Reducing properties of glucose (Item No.: P7186900)

Curricular Relevance

Area of Expertise: Chemie

Education Level: Klasse 10-13

Topic: Organische Chemie

Subtopic: Lebensmittelchemie: Fette, Kohlenhydrate, Aminosäuren/Proteine, Vitamine, Gewürze

Experiment: Reduzierende Wirkung der Glucose

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

carbohydrate, glucose, reducing agent

Task and equipment

Information for teachers

Additional Information

The motivation can result from the "blue bottle" experiment. The questions on how Christmas tree decorations are covered with a reflective surface also opens up the problem.

Notes on content and learning objectives

- The aldehyde groups in glucose can be detected with silver nitrate, Fehling's solution and methylene blue.
- Glucose acts as a strong reducing agent in basic solutions. Glucose is thereby reduced to gluconic acid.
- Glass mirrors can be prepared with ammonical silver nitrate and glucose.

Notes on the method

The experiment can also be carried out using foods containing glucose, such as fruit juices and honey. The differing reactivity of other sugars, particularly that of sucrose, should be worked on in parallel experiments.

Fundamentals and remarks

The aldehyde group is responsible for the reducing properties of glucose. The reaction first takes place in hot alkaline solution. The chain type structure with the reactive acetaldehyde groups is formed from the stable hemiacetal form of glucose under these conditions.

Hints on going deeper

- Formulation of the question, why the test with Fehling's solution is negative with sucrose.
- Detection of milk sugar in whey.

Notes on set-up and procedure

Preparation:
The following solutions should be ready prepared:
Dilute ammonia solution
Dissolve 40 ml of ammonia solution in 100 ml of distilled water.
Dilute caustic soda

Dissolve 10 g NaOH in 100 ml of distilled water.

Notes on the students experiment:
The temperature of the water bath should be approx. 85 °C, so that it may have to be heated up again.
Use new or degreased test tubes if possible for the "silver mirror test". Ammoniacal silver nitrate solution (Tollens reagent) should always be freshly made, as, on storage of the solution, explosive silver compounds may be formed.
Ensure that there is not too great excess of methylene blue.

Hazard and Precautionary statements

Ammonia solution

H314:	Causes severe skin burns and eye damage.
H335:	May cause respiratory irritation.
H400:	Very toxic to aquatic life.
P273:	Avoid release to the environment.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P304 + P340:	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P310:	IF exposed or you feel unwell: Call a POISON CENTER or doctor/physician.

Fehling's solution I:

H411:	Toxic to aquatic life with long lasting effects.
P273:	Avoid release to the environment.

Fehling's solution II:

H314:	Causes severe skin burns and eye damage.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P311:	IF exposed or you feel unwell: Call a POISON CENTER or doctor/physician.

Methylene blue:

H302:	Harmful if swallowed.
P301 + P312:	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.

Sodium hydroxide:

H314:	Causes severe skin burns and eye damage.
H290:	May be corrosive to metals.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P309 + P310:	IF exposed or you feel unwell: Call a POISON CENTER or doctor/physician.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.

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Silver nitrate:	
H272:	May intensify fire; oxidizer.
H314:	Causes severe skin burns and eye damage.
H410:	Very toxic to aquatic life with long lasting effects.
P273:	Avoid release to the environment.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P310:	IF exposed or you feel unwell: Call a POISON CENTER or doctor/physician.

Hazards

- Sodium hydroxide and silver nitrate are caustic. Ammonia solutions irritate the repiratory organs, eyes and skin. Do not allow the liquids to make skin-contact.
- Wear protective glasses and protective gloves.
- Carry out the experiment in a fume cupboard whenever possible.

Waste disposal

When the test tubes have cooled, filter off the copper oxide and silver and put them into the container for heavy metal waste.
Pour the filtrates into the container for solutions of heavy metal salts.
Pour the solution in the beaker to drain.

