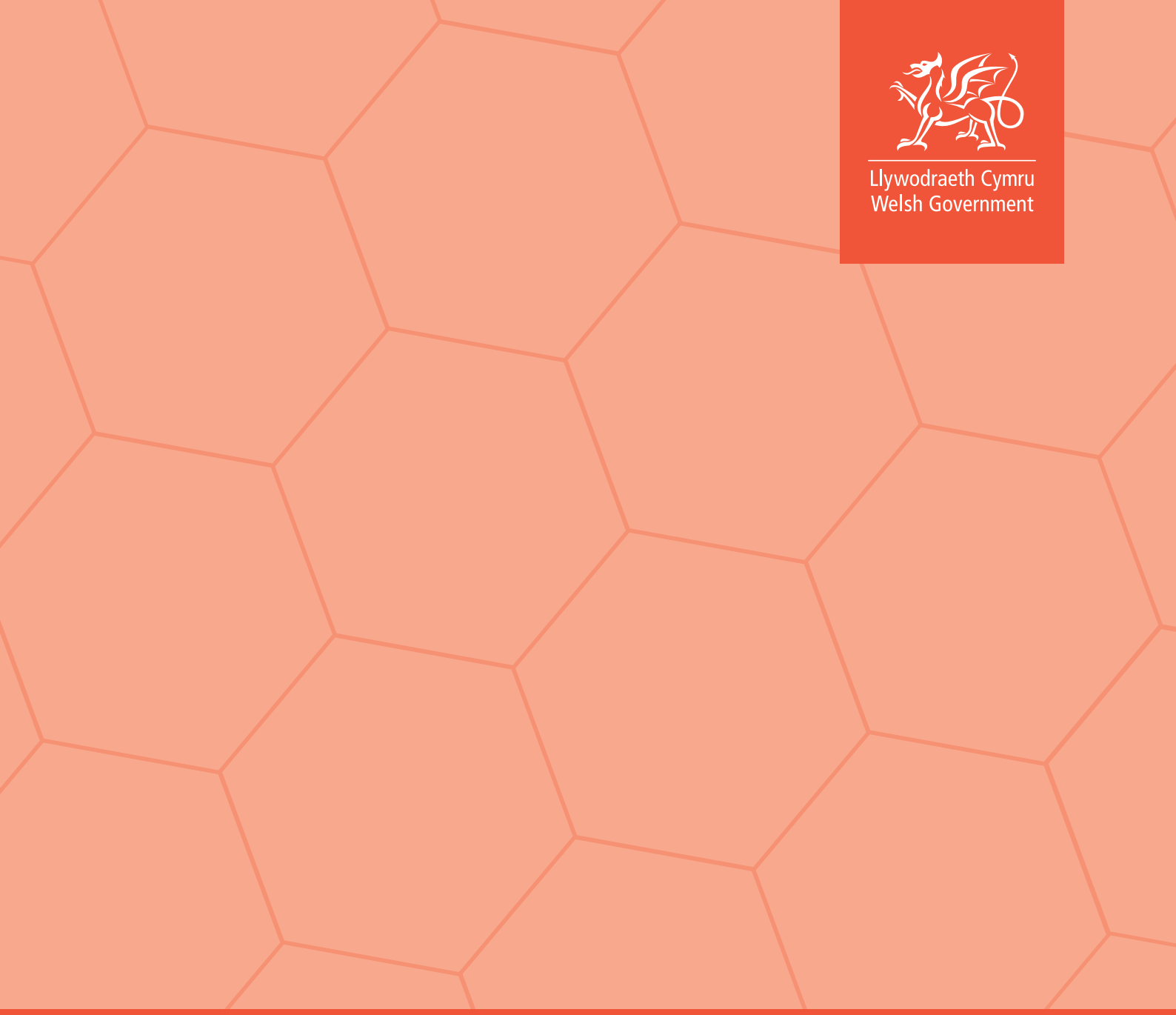

Llywodraeth Cymru
Welsh Government

Exemplification materials at Key Stages 2 and 3 in science

Additional guidance for Level 6

Exemplification materials at Key Stages 2 and 3 in science

Additional guidance for Level 6

Audience

Primary and secondary headteachers and heads of departments of maintained schools; secondary assessment coordinators and teachers at Key Stages 2 and 3; governing bodies of mainstream schools; local authorities; regional consortia; national bodies with an interest in education; tutors in initial teacher training; and others with an interest in continuing professional development.

Overview

The materials consist of examples of learners' work and a written commentary, which exemplify the standards set out in the national curriculum level descriptions. They illustrate how to use level descriptions to make best-fit judgements at the end of Key Stages 2 and 3, and give a justification and explanation for the level awarded.

Action required

To review learning plans and activities, and to prepare to make the required judgements at the end of Key Stages 2 and 3.

Further information

Enquiries about this document should be directed to:
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Additional copies

This document can be accessed from the Welsh Government's website at gov.wales/learning

Related documents

Exemplification materials at Key Stages 2 and 3 in science: Additional guidance for Level 4 (2017); *Exemplification materials at Key Stages 2 and 3 in science: Additional guidance for Level 5* (2017); *Science in the National Curriculum for Wales* (2008); *Science: Guidance for Key Stages 2 and 3* (2009); *Ensuring consistency in teacher assessment: Guidance for Key Stages 2 and 3* (2008); *Making the most of assessment 7–14* (2010)

This document is only available in English.

 WG32489 Digital ISBN 978 1 78859 271 0

Contents

Introduction

When teachers make summative judgements in science, the science skills are broken into 14 separate strands covering communication and enquiry skills, including planning, developing and reflecting. This science subject portfolio has been designed to exemplify the standards for each of the 14 science assessment strands that are available on the *Strands in progression from the level descriptions for science Key Stages 2 and 3* (learning.gov.wales/docs/learningwales/publications/140624-science-standards-of-progression-poster-en.pdf).

The materials here include a mixture of full and part investigations, alongside other transient skills that have been captured, e.g. learner–teacher dialogue, individual graphs and examples of learners' research findings. In the process of exemplifying the 14 strands, we have attempted to include a range of enquiry types, e.g. fair testing, classifying and identifying, and using and applying models. However, these materials are not designed to exemplify the full range of enquiry types. The Level 6 file does not contain an example of strand 1 ('Find evidence, information and ideas') as that strand does not have a level descriptor at Level 6, i.e. progression in that strand stops at Level 5. More information on science enquiry types are contained with *Science: Guidance for Key Stages 2 and 3* (learning.gov.wales/docs/learningwales/publications/140624-science-in-the-national-curriculum-guidance-en.pdf).

These materials are a collection of samples of work from different learners. They are not designed to present a coherent progression of the work of one learner. However, some of the tasks are used as source material for different skill strands. This demonstrates how one enquiry task may be used to enable teachers to develop multiple science skills. Although it is effective to teach science skills discretely, learners will require opportunities to draw together these skills in whole investigations as they work more independently.

The materials consist of examples of learners' work as well as written commentaries which give justifications and explanations for the level awarded. The audience for this work includes teachers working at Key Stages 2 and 3 and those working within a school to moderate and verify judgements. The examples in this document are for Level 6.

Examples of work will have errors that reflect the level being exemplified and some errors will not have been highlighted by teachers, where that aspect is not the focus of the marking.

