ÉRETTSÉGI VIZSGA ● 2013. október 25.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ ÍRÁSBELI ÉRETTSÉGI 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.

FIRST PART

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.

SECOND PART

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 nature and size of the expected solution, and 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 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.

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

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

Total: 40 points.

PART TWO

Problem 1

Data: $p_0 = 1.01\cdot10^5$ Pa, $p_1 = 0.76\cdot10^5$ Pa , $p_{ext} = 2.5\cdot10^4$ Pa, $V = 875\ \text{m}^3$, $h_{window} = 50$ cm, $w_{window} = 30$ cm , $t = 25$ ºC, $R = 8.31\,\frac{\text{J}}{\text{mol}\cdot\text{K}}$, $M = 29$ g/mol .

a) *Calculating the mass of the air in the passenger cabin of the airliner at the airport:*

6 points
(may be divided)

Using the ideal gas law: $p\cdot V = \frac{m}{M} R\cdot T$ (2 points), from which

$m = \frac{p\cdot V\cdot M}{R\cdot T}$ (rearranging the formula 1 point), therefore

$m_0 = \frac{p_0\cdot V\cdot M}{R\cdot T} = \frac{1.01\cdot10^5\cdot875\cdot29\cdot10^{-3}}{8.31\cdot298}\,\text{kg} = 1035\,\text{kg}$ (substitution and calculation, 1 + 2 points)

Calculating the mass of the air in the passenger cabin of the airliner at cruising altitude:

3 points
(may be divided)

$m_1 = \frac{p_1\cdot V\cdot M}{R\cdot T} = \frac{0.76\cdot10^5\cdot875\cdot29\cdot10^{-3}}{8.31\cdot298}\,\text{kg} = 779\,\text{kg}$
(substitution and calculation, 1 + 2 points)

Determining the mass of the air leaving the passenger cabin:

1 points

$m_{out} = 256\,\text{kg}$.

b) *Formulating the force acting on the window and calculating it:*

5 points
(may be divided)

$F = A\cdot p$ (1 point)
Because of the difference in pressures $F_e = A\cdot(p_1 - p_{ext})$ (2 points),
from which $F = 0.25\text{m}\cdot0.4\text{m}\cdot(0.76-0.25)\cdot10^5\ \text{Pa} = 5100\,\text{N}$
(substitution and calculation, 1 + 1 points)

Total 15 points

Problem 2

Data: $m = 900$ kg, $\gamma = 6.67 \cdot 10^{-11} \dfrac{\mathrm{N \cdot m^2}}{\mathrm{kg^2}}$, $M_{Mars} = 6.42 \cdot 10^{23}$ kg, $R_{Mars} = 3400\,\mathrm{km}$.

a) *Calculating the gravitational acceleration on the surface of Mars:*

6 points
(may be divided)

As $g = \gamma \dfrac{M}{R^2}$ (2 points),

$g = 6.67 \cdot 10^{-11} \dfrac{6.42 \cdot 10^{23}}{(3400000)^2} \dfrac{\mathrm{m}}{\mathrm{s}^2} = 3.7 \dfrac{\mathrm{m}}{\mathrm{s}^2}$ (substitution and calculation, 2 + 2 points)

Formulating the weight of Curiosity and calculating it:

1 + 1 points

$G = m \cdot g \approx 3300\,\mathrm{N}$.

b) *Formulating and calculating the 'first cosmic velocity':*

7 points
(may be divided)

The first cosmic velocity is given by $\dfrac{v_I^{\,2}}{R} = g$ (3 points).
(If the examinee does not write down the formula above, but explains the notion of first cosmic velocity, or defines it with a formula, e.g. $F_{cp} = m \cdot g$, 2 points are to be awarded for this part.)

