Biology Coursework

Osmosis- how does the concentration of water affect the mass of a potato?

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Aim: -

My aim is to find the percentage change of mass when a small piece of potato is placed in to molar sucrose solution

Apparatus:

- Molar sucrose solution 0.0 - 0.5
- Potato
- Cutting board
- Knife
- Weighing machine
- Glass test tube
- Glass test tube holder

Plan: -

My plan is too find the percentage change of mass of a small piece of potato when placed in to molar sucrose solution by using osmosis. Osmosis is explained below

Osmosis

Osmosis is the passage of water molecules from a region of their high concentration to a region of their low concentration through a partially permeable membrane. It is best regarded as a form of diffusion in which only water molecules move. For example look at Figure 2. The solute molecules are too large to pass through the pores in the membrane, so the movement of water molecules can only achieve equilibrium. Solution A has the higher concentration of water; so there will be a net movement of water from A to B by osmosis. At equilibrium there will be no further net movement of water. The tendency of water molecules to move from one place to another is measured as the water potential, represented by the symbol
Ψ (☙⑨❧❧② ③❧⓿⓿❧⑨ ⑦⑩⓪🗋🗐 ❸☙⓿❧⑨ ☙③❸☙❺⑩ ④⑥❷❧⑩ ☙⑨⑥④ ☙ ⑨❧☙⓪⑥⑤ ⑥☙ ☙⓪☙☙❧⑨ ⑦⑥⓿⓿❧⑤⓿⓪☙③ ⓿⑥ ⑥⑤❧ ③⑥❸❧⑨ ❸☙⓿❧⑨ ⑦⑥⓿⓿❧⑤⓿⓪☙③🗐 ⑩⑥③❶⓿❧ ④⑥③❧☙❶③❧⑩ ⑨❧☙❶☙❧ Ψ (in effect, they dilute the water). The extent by which they lower Ψ is known as the solute potential, given the symbol Ψs.

Terms used

In 1988 the institute of biology recommended the use of the term water potential to describe water movement through membranes. The two main factors affecting the water potential of plant cells are solute concentration and the pressure generated enters and inflates plant cells. These are expressed in the terms solute potential and pressure potential respectively. All of these terms are explained below.

Water potential (symbol Ψ, the Greek letter psi)[1]

Water potential is a fundamental term derived from thermodynamics. Water molecules possess kinetic energy, which means in liquid or gaseous form they move about rapidly and randomly from one location to another. The greater the concentration of water molecules in a system, the greater the total kinetic energy of water molecules in that system and the higher it's so-called water potential. Pure water therefore has the highest water potential. (Higher energy) to the system with the lower water potential (lower energy) until the concentration of water molecules in both systems is equal. This, in effect, diffusion involving water molecules.

Water potential is usually expressed in pressure units by biologists (such as Pascal; 1 Pascal = 1 Newton per m2).[2] Pure water has the highest water potential, and by convention is zero.

The following points should be considered:

- Pure water has the maximum water potential, which by definition is zero;
- Water always moves from a region of higher Ψ:
- All solutions have lower water potentials than pure water and therefore have a negative values of Ψ at atmospheric pressure and a defined temperature);
- Osmosis can be defined as the movement of water molecules from a region of higher potential to a lower potential through a partially permeable membrane.

The advantage of using water potential

Water potential can be regarded as the tendency of water molecules to move from one place to another. The higher (less negative) the water potential the greater tendency to leave a system. If two systems are in contact, water will move from the system with the higher water potential to the one with lower water potential. The two systems do not have to necessarily be separated by a membrane.

Using the term water potential, the tendency for water to move between any two systems can there fore be measured, not just from one cell to cell in a plant, but also for example, from soil to root or from leaf to air. Water can be said to move through a plant gradient of water potential from soil to air, therefore the steeper the gradient, the faster the flow of water along it.

Solute potential Ψ

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[1] Technically Ψ means potential and water should be presented Ψw. Since in living systems the solvent we are concerned with is always water, it is simpler to use Ψ and assume the w.

