ÉRETTSÉGI VIZSGA ● 2016. május 17.

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.

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 student 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 extent of the expected solution, and the depth of detail required of the student. 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 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.

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

Should the student 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 student.

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).

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

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

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

Total 40 points.

PART TWO

Problem 1

Data: $a = 1.5\,\dfrac{\text{m}}{\text{s}^2}$, m = 24 kg, $g = 9.8\,\dfrac{\text{m}}{\text{s}^2}$, μ = 0.5.

Interpreting the physical situation and calculating the force that the floor of the elevator exerts on the suitcase:

10 points
(may be divided)

Two vertical forces act on the suitcase, the gravitational force (1 point) directed downward and the force from the floor of the elevator (1 point). The sum of these two forces accelerate the suitcase vertically upward (4 points). (It is not necessary to write this fact down explicitly, a diagram depicting the forces or the correct formulation of Newton's law is worth full score, provided that the relationship between the sum of the forces and the acceleration is given by the student.)

As $F_{el} - G = m \cdot a$, and

$G = m \cdot g = 235.2\text{ N} \approx 235\text{ N}$ (1 point),

and $m \cdot a = 36\text{ N}$ (1 point),

$\Rightarrow F_{el} = 271\text{ N}$ (2 points).

Determining the friction force and calculating the necessary pulling force:

5 points
(may be divided)

The maximum value of the force of static friction:

$F_{sf} = \mu \cdot F_{el} = 135.5\text{ N}$ (formula + calculation, 2 + 1 points),

and the pulling force must be greater than this, $F_{sf} < F_{pull}$ (2 points).

Total 15 points

Problem 2

Data: m = 9 kg, Δt = 60 °C, $c = 400\,\dfrac{\text{J}}{\text{kg}\cdot\text{°C}}$, $m_c + m_p$ = 1200 kg.

Calculating the energy required to heat the brakes:

7 points
(may be divided)

The heat absorbed by a single brake:
$Q_1 = c \cdot m \cdot \Delta t = 216$ kJ (formula + calculation 3 + 2 points),

so the total amount of heat absorbed by the brakes:
$Q = 4 \cdot Q_1 = 864$ kJ (2 points).

Realizing that the total amount of energy absorbed by the brakes is equal to the total kinetic energy of the car and the passenger before braking:

4 points

$$Q = E_{kin} = \frac{1}{2}(m_c + m_p) \cdot v^2 .$$

Formulating and calculating the speed of the vehicle:

4 points
(may be divided)

$$v = \sqrt{\frac{2 \cdot Q}{m_c + m_p}} = \sqrt{\frac{1728\,\text{kJ}}{1200\,\text{kg}}} = 37.9\,\frac{\text{m}}{\text{s}} = 136.6\,\frac{\text{km}}{\text{h}} .$$

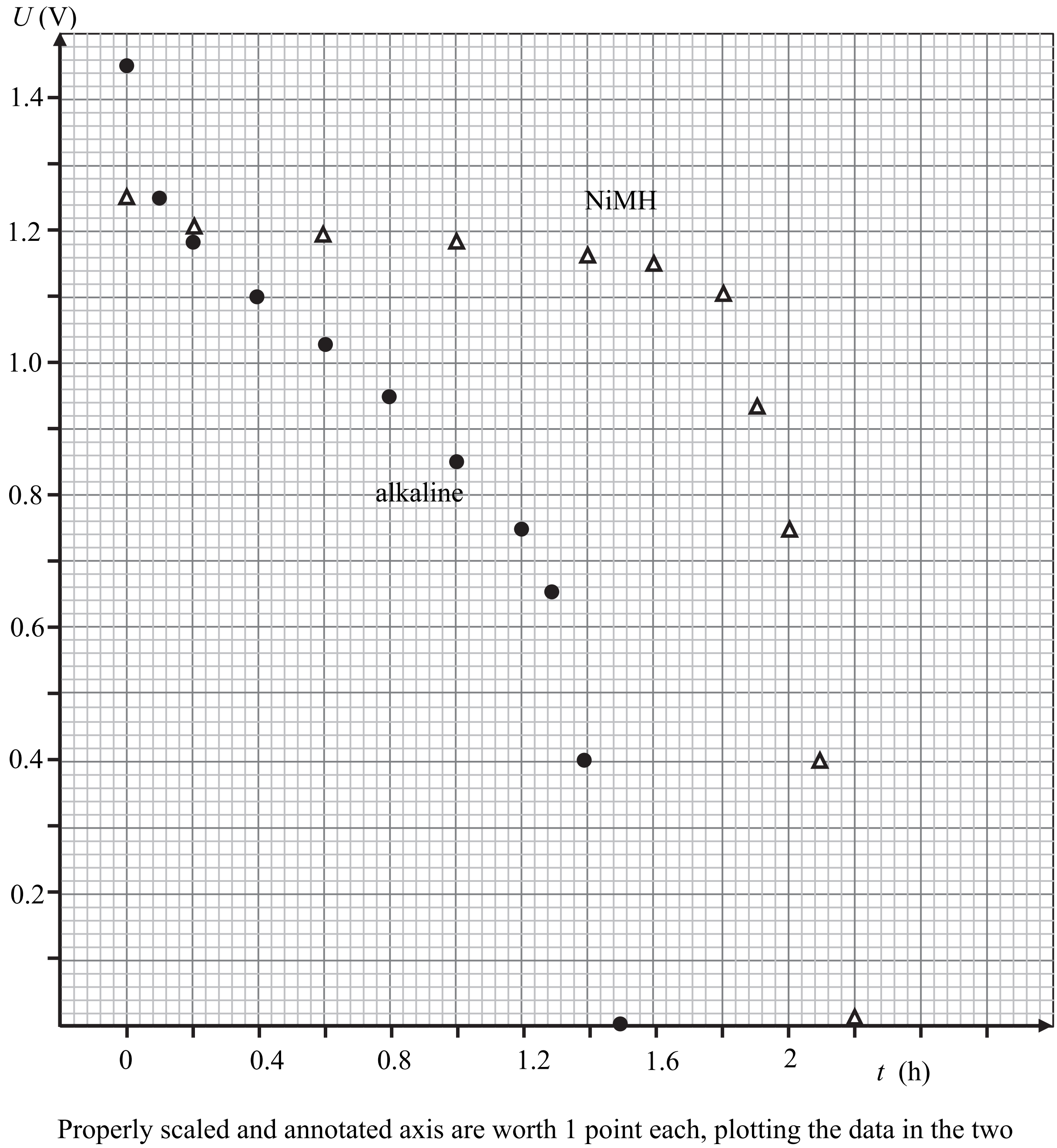
Thus the car did go faster than the speed limit.
(Rearranging the formula + calculation, 2 + 2 points).
(It is sufficient to give the speed in <u>either</u> m/s <u>or</u> km/h.)

