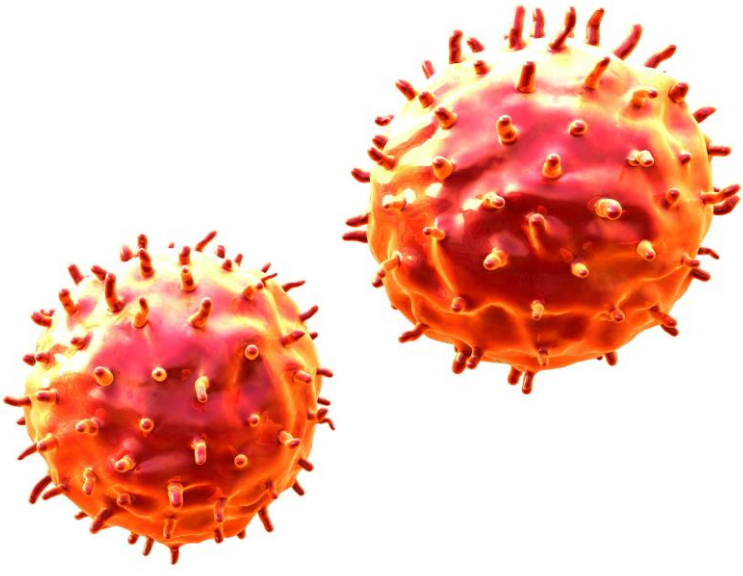
Cambridge Assessment International Education

Teaching Pack

Energy from food

Cambridge O Level

Biology 5090



Version 1.0

Cambridge Pathway

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Debriefing lesson

Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note
Our *Teaching Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and/or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Teaching Packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.

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Lab lesson (1 hour*)	
Option 1 – run the experiment	**Option 2 – virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experimental skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experimental skills introduced in the *Briefing lesson*.

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Debriefing lesson (1 hour*)
This lesson consolidates and builds on the progress learners have made. In some cases, it will also provide the opportunity to practise extended writing skills.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this pack will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: Energy from food

This *Teaching Pack* focuses on comparing the energy that can be released from a variety of foods.

Burning food releases energy (in the form of heat) that can be used to heat a standard volume of water. If the temperature of the water is measured before and after heating, the temperature rise can be calculated for different food samples and compared.

This experiment has links to the following syllabus content (see syllabus for detail):

- 5.2 Diet

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations** (see syllabus for assessment objectives):

- evaluate methods and suggest possible improvements
- record measurements
- interpret experimental data.

Prior knowledge

Knowledge from the following syllabus topics is useful for this experiment.

- 5.2 Diet

Going forward

The knowledge and skills gained from this experiment can be used for when you teach learners about respiration.

Briefing lesson: Identifying sources of error

Resources	• Worksheets A, B and C
Learning objectives	By the end of the lesson: • ***all*** learners should be able to identify at least one potential source of error in a planned method • ***most*** learners should be able to identify all the significant potential sources of error in a planned method • ***some*** learners will be able to suggest ways to reduce the effect of potential sources of error.

Timings	Activity
10 min	**Starter/Introduction** Ask your learners to carry out the activity on **Worksheet A**. They should consider the images and suggest how errors might occur and why. Discuss some of the suggestions; for ideas see the suggested answers for Worksheet A.
40 min	**Main lesson** Give learners **Worksheet B**. Arrange learners into small groups (2–4) and ask them to plan the investigation described. You may need to remind your learners about testing for starch with iodine solution. They should identify the steps that are most likely to lead to errors and for each, suggest a way to reduce the error. Ask groups to share their plans. Highlight any differences between groups and decide which methods would lead to the smallest errors. For points to discuss, see the suggested answers for Worksheet B.
10 min	**Plenary** Explain to your learners that **Worksheet C** provides the method for the experiment they will carry out or watch in the next lesson. Ask them to read through the method and identify any steps that will result in errors in finding the temperature rise and what they could do to minimise them. Explain that in any method, some sources of error are much more significant than others. Learners should try to prioritise them rather than just listing all possible errors. They should not include errors due to carelessness in executing the method. Steps that will introduce the most significant errors in this experiment include: • the positioning of the burning food beneath the boiling tube (samples of food held at different distances from the boiling tube will result in vastly different amounts of energy transferred to the water); • the amount of time the food is held in the Bunsen flame whilst igniting it (some of the food will burn while energy will not be transferred to the water); • whether food burns intact without pieces falling off the tongs (unburned food will not transfer energy to the water). Other less significant sources of error are noted in the *Teacher method*.