[2] Pressure was formerly measure in atmospheres (atm), but now Pascal is used (Pa).
1 Pa = 1NM-2 (N = Newton)

The effect of dissolving solute molecules in pure water is to reduce the concentration of water molecules and hence to lower the water potential. All solutions therefore have lower water potentials than pure water. The amount of lowering is known as the solute potential. In other words, solute potential is a measure of the change in water potential of a system due to the presence of solute molecules. Ψ_s is always negative. The more solute molecules present, the lower (more negative) is Ψ_s. for a solution, $\Psi = \Psi_s$.

Pressure potential, Ψ_p

If pressure is applied to pure water or a solution, it water potential increases. This is because the pressure is tending to force the water from one place to another. Such a situation may occur in living cells. For example, when water enters plant cells by osmosis, pressure may build up inside the cell making the cell turgid and increasing the pressure potential. Also, water potential of blood plasma is raised to a positive value by the high blood pressure in the glomerulus of the kidney. Pressure potential is usually positive, but in certain circumstances, as in xylem when water is under tension (negative pressure) it may be negative.

Summary

Water potential is affected by both solute potential and pressure potential, and the following equation summarises the relation between the two terms.

Ψ =	Ψ_s +	Ψ_p
Water Potential	Solute Potential	Pressure Potential

Solute potential is negative and pressure potential is usually positive.

Osmosis and plant cells

The partially permeable membranes of importance in the water elations of plant cells are shown in figure 1. The cell wall is usually is freely permeable to substances in solution, so its not important in osmosis. The cell contains a large central vacuole contents, the cell sap, contribute to the solute potential of the cell. The two important membranes are the cell surface membrane and the Tonoplast.