Example 1

Subject portfolio:	Science
Task:	Does the current flowing in a wire change if the wire changes?
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Fair testing*

Context

The learners discussed what they thought could influence the current flowing in a circuit and then decided which independent variable they were going to investigate. Some learners decided to investigate the thickness of the wire, length of wire or material from which the wire was made. Learners built a circuit and inserted a metre length of wire. As the length of the wire was changed, learners recorded the current flowing using an ammeter.

Comments

1. The learner identifies a number of variables such as the cell used, wire thickness and equipment used. They plan how to control the variables that need to be kept the same.
2. The learner makes decisions about the range and values of the independent variable. The learner selects five different lengths that are at suitable intervals.

Next steps

- The learner would need to identify key variables that may not be readily controlled and explain why this is the case. An example here could be controlling the temperature of the wire. This would be particularly difficult for the learners as they may not have equipment that would allow them to record this.

Does the current flowing in a wire change if the wire changes?

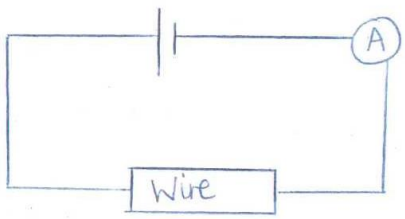
Your group needs to decide what it is going to investigate. When you have agreed on this, complete the table below:

Variable	How I will control it
Width of the wire	by using the same wires.
Volts from the cell	by keeping the dial on 6 volts.
Ammeter	by using the same one.
Wires	by using the same wires each time.

What other factors might affect your results which you cannot control?

- Broken equipment.
- Badly set-up equipment.

Draw a circuit diagram for the experiment



Write a method to describe how you will carry out your investigation

1) first set up your equipment as shown above.
2) Next set your ammeter to 20 and make the gap between your crocodile clips 20cm.
3) Turn on your cell onto 6volts, measure the ~~voltage~~ current on your ammeter.
4. finally record your results, repeat the experiment 3 times and then increase the distance by 10cm and repeat once again.

What could affect how much current flows through a wire?

- Thickness of a wire.
- The amount of amps coming from the cell.
- Type of wire.
- age of the wire.
- The condition of the wire.
- The length of the wire

Planning

Variable	What is this?	What is this in your experiment?
Independent Variable	What you're changing.	Length of the wire.
Dependent Variable	What you're measuring.	Amount of Amps.
Control Variable	What you're keeping the same.	The clips, wires, cell, ammeter and the thickness of the wires
Range	Difference between the ~~of~~ two ends of a set of data.	The difference between the ~~amount of volts~~ length of wire. I will use 20cm, 30cm, 40cm, 50cm & 60cm.

Example 2

Subject portfolio:	Science
Task:	What affects how quickly a plant photosynthesises?
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Methods and strategies*

Context

The learners looked into what plants need to help them grow. This moved to photosynthesis and what plants need to produce glucose (their food). The teacher and learners then discussed how they could investigate the link between light and the rate of photosynthesis. Ideas suggested included the colour of light, angle of the light and amount of light the plant receives.

Learners placed a *Cabomba* into a measuring cylinder full of water. They positioned a lamp a set distance from the plant and recorded the bubbles of oxygen produced over a set period of time.

Comments

1. The learner writes a systematic plan for their investigation.
2. The learner then writes an alternative plan. This is different from their first plan as they now suggest:

    - leaving the plant exposed to the light before starting the investigation (an improvement)
    - using a gas syringe to measure the volume of gas in place of counting bubbles
    - recording the time taken to collect a set volume of oxygen.

Next steps

- The learner needs to justify the changes they made in the second plan to progress to Level 7. Here the learners could indicate that in the second plan the plant reaches a steady state of photosynthesis before beginning to alter the position of the lamp. Alternatively, the learner could suggest that there are inaccuracies in the counting bubbles procedure. The size of the bubbles could vary, and there is the possibility that they could miscount the number of bubbles produced. Using a gas syringe to measure the volume of gas produced gives a more accurate method of recording the rate of photosynthesis.

B

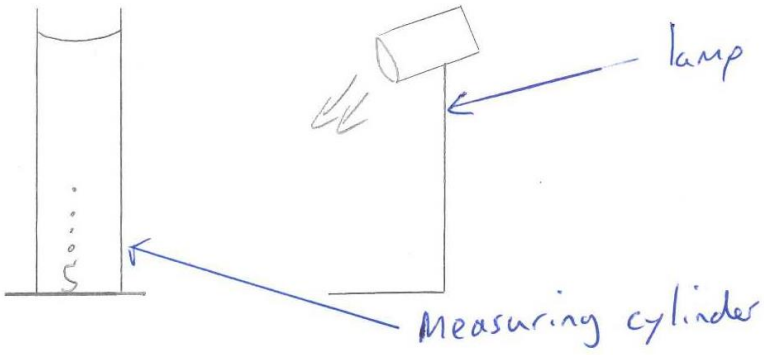
Practical – What affects how quickly a plant photosynthesises?

You need to design an experiment to test how your independent variable affects photosynthesis.

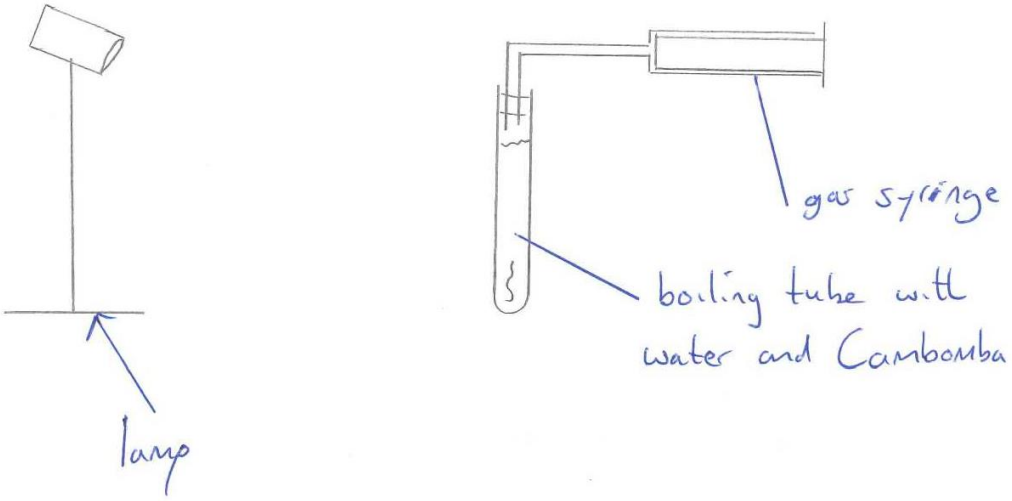
Level	What evidence you need	Teacher assessment
Level 5	You need to write a plan for your investigation that contains: All the steps All the steps in order A diagram	✓
Level 6	A second plan, a different way to do this investigation	✓

Method

Firstly place the Camboma in a measuring cylinder with water. Fill this to the top mark, 250ml. Secondy chop the top off the Camboma. Thirdy place your lamp 10CM away from the measuring cylinder. Switch the light on and start the stopwatch. Fourthly count how many bubbles of oxygen are produced over 90 seconds. Finally move the lamp to 20CM, 30CM, ... 100CM away from the measuring cylinder and count how many bubbles are released over 90 seconds.



