# Spring round 2020./2021.

| SCHOOL | |
|---|---|
| TEAM NUMBER | |
| YEAR | **8.** |

| NAME AND SURNAME OF STUDENT | NAME AND SURNAME OF MENTOR | |
|---|---|---|
| | | **M** |
| | | **F** |
| | | **K** |

**ANSWERS:**

| Mathematics (M) | | Physics (F) | | Chemistry (K) | | M-F-K |
|---|---|---|---|---|---|---|
| M.1. | | F.1. | | K.1. | | |
| M.2. | | F.2. | | K.2. | | |
| M.3. | | F.3. | | K.3. | | |
| M.4. | | F.4. | | K.4. | | |
| M.5. | | F.5. | | K.5. | | |
| M.6. | | F.6. | | K.6. | | |
| M.7. | | F.7. | | K.7. | | |
| M.8. | | F.8. | | K.8. | | |
| M.9. | | F.9. | | K.9. | | |

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# MATHEMATICS

| **CORRECT ANSWER: 10 points** | **ANSWER „E": 0 points** | **ELSE: –2 points** |
| --- | --- | --- |

M.1. How many of the following statements are true for any real number $x$?

- $\sqrt{x^2} = \pm x$
- $\sqrt{x^2} = x$
- $\sqrt{x^2} = |x|$

| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
| --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | |

M.2. The price of gas increased by 2 % in the beginning of January. After a month, at the beginning of February, it increased by 3 %. What is the percentage of increase of the price from December till March?
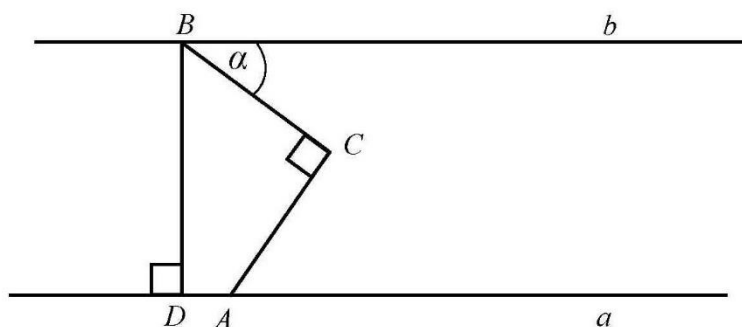
| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
| --- | --- | --- | --- | --- |
| less than 5 % | 5 % | greater than 5 % | it cannot be determined | |

M.3. How many numbers in the set $\left\{-3, 0, \dfrac{\sqrt{2}}{2}, \sqrt{25}, 3.14, 0.2222...\right\}$ are rational?

| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
| --- | --- | --- | --- | --- |
| 6 | 5 | 4 | less than 4 | |

| **CORRECT ANSWER: 20 points** | **THE ANSWER "E" : 0 points** | **ELSE : –4 points** |
| --- | --- | --- |

M.4. If lines $a$ and $b$ are parallel and $|AC| = |BC|$, what is the size of angle $\angle BAD$?



| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
| --- | --- | --- | --- | --- |
| $90° - \alpha$ | $180° - 2\alpha$ | $\alpha + 45°$ | none of the aforementioned | |

M.5. Which of the numbers below has the greatest hundredth decimal?

| **A**. | **B**. | **C**. | **D**. | **E**. we do not wish to answer |
|---|---|---|---|---|
| $\dfrac{7}{111}$ | $\dfrac{70}{111}$ | $\dfrac{70}{1111}$ | $\dfrac{77}{1111}$ | |

M.6. By cutting a square piece of paper along the diagonal, we get two triangles. We can position the triangles so that their intersection is a triangle (as shown in the image). Besides that, they can be positioned so that their intersection is another polygon. How many different polygons (regarding the number of vertices) can we get as the intersection of two such triangles?



| **A**. | **B**. | **C**. | **D**. | **E**. we do not wish to answer |
|---|---|---|---|---|
| 2 | 3 | 4 | 5 | |

| **CORRECT ANSWER: 30 points** | **THE ANSWER "E" : 0 points** | **ELSE : –6 points** |
|---|---|---|

M.7. In parallelogram *ABCD* the base $\overline{AB}$ is twice as long as $\overline{BC}$, and the angle between them is 120°. If the area of the parallelogram is $\dfrac{100\sqrt{3}}{3}$ cm², what is the distance from the intersection of the diagonals of the parallelogram to the line containing the segment $\overline{BC}$ ?

