**Test 3 and associated teacher’s notes**

[**MTA-ELTE Research Group on Inquiry-Based Chemistry Education**](https://mta.hu/kozoktatas-fejlesztesi-kutatasi-program/scientific-foundations-of-education-research-program-of-the-hungarian-academy-of-sciences-111618)

[**Research Programme for Public Education Development of the Hungarian Academy of Sciences**](https://mta.hu/kozoktatas-fejlesztesi-kutatasi-program/research-programme-for-public-education-development-of-the-hungarian-academy-of-sciences-111934)

*Note: More detailed instructions are available in Hungarian in the teacher’s guides, under the title “*[*T3 teszt és javítási útmutatója*](https://ttomc.elte.hu/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBdlVQIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--29ecb46a10cdf56c8ed3e3340395ba8b2aac3aeb/T3_teszt_2024_08_26_MEGOLDOKULCS_HONLAPRA.docx?disposition=attachment)*” for T3 at* [*https://ttomc.elte.hu/publications/92*](https://ttomc.elte.hu/publications/92)

Test 3 (May, 2024)

Number of school:…(A) Number of teacher:…(B) Number of group:…(C) Number of student: …(D)

The aim of our research is to make the teaching of chemistry as interesting and effective as possible.

Thank you for completing this test to the best of your ability. This will help our work considerably. Write your answers on this sheet of paper. Please do not use any other paper.

1. a) Put an x in the box(es) before the name(s) of the solution(s) that is (are) supposed **to neutralise the formic acid** that enters your body when you are bitten by an ant.

BU

[ ]  Lemon juice [ ]  Baking soda solution [ ]  Dilute ammonia solution [ ]  Vinegar

1. b) Formic acid (HCOOH) decolours the yellowish brown bromine water in the following redox reaction:

Br2 + HCOOH = 2 HBr + CO2

We have two formic acid solutions of the same volume and temperature, but one is 5% by weight and the other is 10% by weight. If they are reacted with bromine water of the same volume, concentration and temperature, which formic acid solution decolours the bromine water **first** and **why**? (Both formic acid solutions contain enough formic acid to decolourise the bromine water completely.)

………………………………………………………………….......................………………………………….………....

BV

………………………………………………………………………………………………………………………………………

2. The "bath bomb" is a ball made of citric acid, baking soda, starch and cocoa butter with a few drops of essential oil and colouring. It's fun to use because it bubbles up fragrantly when added to the bath water. In water, the reaction of baking soda and citric acid produces carbon dioxide gas. Let's say you want to make lots of these bath bombs as gifts for your friends. According to a source on the Internet, 50 g of citric acid requires 100 g of baking soda. However, based on the reaction equation and the molar masses, 192 g of citric acid reacts with 252 g of baking soda. You don't want to waste the materials (which cost money), so you decide **to experiment by reacting small amounts of citric acid and baking soda to see which mass ratio** produces more gas. (This can be compared, for example, to reacting the materials in bottles, with a balloon placed over the mouth of the bottle after adding water to the substances.)

a) What would you change during the experiments?

BW

………………………………………………………………………………………………………………………………………....

b) The amount of which product of the chemical reaction that is important for the effervescence

BX

depends on the change you cause? ......................................................................................

c) How could you test the amount of the reaction product named in (b)?

…………………………………………………………………………………………………………………………………….…...

BY

d) How would you decide which weight ratio to use?

…………………………………………………………………………………………………………………………………….…...

BZ

e) Why is it always important to shake the contents of the bottles thoroughly?

CA

…………………………………………………………………………………………………………………………………………..

f) Put a **+** sign **in front of the statement in the list below if you think it is true**, and a **-** sign **in front of the statement if you think it is not true**. (You can write another sign after a clear cross-out if you change your mind.)

 The same mass of citric acid should be used in each experiment.

CB

 The same mass of baking soda should be used in each experiment.

CC

 The same volume of bottle should be used in each experiment.

CD

The bottles used for each experiment should be made of the same material.

CE

3. You may have heard the advice not to stopper the bottle of leftover champagne, but to place a small spoon, handle down, in the mouth of the bottle before putting it in the fridge to prevent carbon dioxide gas escaping. Do you think this method is effective? **Your answer is only valid if you give reasons.**

………………………………………………………………………………………………………………………………………...