Cell wall- freely permeable to small molecules

Figure 1

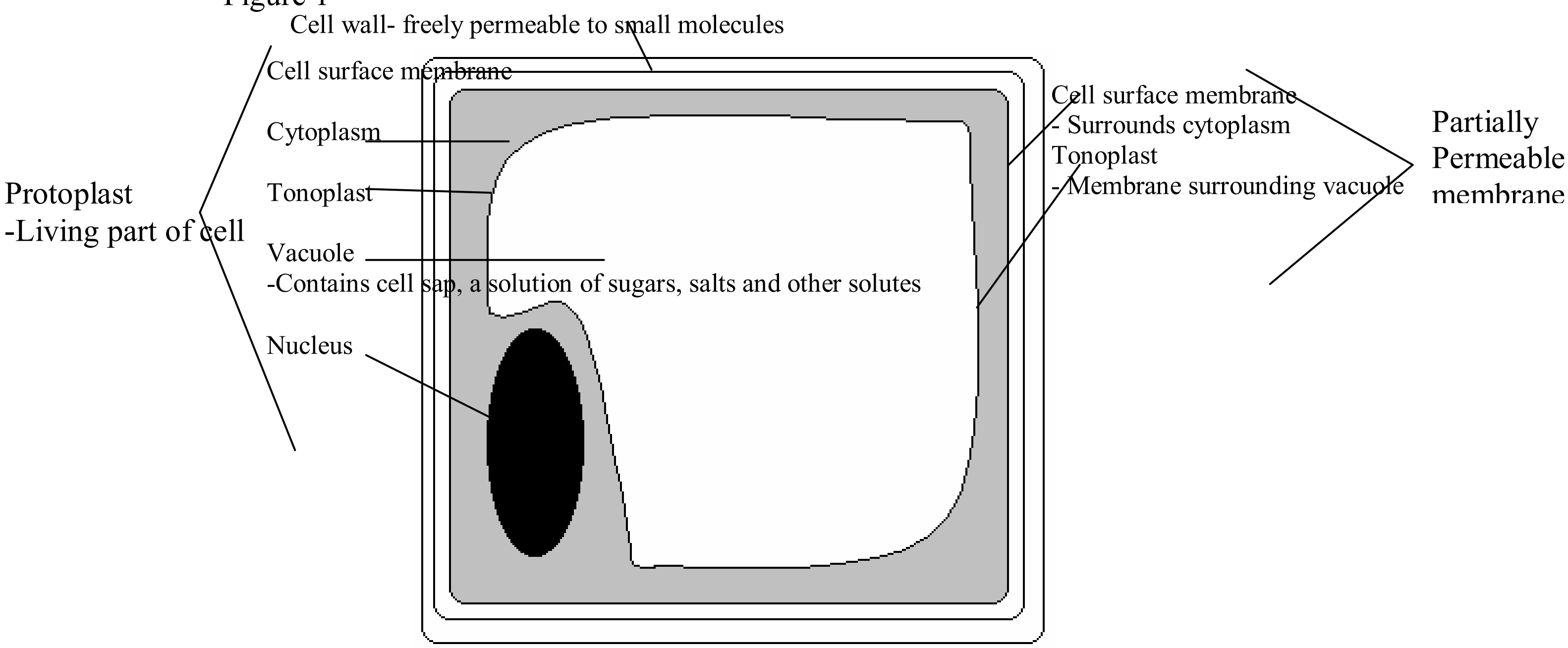
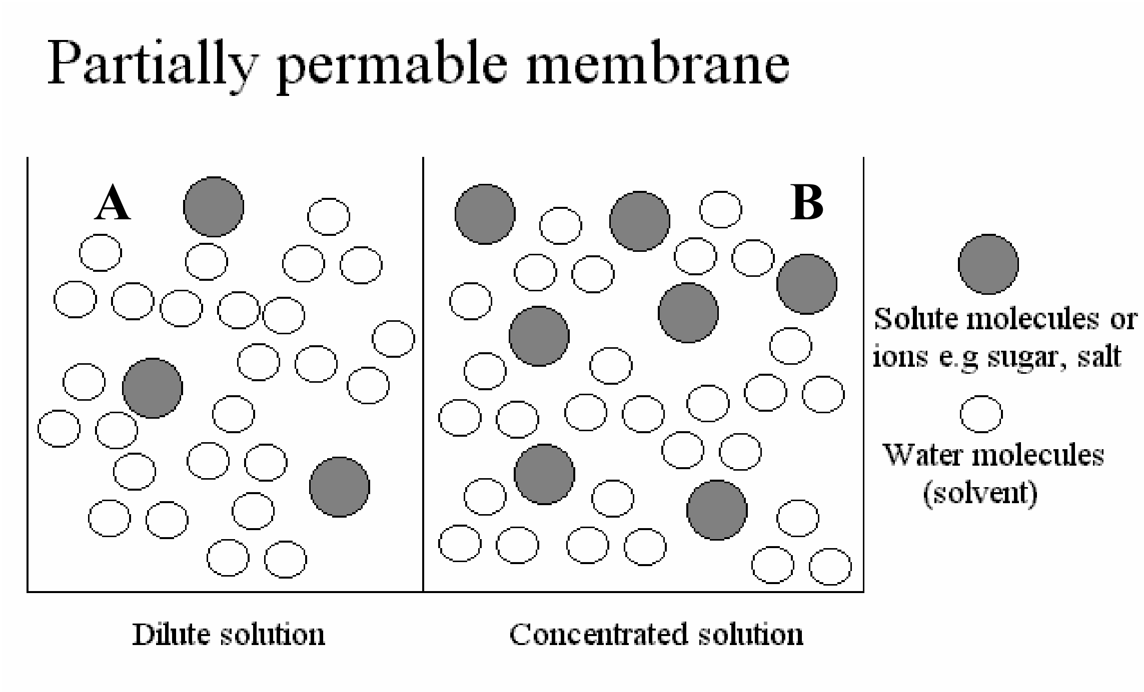


Figure 2:



Method: -

The method that I will be adopting for this experiment will be that I cut a small piece of potato using the knife, and I will measure the mass of the small piece of potato. Then I shall place the potato piece in to a Molar sucrose solution of 0.0. Then I shall take out the small piece of potato and measure the mass of the small piece of potato. I shall perform this procedure five more times but for each time I will put the small pieces of potato in to an different molar sucrose solution ranging from molar sucrose solution of 0.0 to molar sucrose solution of 0.5.After the procedure I will find out the percentage of mass lost of the small piece of potato. For example look at figure 2 - 4.

