ÉRETTSÉGI VIZSGA • 2017. május 22.

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 allocating 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 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.
- 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 it is also not immediately obvious from the exam paper, the solution for the first one of the optional problems 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. **B**
2. **B**
3. **C**
4. **C**
5. **D**
6. **A**
7. **C**
8. **A**
9. **C**
10. **C**
11. **D**
12. **C**
13. **C**
14. **B**
15. **B**
16. **A**
17. **A**
18. **B**
19. **B**
20. **A**

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 in the given case full points may be due at certain steps for solutions that differ from the values given in the evaluation guide.

Problem 1

Data: λ = 680 nm, n = 1.52, $c = 3 \cdot 10^8 \ \frac{\text{m}}{\text{s}}$

a) *Determining the frequency of the light:*

4 points
(may be divided)

As the frequency of light in air (f) and in glass (f') are the same (1 point), it can be determined from the wavelength measured in air:

$f = f' = \frac{c}{\lambda} = 4.4 \cdot 10^{14} \ \frac{1}{\text{s}}$ (formula + calculation, 2 + 1 points).

(The equality of the frequencies need not be explicitly stated. If the student performs the calculation accordingly, full points are to be awarded.)

Determining the wavelength of the light in glass:

5 points
(may be divided)

$\lambda' = \frac{\lambda}{n} = \frac{680 \text{ nm}}{1.52} = 447 \text{ nm}$

(formula + substitution of data + calculation, 3 + 1 + 1 points).

b) *Determining the critical angle for total internal reflection:*

6 points
(may be divided)

$\sin \alpha_{crit} = \frac{1}{n} \rightarrow \alpha = 41°$

(formula + calculation, 4 + 2 points)

Writing down Snell's law (law of refraction) in a general form (without taking $\sin\beta$=1 and n_{air} = 1 into account) is worth 2 points on its own.

Total: 15 points

Problem 2

Data: h = 1.8 m, m = 10 kg, g = 9.81 m/s^2, P_1 = 0.1 W, P_2 = 0.075 W, P_3 = 0.05W, T_2 = 30 minutes.

a) *Describing the energy conversions taking place in the lamp:*

6 points
(may be divided)

In the lamp, the potential energy of the sack (1 point) is first converted to the kinetic energy of the system of gears (1 point). This is converted by the generator (1 point) to electric energy (1 point). The electric energy is converted by the LED (1 point) to light (1 point).

(For the system of gears, the expressions rotational energy or kinetic energy are both acceptable.)

b) *Determining the efficiency of the lamp:*

5 points
(may be divided)

The potential energy of the sack:

$E_h = m \cdot g \cdot h = 176.6\text{ J}$ (formula + calculation, 1 + 1 points)

The electric energy used by the LED:
$E_{LED} = P_2 \cdot T_2 = 135\text{J}$ (formula + calculation, 1 + 1 points),

from which the efficiency:
$\eta = \frac{E_{LED}}{E_h} = 0.76, \text{i.e. } 76\%$ (1 point).

c) *Determining the operation times:*

4 points
(may be divided)

As the energy used by the lamp is the same at all power levels,

$P_1 \cdot T_1 = P_2 \cdot T_2 = P_3 \cdot T_3$ (2 points), it follows that

T_1 = 22.5 minutes (1 point) and T_3 = 45 minutes (1 point).

Writing down the energy balance equation is not absolutely necessary. If the student uses the ratios of the power data correctly, full points are to be awarded.