Alternative Plan



1. Place Cambomba into a boiling tube with water.
2. Use a ruler to place a lamp 10cm from the Cambomba.
3. Switch the lamp on and allow the plant to start photosynthesising.
4. Put the bung, attached to a gas syringe, onto the boiling tube and start the stopwatch.
5. Time how long it takes for the Cambomba to produce 20ml of oxygen.
6. Repeat steps 3 to 5, changing the water each time, and moving the lamp 20, 30, 40 .... 100cm away from the Cambomba.

Example 3

Subject portfolio:	Science
Task:	Decide upon and justify success criteria for a boat ('The Big Boat Race')
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Determine success criteria*

Context

Learners were asked to consider comments made in response to a question about what would make a racing car successful in a grand prix. They were expected to highlight the success criteria and the justification for including them. They then used these ideas to decide upon success criteria for a boat taking part in a race and to justify their selection of criteria.

Comments

1. The learner selects a range of appropriate success criteria such as using waterproof materials, low-density materials and a stabilising feature to stop their boat toppling over.
2. The learner justifies their success criteria, explaining why they selected each of them. For example, needing a large sail to catch the breeze from the fan to allow the boat to move faster, and having a cover over the boat to prevent it filling with water.

Next steps

- Level 6 is the highest level learners can achieve here.

The Big Boat Race

You are going to build a boat. Before you design and build your boat, you will need to decide on some success criteria. To help you understand success criteria, read the following responses, highlight the success criteria by underlining them, and their justification by circling them.

Response 1

Response 2

What will make your grand prix successful?

Response 3

The car needs to be very fast so that I can win the race. Making it out of lightweight materials and making the car low to the ground, to reduce air resistance, will also help it go faster. The tyres need to have good grip so that the car does not slide off the track. For the car to be successful it must also be safe, therefore it needs to have anti-roll bars to stabilise the car, so that it doesn't roll over as it goes around a sharp bend.

Response 4

What will make your grand prix successful?

I'm not sure. I think it would be successful if it looked nice.

Is there anything else? Is speed and safety important?

Yes. The car needs to be very fast and safe for the driver.

Boat Race

How can we make the best boat to carry a person through a storm?

Success Criteria	Justification – Why will these make your boat a success?
Made From Waterproof Material.	If Water leaks into the boat it will force the ~~Water~~ air out and it will no longer Float.
Be able to float, made from low density materials.	The boat must Stay afloat for at least 1 minute.
Have a cover or roof.	We need a cover over the boat so that it does not Fill with water when a wave hits it.
Have Stabilisers on the Side or a fin under it.	To Stop it from toppling over when the water or Sea becomes rough.
Have a light weight Sail but a large Sail also.	We need a large Sail to catch the wind from the Fan to Push it along the tank Faster. The Sail must be made From light weight materials to Stop it Falling over.

Example 4

Subject portfolio:	Science
Task:	Decide upon and justify success criteria for an investigation where learners investigate the energy content of food.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Determine success criteria*

Context

Learners completed a topic on food, looking at food groups and types of foods that provide them. The learners observed their teacher burning a cracker to heat up some water in a boiling tube. The learners considered how they could go about an investigation to find out which of the foods they are provided with would contain the most energy.

Comments

The learner attempts to select success criteria for their project such as the recording of accurate results. The teacher discusses this with the learner who explains their comments further. The learner indicates they want to repeat each experiment, making their results repeatable, and that they want to use equipment such as a digital thermometer, digital weighing scales and a measuring cylinder to make any measurements as accurate as possible. In making these additional comments to their teacher the learner justifies some suitable success criteria.

Next steps

- An alternative or additional task to secure the learner at this level for this skill could be to include a task on how their findings could be presented. Suitable success criteria could then include: ‘making it simple, easy to read, short with bullet points and including colourful pictures or diagrams’. The learner could then justify these success criteria by adding: ‘making the language simple and presented as bullet points would allow more people to read and understand the findings, it would encourage more people who are busy and have little time to read it, and having diagrams and pictures would help poor readers understand our findings from looking at a picture’.

Core Task 1 Dydd Gwener Hydref 11

Success Criteria for burning food investigation - Which Snack Contains the most energy?

My Success Criteria are:

1) I will record how much of each food will heat up my water and this will allow me to know which food contained the most energy and consider if my prediction was correct.
2) I will be able to suggest to different groups of people which snack is more suitable to them. For a person slimming, they need to take less energy than the energy their body uses each day for growth and repair, and movement. The stored energy in their bodies, fat, will then be used up. A person about to exercise, like going jogging, would to eat the food with more energy as their bodies would need fuel such as fats and carbohydrates for respiration.
3) I will be able to identify which foods contain the most carbohydrates or fats or a combination of these. Fats are energy stores in our bodies, and carbohydrates are our source of fuel for respiration. Both of these food groups are energy sources. Therefore if a food heats ~~the~~ up the water by a greater amount it must contain a lot of energy ~~stored~~ and so must contain fats, carbohydrates or both.
4) I will need to record accurate results to allow me to advise people correctly on their diet. To record actual temperature changes the water cannot be allowed to boil. I will therefore need to use a volume of water great enough so that it does boil, but also small enough to measure temperature changes.

Example 5

Subject portfolio:	Science
Task:	Learners, as part of the investigation into which of five foods contains the most energy, are required to predict the outcome.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Predict*

Context

Learners completed a topic on food, looking at food groups and types of foods that provide them. The |earners observed their teacher burning a cracker to heat up some water in a boiling tube. The learners predicted which food they thought would contain the most energy and explained their reasons using a model.

Comments

1. The learner makes a prediction using their abstract scientific ideas by linking the eating of pasta by sporting individuals prior to a marathon.
2. They include in their prediction their scientific knowledge of food groups, linking carbohydrates to pasta and energy.
3. They include a simple scientific model and a diagram showing the energy changes involved.

Next steps

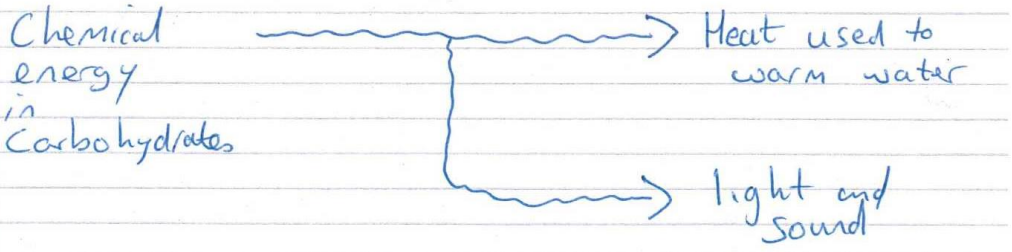
- The learner needs to link information gained from more than one source and use this to support their prediction. They could, for example, research energy labels and consider other ingredients such as fats within each food when making their prediction. They could include reference to the energy content of fats compared to carbohydrates.

My Prediction

I have to decide which of these foods, bread, pasta, Monster Munch crisps, Marsh Mallow biscuits or Digestive biscuits has the most energy. For me it is the pasta because people eat it before a Marathon. I think pasta will have the most energy because it is made from carbohydrates. Our bodies use carbohydrates as a fuel to provide energy in respiration. The glucose we get out of carbohydrates reacts and burns with oxygen.

