ÉRETTSÉGI VIZSGA • 2021. május 18.

# FIZIKA
# ANGOL NYELVEN

# KÖZÉPSZINTŰ
# ÍRÁSBELI VIZSGA

# JAVÍTÁSI-ÉRTÉKELÉSI
# ÚTMUTATÓ

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

The examination papers should be evaluated and graded clearly, according to the instructions of the evaluation guide. Markings should be in red ink, using the conventional notations.

**PART ONE**

For the multiple choice questions, the two points may only be awarded for the correct answer given in the evaluation guide. Enter the score (0 or 2) in the gray rectangle next to the question as well as the table for total scores at the end of the exam paper.

**PART TWO**

***Principles for dividing allocated scores:***

- The sentences printed in italics in the evaluation guide define the steps necessary for the solution. The scores indicated here may and should be awarded if the action or operation described by the text in italics can be clearly identified in the work of the student and is basically correct and complete.
- The „expected solution" is not necessarily complete; its purpose is to indicate the nature and extent of the expected solution, and the depth of detail required from the student. Comments in brackets that follow provide further guidance on the evaluation of possible errors, differences or incomplete answers.

***Principles for evaluating alternative trains of thought:***

- Correct answers that differ from the reasoning of the one (ones) given in the evaluation guide are also acceptable. The lines in italics provide guidance in allocating scores, e.g. what part of the full score may be awarded for a correct interpretation of the question, for stating relationships, for calculations, etc.
- Should the student combine some steps, or carry on calculations algebraically, he/she may skip the calculation of intermediate results shown in the evaluation guide. If these intermediate results are not being explicitly asked for in the original problem, the scores indicated for them should be awarded if the reasoning is otherwise correct. The purpose of indicating scores for intermediate results is to make the evaluation of incomplete solutions easier.

***Principles for the avoidance of multiple deductions:***

- For errors that do not affect the correctness of reasoning (miscalculations, clerical errors, conversion errors, etc.) deduce points only once.
- Should the student display multiple attempts at solving the problem, and does not indicate clearly which one of those he/she wants evaluated, the last one should be considered (i.e. the one at the bottom of the page if there is nothing to indicate otherwise). If the solution contains a mixture of two different trains of thought, the elements of only one of them should be evaluated: that one which is more favorable for the student.
- If an action or operation defined in the evaluation guide is completed, but the results are incorrect due to errors committed previously, full points allocated for this action are to be awarded. If the action can be broken down into steps, partial scores are indicated beside each line of the expected solution.

***Principles regarding the use of units:***

- The lack of units during calculation should not be considered a mistake – unless it causes an error. However, the results asked for in the problem are acceptable only with proper units.
- Graphs, diagrams and notations are acceptable only if they are unambiguous (it must be clear what the graphs show, markings should be in place, unconventional notations must be explained, etc.). The lack of units on the axis labels of graphs should not be considered a mistake however, if the units are otherwise obvious (e.g. quantities given in a table must be plotted, all with the same units).

***Further comments:***

- If, in case of problem 3 the student does not indicate his/her choice, and the choice is also not immediately obvious from the exam paper, the solution for the first problem of the two optional ones must be evaluated in every case.
- After evaluation, the appropriate scores should be entered in the summarizing tables at the bottom of the page.

# PART ONE

**1. C**
**2. A**
**3. B**
**4. B**
**5. B**
**6. A**
**7. B**
**8. B**
**9. A**
**10. C**
**11. A**
**12. C**
**13. B**
**14. A**
**15. C**
**16. B**
**17. C**
**18. C**
**19. A**
**20. C**

Award ***2 points*** for each correct answer.

**Total 40 points**

# PART TWO

*When evaluating the calculations, care must be taken to deduce points for errors that do not affect the correctness of reasoning (miscalculations, clerical errors) only once. If the student uses a previously miscalculated result in further steps of the solution correctly, full points are to be awarded for these steps. Thus it may be possible that full points are due at certain steps for solutions that differ from the values given in the evaluation guide.*

## Problem 1

Data: $T = 5$ days, $\Delta m_0 = 6$ mg.

*a) Determining the initial quantity of the isotopes:*

***10 points***
***(may be divided)***

The amount of isotope that decays during a 5 day interval is always half of the quantity present at the start (1 point), so if the isotope mass was $m_0$ initially:

During the interval 0-5 days the amount that decays is $m_0/2$. (1 point)
During the interval 5-10 days the amount that decays is $m_0/4$. (1 point)
During the interval 10-15 days the amount that decays is $m_0/8$. (1 point)
During the interval 15-20 days the amount that decays is $m_0/16$. (1 point)

Therefore $m_0 \cdot \left(\frac{1}{8} + \frac{1}{16}\right) = 6$ mg (2 points), from which

$m_0 = \frac{16}{3} \cdot 6$ mg = 32 mg (rearrangement + calculation, 2 + 1 points).

