

ÉRETTSÉGI VIZSGA • 2009. május 13.

**FIZIKA
ANGOL NYELVEN**

**KÖZÉPSZINTŰ ÍRÁSBELI
ÉRETTSÉGI VIZSGA**

**JAVÍTÁSI-ÉRTÉKELÉSI
ÚTMUTATÓ**

**OKTATÁSI ÉS KULTURÁLIS
MINISZTERIUM**

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

The individual scores shown in the evaluation guide may not be broken up unless explicitly indicated.

The sentences printed in italics in the evaluation guide define the steps necessary for the solution. The scores indicated here may be awarded if the action or operation described by the text in italics can be clearly identified in the work of the examinee and is basically correct and complete. Wherever the action can be broken down into smaller steps, partial scores are indicated beside each line of the expected solution. The „expected solution” is not necessarily complete; its purpose is to indicate the depth of detail required of the examinee when writing the solution. Comments in brackets that follow provide further guidance on the evaluation of possible errors, differences or incomplete answers.

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. how much of the full score may be awarded for correct interpretation of the question, for stating relationships, for calculations, etc.

Should the examinee 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 may be awarded if the reasoning is correct. The purpose of indicating scores for intermediate results is to make the evaluation of incomplete solutions easier.

For errors that do not affect the correctness of reasoning (miscalculations, clerical errors, conversion errors, etc.) deduce points only once.

Should the examinee write more than one solutions, or 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 examinee.

The lack of units during calculation should not be considered a mistake – unless it causes an error. However, the results questioned by 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).

If, in case of problem 3. the examinee does not indicate his/her choice, the procedure described in the exam description should be followed.

Following the evaluation, the appropriate scores should be entered into the tables at the bottom of each page.

PART ONE

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

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

Total:

40 points.

PART TWO

Problem 1.

Data: $m = 5 \text{ kg}$, $L = 1 \text{ m}$, $g = 10 \frac{\text{m}}{\text{s}^2}$

- a) *Realizing and expressing the fact that at the highest point of the circular orbit, the force of gravity acting on the body is equal to the centripetal force needed to keep it in orbit:*

3 points
(may be divided)

$$F_{top}^{cp} = m \cdot g, \text{ which means } m \cdot \frac{v_{top}^2}{L} = m \cdot g$$

Expressing and calculating the velocity:

1 + 1 points

$$v_{top} = \sqrt{L \cdot g} \Rightarrow v_{top} = 3.2 \frac{\text{m}}{\text{s}}$$

- b) *Stating the conservation of energy at the lowest point of the circular orbit:*

3 points
(may be divided)

$$\frac{m}{2} \cdot v_{top}^2 + m \cdot g \cdot 2 \cdot L = \frac{m}{2} \cdot v_{bottom}^2$$

Expressing and calculating the velocity:

1 + 1 points

$$v_{bottom} = \sqrt{v_{top}^2 + 4 \cdot g \cdot L} = \sqrt{5 \cdot L \cdot g} \Rightarrow v_{bottom} = 7.1 \frac{\text{m}}{\text{s}}$$

- c) *Realizing and stating the fact that the tension in the string at the lowest point of orbit equals the sum of the centripetal force and the force of gravity:*

3 points
(may be divided)

$$F_{string} = m \cdot g + F_{bottom}^{cp}$$

Expressing and calculating the tension in the string:

1 + 1 points

$$F_{string} = m \cdot \frac{v_{bottom}^2}{L} + m \cdot g = 6 m \cdot g \Rightarrow F_{string} = 300 \text{ N}$$

Total: 15 points

Problem 2.

