VITAMIN C
Measuring how quickly vitamin C tablets dissolve

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English, Hungarian

Summary
Imagine you run a pharmaceutical laboratory. Someone asks you to investigate newly formulated vitamin C tablets. They state that these tablets dissolve more slowly than others so, in the human body, this tablet is more efficient. You have to decide if they are right or not. You have to plan and carry out this investigation.
You are a member of the analytical team in the laboratory that carries out the investigation of dissolution of vitamin C (in water). You have to plan time and workload management for this investigation. Your team will use redox titration to determine the amount of dissolved vitamin C (see the procedure on the StandardBase website).

Activity type **C**
Use of scientific knowledge and understanding to solve problems
Working in teams to solve problems
Time and workload management

Techniques
Redox titration

Field
Pharmaceuticals

Time
- Practical lessons: 160 minutes
- Theory lessons: 20 minutes
- Out of class time: 90 minutes

StandardBase procedures
Determination of vitamin C by redox titration

StandardBase techniques
Volumetric analysis

Other resources
Gedeon Richter Plc., Budapest, Gyömrői u. 19-21. Hungary; www.richter.hu
http://en.wikipedia.org/wiki/Vitamin_C
http://paws.wcu.edu/bacon/VitaminC.pdf
http://chemistry.about.com/od/demonstrationsexperiments/ss/vitctitration_2.htm
European Pharmacopeia
www.standardbase.com
D. A. Skoog, D. M. West, F. J. Holler: Fundamentals of analytical chemistry, Saunders Collage Publishing, 1992; ISBN 0-03-075397-x

Student's document

VITAMIN C: Measuring how quickly vitamin C tablets dissolve

Imagine you run a pharmaceutical laboratory. Someone asks you to investigate newly formulated vitamin C tablets. They states that these tablets dissolve more slowly than others so, in the human body, this tablet is more efficient. You have to decide if they are right or not.

This activity will help you to develop the following skills:
- Using scientific knowledge and understanding to solve problems
- Working in teams to solve problems
- Observing, measuring and analysing scientific data
- Time and workload management

Your brief
You are a member of the analytical team in a laboratory that carries out the investigation of vitamin C (in water). You have to plan time and workload management for this investigation.
You have to take careful account of time, because you have to carry out a titration every 5 minutes!
Your team will use redox titration to determine the amount of dissolved vitamin C (see the procedure on the StandardBase website). When the measurements are complete, write a report about your investigation.

Your investigation
- There are two main types of vitamin C: standard form and capsule form. Organise two groups (A and B).
  - Group A will investigate a standard form of vitamin C
  - Group B will investigate "Cetebe" (capsule form of vitamin C), which is supposed to dissolve more slowly (any other retard /capsule form/ vitamin C is appropriate for investigation, not only "Cetebe")

  Vitamin C is identical to ascorbic acid
- Rate of dissolution also depends on temperature. The temperature for the two series of measurements (standard and retard form of vitamin C) has to be the same, between 20 and 25 °C.
- One of the group members must search the Internet for information and the connection between dissolving rate and medical efficiency.
- You need to manage the time and workload plan very carefully because, after you put the vitamin C pill into the beaker containing the given amount water and magnetic stirrer, you have to pipette out a 20 ml sample and titrate it every 5 minutes!
- Visit the www.standardbase.com website and find the appropriate titration procedure (*Determination of vitamin C using redox titration*). According to the StandardBase procedure, the concentration of iodine solution is 0.05 mol/dm^3. This is too high for accurate titration, so use 0.005 mol/dm^3 iodine volumetric solution.
- You will find the main procedure on the **Student sheet**.

A risk assessment must be carried out before starting practical work.

Your findings

- Plan a table to record the findings.
- You have to record the loss of titrant after every titration. (The volume of the solvent decreases as a consequence of taking out 20 ml aliquots. Take this into consideration!)
- Draw a graph of sum of mass (as percentage of total mass of ascorbic acid in the tablet) of dissolved vitamin C as a function of time.
- Compare the Group A and Group B graphs.
- Make a final report about your result and findings. Try to give an explanation about your findings.
- In 50-100 words, describe how the group managed its time and workload.

Student self assessment

Fill in the checklist below. If there are more than 3 "NO" answers, please consult your teacher.

	YES	NO
Using scientific knowledge and understanding to solve problems 1. Can you find information using "keywords" on the Internet? 2. Have you found useful information besides the given articles, websites? 3. Try to write down the reaction equation of vitamin C + iodine 4. How can you determine the exact concentration of iodine volumetric solution? 5. What is the role of the starch solution in this procedure? 6. Why is it important to determine the rate of dissolution of various pharmaceutical tablets?		

Student sheet

Solutions
0.005 mol/dm^3 iodine standard solution ("Ready to use" or AnalaR). If this is not available it may be prepared as follows:
Dissolve pure, sublimed iodine (0.635 g) and potassium iodide (1.2 g) in 20 cm^3 distilled water in a 100 cm^3 beaker. Transfer quantitatively to a 500 cm^3 volumetric flask and make up to volume with distilled water. The exact concentration must be determined every day using sodium thiosulfate solution. This in turn should have been standardised with 0.0050 mol/dm^3 potassium iodate.