| **A**. | **B**. | **C**. | **D**. | **E**. we do not wish to answer |
|---|---|---|---|---|
| 5 cm | 2.5 cm | $5\sqrt{3}$ cm | it cannot be determined | |

M.8. The sum of three different natural numbers $a \le b \le c$ is equal to 1 200, and their greatest common factor is 120. How many such triples ($a$, $b$, $c$) exist?

| **A**. | **B**. | **C**. | **D**. | **E**. we do not wish to answer |
|---|---|---|---|---|
| less than 7 | 7 | 8 | more than 8 | |

M.9. In how many different ways can the tiles be placed onto a terrace 4 m long and 3 m wide using 12 tiles that are 1 m long and 1 m wide, out of which two tiles are black and 10 tiles are white, so that the two black tiles are next to each other? The tiles are next to each other if they share a side or vertex. (Remark: the image shows two different correct tilings)
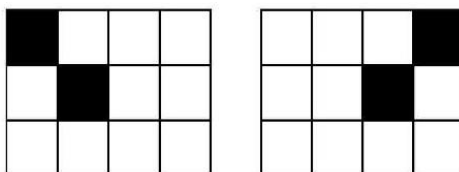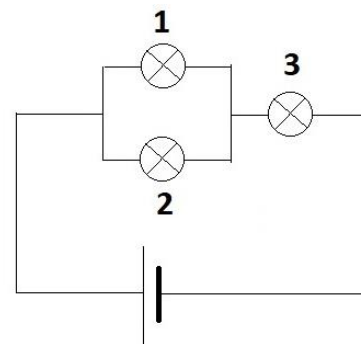


| **A**. less than 21 | **B**. more than 20 and less than 26 | **C**. more than 25 and less than 29 | **D**. more than 28 | **E**. we do not wish to answer |
|---|---|---|---|---|

# PHYSICS

**Use the approximate value $g = 10 \text{ m/s}^2$ for gravitational acceleration.**

| CORRECT ANSWER : 10 points | THE ANSWER "E" : 0 points | ELSE : –2 points |
|---|---|---|

F.1. Three identical light bulbs are connected in a circuit as shown and all three are shining. Which statement is true?



| **A.** light bulbs 1 and 2 have the same brightness which is greater than the brightness of light bulb 3 | **B.** light bulbs 1 and 2 have the same brightness which is smaller than the brightness of light bulb 3 | **C.** light bulb 2 is the least bright | **D.** all three light bulbs have the same brightness | **E.** we do not wish to answer |
|---|---|---|---|---|

F.2. A car starts at a traffic light and moves so that its speed increases uniformly every second by 5 m/s. The air resistance and friction should be neglected. Which is true for the pulling force of the motor $F_v$?

| **A.** $F_v$ increases uniformly | **B.** $F_v$ decreases uniformly | **C.** $F_v$ is constant and different from zero | **D.** $F_v = 0$ N | **E.** we do not wish to answer |
|---|---|---|---|---|

F.3. We have two identical glass bottles of equal volume. We fill one with water completely and we close it with a lid, and we also close the other empty bottle (full of air) with the lid. If both are placed into a pool, we will see the situation shown in the image. Which statement about the buoyancy forces exerted on the bottles is true?
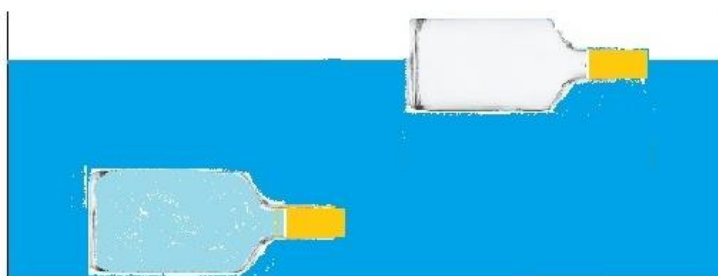


| **A.** equal buoyancy forces are exerted on both bottles | **B.** the buoyancy is greater for the bottle filled with water | **C.** the buoyancy is greater for the empty bottle | **D.** there isn't enough data to compare the forces | **E.** we do not wish to answer |
|---|---|---|---|---|

| CORRECT ANSWER: 20 points | THE ANSWER "E" : 0 points | ELSE : –4 points |
|---|---|---|

