

Exemplar for Internal Achievement Standard Biology Level 2

This exemplar supports assessment against:

Achievement Standard 91153

Carry out a practical investigation in a biology context, with supervision

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. These will assist teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment from 2014

	Grade Boundary: Low Excellence
1.	<p>For Excellence, the student needs to carry out a comprehensive practical investigation in a biology context, with supervision.</p> <p>This involves justification of the choices made during the sound investigation by evaluating the validity of the method or reliability of the data, and explaining the conclusion in terms of the biology ideas relevant to the investigation.</p> <p>This student has developed a hypothesis linked to a scientific concept (1), and used a valid method for a fair test to collect and record data, processing it (2) to enable a trend to be determined.</p> <p>A valid conclusion based on the student's processed data is relevant to the purpose of the sound investigation (3).</p> <p>Biological ideas relating to the investigation, based on the student's findings and those from other sources, are explained (4) and discussed (5).</p> <p>Some choices, made during the investigation by evaluating the validity of the method or reliability of the data, were justified (6).</p> <p>For a more secure Excellence, the student could develop the evidence justifying the choices made during the investigation by evaluating the validity of the method or reliability of the data more thoroughly. For example, by giving more reasons why the steps were taken to justify the choices made.</p>

Please note – These are extracts from one student's response

Purpose: to investigate the effect of the concentration of sugar solutions on the mass of potato chips.

1

Hypothesis: when potato chips are placed in solutions with high concentrations of sugar (for example 0.8 mol L⁻¹) then they will lose mass as the chip will lose water because of osmosis.

Raw Data for investigating the effect of the sugar solution concentration a potato piece is soaked in on osmosis.

Solution concentration		Initial mass (g)	Final mass (g)	% change in mass	Average % change in mass
0.0 mol L ⁻¹	1	1.04	1.20	15.38	15.67%
	2	1.13	1.32	16.81	
	3	1.08	1.24	14.81	
0.2 mol L ⁻¹	1	1.06	1.10	3.77	4.30%
	2	1.03	1.08	4.85	
	3	1.17	1.22	4.27	
0.4 mol L ⁻¹	1	1.15	1.02	-11.30	-11.43%
	2	1.19	1.06	-10.92	
	3	1.16	1.02	-12.07	
0.6 mol L ⁻¹	1	1.16	0.85	-26.72	-24.35%
	2	1.13	0.86	-23.89	
	3	1.07	0.83	-22.43	
0.8 mol L ⁻¹	1	1.05	0.70	-33.33	-31.16%
	2	1.14	0.82	-28.07	
	3	1.06	0.72	-32.08	

3

Conclusion: my results showed that the chips gained mass in water and low sugar concentrations but lost mass in high concentrations of sugar. This is what I predicted in higher sugar concentrations because in these solutions the water will move out of the potato cells by osmosis.

4

When the chips were put in distilled water they gain mass because the chips gain water from the surrounding solution due to osmosis. The process of osmosis causes a net flow of water across the semi permeable membrane, from a solution with a high water concentration to one with a lower water concentration. The chips gain water because the distilled water has a higher water concentration than the chips.

As the concentration of the sugar solution increases from 0.2 to 0.4 mol L⁻¹ the potato chip loses more and more mass because the difference in water concentration between the inside of the potato cells and the surrounding solution is increasingly different. This means that when the chips are placed in the higher concentration solutions more water will move out of the chips as the result of osmosis.

4

We looked at another finding the teacher gave us from a group that studied *Nereis* sp (worms). These worms live under large rocks near the high tide in the sea. The salt concentration of the worm's environment can change due to the weather (rain and sun) meaning that there is sometimes less salt in the surrounding water and sometimes more.

5

The group used three different beakers, each with 50 worms in different concentrations of salt solution instead of potato chips in sugar solutions. Their hypothesis was that worms could tolerate a wide range of salt concentrations within its habitat. They found that in the seawater + distilled water mixture the worms gained weight, but then dropped down to an average rate. When they were in the seawater + salt solution mixture they lost weight but then regained it. This weight loss showed similar pattern to our potato investigation when the chips were in high concentrations of sugar. The normal seawater had no effect on the worms. In the worms case the data shows that they have a mechanism to control the water balance – active transport, and this needs energy. Our potatoes don't use a mechanism like the worms do, as osmosis is passive transport, so the chips do not regain their normal weight.