CF

…………………………………………………………………………………………………………………….………………….

4. a) During the red sludge disaster, the corrosive effect of the alkaline (about pH=12-13) material was reduced to an acceptable level of about pH=10 by the addition of gypsum. A reporter on TV asked an expert why this method was effective, as household bleach has a pH of around 10 and is still corrosive. Could you tell the reporter what type of chemical reaction causes the corrosive effect of the household

bleach?……………………………………………………………………………………………………………………..………

CG

…………………………………………………………………………………………………………………………………………………………….

CH

4. b) Write here the chemical formula of the active substance in household bleach!...........

5. The pond skater gets its prey by running on the surface of the water. Do you think the pond skater could run on the surface of petrol? (Petrol is a liquid containing apolar molecules. Suppose that at the time of the experiment, petrol has no significant physiological effect on the pond skater, and it is nice spring weather.) **Your answer is valid only if you give a reason.**

CI

………………………………………………………………………………………………………………………………………..…

………………………………………………………………………………………………………………………………………………………….…

6. a) What type of reactant (agent) can hydrogen peroxide act during redox

CJ

reactions?…………………………………………………………………………………………………………………..

6. b) Write down the **balanced** equation for the reaction of hydrogen peroxide with potassium iodide.

CK

…………………………………………………………………………………………………………………………………..………

7. The longer the wavelength of light, the lower the energy of the photons of light. Explain from the diagram whether the red flame of lithium or the violet flame of potassium indicates a higher excitation energy!

CL

...................................................................................................................................................................

………………………………………………………………………………………………………………………………………..…………………..

Please also answer the following questions!

CM

* Write your end of first term grade in 9th grade chemistry in the box:
* The bigger the number you circle, the more you like chemistry.

(0: you do not like it at all, 5: you really like it):

CN

1 2 3 4 5

* The bigger the number, the more you consider it important to test ideas in sciences by experiments (0: not important at all; 5: very important)

CO

1 2 3 4 5

* The bigger the number, the more you agree with the following statement:

“I prefer the step-by-step experiments to the ones that I have to design.”

CP

1 2 3 4 5

Instructions given to the teachers to mark the students’ answers of the Test 3

Please complete the columns of the Excel spreadsheet with the marks obtained from following the instructions below. A student’s marks should be written in the appropriate row of the Excel spreadsheet.

Columns BU-CL contain marks for students’ answers.

Columns CM contains the student’s end of first term grade in 9th grade chemistry.

Columns CN-CP contain students’ attitude responses.

Abbreviations:

* DCK: disciplinary content knowledge;
* EDS: experimental design task

Column ‘BU’ (task 1.a)

If x was put in the boxes before the baking soda solution and the ammonia solution and nowhere else.

Marks: 1

In any other case. Marks: 0

1 item: understanding (DCK task)

Column ‘BV’ (task 1.b)

The 10% by weight, because the reaction takes place faster in the more concentrated solution.

or:

The 10% by weight, because particles meet more frequently in the more concentrated solution.

Marks: 1

In any other case. Marks: 0

1 item: understanding (DCK task)

Column ‘BW’ (task 2.a)

Correct answer 1: “The mass/amount of citric acid.”

but it is only acceptable, if the following answers are given in 2.f):

- The same mass of citric acid should be used in each experiment.

+ The same mass of baking soda should be used in each experiment.

Correct answer 2: “The mass/amount of baking soda.”

but it is only acceptable, if the following answers are given in 2.f):

+ The same mass of citric acid should be used in each experiment.

- The same mass of baking soda should be used in each experiment.

Correct answer 3: “The mass/amount ratio of citric acid to baking soda.”

but it is only acceptable, if one of the following answers are given in 2.f):

- The same mass of citric acid should be used in each experiment.

- The same mass of baking soda should be used in each experiment.

or:

- The same mass of citric acid should be used in each experiment.

+ The same mass of baking soda should be used in each experiment.

or:

+ The same mass of citric acid should be used in each experiment.

- The same mass of baking soda should be used in each experiment.

Marks: 1

In any other case. Marks: 0

1 item: higher order cognitive skills (EDS task)

Column ‘BX’ (task 2.b)

That of the carbon dioxide.

Marks: 1

In any other case. Marks: 0.