Glucose + Oxygen → Carbon dioxide + water + Energy

So the more carbohydrate in the food the more energy it will contain.



Example 6

Subject portfolio:	Science
Task:	Learners identify the key variables for their investigation into the energy content of food.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Fair testing*

Context

Learners were asked to conduct an investigation into which snack contained the most energy. They were provided with a range of 15 different snacks. They were then asked to select the snacks they wished to investigate. At this point the teacher offered no guidance as to how many snacks the learners should select to investigate. This learner independently selected five snacks to investigate.

The learners observed their teacher burning a cracker to heat up some water in a boiling tube, and were asked to plan their own investigation, explaining how they would conduct a fair test. The learner independently identified the independent, dependent and control variables for their investigation.

Comments

1. The learner identifies a range of variables. These include the independent variable, their range of five foods, the dependent variable (which is the increase in temperature of the water) and the control variables (which include the volume of water used and the distance between the burning food and the bottom of the container holding the water).
2. The learner is set a task to find out which type of snack contains the most energy and makes decisions about the range and values of the independent variable, selecting five foods.

Next steps

- The learner would need to identify key variables that may not be readily controlled and explain why this is the case. An example of this is the room temperature and breeze, and the distance between the flame and the bottom of the container holding the water.

Burning Food Variables - Making a Fair Test

Type of Variable	What are they
① Control	We will keep the volume of water at 150ml. I will use a Measuring Cylinder. We will keep the gap between the burning food and water at 5cm. I will use a ruler. We will control draughts. We will keep windows and doors shut.
② Independent	I have decided to use 5 foods, Monster Munch, Pasta, Marsh Mallows, Digestives and Bread.
③ Dependent	The dependent variable is the change in temperature of the water. We will be using a thermometer to measure this. I will measure the water temperature at the start and end and work out how much it went up.

Example 7

Subject portfolio:	Science
Task:	Learners conduct their investigation into which of five foods selected contains the most energy.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Observe and measure*

Context

Learners completed a topic on food, looking at food groups and types of foods that provide them. The learners observed their teacher burning a cracker to heat up some water in a boiling tube. The learners carried out their investigation, measuring volumes of water, temperature and mass.

Comments

1. The learner intends to make accurate measurements using equipment with fine divisions, taking accurate measurements of volume, temperature, distance and mass, as recorded in their plan.
2. The learner's actual measurements are recorded on a teacher skills checklist, and there is some evidence of peer and teacher assessment of measurements taken.
3. The learner records additional observations when conducting the investigation.

Next steps

- The learner has made accurate measurements and made some observations in this task. However, this investigation does not lend itself to making precise observations. Carrying out an exploring scientific enquiry type of investigation would involve learners looking for changes, and so would involve the learner in making precise observations.
- To show characteristics of the next level, the learner needs to observe and measure more systematically. In this investigation we would expect the learners to repeat each experiment, allowing them to use the results to calculate an average.

What Food Has The Most Energy Investigation

Use a measuring cylinder to collect 150ml of water and pour into a conical flask.
Use a clamp and stand to hold the conical flask above a tripod.
Measure with a ruler 5cm between the tripod and the conical flask.
Put a thermometer into the flask and write down the temperature. You need to make sure the thermometer has had time to adjust to the waters temperature.
Put some biscuit on the scales to see its mass.
Hold the food and set it on fire with a bunsen.
Place the burning food in the tin lid on the tripod.
Keep watching the thermometer to see the highest temperature the water goes up to.
You have to give the water a stir.
Repeat this for the 4 biscuits we are given.

Equipment

Weighing scales, 50ml measuring cylinder, ruler, thermometer, clamp and stand, conical flask bunsen

Food Burning Practical Teacher Skills Checklist B/8/skills Name [redacted]

Food Used	Height between tin lid and conical flask mm	Teacher / Peer assessed Height between tin lid and conical flask mm	Volume of water in measuring cylinder ml	Teacher / Peer assessed Volume of water in measuring cylinder ml	Any Observations made What can you see happening?
Rich Tea	50		150	✓	We saw some condenstation at the top where the steam was cooling
Digestive	51	✓	150	✓	My boiling tube became black from soot and the flame was big
Waffers	52		150	✓	
Custard Cream	51		150	✓	

Example 8

Subject portfolio:	Science
Task:	Learners investigate which of five foods selected contains the most energy. They write their plan and then suggest changes leading to an alternative plan.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Methods and strategies*

Context

Learners completed a topic on food, looking at food groups and types of foods that provide them. The learners observed their teacher burning a cracker to heat up some water in a boiling tube. The learners wrote a systematic plan and suggestions for improvements.

Comments

1. The learner produces a systematic plan for the investigation.
2. They offer suggestions for improvements that indicate they have thought through an alternative strategy. Here they suggest using a shield (bomb calorimeter) to prevent a breeze affecting the flame, ensuring the heat energy released is not lost to the surroundings.

Next steps

- To show characteristics of the next level, the learner needs to offer some justification for the changes made in the alternative method. In this case, a reference to the use of a screen to cut down on draughts, so allowing more of the heat to reach the water, would be appropriate.

Burning Food Plan

I am going to get the following.

A Measuring Cylinder to Collect 150ml of Water.

A ruler to measure the gap between the burning food and Conical flask holding the Water, Making Sure that this is 5cm.

Stand and Clamp to hold the Conical flask.

Tripod to hold the tin lid With burning food.

A thermometer to record the temperature of the Water

Weighing Scales to Measure the mass of food burnt.

Conical flask to hold the Water.