5

The trend in the data from the kumera chips investigation was almost the same as mine for the potatoes. Even though they did not use distilled water, there was a point on the graph where the weight did not change, like mine, as the net flow of water was at equilibrium.

5

My method is valid because I did things to make my investigation a fair test. For example, I used a cork borer to make sure all the chips used were cut as close to exactly the same shape as possible so each chip had a similar surface area. This may otherwise have had an effect on the diffusion rate or water. The repeats used at each concentration showed similar results to each other, with no significant outliers.

6

A change made to my original method was to make the chips slightly smaller than planned. This was because I had to get all 15 chips from the same potato.

The method was carried out in a way that variables were controlled by covering the test tubes with gladwrap and keeping them in the fridge for 12 hours

6

	Grade Boundary: High Merit
2.	<p>For Merit, the student needs to carry out an in-depth practical investigation in a biology context, with supervision.</p> <p>This involves:</p> <ul style="list-style-type: none"> • using a valid method that describes the control of key variables and consideration of factors such as sampling bias and sources of errors • collecting, recording, and processing data to enable a trend or pattern (or the absence of a trend or pattern) to be determined • reaching a valid conclusion based on the student's processed data which is relevant to the purpose • a discussion of the biological ideas relating to the investigation based on the student's findings and those from other source(s). <p>This student has developed a hypothesis linked to a scientific concept (1), and used a valid method to collect and record data, processing it (2) to enable a trend to be determined.</p> <p>A valid conclusion based on the student's processed data is relevant to the purpose (3).</p> <p>Biological ideas relating to the investigation, based on the student's findings and those from other sources, are explained (4) and discussed (5).</p> <p>An attempt is made to justify some choices made during the investigation by evaluating the validity of the method and reliability of the data (6).</p> <p>To reach Excellence, the student could justify in more depth the choices made during the investigation by evaluating the validity of the method or reliability of the data further. For example, a stronger evaluation could give reasons for what was done to justify the choices made during the investigation rather than limitations and/or future improvements (7).</p>

Please note – These are extracts from one student's response

Purpose: to investigate the effect of the concentration of sugar solutions on the mass of potato chips.

1

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Raw Data for investigating the effect of the sugar solution concentration a potato piece is soaked in on osmosis.

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Conclusion: my results showed that the chips gained mass in water and low sugar concentrations but lost mass in high concentrations of sugar. This is what I predicted in higher sugar concentrations because in these solutions the water will move out of the potato cells by osmosis.

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When the chips were put in distilled water they gain mass because the chips gain water from the surrounding solution due to osmosis. The process of osmosis causes a net flow of water across the semi permeable membrane, from a solution with a high water concentration to one with a lower water concentration. The chips gain water because the distilled water has a higher water concentration than the chips.

As the concentration of the sugar solution increases from 0.2 to 0.4 mol L⁻¹ the potato chip loses more and more mass because the difference in water concentration between the inside of the potato cells and the surrounding solution is increasingly different. This means that when the chips are placed in the higher concentration solutions more water will move out of the chips as the result of osmosis.

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We looked at another finding the teacher gave us from a group that studied *Nereis* sp (worms). These worms live under large rocks near the high tide in the sea. The salt concentration of the worm's environment can change due to the weather (rain and sun) meaning that there is sometimes less salt in the surrounding water and sometimes more.

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The group used three different beakers, each with 50 worms in different concentrations of salt solution instead of potato chips in sugar solutions. Their hypothesis was that worms could tolerate a wide range of salt concentrations within its habitat. They found that in the seawater + distilled water mixture the worms gained weight, but then dropped down to an average rate. When they were in the seawater + salt solution mixture they lost weight but then regained it. This weight loss showed similar pattern to our potato investigation when the chips were in high concentrations of sugar. The normal seawater had no effect on the worms. In the worms case the data shows that they have a mechanism to control the water balance – active transport. Our potatoes don't use a mechanism like the worms do, so the chips do not regain their normal weight.

5

The trend in the data from the kumera chips investigation was almost the same as mine for the potatoes. Even though they did not use distilled water, there was a point on the graph like mine at zero where the weight did not change, like mine.

5

My method is valid because I did things to make my investigation a fair test. For example I used a cork borer to make sure all the chips used were cut as close to exactly the same shape as possible. The repeats used showed similar results to each other.