Lab lesson: Option 1 – run the experiment

Resources	• Teacher notes and method • *Teacher Walkthrough* video • Equipment as outlined in the Teacher notes • Worksheets C, D and E

Learning objectives	By the end of the lesson: • ***all*** learners should be able to record a complete set of measurements • ***most*** learners should be able to record sufficiently accurate measurements and carry out the calculations • ***some*** learners will be able to record sufficiently precise measurements.

Timings	Activity
5 min	**Starter/Introduction** Ensure learners understand that any rise in temperature of the water is a measure of the energy released from the food and that the method depends on obtaining comparable results for each food sample. Remind learners of the potential sources of error in the method using **Worksheet C** and **Worksheet D**. Ask learners to recall what they can do to minimise them to ensure the results for food samples are comparable.
5 min 40 min	**Main lesson** In groups of 2–4, learners collect the equipment and set it up using **Worksheet D**. Make sure you draw their attention to the safety precautions they should take, such as the care needed when handling the hot boiling tubes, or the safe positioning of the Bunsen when it is not required. When you have checked all the equipment is set up correctly and safely, learners should begin the experiment. They record their results for each food sample in the blank table on **Worksheet E**. Alternatively, you could ask your learners to draw their own table by referring to the method (**Worksheet C**). Learners could also note any observations of the food whilst burning (for example, did the food burn completely or not?) that might help them evaluate their results in terms of comparability. **Safety** Circulate the classroom at all times during the experiment so you can make sure that your learners are safe and that the data they are collecting is accurate. Once all the food samples have been tested, learners should calculate the temperature increase for each food sample and add the results to their table.
10 min	**Plenary** Compare the results of different groups. Discuss with your learners which food sample appears to have released the most energy and which the least. Ask them to decide if the results are comparable and get them to think about the mass of food used.

Teacher notes

Watch the *Teacher Walkthrough* video and read these notes.

Each group will require:

- access to water
- samples of food materials
- Bunsen burner
- six boiling tubes
- boiling tube rack
- clamp stand
- balance
- boss and clamp
- heatproof mat
- measuring cylinder
- mounted needle
- tongs
- thermometer.

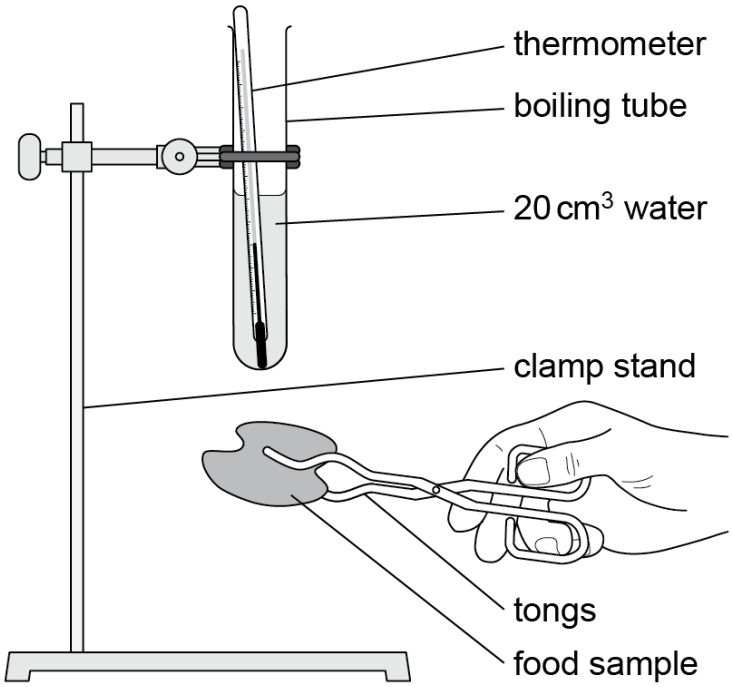
Safety

The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.

It is your responsibility to carry out an appropriate risk assessment for this experiment.