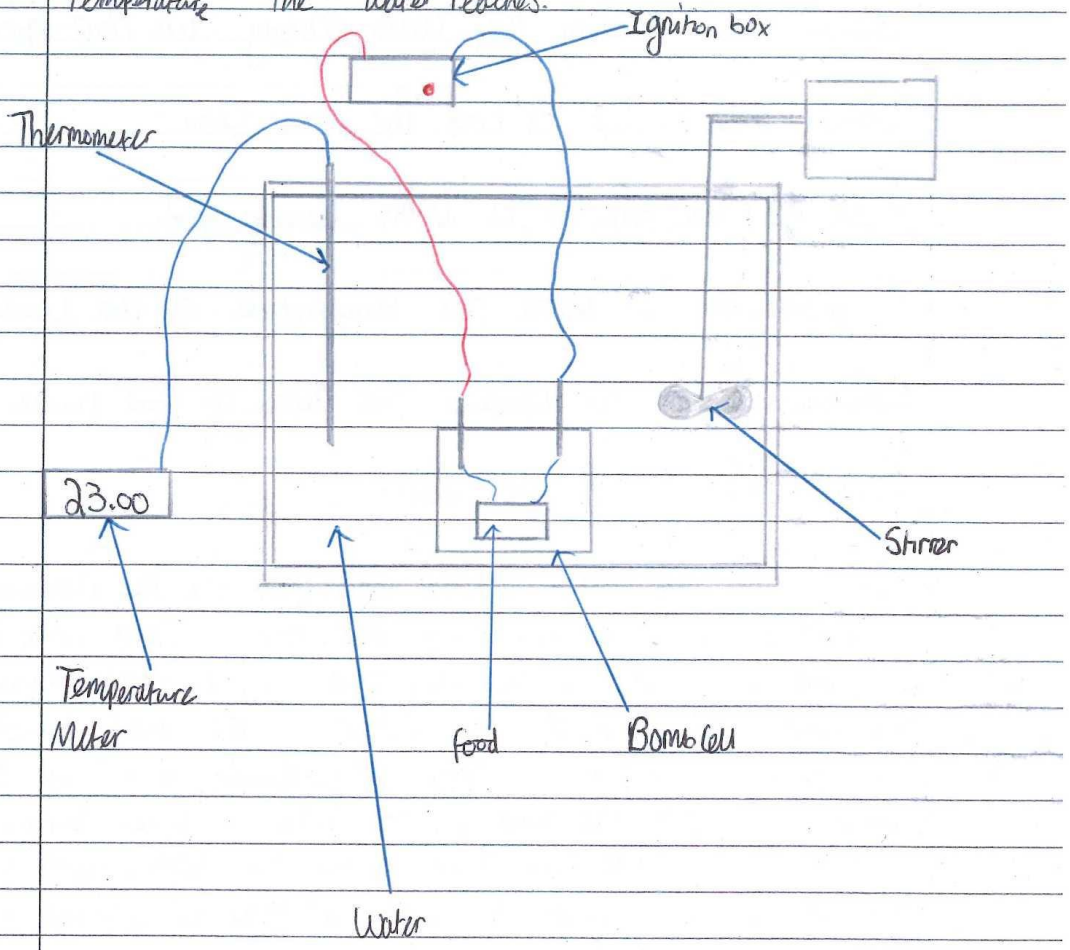
Place 150ml of Water into the Conical flask. Use the Measuring Cylinder for this. Place the Conical flask into the clamp and position it above the lid. Measure the temperature of the Water using a thermometer and record this in a table as the Starting temperature. Use the ruler to make a 5cm gap between the tin lid and the Conical flask. Set the food on fire With a bunsen burner, Once it is burning Slide the tripod holding the burning food under the Conical flask. When the food no longer burns, record the temperature of the Water again, Making Sure the Water is Stirred first. Record the new temperature and repeat this With fresh water and the Second food.

~~Alternative plans Using a Colorimeter~~

~~Using a Measuring Cylinder, measure the volume of water added to a~~

Alternative Plan

Measure the mass of the good that will burn and record this. Add water to the bomb calorimeter using a measuring cylinder, using a thermometer. Record the temperature of the water. Set the good alight using the ignition box, and record the maximum temperature the water reaches.



Example 9

Subject portfolio:	Science
Task:	Learners investigate which of five foods selected contains the most energy. From the data they collect, using their scientific knowledge, they produce a conclusion.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Communicate findings*

Context

Learners have completed a topic on food, looking at food groups and types of foods that provide them. The learners observed their teacher burning a cracker to heat up some water in a boiling tube. The learners conducted their own investigation, burning five different foods and recording and presenting their findings.

Comments

1. The learner presents their evidence in a variety of ways, including a results table, graph and conclusion. The conclusion includes a diagram that places the foods in order showing which contains the most energy.
2. The graph produced has appropriately labelled axes, and uses appropriate SI units for mass and temperature.
3. The learner communicates their findings in the conclusion and the graph, where appropriate scales (the *y*-axis scale does need to be extended) and labels are used for the axes. They have, therefore, organised and communicated their findings in a variety of ways that are fit for purpose and audience.

Next steps

- To progress to a higher level, the learner would need to be able to draw an appropriate line of best fit on a graph.

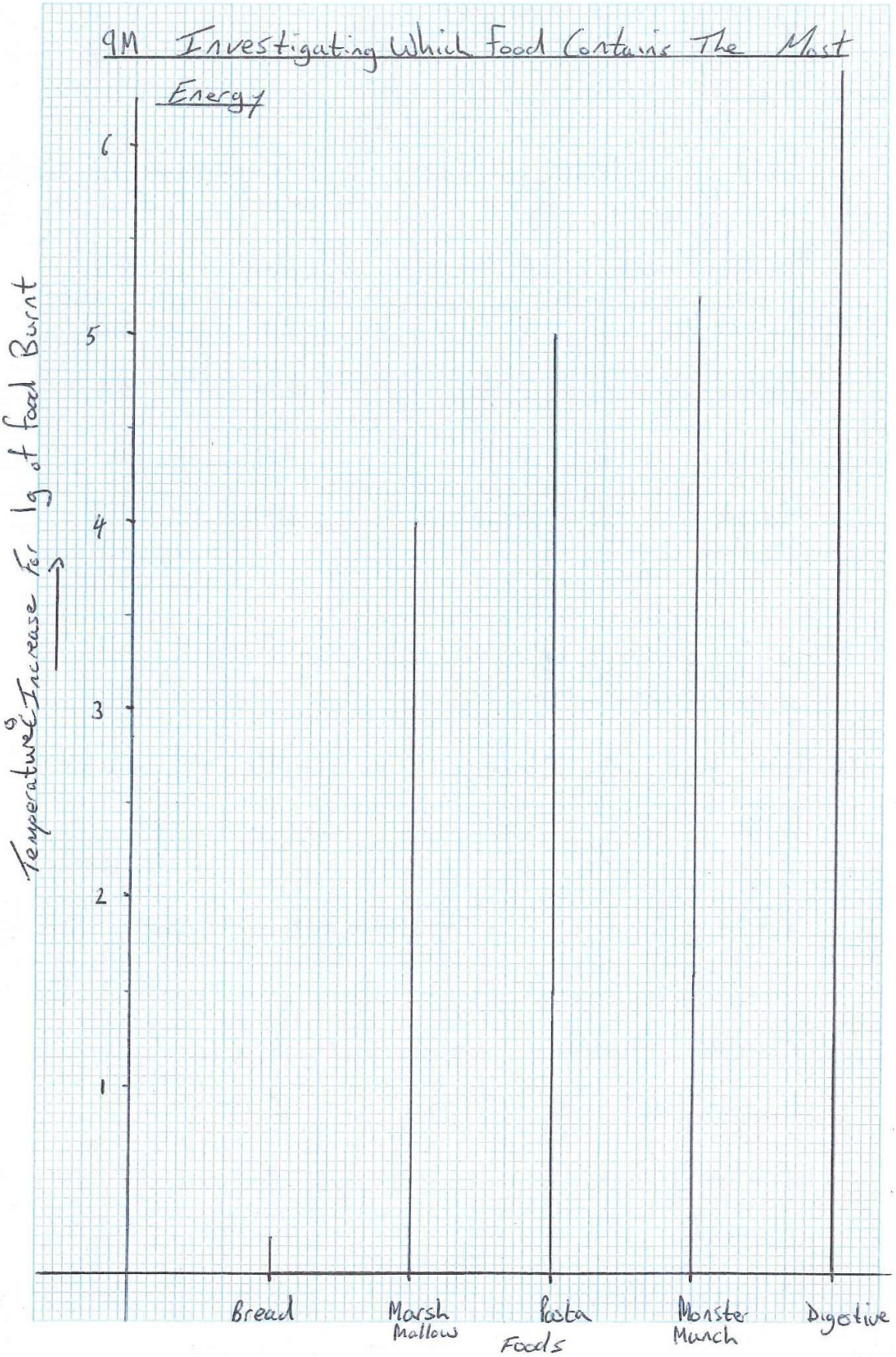
Burning Food Results

Food	Mass of food (g)	Temperature of Water °C		
		Start	End	Change
Monster Munch	4·4	20	43	23
Digestives	9·7	20	82	62
Pasta	7·6	20	58	38
Bread	5·8	20	31	11
Marsh Mallow	14·6	20	79	59

Updated Results

We had to change the results to make it fair.