6

A change made to my original method was to make the chips slightly smaller than planned.

The method was carried out in a way that variables that could have changed the rate of osmosis, such as evaporation and temperature, were controlled.

6

There were many things that could have been changed to make the method more valid and results more reliable. For example, making sure the temperature was kept constant and the volume of sugar solutions measured more accurately.

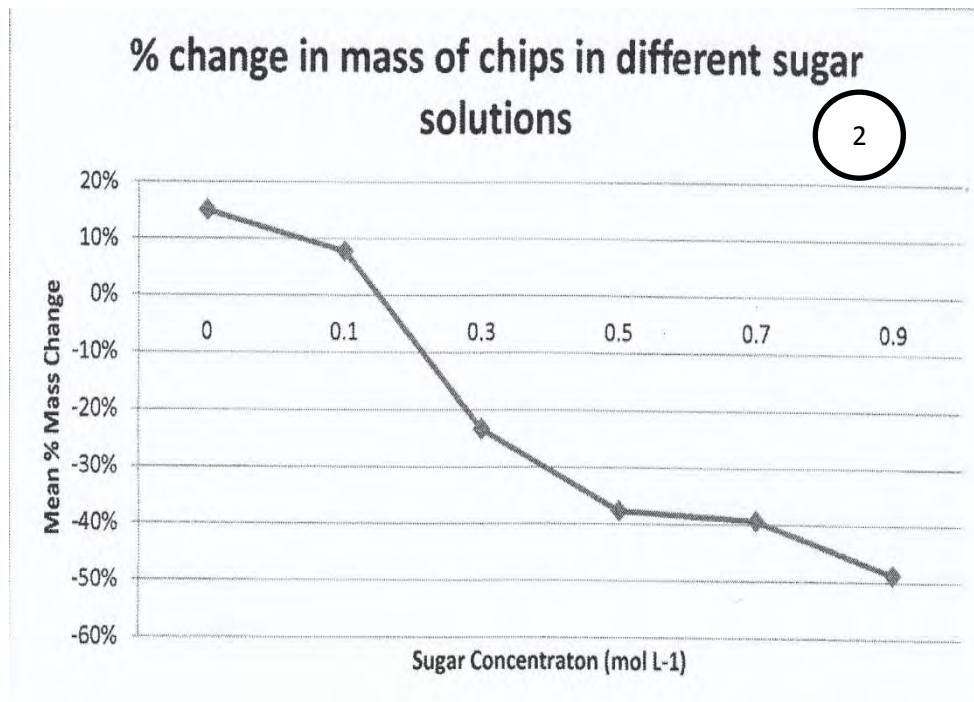
7

	Grade Boundary: Low Merit
3.	<p>For Merit, the student needs to carry out an in-depth practical investigation in a biology context, with supervision.</p> <p>This involves:</p> <ul style="list-style-type: none"> • using a valid method that describes the control of key variables and consideration of factors such as sampling bias and sources of errors • collecting, recording, and processing data to enable a trend or pattern (or the absence of a trend or pattern) to be determined • reaching a valid conclusion based on the student's processed data which is relevant to the purpose • a discussion of the biological ideas relating to the investigation based on the student's findings and those from other source(s). <p>This student has developed a hypothesis linked to a scientific concept (1), and used a valid method for a fair test to collect and record data, processing it (2) to enable a trend to be determined.</p> <p>A valid conclusion based on the student's processed data is relevant to the purpose of the investigation (3).</p> <p>Some biological ideas relating to the investigation that are based on the student's findings and those from other sources are explained (4) and discussed (5).</p> <p>For a more secure Merit, the student could elaborate further on the biological ideas based on the findings and relating them more thoroughly to those from the other sources. For example, by using more information from the processed data and the findings to compare the results as evidence in the discussion.</p>

Please note – These are extracts from one student's response

Purpose: to investigate the effect of the concentration of sugar solutions on the mass of potato chips.

1 Hypothesis: when chips are placed in solutions with high concentrations of sugar e.g. 0.9 mol L⁻¹, then the potato chips will lose mass as the chip will lose water because of osmosis.



Analysing my data that I have collected I can see that my hypothesis is correct. With an increasing amount of sugar in the solutions, the mass of the potatoes has decreased because the water molecules moved outside the cell due to osmosis (diffusion through a semi-permeable membrane).