1 item: higher order cognitive skills (EDS task)

Column ‘BY’ (task 2.c)

By comparing the size of the balloons.

Marks: 1

In any other case. Marks: 0

1 item: higher order cognitive skills (EDS task)

Column ‘BZ’ (task 2.d)

In the case of the largest (volume / circumference / diameter / length) balloon.

Marks: 1

In any other case. Marks: 0

1 item: higher order cognitive skills (EDS task)

Column ‘CA’ (task 2.e)

So that the reaction take place completely.

or:

In order to produce the most (largest / maximum amount / volume of carbon dioxide) gas possible.

Marks: 1

In any other case. Marks: 0

1 item: higher order cognitive skills (EDS task)

Column ‘CB’ and ‘CC’ (task 2.f)

Correct answer 1:

- The same mass of citric acid should be used in each experiment.

+ The same mass of baking soda should be used in each experiment.

but it is only acceptable, if one the following answers are given in 2.a):

“The mass/amount of citric acid.”

or:

“The mass/amount ratio of citric acid to baking soda.”

Correct answer 2:

+ The same mass of citric acid should be used in each experiment.

- The same mass of baking soda should be used in each experiment.

but it is only acceptable, if one the following answers are given in 2.a):

“The mass/amount of baking soda.”

or:

“The mass/amount ratio of citric acid to baking soda.”

Correct answer 3:

- The same mass of citric acid should be used in each experiment.

- The same mass of baking soda should be used in each experiment.

but it is only acceptable, if one the following answer is given in 2.a):

“The mass/amount ratio of citric acid to baking soda.”

Marks: 1+1

In any other case. Marks: 0

1+1 item: higher order cognitive skills (EDS task)

Column ‘CD’ (task 2.f)

+ The same volume of bottle should be used in each experiment.

Marks: 1

In any other case. Marks: 0

1 item: higher order cognitive skills (EDS task)

Column ‘CE’ (task 2.f)

- The bottles used for each experiment should be made of the same material.

Marks: 1

In any other case. Marks: 0

1 item: higher order cognitive skills (EDS task)

Column ‘CF’ (task 3.)

No, because the spoon does not close the mouth of the bottle completely, so the gas escapes from the bottle.

Marks: 1

In any other case. Marks: 0

1 item: application (DCK task)

Column ‘CG’ (task 4.a)

Redox reaction.

or:

The household beach is an oxidising agent.

Marks: 1

In any other case. Marks: 0

1 item: application (DCK task)

Column ‘CH’ (task 4.b)

NaOCl

Marks: 1

In any other case. Marks: 0

1 item: recall (DCK task)

Column ‘CI’ (task 5.)

No, because petrol has a lower surface tension (than water).

or:

No, because there is only weak (dispersion) interaction between the (apolar) molecules.

Marks: 1

In any other case. Marks: 0

1 item: application (DCK task)

Column ‘CJ’ (task 6.a)

As an oxidising and also as a reducing agent.

Marks: 1

Marks: 0

1 item: recall (DCK task)

Column ‘CK’ (task 6.b)

Any of the following equations:

H2O2 + 2 I- = I2 + 2 OH-

H2O2 + 2 KI = I2 + 2 KOH

H2O2 + 2 I- + 2 H+ = I2 + 2 H2O

H2O2 + 2 KI + H2SO4 = I2 + 2 H2O + K2SO4

Marks: 1

In any other case. Marks: 0

1 item: recall (DCK task)

Column ‘CL’ (task 7)

Potassium, because the photons of violet light have higher energy

or:

Potassium, because the longer the wavelength of light, the lower the energy of the photons of light.

Marks: 1

In any other case. Marks: 0

1 item: understanding (DCK task)

Column ‘CM’

The student’s end of first term grade in 9th grade chemistry.

Column ‘CN’

The answer given by the student to the question how much he/she likes chemistry. (Insert the number circled by the student.)

Column ‘CO’

The answer given by the student to the question how important he/she thinks it is in science to test ideas by experiments. (Insert the number circled by the student.)

Columns ‘CP’

The answer given by the student to the question: “The bigger the number, the more you agree with the following statement: ‘I prefer the step-by-step experiments to the ones that I have to design.’” (Insert the number circled by the student.)

END OF EVALUATION OF THE TEST 3