Figure 2:

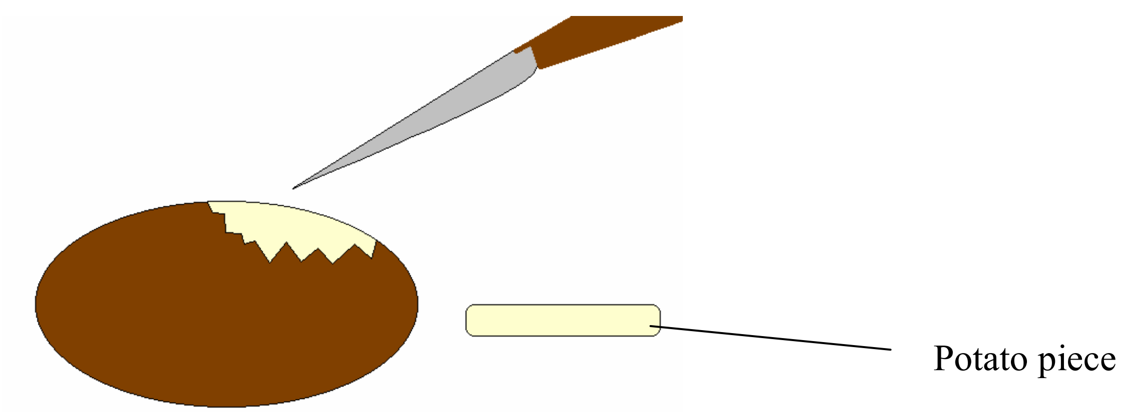


Figure 3:

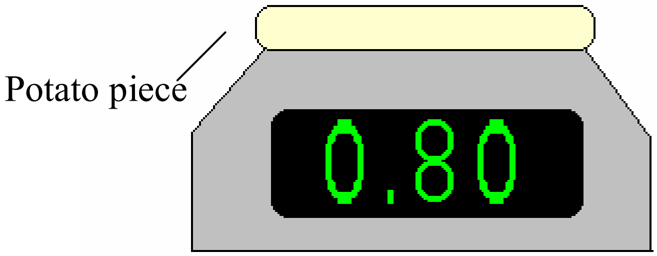
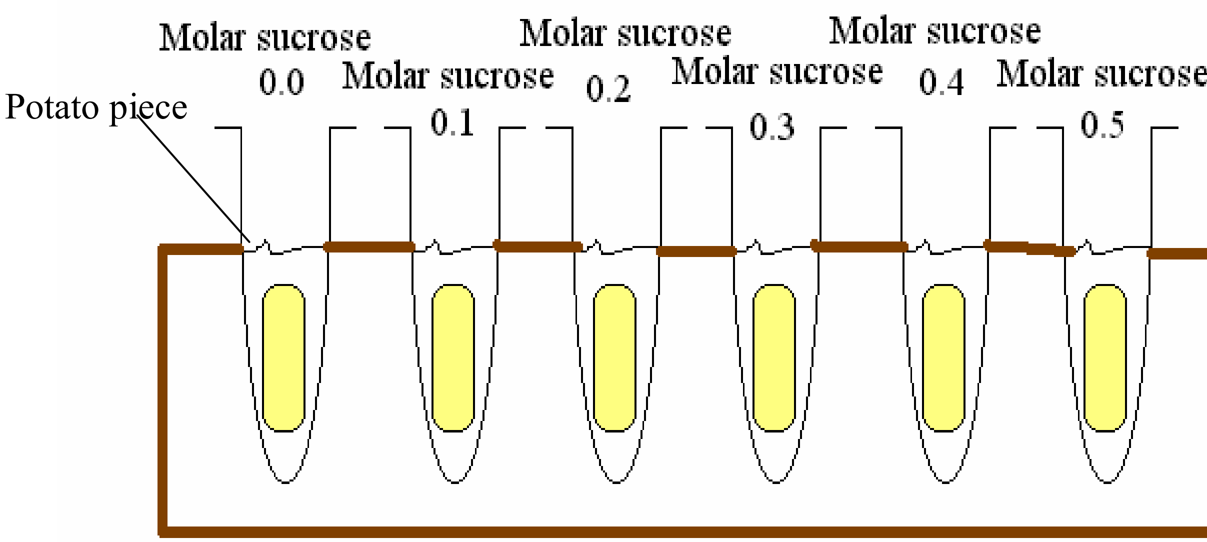
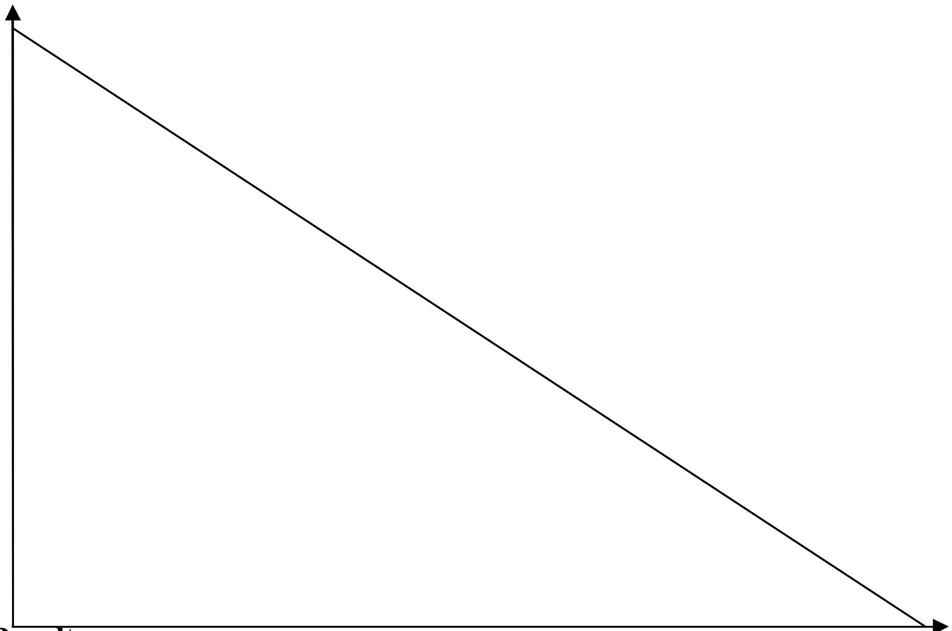


