ÉRETTSÉGI VIZSGA • 2012. október 29.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ ÍRÁSBELI ÉRETTSÉGI VIZSGA

JAVÍTÁSI-ÉRTÉKELÉSI ÚTMUTATÓ

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

The examination papers should be corrected and evaluated 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 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.

FIRST PART

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

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

Total: 40 points.

SECOND PART

Problem 1

Data: U_{nominal} =110 V, P_{nominal} = 60 W, U_{network}= 230 V

Determining the voltage on the auxiliary resistor:

4 points
(may be divided)

As we connect the auxiliary resistor in series with the light bulb, the voltage U' on it is:
$U_{network} = U_{bulb} + U'$ (2 points), so $U' = 230\text{ V} - 110\text{ V} = 120\text{ V}$ (2 points).

Determining the current that corresponds to the nominal power rating of the light bulb:

5 points
(may be divided)

If we connect the light bulb to a 110 V network identical to its nominal voltage rating, it shines with a power of 60 W. Thus
$P_{nominal} = U_{nominal} \cdot I_{nominal} = 60\text{ W}$ (2 points), from which the current flowing through the light bulb

$I_{nominal} = \frac{P_{nominal}}{U_{nominal}} = 0.55\text{ A}$ (transforming the formula and calculation, 1 + 2 points).

Determining the resistance of the auxiliary resistor:

4 points
(may be divided)

If the voltage drop on the auxiliary resistor that corresponds to the nominal current of the light bulb is $U' = 120$ V, then its resistance is

$R' = \frac{U'}{I_{nominal}} = 220\,\Omega$ (formula and calculation 2 + 2 points)

Total 13 points

Solution II:

Determining the voltage drop on the auxiliary resistor: (see above, 4 points)
Determining the resistance of the light bulb:

5 points
(may be divided)

$P_{nominal} = \frac{U_{nominal}^2}{R} = 60\text{ W}$ (2 points), from which the resistance of the light bulb is

$R = \frac{U_{nominal}^2}{P_{nominal}} = 201.7\,\Omega$ (transforming the formula and calculation, 1 + 2 points).

Determining the resistance of the auxiliary resistor:

4 points
(may be divided)

As the voltage drop on resistors connected in series is directly proportional to the resistances,

$\frac{R'}{U'} = \frac{R}{U_{nominal}} \Rightarrow 220\,\Omega$ (formula and calculation 2 + 2 points)

Problem 2

Data: $C_{water} = 4200 \frac{\text{J}}{\text{kg} \cdot ^\circ\text{C}}$, $C_{Al} = 900 \frac{\text{J}}{\text{kg} \cdot ^\circ\text{C}}$, m_{pot} = 0.3 kg, V_{water} = 1.2 liters, T_{water} = 15°C, d = 1.4 m, P_{Sun} = 750 W/m^2, η = 85 %

Determining the temperature change required for the water to boil:

1 point

$\Delta T = 85\,°C$

Formulating and calculating the amount of heat necessary for warming up the water:

2 + 1 points

$Q_{water} = c_{water} \cdot \Delta T \cdot m_{water} = 428400\ \text{J}$

Formulating and calculating the amount of heat necessary for warming up the pot:

2 + 1 points

$Q_{Al} = c_{Al} \cdot \Delta T \cdot m_{pot} = 22950\ \text{J}$

Calculating the useful power output of the furnace:

7 points
(may be divided)

The area of the mirror: $A_{mirror} = \left(\frac{d}{2}\right)^2 \cdot \pi = 1.54\ \text{m}^2$ (1 points)

The power consumed by the furnace: $P_{consumed} = A_{mirror} \cdot P_{Sun} = 1.54\ \text{m}^2 \cdot 750 \frac{\text{W}}{\text{m}^2} = 1155\ \text{W}$

(formula and calculation 3 + 1 points)

Calculating the useful power output of the furnace:

$P_{useful} = P_{consumed} \cdot \eta = 1155\ \text{W} \cdot 0.85 = 981.75\ \text{W}$ (formula and calculation 1 + 1 points)

Determining the time required for the warming of the water:

3 points
(may be divided)

$t = \frac{Q_{water} + Q_{pot}}{P_{useful}} = \frac{451350\ \text{J}}{981.75\ \text{W}} = 459.7\ \text{s} \approx 460\text{s} = 7\ \text{minutes}\ 40\ \text{seconds}$

(Formula and calculation 2 + 1 points. Full points are to be awarded also if the conversion to minutes is absent.)