Substance	Hazard	First aid
Food	Allergies **Do not use peanuts in the lab if any of the learners have a nut allergy.**	Do not consume any foodstuffs in the labs. If discomfort persists, see a doctor.
	Risk of cuts due to sharps, e.g. broken glass or scalpels. Wounds can lead to infection, especially if the blade or point is contaminated.	**Minor cuts:** Rinse the wound with water. Get the casualty to apply a small, sterile dressing. **Severe cuts**: Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Send for a first aider.
	Burns	Flood burnt area with water for at least 10 minutes. For serious injuries see a doctor.

Experiment set-up



Teacher method

This is your version of the method for this experiment that accompanies the *Teacher walkthrough* video.

Do not share this method with learners. Give them **Worksheet C**.

Before you begin

Plan how you will group your learners during the experiment session.

Think about:

- the number of groups you will need (group size 2–4 learners)
- the amount of equipment/each food material required
- the number of food sample learners will test
- whether you would prefer learners to draw their own table or use **Worksheet D**.

Experiment

Walk around the learners during the experiment in case they encounter any difficulties.

Steps	**Notes**
1. Learners should collect all the equipment they need from the front of the class.	
2. Learners measure 20 cm^3 of water with a measuring cylinder and place it into a boiling tube.	*It is important that this measurement is accurate because inconsistent volumes of water will introduce error to the temperature changes.*
3. Learners then clamp the boiling tube vertically with the base of the tube positioned approximately 30cm above a heatproof mat.	
4. A thermometer is placed into the boiling tube and the initial temperature of the water is measured and recorded.	*Temperatures should be measured to the nearest half degree otherwise calculated temperature changes may lack sufficient precision to be distinguishable.*
5. Learners cut or break a sample from the first food material to be tested. A piece weighing as close to 1g as possible is required. Learners record the actual mass of the sample.	*Inconsistent masses will mean the results are less comparable; learners will be able to evaluate their results by considering the mass data.*

6. Holding the food sample in tongs, learners set it alight in the flame of a Bunsen.

7. The burning food sample should be immediately positioned beneath the base of the boiling tube and used to heat the water.

As soon as the food is alight it must be positioned beneath the boiling tube. Any delay will reduce the amount of energy transferred to the water.

8. The burning food sample should be kept in position until the flame goes out.

Learners should observe the food whilst it is burning. They should note if any pieces fall off or if the flame goes out prematurely, leaving some of the sample unburned. You might suggest that learners repeat a food sample if this occurs.

9. Learners should then gently stir the water using the thermometer before measuring and recording the final temperature as accurately as possible.

Unevenly distributed heat in the water and a delay in measuring the temperature that allows cooling to occur will both introduce error to the final temperature measurement. It is important that the final temperature is measured when at its maximum value.

10. The boiling tube should be removed from the clamp and replaced with a clean one.

Boiling tubes reused whilst still hot will warm the water before burning takes place, introducing error to the temperature changes.

11. The procedure should then be repeated for the remaining food samples.

12. Once all the food samples have been tested, learners should calculate the temperature rise for each food sample.

Clean-up

After the experiment learners should:

- clean all glassware
- tidy up their work space
- ensure any unburned food and ash has been cleared up
- return all equipment to you.

Lab lesson: Option 2 – virtual experiment

Resources	• *Virtual Experiment video* • Worksheets C, D and E
Learning objectives	By the end of the lesson: • ***all*** learners should be able to record a complete set of measurements • ***most*** learners should be able to record sufficiently accurate measurements and carry out the calculations • ***some*** learners will be able to record sufficiently precise measurements.

Timings	Activity
10 min	**Starter/Introduction** Show learners the introduction to the video (00:00–00:34 min). Ensure learners understand that any rise in temperature of the water is a measure of the energy released from the food and that the method depends on obtaining comparable results for each food sample. Remind learners of the potential sources of error in the method using **Worksheet C** and **Worksheet D**.
5 min 10 min 15 min 10 min	**Main lesson** Give learners a blank results table (**Worksheet E**) or ask them to draw their own by referring to the method (**Worksheet C**). Show learners the method for testing the first food sample. Pause the video at the initial temperature reading (01:13 min) to allow learners to record the value. Pause the video again at the weighing of the first food sample (01:20 min) so learners can record the food type and the actual mass of the sample. When the food has finished burning, learners could note if any of the sample remains unburned. Finally, pause the video at the final temperature reading (02:17 min) to allow learners to record the value when at its maximum. They should then calculate the temperature rise. You may wish to pause the video at the calculation (02:30 min). For the remaining five food samples, pause the video to allow learners to record their actual masses (03:08 min and 03:17 min) and initial and final temperatures (03:53 – 04:03 min). They could also note if any of the food remained unburned. You may need to replay this section several times for learners to record all the data and observations. A completed table is provided. Learners should calculate and record the remaining temperature rises. Show learners the last section of the video.
10 min	**Plenary** Discuss with your learners which food sample appears to have released the most energy and which the least. Ask them to decide if the results are comparable and get them to think about the mass of food used.