Figure 4:



Prediction

I predict that when I will perform my experiment the potato that is in the most lowly concentrated solution will loose most mass. I predict this because this investigation is based on osmosis and osmosis is the movement of water molecules of a high concentration to the movement of a low concentration through a semi permeable membrane. So the lowest concentrated solution will be receiving the most water molecules because it is least concentrated, I predict that the graphs best line of fit will look very similar to this



Results:

Experiment 1

Molar sucrose	Initial mass (g)	Final mass (g)	Percentage of mass lost
0.00	1.77	1.79	1.13
0.10	1.78	1.80	1.12
0.20	1.76	1.79	1.70
0.30	1.85	1.73	-6.49
0.40	1.90	1.87	-1.58
0.50	2.00	1.90	-5.00

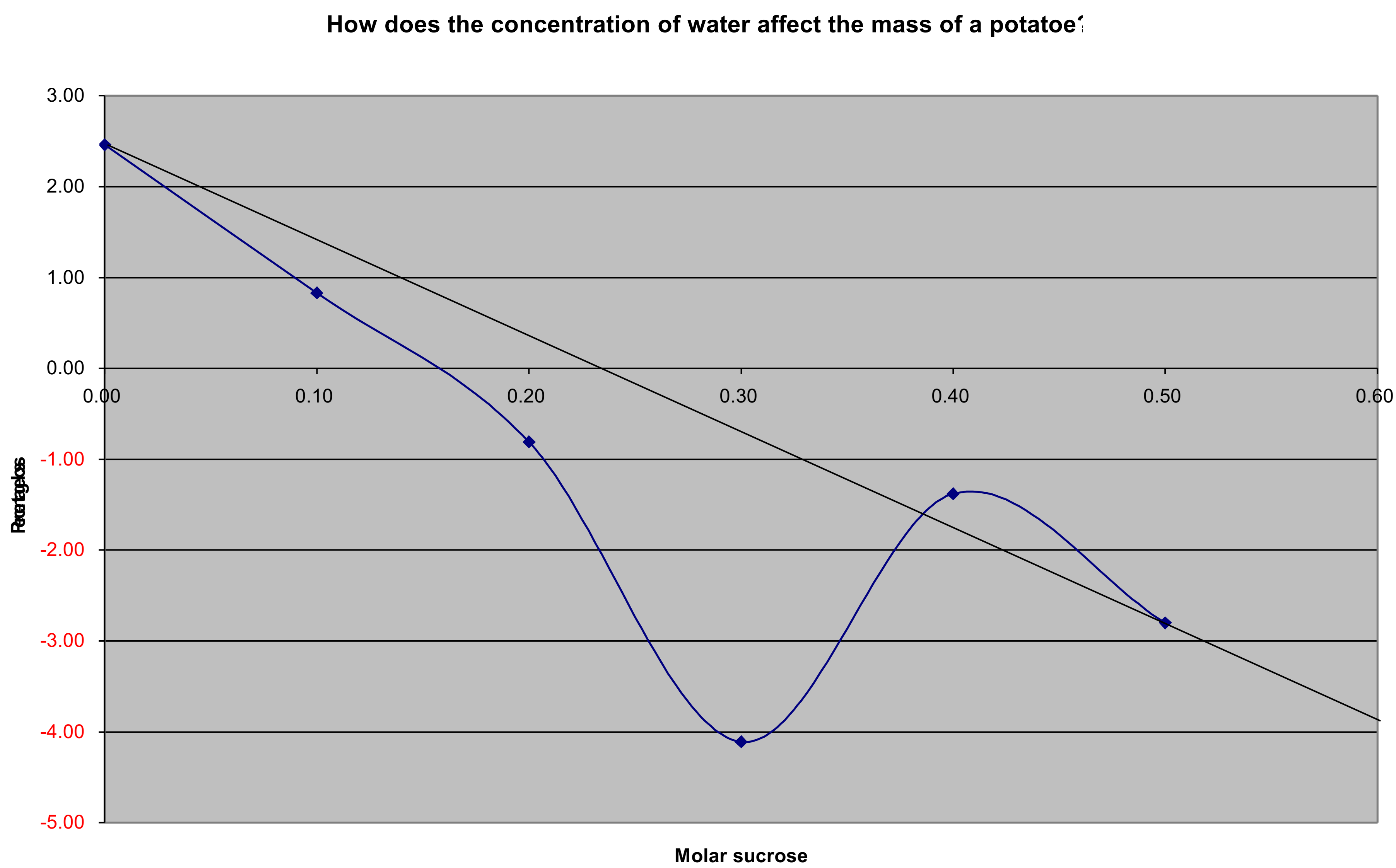
Experiment 2

Molar sucrose	Initial mass (g)	Final mass (g)	Percentage of mass lost
0.00	1.85	1.92	3.78
0.10	1.84	1.85	0.54
0.20	1.80	1.74	-3.33
0.30	1.73	1.70	-1.73
0.40	1.69	1.67	-1.18
0.50	1.68	1.67	-0.60

Average results

Average molar sucrose	Average Initial mass (g)	Average Final mass (g)	Average percentage of mass lost
0.00	1.81	1.86	2.46
0.10	1.81	1.83	0.83
0.20	1.78	1.77	-0.81
0.30	1.79	1.72	-4.11
0.40	1.80	1.77	-1.38
0.50	1.84	1.79	-2.80

The graph showing the average percentage loss of mass of the small potatoes pieces of the two experiments is shown on the next page.


How does the concentration of water affect the mass of a potatoe?
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Molar sucrose

Conclusion