3

Osmosis is the term describing the movement of water molecules from high concentrations to lower concentrations through a semipermeable membrane. I used pieces of potato because the potato provided the semipermeable membranes. The direction of movement of water through the semipermeable membrane depends on the relative concentrations of water on each side of the membrane. At 0.5 mol L⁻¹ there is more water inside the potato than outside, so the water moves out.

4

3 From the graph we can see that as the sugar concentration goes up, the weight changes from increasing to decreasing, with the level close to being balanced when it gets to the 0.2 mol L⁻¹. This is called the isotonic point.

We looked at another finding the teacher gave us from a group that studied *Nereis* sp (worms). These worms live under large rocks near the high tide in the sea. The salt concentration can change due to the weather (rain and sun) meaning that there is sometimes less salt and sometimes more.

5

The group used three different beakers, each with 50 worms in different concentrations of salt. Their hypothesis was correct as they found that in the seawater/distilled water mixture the worms gained weight, whereas in the seawater/salt mix they lost weight but then

regained it, which shows a similar but different pattern to our potato investigation. The normal seawater had no effect.

5

These worms have a system to re-establish the water balance. Our potatoes don't use a mechanism against osmosis like the worms do, so they do not regain their normal weight.

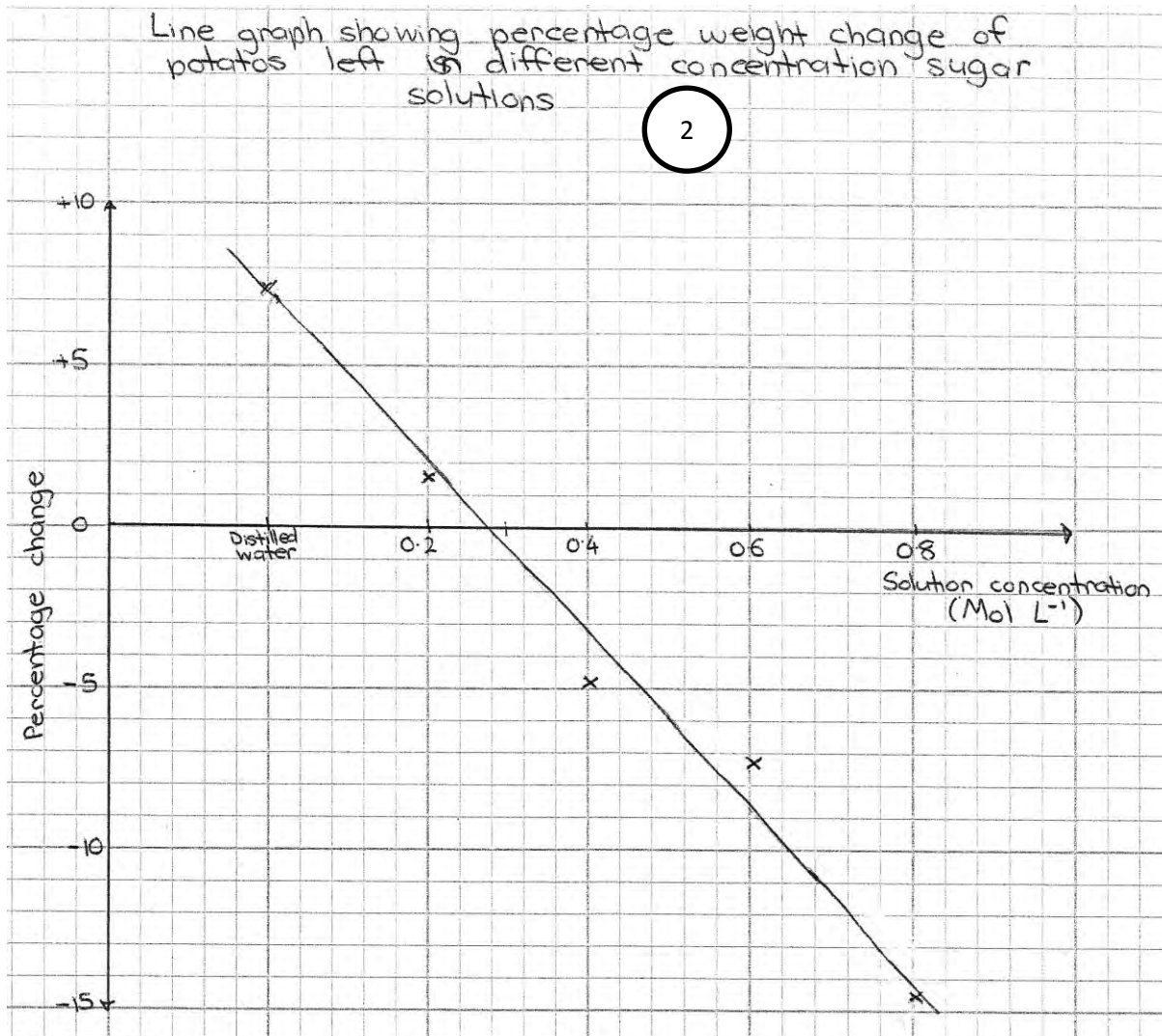
The trend in the data from the kumera chips investigation was almost the same as mine but they did not use distilled water.