Procedure
Suggested samples:
1 Standard form of vitamin C, containing 500 mg ascorbic acid
2 Capsule form (e.g. Cetebe), containing 500 mg ascorbic acid. Carry out the investigation with Cetebe without the capsule (remove it)

Drop one pill into 900 cm^3 distilled water (at a water temperature between 20 and 25 °C) and start stirring it (with magnetic stirrer) at about 300 rpm. Measure the time accurately from this point.

Every 5 minutes, pipette out 20 cm^3 solution, add to 5 cm^3 1 mol/dm^3 sulfuric acid and 2 cm^3 starch solution and titrate it with 0.005 mol/dm^3 iodine volumetric solution. 1 cm^3 of 0.005 mol/dm^3 iodine solution is equivalent to 0.881 mg vitamin C (ascorbic acid).

Draw a graph of the dissolved vitamin C versus time.

According to the European Pharmacopoeia, 75% of vitamin C must dissolve in under 45 minutes.

Teacher's document

Overview
The main goal of this activity (besides practising redox titration) is to make a carefully considered time and workload plan.

Developing students' skills
The main aim of this activity is to develop student competence at managing time and workload.
Guide the students with suggestions, but leave them to manage their work independently. The amount of help depends on the nature of the students and their prior experience. It is the nature of this task that it cannot be successfully completed in the time available without the need for team work and setting targets with deadlines. Trouble shooting vigilance may be needed to help with:
- Technical aspects, including manipulative skills
- Planning the correct table for collecting measurements data
- Working relationships with others

Organising and managing the class
- Divide the class into groups (at least two groups)
- Suggested group size: 4 people

Student 1 takes the samples every 5 minutes, students 2 and 3 make 1st, 3rd, 5th etc. and 2nd, 4th, 6th etc. titrations, respectively. Therefore two sets of titration apparatus are needed for each group. Student 4 makes the Internet search. This distribution of tasks demands clear and detailed time and workload planning and management.
- Number of groups: 2 or more
  - 2 groups: split up the activities
  - More than 2 groups: some groups can do the same procedure; communication between the groups is then essential

Working environment and conditions:
- Inside school
- Laboratory
- Computers with access to Internet

Students may need help with working relationships in their group. Every student should contribute to the planning, the practical activity and the report.

Session plan for teachers
- Teacher's introduction to the scenario (20 minutes)
  - Outline of the purpose of the project
  - Statement of expected output (content, format)
- Collecting information and self assessment with questions related to the subject (30 minutes)
- Activity
  - Organising the teamwork
  - Carrying out practical work, without standardisation of iodine solution (160 minutes)
  - Making final report, evaluating results (60 minutes)

Technical notes

- **Preparation**

This activity needs only an analytical laboratory with equipment and glassware for volumetric titrations. No special preparation is necessary.

- **Equipment and materials**

Materials

Name	**CAS number**
Iodine	7553-56-2
Potassium iodide	7681-11-0
Sodium thiosulfate	10102-17-7
Hydrochloric acid	7647-01-0
Sulfuric acid	7664-93-9
Soluble starch	9005-84-9

Instruments

- Analytical balance (accuracy 0.1 mg)
- Magnetic stirrer
- Stop watch
- Thermometer

Glassware

- 1000 cm^3 volumetric flask
- 250 cm^3 conical flask
- 100 cm^3 volumetric flask
- 1000 cm^3 beaker
- 50 cm^3 burette
- 20 cm^3 pipette

Procedure and *solutions* are listed on the **Student sheet**.

TESTING PRIOR KNOWLEDGE

Choose only one answer.

1 Dissolve 24.822 g crystalline sodium thiosulfate in 1 dm^3 water. What will be the concentration of the solution?
   a. 0.1 mol/dm^3
   b. 0.05 mol/dm^3
   c. 0.0051 mol/dm^3
   d. 1.0 mol/dm^3

2 Do you need to determine the exact concentration of sodium thiosulfate solution?
   a. no
   b. maybe, but not necessarily
   c. only after one day after preparation
   d. yes

3 1 cm^3 of 0.05 mol/dm^3 iodine solution is equivalent to 8.81 mg ascorbic acid
   a. not true
   b. if the solution has H^+ ions
   c. true
   d. iodine does not react with ascorbic acid

4 Iodine is insoluble in water, but it will soluble if
   a. we add some KIO_3
   b. we add some KI
   c. we warm the solution
   d. we add HCl to the solution

Note: Correct answers are given in red. These need to be changed to black before the test is used.

TESTING PRIOR KNOWLEDGE

Choose only one answer.

5 Dissolve 24.822 g crystalline sodium thiosulfate in 1 dm^3 water. What will be the concentration of the solution?
   a. 0.1 mol/dm^3
   b. 0.05 mol/dm^3
   c. 0.0051 mol/dm^3
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   b. maybe, but not necessarily
   c. only after one day after preparation
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