Unit: Cell and Molecular Biology (AH):
Structure and Function of cell components i) Carbohydrates – structure of monomer glucose
Title: Estimating glucose concentration in solution

BACKGROUND INFORMATION

It is often important to measure the concentration of glucose in a solution. The so-called ISOTONIC drinks can be tested to see if they are in fact isotonic with the blood.

You may have tested fluids, which had been made to represent the blood going in and out of the kidneys, to determine if they contained glucose. Diabetes mellitus is a condition where blood sugar level is not controlled correctly and affected people take insulin to help to control their glucose levels and test their blood to determine the level of glucose in it.

There are a variety of different ways in which blood glucose level can be measured. You could perform a quantitative Benedicts test where you time how long it takes for a certain volume of glucose to change colour when heated with a certain volume of Benedicts solution.

In this practical you will test the glucose concentration in a variety of solutions of known value and you will draw a graph to show your results. This type of graph is known as a Standard Curve. You will then use this graph to estimate the glucose concentration in some unknown solutions. This is the method which was used in hospital labs to measure the glucose level in blood samples. You will be measuring the time taken for a pink colour (potassium permanganate) to disappear.

Glucose ($C_6H_{12}O_6$) is a monosaccharide reducing sugar. In this reaction the glucose readily donates electrons which are accepted by the permanganate causing it to change colour.
The purple pink solution of potassium permanganate (MnO_4^-) is reduced to a colourless solution of manganese ions (Mn^{2+}).

$$\underset{\text{Purple pink in solution}}{MnO_4^-} + 8H^+ + 5e^- \Rightarrow \underset{\text{colourless in solution}}{Mn^{2+}} + 4H_2O$$

As a result of this reaction the glucose is oxidised.

The time taken for the loss of colour from a standardised solution of permanganate is directly related to the concentration of glucose present in solution.

When carrying out this practical it is very important to time everything accurately and to use clean syringes and beakers for each of the different glucose concentrations.

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Equipment and materials

Materials required by each group:

Eye protection
A timer
A glass rod
A boiling tube and rack
3 beakers
3 syringes
6 labels

Materials to be shared:

Glucose solutions (2% 4% 6% 8% 10% 12%)
3 Solutions of unknown glucose concentration (A B C)
Sulphuric Acid
Potassium Permanganate

Instructions

1. Label your 3 beakers Sulphuric acid
   PP- for potassium permanganate
   G- for glucose.

2. Label your syringes in the same way.

3. Add **about** 25 cm^3 of sulphuric acid and potassium permanganate to the beakers – this will be your stock to use throughout the experiment. Note which glucose solution you are testing first.

4. Use the correct syringe to place 10 cm^3 of the first glucose solution in to the boiling tube.

5. Add 5 cm^3 of sulphuric acid.

6. Add 2 cm^3 of potassium permanganate and start the clock.

7. Stir with a stirring rod and stop the clock as soon as the pink colour disappears.

8. Record the time and the glucose solution used.

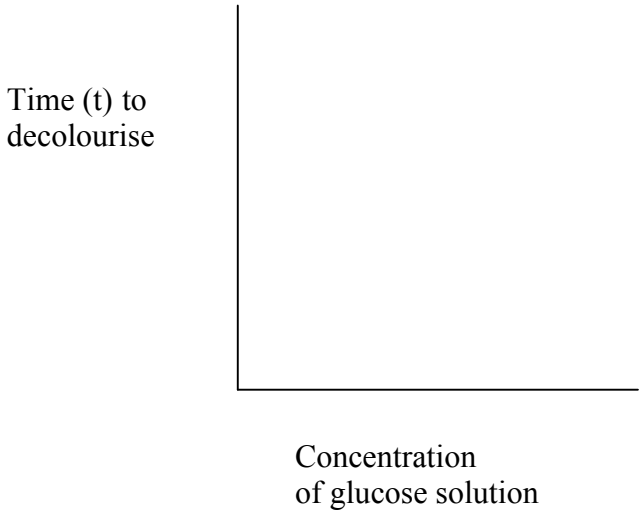
9. Rinse the syringe you used for the glucose solution.

10. Repeat using the other glucose solutions of known concentration.

11. Repeat for a solution of unknown concentration (A B or C).

12. Record your own results and if possible class average results in a table.

13. Plot a standard curve of the class results on graph paper and use this to estimate the unknown solution which you tested.



14. Now plot a graph showing $^{1}/t$ against concentration of glucose – it would be best to use class average results.

Conclusions

- Relate your results back to the aim of the experiment
- Describe any trend you see in your graphs
- Describe what you have found out about the concentrations of the unknown solutions and show them clearly on the appropriate graph.

Evaluating your experiment

In your evaluation of the experiment you should discuss:

- The effectiveness of the procedure
- The limitations of the equipment
- Sources of error
- Possible improvements
- Ideas for further work
- The importance of the procedure.

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Questions

1. Describe why it might be important to measure the concentration of glucose in a solution.

2. Why does a colour change take place during this experiment?

3. What does it mean to say that glucose is a *reducing* sugar?

4. Describe what happens biochemically to the glucose during this experiment.

5. Why might it lead to inaccuracies to use a 12% glucose solution followed by a 2% glucose solution when carrying out these tests?

6. Why should you use class average results to plot your graphs?

7. What would a near straight line show in the $^{1}/t$ graph?

8. Describe some improvements which you could make to the procedure which you have now completed.

Ideas for Projects

Use this method and other methods such as Benedicts and diastix to test a variety of “health” drinks to determine their actual glucose content and relate this to claims on the drinks contents – if the drinks chosen contain Vit C this will interfere with the reaction causing the colour change to take place very quickly.

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TECHNICAL GUIDE

Materials required by each group:

Eye protection
A timer
A glass rod
A boiling tube and rack
3 beakers
3 syringes
6 labels

Materials to be Shared:

Glucose solutions (2% 4% 8% 10% 12%)
3 solutions of unknown glucose concentration (A – 8% B - water C – 5%)
1 M sulphuric acid
potassium permanganate (0.4 g in 1litre)

Each group will require:

- 10 cm^3 of each glucose solution
- 50 cm^3 sulphuric acid
- 20 cm^3 of potassium permanganate

It would be a good idea to have slightly more of each solution available as some groups may need to repeat parts of the experiment

Preparation of Materials

Potassium permanganate must be made up just before use.

Any number of unknowns could be provided.