Food	Temperature increase for 1g of food °C
Monster Munch	5·2
Digestives	6·4
Pasta	5
Bread	0·19
Marsh Mallow	4·0


9M Investigating Which Food Contains The Most Energy
Temperature Increase for 1g of food Burnt
6
5
4
3
2
1
Bread
Marsh Mallow
Pasta
Monster Munch
Digestive
Foods

Burning Food - What You found Out

Conclusion

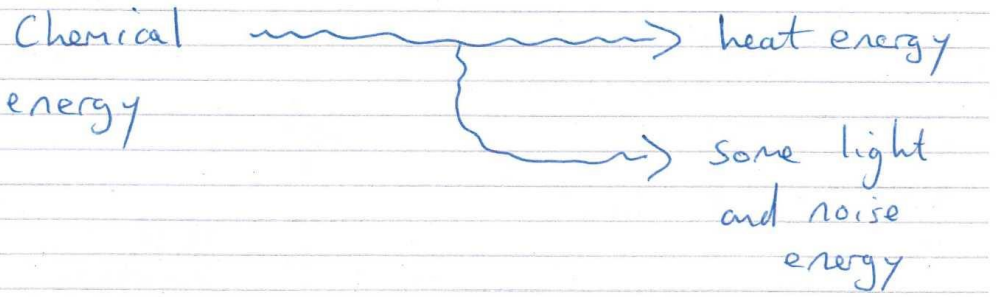
My results don't allow me to know which food has more energy. It was not a fair comparison because some foods were heavier. To fix this we made a new table comparing 1g of each food.

I can see from the second table that digestive heat the water up the most when 1g is used. Bread is the worst it does not heat the water much. We can now say that digestives have the most energy and bread has the least energy. I have placed the foods in order to show which contains the most energy.

Digestives
Monster Munch
Pasta
Marsh Mallow
Bread

Most Energy

My prediction on pasta was wrong it does not have the most energy. The digestive biscuit beat it. I think the digestive biscuit had the most energy because it has a lot of fat in it. On the packet I checked it said a lot of fat was in them. Fat is a Material that is used as an energy store in animals. We use it as an insulator and as a store of Clemical energy. When we burnt the ~~food~~ the clemical energy changed into heat energy. The digestive must of had More Clemical energy in it to heat the water More.



Example 10

Subject portfolio:	Science
Task:	Learners were tasked with designing an investigation to find out why ships have a pointed front
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Explaining*

Context

Learners were set a task by their teacher to design an investigation to find the best shape ships should have. The learner was directed to a range of websites that have video clips of objects being dropped through oil and other liquids. From this the learner designed their investigation using card of differing surface areas to drop through wallpaper paste.

Comments

1. The learner records their evidence and writes a simple conclusion for their findings. They explain their findings using abstract scientific knowledge, explaining the forces acting on the card, and how the increase in surface area results in more molecules being hit by the falling card. They link this increase in contact between molecules being hit and the upward force on the card.

Next steps

- The learner needs to explain to what extent their findings are consistent with scientific knowledge.
- They could begin to use their explanations to make predictions. Here they could look at the link between surface area and time taken to fall, and make predictions, or estimates for the time it would take for untested surface areas to fall through the wallpaper paste. Alternatively, they could make predictions as to the time the card would take to fall through different liquids where viscosity changes.

Ship Shape Investigation

Our Challenge is to design an investigation that can prove a ship with smaller surface area at the front can pass through water more easily

Our Plan

- Cut card into different sized surface areas (use 5 different areas)
- Make sure the card has the same mass by adding plasticine to the back of the cards.
- Drop the cards through a glass tube of wall paper paste
- Time how long they take to fall to the bottom

What I found Out

When the surface area is bigger it takes longer for the card to fall through the paste, and when the surface area is smaller it takes less time for the card to reach the bottom.

The wall paper paste is made from molecules. When the card is placed into the paste the force of gravity starts to pull it down. When the card is falling through the paste it hits the molecules, which slows it down. The molecules represent a force in the opposite direction to gravity, and slow the card down. So when the card falls two forces are in action, one pulling it down and the other pushing it up. This is like a tug of war, and in this case gravity is bigger and over powers the upward force so the card falls.

Large surface area – Here the card was hitting more of the paste particles as it was falling. This means the upward force was bigger and counter acting more of the downward force of gravity. It has a smaller resultant force pulling it down so it moves slowly.

Small surface area – Here the card hots less particles of paste and so has a smaller upward force working against gravity. The overall force downwards is now bigger so the card falls faster.

Why do ships need a pointy front?

I can now see that pointy fronts on boats give it a smaller surface area. The front of the boat hits less water particles, and so there is a lower backward force working against the push of the boats engines.

Our results

Area of Card used cm^2	Time taken to fall seconds
4	12
6.25	16
9	26
12.25	41
16	87

Example 11

Subject portfolio:	Science
Task:	Investigation into which of five foods contains the most energy – review of findings and conclusions.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Explaining* *Review findings* *Conclusions and decisions*

Context

Learners completed a topic on food, looking at food groups and types of foods that provide them. The learners then observed their teacher burning a cracker to heat up some water in a boiling tube. Having conducted their own investigations, they reviewed their findings and considered both other factors that could influence their results and the views of others.

Comments

1. The learner considers the reliability of their results. They comment on their ability to make accurate measurements, using equipment such as thermometers, measuring cylinders and rulers. They consider the likelihood of anomalies, recognising that the marshmallows melting was a source of error, and recognise the fact that repeat readings were not taken.
2. In including the word equation for respiration and the diagram showing the energy changes, the learner uses abstract scientific ideas, and recognises a number of processes are taking place. The learner uses these ideas to explain their findings and draw a conclusion.
3. The learner considers the views of other groups in the class, and uses the internet to start looking at food labels to check the validity of their own results.

Next steps

- The learner needs to develop their ideas on room temperature, draughts and repeat readings to evaluate fully their results when considering the reliability and validity of their conclusion.
- The learner could use their results to make predictions, and develop their ideas on respiration and energy changes by linking these processes.
- The learner needs to suggest how more information could be collected to check the validity of their conclusions. This could be done by looking at food labels for all foods used and then comparing the energy for a standard 100g of each food.

Are your results Reliable Enough To Make A Conclusion

Food	Mass of food(g)	Temp at start °C	Temp at end °C	change
Monster Munch	4.6	20	45	25
Digestives	9.1	20	87	67
Pasta	7.6	19	53	34
bread	5.8	20	30	10
Marshmellows	12.2	19	76	57

If I just consider my results in my table, I would have to say Digestives contain the most energy and bread contains the least energy. This must mean that the Digestives contain more energy containing food groups are used by our bodies to release energy during respiration.