Data: $t_1 = 11.25$ hours, $t_2 = 7.5$ hours $m = 15$ g

a) *Applying the law of radioactive decay:*

4 points
(may be divided)

The ratio of the radioactive nuclei that have not yet decayed compared to their original number is 0.125, i.e.

$$\frac{1}{8} = \frac{1}{2^3}, \text{ so } t_1 = 3 \cdot T_{1/2}$$

Calculating the half-life of the isotope:

2 points

$$T_{1/2} = \frac{t_1}{3} = 3.75 \text{ hours} = 3 \text{ hours } 45 \text{ minutes}$$

If the examinee writes the general form of the radioactive decay law correctly:

$\frac{N_1}{N_0} = 0.125 = \left(\frac{1}{2}\right)^{t_1/T_{1/2}}$, but does not present any further calculations, a total of 2 points may be awarded for this part.

b) *Determining the ratio of t_2 and $T_{1/2}$:*

2 points

$$t_2 = 2 \cdot T_{1/2}$$

Determining the fraction of the radioactive nuclei that have decayed during the first 7.5 hours:

4 points
(may be divided)

After a time amounting to the duration of two half-lives the fraction of radioactive nuclei that have decayed is $50\% + 25\% = 75\%$

Determining the initial mass of the radioactive nuclei:

3 points
(may be divided)

$$m_0 = \frac{15 \text{ g}}{0.75} = 20 \text{ g}$$

Total: 15 points

Problem 3/A

(Each of the individual scores may be divided!)

Description of the phenomenon must explicitly contain the following facts:

As we shine the laser into the water, the light passed through the bottle and into the stream of water leaving the bottle. Its direction was roughly parallel to the axis of the stream.

1 point

The stream of water started falling towards the ground. As the stream was narrow, and the light propagated in a direction nearly parallel to the initial axis of the stream, the light reached the boundary between the water and the air at a large angle.

1 + 2 points

The liquid's index of refraction is greater than that of air, so the light undergoes total internal reflection on the liquid-air interface due to the large angle of incidence.

2 + 2 points

The light thus propagates further within the stream, until it again reaches the boundary and is reflected. Because of the multiple reflections, light is confined within the stream and forced to follow its curved path.

2 points

For the phenomena to occur, the light must enter the stream roughly parallel to the initial direction of the stream axis.

2 points

The stream must bend gradually; an excessive curvature will allow the light to escape.

2 points

The phenomenon can be observed because impurities within the liquid scatter a small portion of the light. This light then leaves the liquid and reaches our eyes.

2 + 2 points

Optical fibers used in the communication industry guide light in a similar manner.

2 points

Total: 20 points

Problem 3/B

a) *Plotting the data and stating the linear relationship between the quantities:*

2 + 2 points
(may be divided)

The linear relationship must be visible on the graph and it must be explicitly named.
(If the linear relationship is not named explicitly, but is evident later from the functional relationship, full score should be given.)

b) *Writing down the formula for the linear relationship and calculating the slope using data from the table:*

2 + 2 points
(may be divided)

$$V(t) = V_1 + \beta \cdot (t - t_1) \quad \text{where } \beta \approx 12 \frac{\text{cm}^3}{^\circ\text{C}}$$

c) *Determining the volume at 0 °C using the relationship, or reading it from the graph:*

3 points
(may be divided)

(In case of direct application of the Gay-Lussac formula: $V_2 = V_1 \cdot \frac{T_2}{T_1}$, only 1 point should be given!)

d) *Calculating the temperature corresponding to zero volume using the functional relationship:*

5 points
(may be divided)

The functional relationship derived using the experimental data yields $t_0 \approx -255 \text{ } ^\circ\text{C}$ for the temperature in question. (Should the examinee simply state, based on Gay-Lussac's law, that the temperature in question is the absolute zero, and convert this to Celsius, 1 point may be given.)

e) *The temperature that could be determined with a more accurate measurement is called the absolute zero.*

2 points

The precise value is $-273 \text{ } ^\circ\text{C}$, the value obtained in this measurement is slightly different.

1 point

*One may introduce a new temperature scale using this as the zero point, the **Kelvin scale**.*

1 point

Total: 20 points