Debriefing lesson: Interpreting results graphically

Resources	• Completed Worksheet E and Worksheet F • Graph paper
Learning objectives	By the end of the lesson: • ***all*** learners should be able to plot a bar chart • ***most*** learners should know when to use a bar chart to present results • ***some*** learners will be able to use the bar chart to interpret their results.

Timings	Activity
	**Starter/Introduction** Ask your learners to carry out the activity on **Worksheet F.** They should match the different ways of presenting results to the datasets and explain their choices. Discuss their responses as a class.
	**Main lesson** Learners use the completed results table from the previous lesson (**Worksheet E**) to draw a bar chart of the change in temperature for each type of food. Make sure your learners draw bars of equal width with spaces between them. Bars should be labelled along the *x* axis with the type of food. The *y* axis should have an appropriate scale to clearly represent the differences between changes in temperature and be labelled, including the units.
	When the bar chart has been completed, ask your learners to interpret the results using the chart. Points to discuss as a class could include: • which food released the most energy; • which food released the least energy; • which differences between samples are significant; • which samples might be insignificant given the likely error based on observations or food mass data; • how many times was the energy released from food 'x' greater/smaller than food 'y'; • if there is a zero value, is it correct that the food sample released no energy at all?
	Ask learners to look at the information on **Worksheet G** and write a paragraph explaining how it relates to their results.
	**Plenary** Discuss with your learners to what extent they feel drawing a bar chart helped their interpretation of their food energy results.

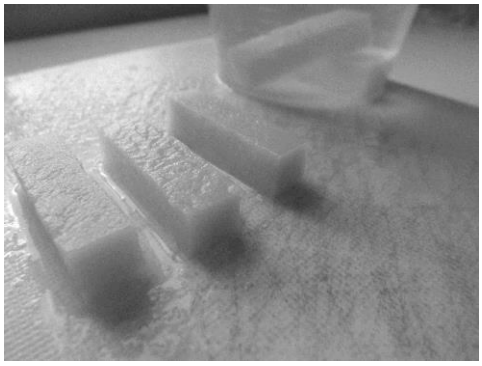
Worksheets and answers

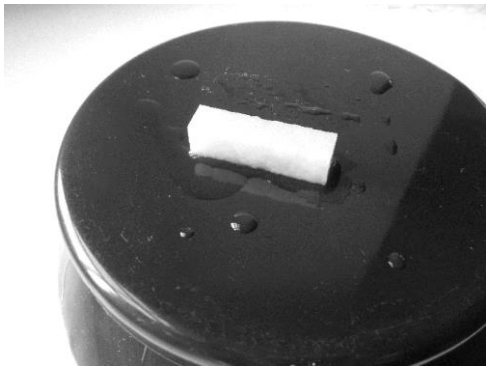
	Worksheets	Answers
For use in the *Briefing lesson*:		
A: Spotting potential sources of error	**15**	**22**
B: Planning to reduce errors	**16**	**23**
C: Method	**17**	—
For use in *Lab lesson: Option 1*:		
C: Method	**17**	—
D: Equipment set-up	**18**	—
E: Table of results	**19**	**24**
For use in *Lab lesson: Option 2*:		
C: Method	**17**	—
D: Equipment set-up	**18**	—
E: Table of results	**19**	**24**
For use in the *Debriefing lesson*:		
E: Table of results	**19**	—
F: Presenting data	**20**	**25**
G: Analysing dietary information	**21**	—

Worksheet A: Spotting potential sources of error

In an experiment to investigate osmosis, pieces of potato were weighed and then put into sugar solutions of different concentration. After several hours, they were taken out of the sugar solutions and re-weighed to find out if they had gained or lost mass. The pictures show some of the pieces of potato being re-weighed.

Discuss with your group any possible sources of error in the re-weighing.