Total 15 points

Problem 3/A

a) *Plotting the data on a graph:*

8 points
(may be divided)



Properly scaled and annotated axis are worth 1 point each, plotting the data in the two tables are worth 3 points each (10-11 data points plotted correctly 3 points, 7-9 data 2 points, 4-6 data 1 point). If the student does not indicate clearly which data belongs to which battery, 2 points are to be deduced.

b) *Analyzing the voltages of the batteries:*

3 points
(may be divided)

The nominal voltage of the alkaline battery is greater (1 point) and its output voltage is greater at the start of the experiment (1 point). However, at the given instant the output voltage of the NiMH battery is already greater (1 point).

c) *Answering the question on durability and determining the amount of charge provided by the batteries:*

7 points
(may be divided)

As the output voltage of the NiMH battery drops to zero later, this is the one that operates the circuit longer (1 point).
Because the current is constant during the whole experiment, the amount of charge provided by the batteries is $Q = I \cdot t$ (2 points).
In case of the alkaline battery t = 1.5 h (1 point), so Q = 1.5 Ah (1 point).
In case of the NiMH battery t = 2.2 h (1 point), so Q = 2.2 Ah (1 point).

d) *Answering the question on the constancy of the torchlight:*

2 points

The light of the torch operated by the NiMH battery will be more constant (2 points).

Total 20 points

Problem 3/B

a) *Naming the planets inside and outside the habitable zone of the Sun:*

4 points (may be divided)

According to the figure, Earth (1 point) and Mars (1 point) are definitely within the habitable zone of the Sun. (Venus is a borderline case, neither mentioning it, nor omitting it counts as a mistake.) Mercury (1 point) on the other hand is definitely too close, while Jupiter (1 point) is definitely too far. (Instead of Jupiter, any other more distant planet is acceptable e.g. Saturn, even though it is not depicted on the figure.)

b) *Naming the planets inside and outside the habitable zone of Gliese 581:*

4 points (may be divided)

According to the figure, the planets marked by g (1 point) and d (1 point) are definitely within the habitable zone of Gliese 581.
The planets marked by e, b or c are all definitely too close (the point should be awarded for naming any one of them), while the planet marked by f (1 point) is definitely too far.

c) *Analyzing the distance of the habitable zone from the star:*

6 points (may be divided)

It is the habitable zone of Gliese 581 that is closer to its star (2 points).
As the Gliese 581 is a "red dwarf star", smaller than the Sun (2 points), it is less hot, radiates less heat (2 points).
Or: As this star is, according to the figure, smaller than the Sun (2 points) it is less hot, radiates less heat (2 points).

d) *Comparing the orbital periods of Venus and Gliese 581 f:*

6 points (may be divided)

The distance of the named planets from their star is approximately equal (1 point). The gravitational force acting on a planet that orbits a star on a circular trajectory is equal to the centripetal force:
$F_{cp} = G \Rightarrow m_p \cdot R \cdot \left(\frac{2\pi}{T}\right)^2 = \gamma \frac{m_p \cdot M_s}{R^2}$ (2 points), from which, for the orbital period we obtain: $T^2 = \frac{R^3 \cdot (2\pi)^2}{\gamma \cdot M_s}$ (1 point). Because, out of the two stars the Sun is heavier than Gliese 581 (1 point), the orbital period of Venus is smaller (1 point). (The deduction of the proportionality $T^2 \propto \frac{1}{M_s}$ using any valid consideration, e.g. Kepler's laws is worth full points. The constant of proportionality need not be determined. Or, if the student reasons correctly without the use of formulas, e.g. the mass of Gliese 581 is smaller than that of the Sun, so at an identical distance it generates a smaller gravitational acceleration, so the *f* planet must move slower on a circular orbit with the same radius.)

Total 20 points