Total 17 points

Problem 3/A

Data: $M_{Al} = 27$ g/mol, $M_{Ag} = 108$ g/mol.

a) *Presenting a concise review of the process of electrolysis:*

1+1+1 points

In the vessels, electrons emitted from the cathode neutralize (1 point) the positively charged ions of the metals (1 point). Thus metals are deposited (1 point) on the cathode, i.e. the negative electrode.

b) *Explaining the mass ratio of the deposited metals:*

8 points
(may be divided)

Because the vessels are connected in series, the amount of charge that flows through them during the same time interval is equal (1 point). In this case the mass ratio of the deposited metals is determined by the masses of the ions (1 point) on the one hand and the charges of the ions (2 points) on the other. From the given masses it follows that 1 mole of silver (1 point) has been deposited and 1/3 mole of aluminum (1 point), i.e. for every aluminum ion that was neutralized, there were three neutralized silver ions. This is because the charge of the aluminum ions is three times the charge of silver ions (2 points).

c) *Answering the question concerning the concentration of the solutions and justifying the answer:*

4 points
(may be divided)

The amount of metals deposited is not influenced directly by the concentration of the solutions (2 points) because the number of ions neutralized is determined by the charge flowing through the vessel (2 points). Should any of the vessels contain twice the number of ions, it would have no effect.

d) *Determining the time necessary for the electrolysis:*

5 points
(may be divided)

The amount of charge required for the metals to be deposited is the charge of one mole of electrons, which is 96500 Coulombs (2 points). At the given current

$t = \frac{Q}{I} = \frac{96500\,\text{C}}{120\,\text{A}} \approx 800\,\text{s}$ (3 points).