F.4. Marko must take a shower before going to school but the water in the water heater is too cold. The temperature of the water in the heater is 20 °C and Marko wants to shower with water of temperature 35 °C. There is 50 litres of water in the heater. The power of the electric heater is 3000 W, and the efficiency of heating is 90 %. When should Marko turn on the water heater if he wants the water to be heated at 10:00? The specific heat capacity of water is 4200 J/(kg·K)

| A. | B. | C. | D. | E.   we do not wish to answer |
|---|---|---|---|---|
| at 9:38 | at 9:42 | at 9:46 | at 9:50 | |

F.5. Petra covers 200 m in 18 seconds on a straight road on her electric scooter. The pulling force of the electromotor is 55 N during the whole drive. What is the electric current through the motor if the voltage at the ends of the batteries is 48 V? Suppose that friction can be neglected.
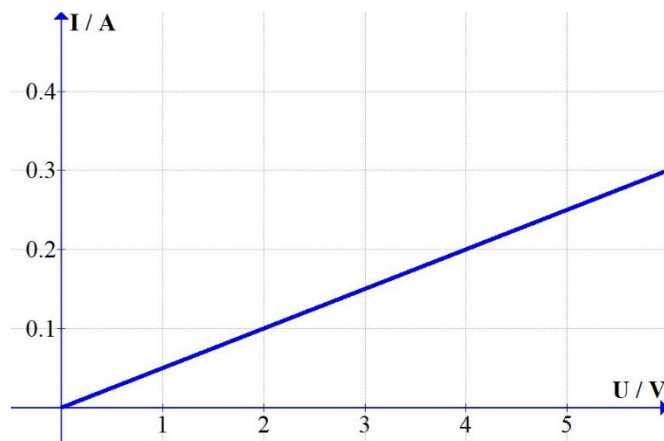
| A. | B. | C. | D. | E.   we do not wish to answer |
|---|---|---|---|---|
| 10,73 A | 11,73 A | 12,73 A | 13,73 A | |

F.6. An Eskimo whose mass is 70 kg stands in deep snow in shoes, and each of his shoes has a sole of area 160 cm$^2$. Not to fall into the snow he put snowshoes on that have a greater area than the soles of the shoes. Snow can endure a pressure of 10000 Pa without falling through. By how many cm$^2$ should the area of each snowshoe be greater than the area of each shoe so that he can walk on show without falling through?

| A. | B. | C. | D. | E.   we do not wish to answer |
|---|---|---|---|---|
| by 160 cm$^2$ | by 170 cm$^2$ | by 180 cm$^2$ | by 190 cm$^2$ | |

| **CORRECT ANSWER: 30 points** | **THE ANSWER "E" : 0 points** | **ELSE : –6 points** |
|---|---|---|

**F.7.** Iva got a wire 2 m long and with a diameter of 0.252 mm, and she had to figure out which material the wire is made of. She decided to determine the resistance of the material and then to search on the internet which material it could be. She connected the wire to a source of voltage. She measured how the electric current depends on the voltage and she showed her results graphically (image). From the given data, determine the electric resistance of the material Iva's wire is made of.
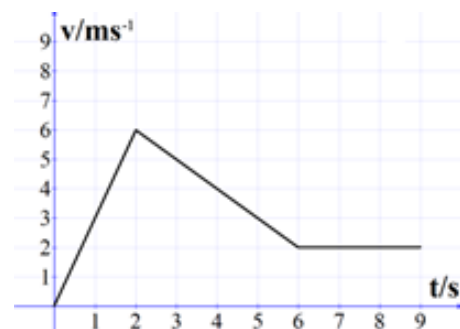


| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
|---|---|---|---|---|
| $0{,}028 \cdot 10^{-6}$ Ωm, aluminium | $0{,}0172 \cdot 10^{-6}$ Ωm, copper | $0{,}1 \cdot 10^{-6}$ Ωm, iron | $0{,}5 \cdot 10^{-6}$ Ωm, constantan | |

**F.8.** Jure and Nino decided to go to Vatroslav's place after school to solve physics problems for the competition together. Jure left first and walked at speed 3.6 km/h. Nino left 15 minutes later by bike and drove at speed of 18 km/h on the same path that Jure walked. At which distance from school did Nino meet Jure?

| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
|---|---|---|---|---|
| 900 m | 1 125 m | 1 350 m | 1 575 m | |