	Grade Boundary: High Achieved
4.	<p>For Achieved, the student needs to carry out a practical investigation in a biology context, with supervision.</p> <p>This involves:</p> <ul style="list-style-type: none"> • developing a statement of the purpose written as a hypothesis linked to a scientific concept or idea • using a method that describes in steps the data that will be collected: <ul style="list-style-type: none"> • a range for the independent variable (a fair test - at least four values), the measurement of the dependent variable, with units, and the control of some other key variables • or the range of data/samples (pattern seeking or modelling activity) and consideration of some other key factors • collecting, recording, and processing data relevant to the purpose • interpreting and reporting on the findings by reaching a conclusion based on the student's processed data, which is relevant to the purpose of the investigation, and • identifying and including relevant findings from another source. <p>This student has developed a hypothesis linked to a scientific concept (1), and used a valid method for a fair test to collect and record data, processing it (2) to enable a trend to be determined.</p> <p>The conclusion reached (3) and findings from another source (4) are identified and included.</p> <p>A description and some explanation of the biological ideas are given, relating to the investigation, based on the student's findings and those from another source (4).</p> <p>To reach Merit, the student could include more evidence showing discussion of the biological ideas relating to the investigation, based on the student's findings and those from other source(s).</p>

Please note – These are extracts from one student's response

Purpose: to find out the effect of osmosis on potatoes by placing potato chips in different strength sugar solutions.

1 **Hypothesis:** that the potato chips will become soft and rubbery because their mass will decrease as they lose water in strong sugar solutions because of osmosis.



The general trend for the graph is that it starts high on the left and slopes down to negative values on the right. This is because for distilled water and the low concentration of sugar solution (0.2molL⁻¹) there was an increase in the mass of the potato chips. For the higher concentrations of sugar solutions (0.4molL⁻¹ to 0.8molL⁻¹) there was a decrease in the mass of the potato chips. The graph shows this pattern as a gradual trend.

3

3 **Conclusion:** my purpose was to investigate the effect of different sugar solution concentrations in relation to the mass potato chips and osmosis. From about 0.3molL⁻¹ sugar concentration, the mass in the potato decreased as shown by the graph.

My results are based on osmosis, the term that describes the movement of water molecules from high concentrations to lower concentrations through a semipermeable membrane. I used pieces of potato because the potato provided the semipermeable membranes.

4

The other source can be compared with my results. The *Nereis* worms in the beakers of salt solutions react in a similar way to the potato chips in the sugar solutions. They both lose mass as the salt/sugar concentrations get higher and gain mass when the salt/sugar concentrations are lower. Both graphs show the same trend.

4

	Grade Boundary: Low Achieved
5.	<p>For Achieved, the student needs to carry out a practical investigation in a biology context, with supervision.</p> <p>This involves:</p> <ul style="list-style-type: none"> • developing a statement of the purpose written as a hypothesis linked to a scientific concept or idea • using a method that describes in steps the data that will be collected: <ul style="list-style-type: none"> • a range for the independent variable (fair test - at least four values), the measurement of the dependent variable, with units, and the control of some other key variables • or the range of data/samples (pattern seeking or modelling activity) and consideration of some other key factors • collecting, recording, and processing data relevant to the purpose • interpreting and reporting on the findings by reaching a conclusion based on the student's processed data, which is relevant to the purpose of the investigation, and • identifying and including relevant findings from another source. <p>This student has developed a general hypothesis linked to a scientific concept (1), using a method for a fair test to collect and record data, and processing it (2) in a way that is relevant to the purpose of the investigation.</p> <p>The conclusion reached (3) and findings from another source (4) are briefly considered.</p> <p>For a more secure Achieved, the student could include more detail in the hypothesis, by linking the change of the potato chip in distilled water to a gain in mass. The student could also provide more detail to reach a conclusion based on the processed data that is more relevant to the purpose of the investigation, describing the trend shown.</p>