Total 20 points

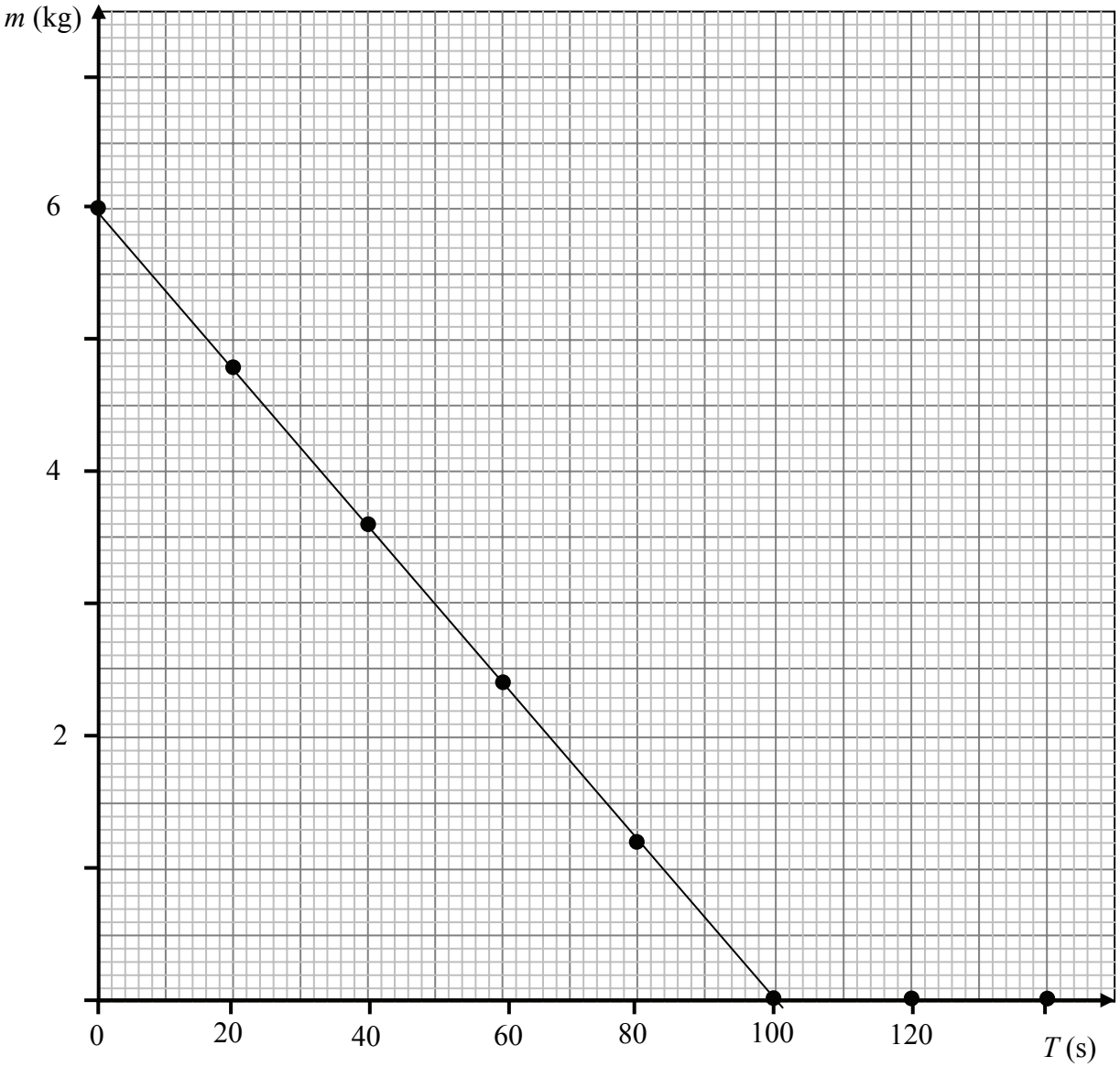
Problem 3/B

Data: $g = 10 \frac{\mathrm{m}}{\mathrm{s}^2}$

a) *Preparing a suitable plot of the data:*

4 points
(may be divided)

Properly scaled and labeled axes: 1 point.
The correct plotting of the data points on the graph: 2 points.
Drawing the line of best fit: 1 point.



Analyzing the curve:

4 points
(may be divided)

The weight measured by the scale during the experiment decreases (1 point) at first, because less and less of the rope remains on the scale. As we raise the rope with a constant speed, the mass of the piece of rope that is hanging in the air increases proportionally to the time (1 point), so the weight shown by the scale also decreases linearly (1 point). After a while, no rope remains on the scale (1 point), so with nothing left on it, the scale reads zero.

b) *Determining the weight of the rope:*

2 points

Using the data measured at $t = 0$ s, $m = 6$ kg.

c) *Determining the length of the rope:*

2 points

Because the rope remaining on the scale runs out at $t_1 = 100$ s, and its end at this time is at a height $l = v \cdot t_1 = 5\,m$, its length is 5 meters.

d) *Determining the force required to pull the rope:*

3 points
(may be divided)

One can read from the table or the graph that at $t = 80$ s, $m = 1.2$ kg of rope remains on the scale (1 point), so the force we need to exert on the rope is $F = 4{,}8\,\text{kg} \cdot 10\,\text{m/s}^2 = 48\,\text{N}$ (2 points).

e) *Determining the work done:*

5 points
(may be divided)

The rope's center of mass at time $t = 100$ s is at a height of $l/2 = 2.5$ m (2 points).

The potential energy of the rope at this time is thus $E = m \cdot g \cdot \frac{l}{2} = 150\,\text{J}$ (2 points), which is equal to the amount of work done by us (1 point).

Total 20 points