**F.9.** Ana went to visit a friend on her bike. The first nine seconds of her movement is shown graphically in the image. Determine the average speed of Ana's motion during those 9 seconds.



| **A.** | **B.** | **C.** | **D.** | **E.** we do not wish to answer |
|---|---|---|---|---|
| 3,44 m/s | 3,33 m/s | 3,22 m/s | 3,11 m/s | |

# CHEMISTRY

**Note: In all tasks, follow the data from the obtained Periodic table of elements.**

| CORRECT ANSWER: 10 points | ANSWER „E" : 0 points | OTHER : –2 points |
|---|---|---|

K.1. The figure shows the cooling curve of pure liquid substance X. In which part of the diagram, substance X is in both liquid and solid aggregation state at the same time?
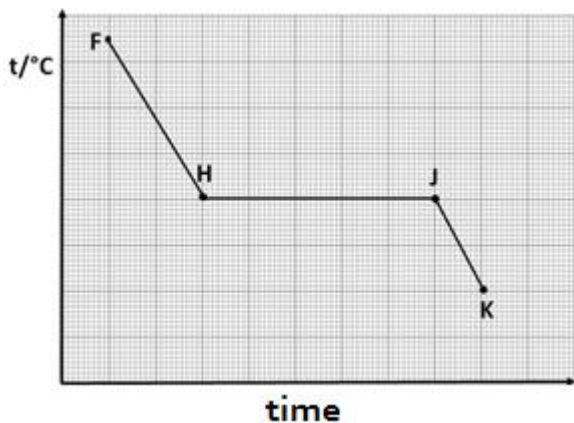


| **A.** only at point F |
|---|
| **B.** only at point H |
| **C.** between points X and J. |
| **D.** between points J and K |
| **E.** we do not want to answer the question |

K.2. Which molecule of the listed compounds contains a chemical element in whose neutral atom has the sum of protons and electrons 14?

| **A.** | **B.** | **C.** | **D.** | **E.** we do not want to answer the question |
|---|---|---|---|---|
| ammonia | glucose | Blue vitriol | Sulfuric acid | |

K.3. Drug **X** is used to relieve the symptoms of heartburn and other stomach problems caused by it for a short time. The manufacturer states that the drug contains magnesium hydroxide, aluminum hydroxide and magnesium carbonate.

**a)** Which of the following indicators will change color to blue if added to an aqueous solution of drug X?

**b)** Which of the following chemical formulas of the ingredients of drug **X** are written correctly?

| **A.** | **B.** | **C.** | **D.** | **E.** we do not want to answer the question |
|---|---|---|---|---|
| a) Phenolphthalein | a) Phenolphthalein | a) Red litmus paper | a) Red litmus paper | |
| b) $Mg_2(OH)_2$ | b) $MgOH_2$ | b) $Mg(OH)_2$ | b) $Mg_2OH_2$ | |
| $Al_2(OH)_3$ | $AlOH_3$ | $Al(OH)_3$ | $Al_2OH_3$ | |
| $Mg(CO_3)_2$ | $Mg_2CO_3$ | $MgCO_3$ | $Mg_2CO_3$ | |

| CORRECT ANSWER: 20 points | ANSWER „E" : 0 points | OTHER : –4 points |
|---|---|---|

K.4. Which of the following pairs of hydrocarbons have the same molecular formula?

| |
|---|
| **A**. 2,2-dimethylpropane and cyclopentane |
| **B**. hex-2-yne and cyclohexene |
| **C**. pent-2-ene and cyclohexane |
| **D**. cyclopentene and 3-methylpent-1-yne |
| **E**. we do not want to answer the question |