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Reducing properties of glucose (Item No.: P7186900)

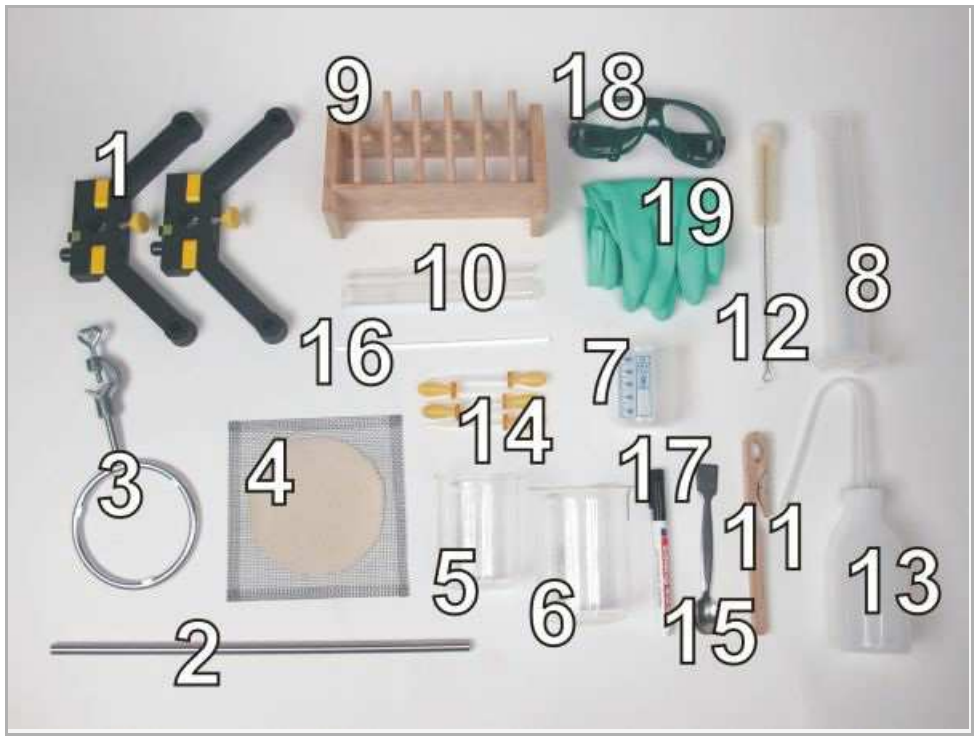
Task and equipment

Task

How can aldehyde groups in glucose be detected?

Examine the various reactions of glucose.

Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Ring with boss head, i. d. = 10 cm	37701-01	1
4	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
5	Glass beaker DURAN®, short, 250 ml	36013-00	1
6	Glass beaker DURAN®, short, 400 ml	36014-00	1
7	Beaker, 250 ml, low form, stackable, plastic	36082-00	1
8	Graduated cylinder 100 ml, PP transparent	36629-01	1
9	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
10	Test tube, 180x18 mm,100pcs	37658-10	(2)
11	Test tube holder, up to d 22mm	38823-00	1
12	Test tube brush w. wool tip,d25mm	38762-00	1
13	Wash bottle, 250 ml, plastic	33930-00	1
14	Pipette with rubber bulb	64701-00	5
15	Spoon, special steel	33398-00	1
16	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
17	Labor pencil, waterproof	38711-00	1
18	Protecting glasses, clear glass	39316-00	1
19	Rubber gloves, size S (7)	39325-00	1
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Compact Balance, OHAUS TA 302, 300 g / 0.01 g	49241-93	1
	Fehling's solution I 1000 ml	30079-70	1
	Fehling's solution II 500 ml	30080-50	1
	Sodium hydroxide, flakes, 1000 g	30157-70	1
	Silver nitrate solution 5% 100 ml	30223-10	1
	D(+)-glucose 1000 g	30237-70	1
	Ammonia solution, 25% 1000 ml	30933-70	1
	Water, distilled 5 l	31246-81	1
	Methylene blue sol.,alkal. 250 ml	31568-25	1
	Boiling beads, 200 g	36937-20	1

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Set-up and procedure

Set-up

Hazards

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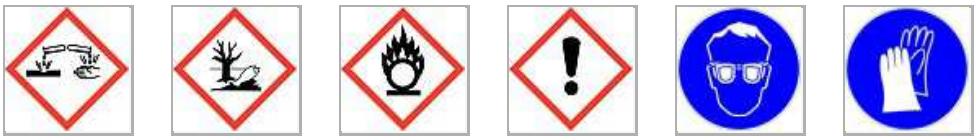
- Wear protective glasses and protective gloves.
- Carry out the experiment in a fume cupboard whenever possible.