Please note – These are extracts from one student’s response

Purpose: to show that potato sticks placed in different sugar solutions will have a change in mass.

Hypothesis: the potato sticks left in distilled water will change in mass because of osmosis

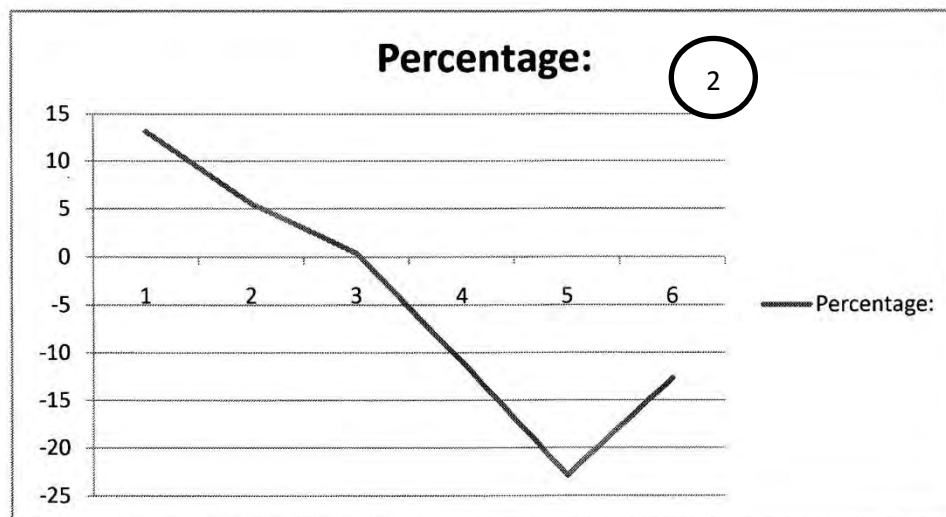
1

Solution	Distilled water	0.1	0.3	0.5	0.7	0.9
Starting weight:						
Test A: (Red)	2.71	2.73	2.88	2.77	2.69	2.72
Test B: (White)	2.73	2.68	2.72	2.49	2.67	2.73
Test C: (Black)	2.32	2.72	2.7	2.73	2.78	2.83
Carrot:	2.17	2.28	2.49	2.43	2.5	2.29
Average:	2.59	2.71	2.76	2.66	2.71	2.29

2

Solution	Distilled water	0.1	0.3	0.5	0.7	0.9
Ending weight:						
Test A: (Red)	2.97	2.88	2.96	2.53	2.03	1.99
Test B (White):	3.08	2.86	2.72	2.28	2.03	1.98
Test C: (Black)	2.74	2.84	2.65	2.31	2.21	2.04
Carrot:	2.25	2.54	2.55	2.41	2.27	1.89
Average:	2.93	2.86	2.77	2.37	2.09	2
Percentage:	13.12741313	5.535055	0.369004	-10.9023	-22.8782	-12.6638

Table of results for weight change in potatoes



2

From my experiment I can conclude that potato sticks placed in different sugar solutions had a change in mass. The potato sticks left in distilled water gained mass because of osmosis (13.1%); therefore I have carried out my purpose and proved my hypothesis to be correct.

3

The other source from the teacher also supports my findings and my conclusion, but has much larger percentage changes. This may be because the potato sticks were left longer in the sugar solutions or were another brand or aged potato. The chips in their distilled water gained the most - 16%.