*b) Determining the amount of isotopes left by the end of day 20:*

***5 points***
***(may be divided)***

The amount of isotope left after 5 days is always half of the initial quantity (1 point), so:

$m_{20} = m_0 \cdot \left(\frac{1}{2}\right)^4 = m_0 \cdot \frac{1}{16}$ = 2 mg (formula + calculation, 2 + 2 points).

**Total: 15 points**

## Problem 2

*a) Explaining the role of the direction that the valley faces:*

***2 points***

It is important for the valley to face north because a valley facing south is heated much more by solar radiation.

*b) Justifying the direction of flow of cold air:*

***3 points***
***(may be divided)***

The warmer air in the cave is less dense (or more rare) (1 point) so it exchanges its place (2 points) with the cold air coming from above in winter.

*c) Explaining why the cold air is trapped inside:*

***3 points***
***(may be divided)***

In summer, the colder air in the cave is denser (1 point) than the warm air outside, so the cold air is trapped (2 points) down in the depths of the cave.

*d) Explaining the destructive effect of draft:*

***2 points***

Draft is a flow of air which exchanges the warm air outside and the cold air inside.

*e) Explaining the seasonal changes in ice formation:*

***2 points***
***(may be divided)***

In summer, rainwater seeping into the ground enters the cave and freezes (1 point).
In winter, frozen precipitation does not seep into the ground (1 point).

*f) Explaining how freezing widens cracks:*

***3 points***
***(may be divided)***

Water expands (1 point) when it freezes, so if water fills a crack and then freezes, it forces rocks apart (2 points).

**Total: 15 points**

## Problem 3/A

*a) Determining the two data values missing from lines 2 and 3:*

***5 points***
***(may be divided)***

The light power of a laser pulse is given by the quotient of the pulse energy and its time duration:

$P = \frac{E}{T}$ (2 points), using which:

The light power of the terahertz pump laser: $2 \cdot 10^{12}\,\mathrm{W}$ (1 point).
HF pulse energy: $E = P \cdot T = 20$ J (rearrangement + calculation, 1 + 1 points).
(If the student determines both quantities correctly, full points are to be awarded even in the absence of the formulas.)

*b) Determining the spatial length of the HR laser pulse:*

***3 points***
***(may be divided)***

$$d = c \cdot t \rightarrow d = 6 \cdot 10^{-15}\,\mathrm{s} \cdot 3 \cdot 10^{8}\,\frac{\mathrm{m}}{\mathrm{s}} = 1.8 \cdot 10^{-6}\,\mathrm{m}$$

(formula + substitution of data + calculation, 1 + 1 + 1 points).

*c) Determining the parameters of the MIR laser in question:*

***4 points***
***(may be divided)***

As $T = 2 \cdot \lambda / c = 4 \cdot 10^{-14}\,\mathrm{s}$
(formula + substitution of data + calculation, 1 + 1 + 1 points),
so $P = 2.5 \cdot 10^{11}\,\mathrm{W}$ (1 points).

*d) Naming the laser with the lowest repetition rate and determining the number of pulses emitted per second:*

***2 points***
***(may be divided)***

The HF laser (1 point) emits 10 pulses (1 point) per second.

*e) Naming the laser with the largest pulse energy:*

***1 point***

The HF laser.

*f) Determining the average power of the HR laser:*

***5 points***
***(may be divided)***

As the average power equals the amount of energy emitted during one second:
$P_{average} = f \cdot E_{\mathrm{pulse}} = 10^{5}\ \mathrm{Hz} \cdot 5 \cdot 10^{-3}\,\mathrm{J} = 500\ \mathrm{W}$
(formula + substitution of data + calculation, 3 + 1 + 1 points).

**Total: 20 points**

## Problem 3/B

*a) Characterization of the force of kinetic friction:*

***8 points***
***(may be divided)***

The force of kinetic friction is given by the product (2 points) of the normal force (1 point) that compresses the two surfaces together and the coefficient of kinetic friction (2 points). The normal force equals the weight of the rock (1 point).

(The formula $F_f = \mu \cdot F_n$ in itself, without any explanation of the symbols is worth 2 points only.)

The force of kinetic friction hinders the movement of surfaces with respect to each other (2 points). (Different formulations are acceptable, e.g. its direction is opposite to the direction of the movement of the load, etc.)

*b) Explanation of the use of the pole:*

***8 points***
***(may be divided)***

In the present case, the pole serves as a lever of the first kind (or class one lever) (2 points).

The support serves as the pivot (or fulcrum or hinge) (2 points). In the depicted arrangement, on the side of the load the weight of the rock slab has a short lever arm (2 points), while the weight of the men pulling on the other end has a long lever arm (2 points).

*c) Explanation of the decrease of the friction force:*

***4 points***
***(may be divided)***

The normal force can be decreased (2 points) using the lever, while the coefficient of friction is decreased (2 points) by using wooden logs with a smooth surface.

**Total: 20 points**