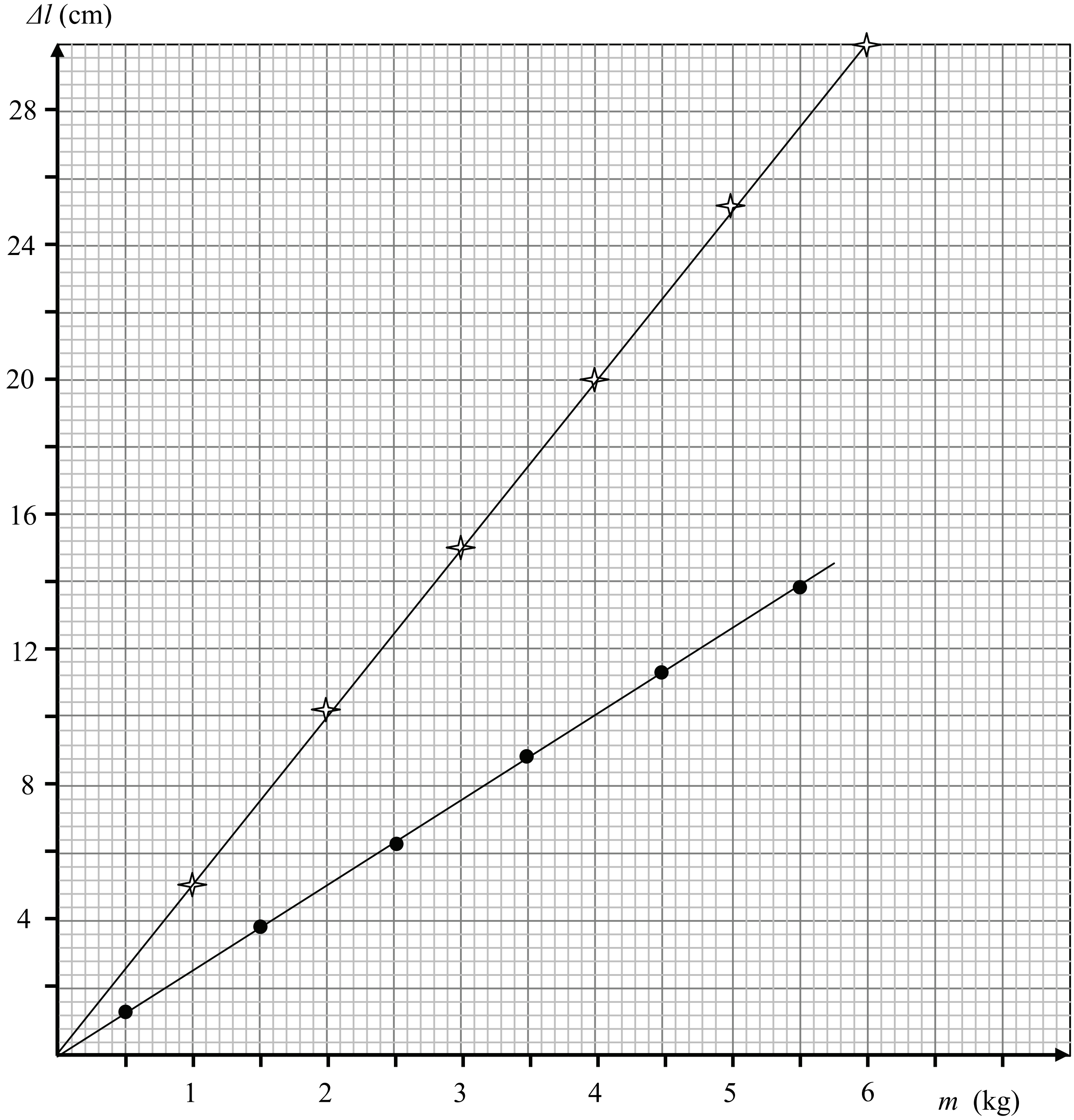
From which $v_I = \sqrt{g \cdot R} = \sqrt{3400000 \cdot 3.7} \dfrac{\mathrm{m}}{\mathrm{s}} \approx 3550 \dfrac{\mathrm{m}}{\mathrm{s}}$ (rearranging the formula + substitution + calculation 1 + 1 + 2 points).