4

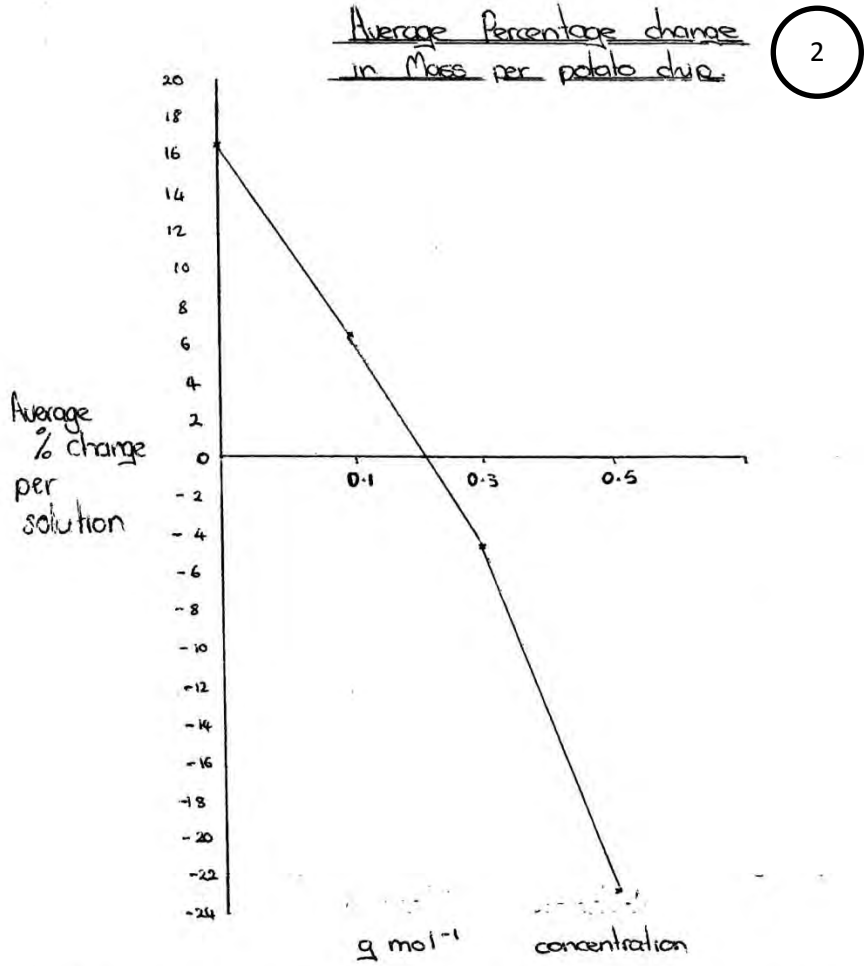
	Grade Boundary: High Not Achieved
6.	<p>For Achieved, the student needs to carry out a practical investigation in a biology context, with supervision.</p> <p>This involves:</p> <ul style="list-style-type: none"> • developing a statement of the purpose written as a hypothesis linked to a scientific concept or idea • using a method that describes in steps the data that will be collected: <ul style="list-style-type: none"> • a range for the independent variable (fair test - at least four values), the measurement of the dependent variable, with units, and the control of some other key variables • or the range of data/samples (pattern seeking or modelling activity) and consideration of some other key factors • collecting, recording, and processing data relevant to the purpose • interpreting and reporting on the findings by reaching a conclusion based on the student's processed data, which is relevant to the purpose of the investigation, and • identifying and including relevant findings from another source. <p>This student has developed a general hypothesis linked to a scientific concept (1), using a method for a fair test to collect and record data, and processing it (2) in a way that is relevant to the purpose of the investigation.</p> <p>The conclusion (3) reached and findings from another source (4) are briefly considered.</p> <p>To reach Achieved, the student could include more detail in the hypothesis, by relating the change in physical properties of the potato chip to a change in mass. More detail could also be provided in describing the findings from the source provided. Further, more detail is also needed in order to reach a conclusion based on the processed data that is relevant to the purpose of the investigation.</p>

Please note – These are extracts from one student’s response

Purpose: to investigate the presence or absence of a relationship between osmosis and sugar concentration within potato cells.

Hypothesis: I think that the potato chips will become soft, rubbery and shrink as they lose water to high sugar solutions.

1



2

3

There is a dramatic change in the curve as concentration increases however the weight decrease is fairly consistent. As the concentration of the solution increases the weight of the potato chip decreases therefore resulting in a negative gradient of the curve.

4

The other source the teacher gave us does support my findings and conclusion but it has much larger percentage changes.

It supports my conclusion and trend – as the concentration of sugar increases the potato chips change weight because of osmosis.

3