K.5. Consider a diagram showing the chemical reactions of one inorganic acid with different substances.
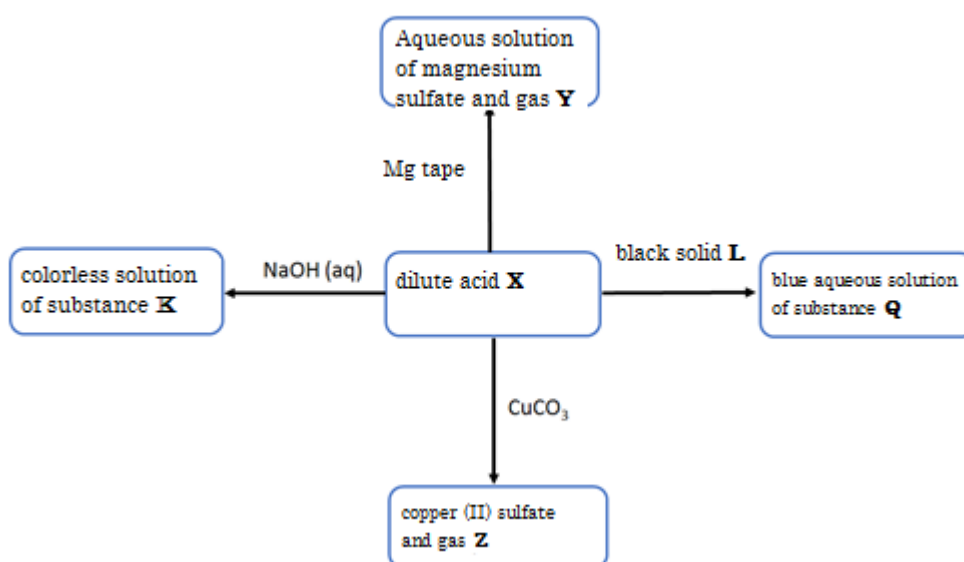


**a)** Which of the following answers contains the exact chemical formulas of all the substances indicated by the letters on the chemical reaction diagram?

**b)** What is the name of chemical reaction that produces a colorless solution of substance K?

| **A. a)** | **B. a)** | **C. a)** | **D. a)** | **E.** we do not want to answer the question |
|---|---|---|---|---|
| **X**– $H_2SO_4$(aq) | **X**– $H_2SO_3$(aq) | **X**– $H_2SO_3$(aq) | **X**– $H_2SO_4$(aq) | |
| **Y** – $H_2S$(g) | **Y** – $SO_2$(g) | **Y** – $CO_2$(g) | **Y** – $H_2$(g) | |
| **Z** – $SO_2$(g) | **Z** – $CO$(g) | **Z** – $SO_3$(g) | **Z** – $CO_2$(g) | |
| **K** – $H_2SO_4$(aq) | **K** – NaOH(aq) | **K** – $H_2O$(l) | **K** – $Na_2SO_4$(aq) | |
| **L** – CuO | **L** – Cu(s) | **L** – C(s) | **L** – CuO(s) | |
| **Q** – CuO(aq) | **Q** – $CuSO_4$(s) | **Q** – $CuCO_3$(aq) | **Q** – $CuSO_4$(aq) | |
| **b)** oxidation | **b)** neutralization | **b)** oxidation | **b)** neutralization | |

K.6. Based on the observation of the structural formula of the molecule of a chemical compound that is an ingredient of an insecticide, and is isolated from a Dalmatian pellitory plant, answer the questions.
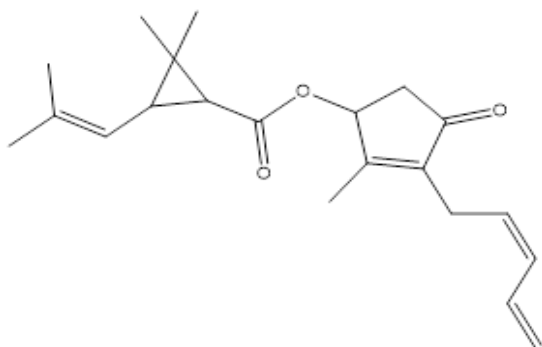


a) What is the molecular formula of the chemical compound shown?

b) What is the ratio of the number of double bonds between carbon atoms to the number of double bonds between carbon atoms and oxygen?

| A. | B. | C. | D. | E.  we do not want to answer the question |
|---|---|---|---|---|
| a) $C_{20}H_{30}O_2$  b) 1 : 2 | a) $C_{21}H_{28}O_3$  b) 2 : 1 | a) $C_{19}H_{29}O_2$  b) 2 : 3 | a) $C_{22}H_{25}O_3$  b) 3 : 2 | |

| CORRECT ANSWER: 30 points | ANSWER „E" : 0 points | OTHER : –6 points |
|---|---|---|

K.7. The molecular formula of the organic compound is $(CH_2)_n(CH_2O)_2$. What is the number $n$ if the mass fraction of oxygen in the molecule of this compound is 14.01%?

| A. | B. | C. | D. | E.  we do not want to answer the question |
|---|---|---|---|---|
| 10 | 12 | 14 | 16 | |