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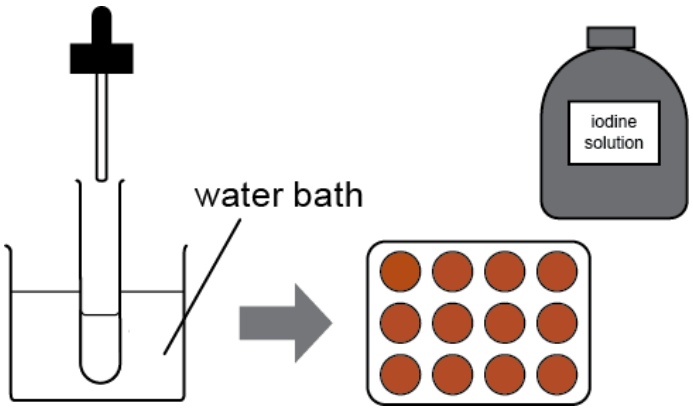
Worksheet B: Planning to reduce errors

An experiment using amylase to break down starch to maltose uses the apparatus shown in the diagram.

Amylase solution breaks down the starch solution in a test-tube kept at a constant temperature in a water-bath.

Every so often the mixture in the test-tube is tested to see if there is any starch left.

A drop of the mixture is removed using a dropping pipette and added to a drop of iodine solution on a spotting tile.



- Plan an experiment to find how varying the temperature affects the time taken for all the starch to be broken down.
- Identify the most likely sources of error in your experiment.
- For each source of error, suggest a way to reduce the error as far as possible.

Worksheet C: Method

1. Collect all your equipment from the front of the class.
2. Using a measuring cylinder, add 20 cm^3 of water to a boiling tube.
3. Clamp the boiling tube vertically about 30 cm above a heatproof mat
4. Place a thermometer into the water.
5. Measure and record the initial temperature of the water.
6. Cut or break the first food sample to create a piece with a mass of about 1 g.
7. Use the balance to measure and record the actual mass of food.
8. Hold the sample of food using tongs and set it alight in a Bunsen flame.

Position the Bunsen safely to one side between food samples and set to a yellow flame.

9. Immediately position the burning food sample under the boiling tube.
10. Keep the burning food sample in position until the flame goes out.
11. Stir the water gently with the thermometer and record the final temperature of the water.
12. Record any observations about how the food burned.
13. Remove the boiling tube from the clamp and replace it with a clean one.

Take care when handling the hot boiling tube.

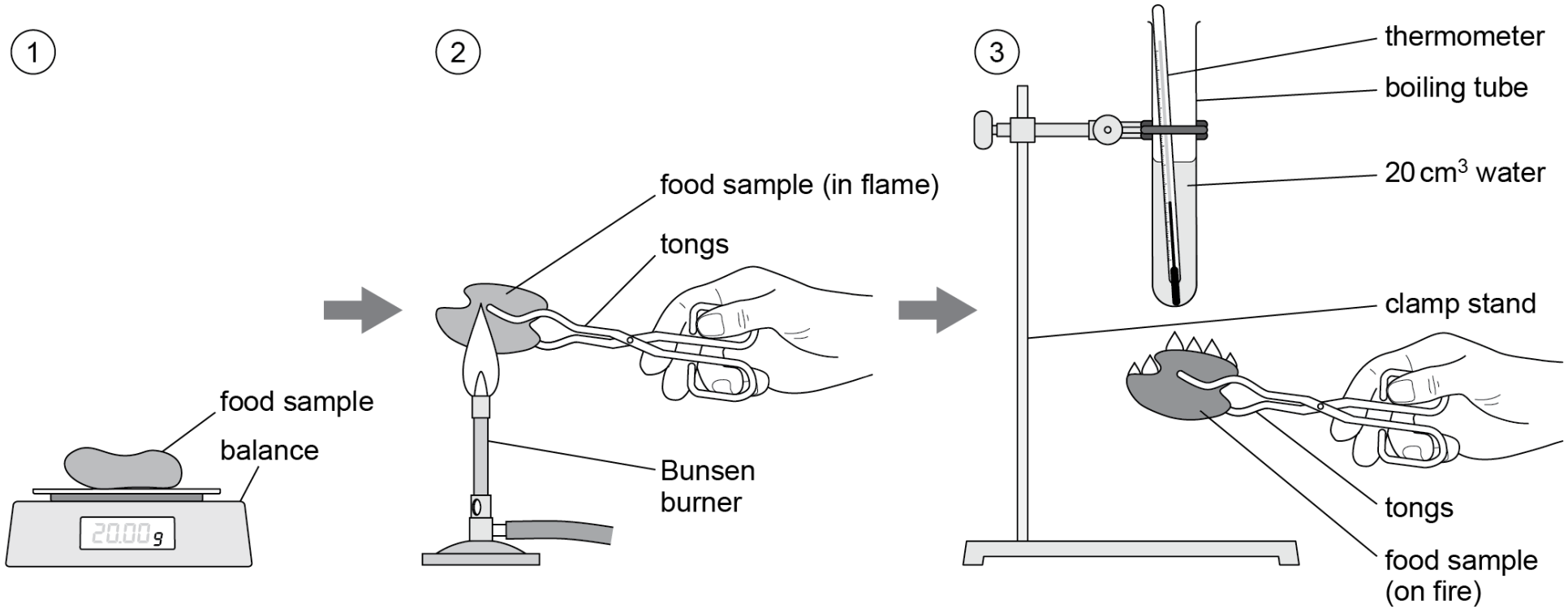
14. Repeat the procedure for the remaining food samples.
15. Calculate and record the temperature rise for each food sample.