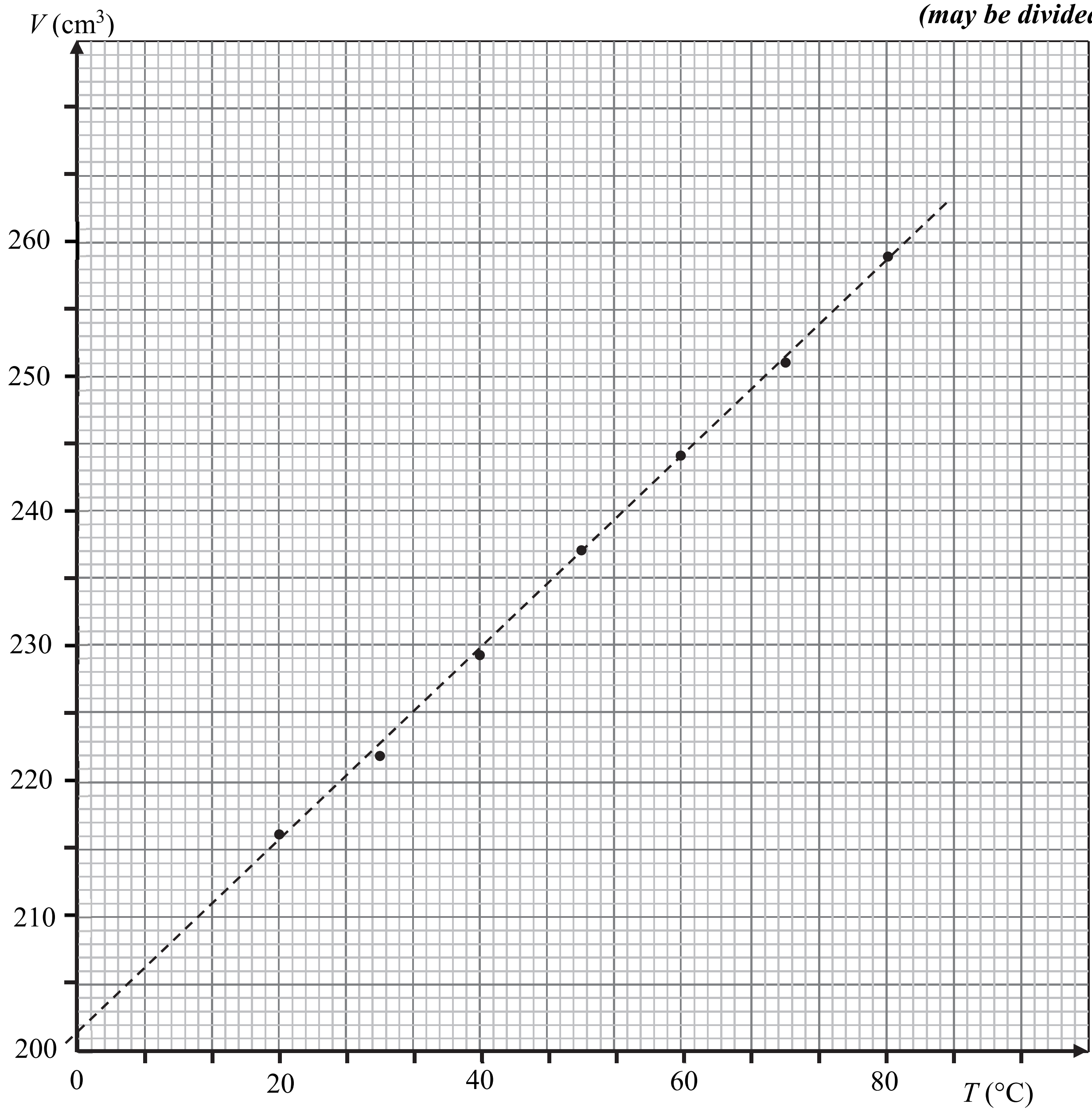
Total: 15 points

Problem 3/A

Data: $R = 8.31 \frac{\text{J}}{\text{mol} \cdot \text{K}}$, $p_0 = 10^5 \text{ Pa}$, $M = 29 \frac{\text{g}}{\text{mol}}$

a) *Plotting the data in the table on the graph:*

4 points (may be divided)



7 data points plotted correctly are worth *4 points*, 5-6 data points are worth *3 points*, 3-4 data points are worth *2 points,* 1-2 data points are worth *1 point*.

b) *Realizing that the absolute zero point of temperature is given by the intersection of the line of best fit on the data points and the $V = 0\ cm^3$ axis:* **2 points**

Any correct formulation of the above fact is acceptable. If the student does not write this recognition down but carries on his calculations correctly according to it, full points are to be awarded.

Determining the temperature corresponding to zero volume, i.e. the value of absolute zero measured in ºC using the graph:

4 points
(may be divided)

The steepness of the line calculated from the data of the two endpoints is:

$\alpha = \frac{V_7 - V_1}{t_7 - t_1} = \frac{43\,\text{cm}^3}{60\ ^\circ\text{C}}$ (2 points), from which for the intersection we obtain

$T_0 = T_1 - \frac{V_1}{\alpha} = -281\ ^\circ\text{C}$ (formula + calculation, 1 + 1 points).

(Alternative calculations or geometrical methods are also acceptable provided they are correct. Only a “calculated” value for the absolute zero temperature in ºC is worth points. If the student writes the known value (-273 ºC) down without any calculations, no points may be awarded. Points may be awarded for any other, correct reasoning that is equivalent to the one above.)

c) *Drawing a line of best fit on the data points of the graph and determining its intersection with the $T = 0$ ºC axis:*

2 + 2 points

The volume at 0 ºC is approximately 200 cm^3.
(The volume may also be determined by calculation; full points should be awarded if the value is correct. If the student uses the Gay-Lussac law with 273 K, the result must be accepted. If the student uses only one pair of data values to determine the volume, 2 points may be awarded.

d) *Determining the mass of the enclosed air:*

6 points
(may be divided)

Using the equation of state:

$\frac{m}{M} \cdot R \cdot T = p \cdot V \Rightarrow m = \frac{p \cdot V \cdot M}{R \cdot T} = 0.26\,\text{g}$

(formula + rearranging + calculation, 2 + 2 + 2 points)

The V/T ratio necessary for the calculation of the mass may be determined using a calculation or from the line of best fit. If the student uses 273 K and V_0 for the calculation, or any other volume for a given temperature and a transformation of the temperature according to X K = 273 + X ºC, the solution must be accepted with full points.)

Total: 20 points

Problem 3/B

a) *Explaining why the light bulb does not operate in case of distilled water:*

6 points
(may be divided)

Because in perfectly clean water there are no free charge carriers (2 points), distilled water is an insulator (2 points), so the circuit is broken (2 points) and the light bulb does not operate.

(Any similar explanation is acceptable, instead of free charge carriers e.g. ions, instead of insulator a bad conductor, etc.)

b) *Explaining why the light bulb operates in case of a salt solution:*

8 points
(may be divided)

Because in salt water there are free charge carriers (2 points) and under the action of an electric field these move or flow (2 points), salt water acts as a conductor (2 points) and the circuit is closed (2 points).

(Any similar explanation is acceptable. It is not necessary to name explicitly the ions responsible for conduction.)

c) *Realizing that it is the negative ions that move towards the positive pole, while the positive ions in the solution move towards the negative pole:*

2 points

Naming the ions is not necessary, the expression of negative and positive charge carriers is sufficient.

d) *Explaining the behavior of a solution with higher concentration of salt:*

4 points
(may be divided)

In a solution with a higher concentration of salt there are more free charge carriers (1 point), so its conductance is better, its resistance is smaller (2 points).
The light bulb therefore shines more brightly (1 point).

Total: 20 points