K.8. Figures **A, B** and **C** show the composition of three different mixtures of methane and oxygen before the combustion reaction.
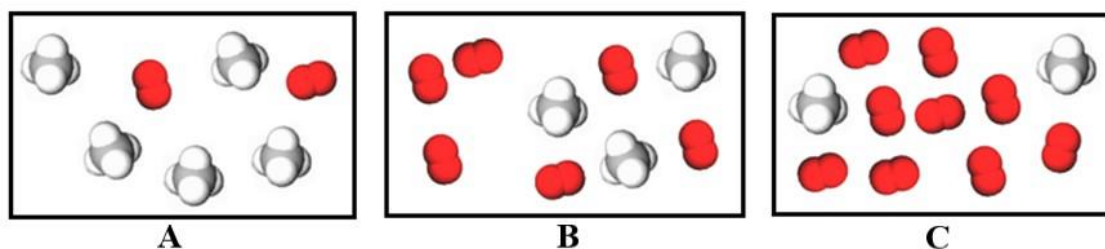


Figures **1, 2** and **3** show the composition of products in three different mixtures after the methane combustion reaction.
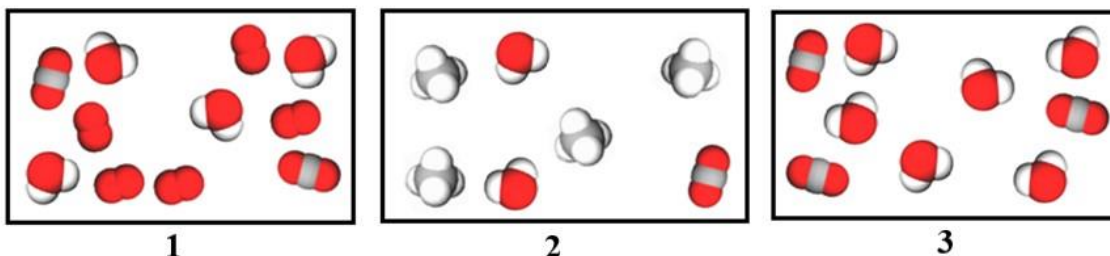


In which sequence are the images of the reactants (**A, B, C**) exactly associated with the images of the products (**1, 2, 3**)?

| **A**. | **B**. | **C**. | **D**. | **E**. we do not want to answer the question |
|---|---|---|---|---|
| **A1, B2, C3** | **A2, B1, C3** | **A2, B3, C1** | **A3, B2, C1** | |

K.9. In 1 dm$^3$ of a gas mixture with a density of 1.19 kg / m$^3$, the mass fraction of oxygen is 19.5%, nitrogen 77.5%, carbon dioxide 0.5%, and the rest is sulfur dioxide. What is the mass of sulfur dioxide in the described mixture?

| **A**. | **B**. | **C**. | **D**. | **E**. we do not want to answer the question |
|---|---|---|---|---|
| 0,025 g | 0,975 mg | 1,19 g | 29,75 mg | |

# M– F - K

| **CORRECT ANSWER: 30 points** | **ANSWER „E" : 0 points** | **OTHER : –6 points** |
|---|---|---|

M-F-K. The clumsy chemist Bojan filled the beaker with sugar X-oz. The mass of X-oz in the beaker was in grams equal to the relative molecular mass of X-oze. It is known that one molecule of X-oz contains 5 carbon atoms. The mass fraction of hydrogen in X-oz is 7.53%, the mass fraction of oxygen is 47.71%, and the rest is carbon. Cheerful mathematician Mia, played with right triangles and noticed that the volume of the glass from which the beaker is made is equal to the length of the hypotenuse of a triangle whose cathetus are 0.6 cm and $\sqrt{0.13}$ cm multiplied by a factor $\left(\frac{10^{420}}{10^{369} \cdot 10^{49}}\right)$ cm$^2$. Bojan accidentally ran the beaker on the table and, in order not to fall to the floor, he used force on it. Crazy physicist Theo measured that the beaker slows down uniformly to rest with an acceleration of -9 m / s$^2$. If the density of the glass is 2500 kg / m$^3$ and the friction factor between the table and the beaker is 0.5, how much force did Bojan use to prevent the catastrophe? (Author of the task: Jakov Budić)

| **A.** | **B.** | **C.** | **D.** | **E.** we do not want to answer the question |
|---|---|---|---|---|
| 0,8 N | 1,2 N | 4,3 N | 6,1 N | |