Look over your data from the experiment and consider how effectively you think you managed to reduce any error in the temperature measurements.

Worksheet D: Equipment set-up

Make sure that you follow the diagram carefully.

Take particular care with any glassware.



Worksheet E: Results

Food sample	Food mass (g)	Initial temperature (ºC)	Final temperature (ºC)	Change in temperature (ºC)

Worksheet F: Presenting data

How would you present the data in these tables?

Match each table to either **bar chart**, **line graph** or **histogram**.

Mass (g)	Number of seeds
1–2	15
3–4	31
4–5	47
5–6	25

Test subject	Reaction time (s)
1	0.12
2	0.10
3	0.07
4	0.11
5	0.13
6	0.09

Bar chart

Line graph

Histogram

Time (days)	Shoot length (mm)
2	8
3	13
5	18
7	21
10	23

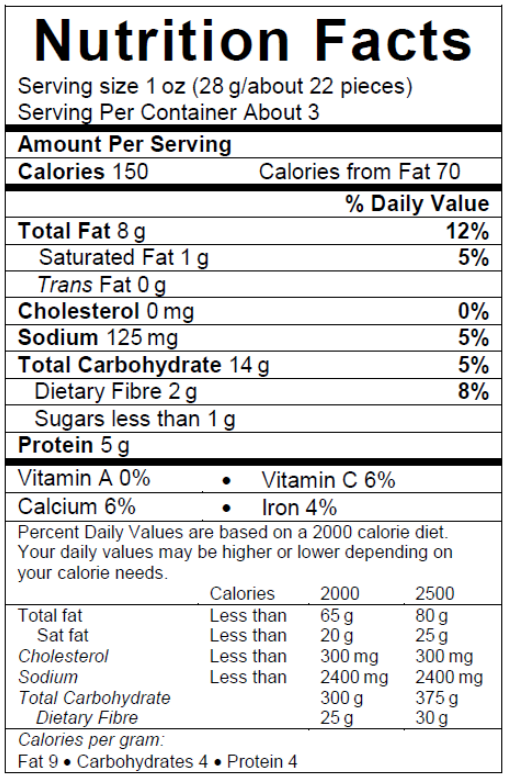
Time (min)	Volume of O_2 produced (mm^3)
1	2.3
2	3.6
3	4.2
4	5.5
5	5.9

Blood group	% of population
A	42
B	9
AB	3
O	46

Worksheet G: Analysing dietary information

The pictures show packet dietary information for crisps (left) and pasta (right).

Look at the information carefully and then write a paragraph to explain how this information relates to your results.