From the results that have been obtained from the experiment we had learned that the small pieces of potatoes had a higher level of concentration than the molar sucrose from 0.0 to 0.2 because the mass that was lost was above 0%. After 0.2 molar sucrose the sucrose solution was more higher concentrated than the potato, therefore the water molecules in the sucrose solution moved into the potato because of osmosis the this sucrose solution had a higher concentration level than the potato, therefore the water molecules travelled into the piece of potato. Proof, well the potato had lost mass of less than 0%, so we learn that the concentration of water or a liquid can effect the mass of a potato by if it has a lower concentration level than the potato, the potato will lose weight and if the liquid has a higher concentrated level than the potato, the potato will gain weight.

Evaluation

I have come to an end with my project, but there could have been some changes that I could have done to make the project better.

Firstly, I could have made the project better by doing more experiments so that the average results would be more accurate. I only did two experiments so the experiment was accurate by it self but the whole project was not a fair experiment. I could have probably done three more experiments to be accurate.

Secondly, what I could have also done to make my experiment better is that I could have timed the small pieces of potato so that they were in the solution the same time and the osmosis processing time will be the same and the potatoes would have a fair experiment., I reckon that this was one of the reasons that the experiment was not so accurate.

Thirdly, I should have cut the pieces of potato as the same weight for all. This would have made the experiment simpler to understand and this would have become more accurate experiment. The osmosis process would have worked equally because they all had the same mass, therefore the experiment would be more accurate.