Setup

Weigh 2 g of glucose into a beaker. Label the beaker "$C_6H_{12}O_6$ / H_2O" and dissolve the glucose in 20 ml of distilled water (Fig. 1).

Fig. 1

Number two test tubes 1 and 2, and place them in the test tube rack.

Fig. 2

Assemble the stand as shown in figures 2 to 6. Fasten the support ring to the support rod and place the wire gauze on it. Adjust the height of the support ring so that the flame of the burner just reaches the wire gauze.

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Half-fill a 400 ml beaker with water and add a few boiling stones (Fig. 7). Heat it to boiling, then put it aside. Extinguish the bunsen burner flame!

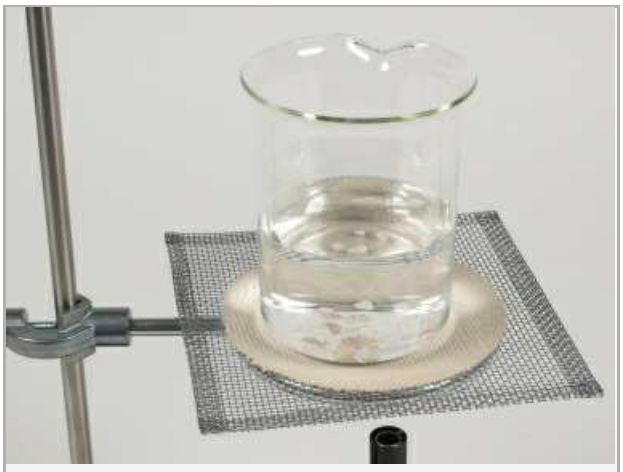


Fig. 8

Procedure

Pipette silver nitrate solution in test tube 1 to a height of 2 cm. Shake the tube while adding so much ammonia solution, that the precipitate which is first formed is redissolved.
Add glucose solution to this ammoniacal silver nitrate solution to a height of 4 cm. Place the test tube in the prepared hot water bath for a few minutes.

Add Fehling's solution I to test tube 2 to a height of 2 cm, then pipette in the same amount of Fehling's solution II. Pipette 10 drops of glucose solution into the test tube and place it in the prepared hot water bath for a few minutes.
Watch out for colour changes.

Fig. 9

Transfer 10 ml of glucose solution to a 250 ml beaker. Add 10 ml of sodium hydroxide solution. Dilute the solution to 100 ml with distilled water. Add methylene blue dropwise until the solution is light blue in colour (Fig. 10).

Fig. 10

Allow the beaker to stand for a few minutes. When the solution is colourless, stir it with a glass rod. Repeat this procedure.

Waste disposal

When the test tubes have cooled, filter off the copper oxide and silver and put them into the container for heavy metal waste.
Pour the filtrates into the container for solutions of heavy metal salts.
Pour the solution in the beaker to drain.

Report: Reducing properties of glucose

Result - Observations

Note your observations.

a) Test tube 1: Glucose with silver nitrate

b) Test tube 2: Glucose with Fehling's solution

c) Beaker: Glucose with methylene blue

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Evaluation - Question 1

Formulate the partial steps of the redox reaction of silver nitrate with glucose.

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Evaluation - Question 2

Sketch the molecules that take part in the oxidation reaction.

Evaluation - Question 3

Draw conclusions from your observations.

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Evaluation - Question 4

Complete the following statements.

1. The ..... of glucose ..... silver ions to elementary silver.
2. The ..... of glucose ..... copper(II) ions to copper(I) ions. A precipitate of ..... copper(I) oxide is formed.
3. The ..... of glucose ..... methylene blue solution to colourless .....

Evaluation - Question 5

Decribe the production process for glass mirrors and Christmas tree decorations.

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Evaluation - Question 6

Which chemical reaction is the basis of the "blue bottle" magican's trick?

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