Glucose from + Oxygen → water + carbon dioxide + energy
carbohydrates

On burning these foods there is an energy change,

Chemical energy in food → heat energy to heat water

→ light energy
sound energy
[wasted energy]

However I do not think my results are reliable enough to say for certain that Digestives do contain more energy than the other foods tested. This is because we did not repeat the experiments and the

Marsh Mellow results are wrong or unreliable as it dipped when burned. What I can say are the measurements we took were accurate as we used equipment like a thermometer, ruler and measuring cylinders. Another reason our results are not reliable is because we did the experiment over 3 lessons so room temperature could be different and there could be draughts on different days.

To check if our prediction that pasta would contain the most energy we did 2 things. We looked at results from other groups in our class. Two groups had the same results as us, digestives heating the water the most. All the other groups found Marshmellow heated water the most. The second thing we did was to check the internet to research the energy in pasta and Digestives. The food label for digestives showed more energy, so our initial prediction could be wrong.

Example 12

Subject portfolio:	Science
Task:	Learners investigate which of five foods selected contains the most energy. They review success criteria in light of their experiences.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Review success* *Evaluate learning*

Context

Learners completed a topic on food, looking at food groups and types of foods that provide them. The learners observed their teacher burning a cracker to heat up some water in a boiling tube. Having set success criteria and conducted their own investigations, learners evaluated how far the success criteria had been achieved.

Comments

1. The learner evaluates effectively how far the conduct and the outcomes of the investigation fully reflect the success criteria. They comment, for example, on the fact that the water did not boil and they were able to rank the foods in order of energy content. The learner also identifies the learning strategies being used.
2. The learner identifies the learning strategies being used, and links these to experiences in other subject areas.

Next steps

- The learner needs to refine the success criteria in light of their findings to inform future investigations.
- They could use the refined success criteria, of being able to compare foods rich in fats to foods rich in carbohydrates, to see which contains the most energy.
- The learner needs to review the learning strategies used having completed their investigation and gathered their results. They need to consider the effectiveness of the strategies used in light of the success or lack of it on completing the task.

Core Task Burning Food Evaluation

The aim of our investigation was to find out which snack contained the most energy, and then to use our findings to decide on the best snack for a person exercising for aiming. From doing our investigation we can say we have some sucess and some failings. Looking at our results in a results table makes it look as if we were succesful as we have identified the food with the most and least energy content. If we were to assume our results were accurate we could advise a swimmer or a person about to exercise on what snack to eat. Another positive thing about our investigation and readings taken was the accuracy of measurements taken. We used expensive equipment with accurate scales that allowed accurate readings to be taken. There were also issues that makes me not sure about our findings. The marshmellow melted, so not all of the food weighed burned and heated the water. This is a duel result. We also in most experiments do it more than once to check if our results is accurate, and to see if we made mistakes. We did not do this, so it is hard to say if our experiment can answer our sucess criteria fully.

How I learnt	Do I like this way of learning?	Where?
Teacher talk, giving instructions	NO - too much	French
Research looking at food tables on internet	Good, helped me with working out why some foods heated the water alot. Also show's what is in the foods.	English we have to research characters like Shakespeare. we sometimes do this in history about life in the old days.
Demonstration by teacher	Good, it shows us what to do and we can then copy it.	DT teachers always show us how to use equipment like saws and drills
Group work	Good, to talk to friends you dont get embarased if you don't know what to do.	In Maths we get a challange and work on it in groups
Reading books	NO, too much stuff in there and there is always loads to read.	Science, RE and Geography.

Example 13

Subject portfolio:	Science
Task:	Investigating the effect of surface area on the time a falling object takes to hit the ground.
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Observe and measure* *Communicate findings* *Review findings* *Explaining*

Context

Learners watched a video clip of the space shuttle *Atlanta* landing. To aid its slowing down it deployed a parachute. Learners were asked 'How did NASA know what size parachute to use and does the size of the parachute have any effect on slowing the shuttle down?' Learners were then asked to investigate the link between canopy size and the braking effect of the canopy, using paper, a stopwatch and a metre stick.

Comments

Observe and measure

1. The learner uses various ways, text, table and a graph, to present their findings.
2. They measure with precision the dimensions of the paper used. Measurement is accurate to the nearest 0.1cm which, given the equipment generally available, reflects the maximum precision which can be achieved.
3. They calculate and display surface area with appropriate precision.
4. The learner measures the time taken for the paper to fall to one decimal place, which was the maximum precision of the equipment supplied.
5. The learner calculates and displays the mean time accurately.

Communicate findings

6. The learner explains the link between surface area and time taken to fall, stating that as the surface area increases the time taken to fall also increases.
7. The learner draws an appropriate graph to display the data effectively.
8. The learner accurately plots the data on a chart with appropriate scales, axes and titles.
9. The learner attempts a best fit line, which begins to show characteristics of Level 7.

Review findings

10. The learner discusses the reliability of the results and offers some justification for their opinion, stating there are no anomalies and all results are close to the mean value.
11. They suggest a method for improving the reliability of the timing element of the experiment, suggesting electronic timing.
12. They begin to link the number of experimental repeats to the concept of reliability.

Explaining

13. The learner uses an abstract model (particle theory) to explain their results, i.e. more particles hit the paper when its area is larger.
14. The learner relates the mass of the paper to the weight and begins to link this force to the retarding force of air resistance.

Next steps

- The learner employs a method (repeated folding of a single sheet) that prevents them from progressing to a higher level. They need to take a more systematic approach using paper with surface areas of 600, 500, 400 and 300cm^2, for example.
- The learner has attempted to demonstrate a linear relationship between time and surface area. While producing a line of best fit is characteristic of Level 7, in this case the relationship is not linear and a best fit curve is more appropriate. For the learner to progress to the next level a curve of best fit needs to be drawn and, where possible, calculations need to be included. In this instance, the learners could calculate the mean speed of the paper as it falls.
- If a non-linear line (i.e. curve) is fitted to the data, the learner can describe the curve by reference to the changing gradient; for example, as surface area increases, the gradient decreases.
- The learner has commented that the results are ‘reliable as they are similar to the mean’. Characteristic of Level 7 would be an attempt to quantify how similar they are, e.g. all values are within 5 per cent of the mean.
- The learner mentions using electronic timing to improve the reliability of measuring the time to fall. More characteristic of a Level 7 would be the learner explaining why using electronic timing would be more reliable than manual.
- To move to the next level, the learner needs to use their explanations to make predictions. They could begin to make predictions about the results of the experiment if it were conducted under different conditions. An example could include a prediction where the air density changes, such as at varying altitudes.
- They could begin to explore and compare results to actual theory. Non-linear aerodynamics is a complex area, but learners progressing to a higher level should be able to appreciate that drag is linked to velocity^2 and the implication that this will make the response (as observed) non-linear.

