science further, as well as for those entering employment or a non-science career.

The science syllabuses address practical skills that contribute to the overall understanding of scientific methodology. Learners should be able to:

1. plan experiments and investigations
2. collect, record and present observations, measurements and estimates
3. analyse and interpret data to reach conclusions
4. evaluate methods and quality of data, and suggest improvements.

The practical skills established at AS Level are extended further in the full A Level. Learners will need to have practised basic skills from the AS Level experiments before using these skills to tackle the more demanding A Level exercises. Although A Level practical skills are assessed by a timetabled written paper, the best preparation for this paper is through extensive hands-on experience in the laboratory.

The example experiments suggested here can form the basis of a well-structured scheme of practical work for the teaching of AS and A Level science. The experiments have been carefully selected to reinforce theory and to develop learners' practical skills. The syllabus, scheme of work and past papers also provide a useful guide to the type of practical skills that learners might be expected to develop further. About 20% of teaching time should be allocated to practical work (not including the time spent observing teacher demonstrations), so this set of experiments provides only the starting point for a much more extensive scheme of practical work.

Guidance for teachers

Aim

To use tests for biological molecules to determine which molecules are present in solutions of unknown composition.

Outcomes

Syllabus sections 2.1 (a) and (b)

Skills included in the practical

AS Level skills	How learners develop the skills
MMO decisions	Decide which tests should be used to identify the biological molecules present in unknown solutions
MMO collection	Complete a risk assessment Make qualitative observations of colour changes Collect quantitative results, time for a colour change
PDO recording	Record qualitative observations and quantitative results in appropriate tables
ACE conclusions	Conclude the composition of each unknown solution from their results
MMO decisions	Decide which tests should be used to identify the biological molecules present in unknown solutions

Method

Safety glasses must be worn when preparing the slide.

- In preparation for this practical, learners need to be familiar with the tests for biological molecules outlined in sections 2.1 (a) and (b) of the syllabus.
- The method for each of the tests should be reviewed before the practical begins.
- Learners are provided with five beakers labelled **A**, **B**, **C**, **D** and **E**, each containing a different solution.
- The solutions are as follows:

Solution label	Contents
A	1.0% sucrose solution
B	0.5% glucose solution
C	1.0% starch solution
D	4.0% glucose solution
E	5.0% sucrose solution

- Learners are told that the five solutions lost their content labels and were muddled up. Their task is to identify the composition of each solution.
- They are told that the solutions are as follows:
 - 5.0% sucrose solution
 - 1.0% sucrose solution
 - 1.0% starch solution
 - 4.0% glucose solution
 - 0.5% glucose solution

Guidance for teachers, *continued*

- A risk assessment identifying the hazards in the method must be carried out by each learner and they should assign an appropriate level of risk to the investigation. This will allow the teacher to ensure that the planned method is safe. The risk level is **medium** as learners will be using chemicals that are harmful. Safety glasses must be worn when carrying out this investigation.
- The learners will need to decide in which order to carry out the tests. They will also need to develop a method for each test. These activities can be done as a class activity prior to the practical.
- A suggested order would be to test all five solutions for starch using iodine in potassium iodide solution. This will allow the identification of the starch solution. The test for reducing sugars could then be carried out to identify the glucose solutions, and the time for the first appearance of a colour change recorded to enable identification of the more concentrated glucose solution. Finally the non-reducing sugar test can be carried out on the two sucrose solutions. If learners record the time taken for the first appearance of a colour change when performing the Benedict's test after hydrolysis, they should be able to distinguish between the two different concentrations of sucrose.

Results

- Learners should have prepared a table similar to the one below. They should be reminded that this is an appropriate results table because the:
 - table has been drawn with lines separating each of the columns and rows
 - independent variable is in the first column
 - table has descriptive column headings
 - units are included in the column headings, not next to each result recorded in the table.

Solution	Colour with iodine in potassium iodide solution	Colour with Benedict's solution	Time taken for colour change with Benedict's solution / s	Colour with Benedict's solution after hydrolysis	Time taken for colour change with Benedict's solution after hydrolysis / s
A					
B					
C					
D					
E					

Interpretation and evaluation

- Learners are asked to identify the contents of each solution by completing a table.

Solution label	Contents
A	
B	
C	
D	
E	

Extension

The need for reliable results and the importance of taking repeat results could be discussed. If time allows this could be carried out.

Information for technicians

Each learner will require:

- safety glasses
- at least 30 cm³ 5.0% sucrose solution, labelled **E**
- at least 30 cm³ 1.0% sucrose, labelled **A**
- at least 30 cm³ 4.0% glucose solution, labelled **D**
- at least 30 cm³ 0.5% glucose solution, labelled **B**
- at least 30 cm³ 1.0% starch solution, labelled **C**
- 50 cm³ Benedict's solution [**H**]
- at least 10 cm³ iodine in potassium iodide solution, labelled **iodine solution [H]**
- at least 20 cm³ of 1 mol dm⁻³ hydrochloric acid [**H**]
- sodium hydrogen carbonate
- 1 × spotting tile
- 1 × glass rod or dropping pipette
- 2 × 5 cm³ syringes and the means to wash them out
- 5 × large test-tubes (boiling tubes)
- 1 × test-tube rack to hold large test-tubes
- 1 × Bunsen burner
- 1 × tripod
- 1 × gauze
- 1 × bench mat
- at least 400 cm³ beaker with water suitable for a water-bath (at approximately 40 – 45 °C)
- 1 × thermometer, 0 °C to 110 °C
- 1 × stop clock
- 1 × glass marker pen

Additional instructions

The sodium hydrogen carbonate should be provided with a spatula or an alternative that learners usually use in the test for non-reducing sugars.

Hazard symbols

C = corrosive substance

F = highly flammable substance

H = harmful or irritating substance

O = oxidising substance

N = harmful to the environment

T = toxic substance

Worksheet

Aim

To use tests for biological molecules to determine which molecules are present in solutions of unknown composition.

Method

Safety glasses must be worn when preparing the investigation.

1. You are provided with five beakers labelled **A, B, C, D** and **E**, each containing a different solution. The labels showing the contents of the beakers have fallen off and the beakers have been muddled up.
2. Your task is to plan an investigation using tests for biological molecules to decide what the content of each beaker is.
3. The solutions are as follows:
 - 5.0% sucrose solution
 - 1.0% sucrose solution
 - 4.0% glucose solution
 - 0.5% glucose solution
 - 1.0% starch solution
4. You must carry out a risk assessment identifying the hazards in your method. You should assign an appropriate level of risk to the investigation.

Results

Record your results in an appropriate table. When drawing a results table remember that you should:

- put the independent variable in the first column
- use descriptive column headings
- include units in the column headings only

Interpretation and evaluation

Complete the table below identifying the contents of each solution.

Solution label	Contents
A	
B	
C	
D	
E	

Extension

How could you amend your method to increase the reliability of your results?

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