Nutrition Facts

Serving size 1 oz (28 g/about 22 pieces)
Serving Per Container About 3

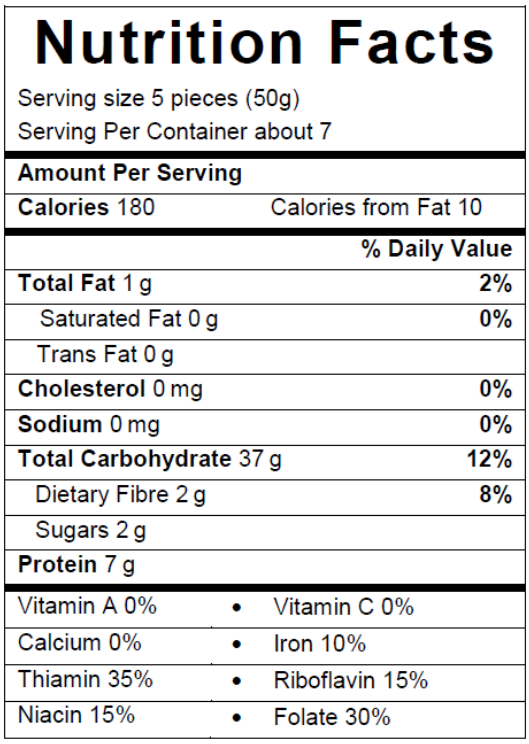
Amount Per Serving	
Calories 150	Calories from Fat 70
	% Daily Value
Total Fat 8 g	**12%**
Saturated Fat 1 g	**5%**
Trans Fat 0 g	
Cholesterol 0 mg	**0%**
Sodium 125 mg	**5%**
Total Carbohydrate 14 g	**5%**
Dietary Fibre 2 g	**8%**
Sugars less than 1 g	
Protein 5 g	

Vitamin A 0%	• Vitamin C 6%
Calcium 6%	• Iron 4%

Percent Daily Values are based on a 2000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories	2000	2500
Total fat	Less than	65 g	80 g
Sat fat	Less than	20 g	25 g
Cholesterol	Less than	300 mg	300 mg
Sodium	Less than	2400 mg	2400 mg
Total Carbohydrate		300 g	375 g
Dietary Fibre		25 g	30 g

Calories per gram:
Fat 9 • Carbohydrates 4 • Protein 4



Nutrition Facts

Serving size 5 pieces (50g)
Serving Per Container about 7

Amount Per Serving	
Calories 180	Calories from Fat 10
	% Daily Value
Total Fat 1 g	**2%**
Saturated Fat 0 g	**0%**
Trans Fat 0 g	
Cholesterol 0 mg	**0%**
Sodium 0 mg	**0%**
Total Carbohydrate 37 g	**12%**
Dietary Fibre 2 g	**8%**
Sugars 2 g	
Protein 7 g	

Vitamin A 0%	• Vitamin C 0%
Calcium 0%	• Iron 10%
Thiamin 35%	• Riboflavin 15%
Niacin 15%	• Folate 30%

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Worksheet A: Answers

Possible sources of error in the gain or loss of mass values might include:

- The pieces of potato have not been dried before re-weighing (so varying amounts of sugar solution will be adhering to each piece).
- The three pieces of potato are grouped together in one beaker for one sugar solution (so their original masses will be muddled up).
- The pieces of potato are left in the open whilst each one is weighed (so different amounts of evaporation may occur from each piece of potato).
- Some sugar solution has been dripped onto the balance along with the piece of potato or the balance has not been dried before weighing a piece of potato (which will add to the mass reading).

Worksheet B: Answers

Likely sources of error for discussion include:

- *Not being ready to start clock immediately amylase added.*
- *Failure to pre-incubate both solutions sufficiently before mixing.*
- *Not mixing solutions sufficiently and repeatedly.*
- *Choosing a time interval that is too long to identify the end point accurately.*
- *Failure to clean dropping pipette between samples.*

Worksheet E: Answers

Table of results for the virtual experiment:

Food sample	Food mass (g)	Initial temperature (°C)	Final temperature (°C)	Change in temperature (°C)
biscuit	1.15	24.0	25.5	1.5
pasta	1.09	24.0	25.5	1.5
marshmallow	1.0	24.0	24.5	0.5
peanut	1.11	24.0	37.0	13.0
crisp	0.98	24.0	29.0	5.0
banana	1.03	24.0	24.0	0

Worksheet F: Answers

Bar chart

Test subject	Reaction time (s)
1	0.12
2	0.10
3	0.07
4	0.11
5	0.13
6	0.09

Blood group	% of population
A	42
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Histogram

Mass (g)	Number of seeds
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Line graph

Time (days)	Shoot length (mm)
2	8
3	13
5	18
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10	23

Time (min)	Volume of O_2 produced (cm^3)
1	2.3
2	3.6
3	4.2
4	5.5
5	5.9

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