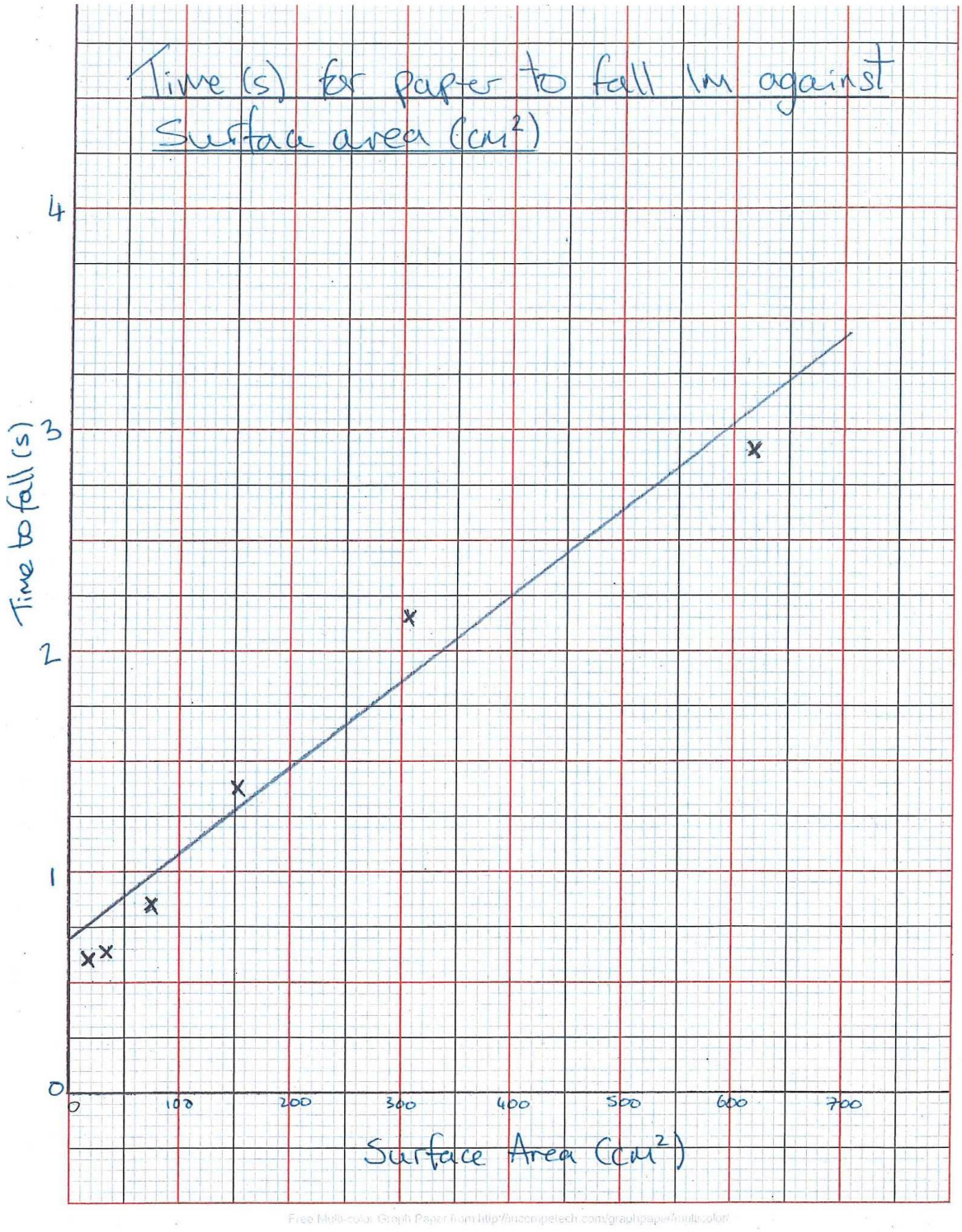
Results

Length (cm)	Width (cm)	Surface Area (cm^2)	Time to fall (s)			Mean (s)
			1	2	3	
29.6	20.9	618.64	2.9	2.7	3.1	2.90
14.8	20.9	309.32	2.0	2.2	2.2	2.13
14.8	10.4	153.92	1.4	1.3	1.4	1.37
7.4	10.4	76.96	0.9	0.8	0.9	0.87
7.4	5.3	39.22	0.7	0.6	0.6	0.63
3.8	5.3	20.14	0.5	0.5	0.6	0.53

My results show that as surface area increases, the time for the paper to fall increases. The bigger the surface area, the slower the paper falls. This is because the larger the surface area more air particles get trapped as the paper falls and it's air resistance is higher. We used the same paper for all the experiments, so the mass was the same. As the mass was the same, the force downwards, weight was the same but for a larger piece of paper the air resistance upwards was larger, so the resultant force was less so it fell slower.

My results are quite reliable as they are all similar to the mean, with no obvious anomalies. The reliability of the results could be improved by using

electronic timing to determine when the paper hit the ground. Also we could have repeated the experiment 5 times instead of 3.


Time (s) for paper to fall 1m against Surface area (cm²)
Time to fall (s)
0
1
2
3
4
0
100
200
300
400
500
600
700
Surface Area (cm²)
Free Multi-color Graph Paper from http://incompetech.com/graphpaper/multicolor/

Example 14

Subject portfolio:	Science
Task:	How does the volume of water used in a water-propelled rocket affect the time it's in the air?
Illustrative of characteristics mainly at:	Level 6
Skill assessed:	*Predict*

Context

The teacher demonstrated the launch of a water-propelled rocket using two different volumes of water. Learners were also given the value for the maximum volume of water the rocket could hold. The learners were then asked to address the following two points when making their prediction.

- Would the addition of more water result in the rocket always going higher?
- Why does the rocket take off?

Comments

1. The learner makes a valid prediction, addressing one of the questions the teacher puts to them, i.e. that there will be an 'optimum amount of water', but then fails to add any justification or science to support this.
2. When addressing the second question asked by the teacher the learner uses abstract scientific knowledge of forces and Newton's third law to explain why the rocket will rise up into the air.

Next steps

- Although the prediction satisfies the characteristics of Level 6, to strengthen their prediction the learner could add further explanations. For example, why they feel there is an optimum volume of water, and what is making the bottle fall back to earth, with a discussion around the forces acting against each other.
- To progress to the next level, the learner needs to link their scientific knowledge and understanding. In this case they need to link the forces working against each other, for example by adding more water there is an increase in the generated upthrust and so the rocket should travel further up into the air.
- The learner needs to explain further how this increase in water also increases weight, the downward force that acts against upthrust. Therefore, there will be an optimum point of the trajectory where the extra upthrust generated will be negated by the additional weight and so the rocket will not travel any higher and even more water added will mean less height gained.

Prediction

I predict that there will be an optimum amount of water in the bottle rocket which will make the rocket stay in the air the longest. The rocket will go up in the air because of Newton's third law. When object A (ground) exerts a force on object B (rocket), object B will exert the opposite force on object A, making the bottle fly up in the sky.

Amount of water (ml)	Try 1 (seconds)	Try 2 (seconds)	Try 3 (seconds)	Average (seconds)
50	3.00	2.89	2.98	2.96
100	2.94	2.92	3.02	2.96
150	3.19	3.11	3.12	3.14
200	3.15	3.60	3.72	3.49
250	3.25	3.48	3.92	3.55
300	3.72	3.84	3.99	3.85
350	3.45	3.96	4.01	3.81
400	3.36	4.56	4.45	4.12
450	3.24	3.58	3.61	3.41
500	3.84	3.61	3.52	3.66