Total 15 points

Problem 3/A

a) Preparing a suitable graph, correctly plotting the data in the table and sorting out the data corresponding to the two measurements:

10 points
(may be divided)



In the plot, the properly scaled and labeled axes are worth 1 point each. The correct plotting of the data is worth 4 points overall, one point per three data points, rounded up. Sorting out the data corresponding to the two measurements unambiguously is worth 2 points. Anything is acceptable that is unambiguous, e.g. the data corresponding to the two measurements can be plotted using different symbols, lines can be drawn over the data from the same measurement, or perhaps the data can be grouped by explicitly listing them. Finally, explaining how the sorting can be accomplished is worth 2 points. (Should the examinee exchange the axes, the correct answer must still be accepted.)

b) Determining the two spring constants:

4 points
(may be divided)

$D = \dfrac{F}{\Delta l}$ (2 points), from which, using two suitable data pairs $D_1 = 2\,\dfrac{\text{N}}{\text{cm}}$ (1 point) and $D_2 = 4\,\dfrac{\text{N}}{\text{cm}}$ (1 point).

c) Determining the overall extension of the two springs:

6 points
(may be divided)

$\Delta l = \Delta l_1 + \Delta l_2$ (2 points),

$\Delta l = \dfrac{F}{D_1} + \dfrac{F}{D_2}$ (1 point),

$$\Delta l = \frac{m \cdot g}{D_1} + \frac{m \cdot g}{D_2} = \frac{60}{2}\,\text{cm} + \frac{60}{4}\,\text{cm} = 30\,\text{cm} + 15\,\text{cm} = 45\,\text{cm}$$

(formulation + substitution + calculation, 1 + 1 + 1 points).

Total 20 points

Problem 3/B

a) Analyzing the shape of the speed vs. time graph:

3 points
(may be divided)

At first, the skydiver was moving with a constant acceleration (1 point).
He reached his maximum speed about 45 seconds after the start of the freefall (1 point).
(Because the graph is sketchy, any value between 40 s and 50 s must be accepted.)
After this, his motion was decelerating gradually (1 point).

b) Listing the forces acting on the skydiver and determining their directions:

5 points
(may be divided)

The forces acting on the skydiver during freefall are the gravitational force pointing downward (1 point), and the air drag pointing upward, opposite to the velocity (1 point). These two forces balance each other at the moment the skydiver reaches the maximum velocity. At this point, the acceleration of the skydiver is zero, the tangent of the velocity curve is horizontal (3 points).
(Full points can only be awarded if the answer connects the point of maximum speed with the state of zero acceleration.)

c) Explaining the changes in speed:

9 points
(may be divided)

During the first phase of the dive, in a very thin atmosphere (1 point), air drag was practically negligible (1 point), so the skydiver was falling freely under the action of the gravitational force, his speed increasing at a constant rate (1 point).
(Gravitational acceleration at this height is only 9.86 m/s^2.)
As the skydiver was getting closer to the ground, the density of the air increased gradually (2 points).
The skydiver extended his hands and feet, thereby increasing his front surface (2 points), so the air drag increased as well (1 point) and
the diver began to decelerate (1 point).

(Air drag decreased with the decreasing velocity, so the rate of deceleration also decreases gradually, this can be observed on the curve.)

d) Analyzing the properties of the protective suit:

3 points
(may be divided)

The protective suit was equipped with an oxygen tank, because there is too little oxygen at this altitude for a human to survive (1 point).
The thermal insulation properties of the suit were important because of the low external temperature (1 point).
The helmet's visor needed to be heatable, because water vapor condenses on the inside of a cold visor, which decreases transparency (1 point).

Total 20 points