ÉRETTSÉGI VIZSGA ● 2016. május 17.

FIZIKA
ANGOL NYELVEN

EMELT SZINTŰ 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. The score (0 or 2) should be entered in the table next to the question as well as the table for total scores at the end of the exam paper.

PART TWO

The student should explicate the answers to the questions in a continuous text in whole sentences, so sketchy outlines are not to be evaluated. The only exception is any explanatory text or label of a drawing. Scores for facts or information mentioned in the evaluation guide may only be awarded if the student explains it in proper context. Partial scores must be written on the margin with indication as to which item of the evaluation guide is the basis of awarding it. The evaluated statement in the text must be ticked. The scores must also be entered in the table following the questions of the second part.

PART THREE

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. 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 length and nature of the expected solution, and the depth of detail required of the student 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 writing down 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 can 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 considers the final version, the last one should be evaluated (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.

PART ONE

1. D
2. A
3. B
4. A
5. C
6. B
7. C
8. A
9. A
10. D
11. C
12. B
13. C
14. B
15. D

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

Total: 30 points.

PART TWO

Each of the scores may be divided for all three topics.

1. Thermodynamic cycle

a) Defining the notion of the thermodynamic cycle:

1 point

b) Presenting a specific cycle on a p-V graph and explaining the constituent processes:

4 points

c) Defining the thermodynamic efficiency:

2 points

d) Giving two practical applications of thermodynamic cycles:

2 points

e) Formulating the second law of thermodynamics in the context of cycles:

2 points

f) Giving another formulation of the second law:

3 points

g) *Presenting a process that is not forbidden by the fist law of thermodynamics, but it does not occur in nature in accordance with the second law of thermodynamics:*

4 points

Total 18 points

2. Wave optics

a) Reviewing the wave properties of light and determining the relationship between them:

2 points

b) Explaining the relationship between the frequency and color of light:

1 point

c) Reviewing the two-slit interference experiment, explaining the interference pattern:

5 points

(Reviewing the experiment: 1 point, explaining the interference pattern: 4 points)

d) Interpreting the changing of the interference pattern when the red light source is exchanged for a green one:

3 points

(The wavelength changes: 1point, so the directions of constructive interference will be different: 1 point, determining the new points of constructive interference relative to the old ones: 1 point.)

e) Describing the interference pattern of the two slit interference experiment performed with white light:

2 points

f) Reviewing the effect of varying the slit distance on the interference pattern:

2 points

g) Reviewing the phenomenon of polarization and demonstrating it on a practical example:

3 points

(Explanation: 2 points, mentioning a practical example: 1 point.)

Total 18 points

3. Household electricity

a) Reviewing the properties of the 230 V electrical network:

3 points

The voltage is a 50 Hz alternating voltage (1 point), defining the maximum and effective voltages (2 points).

b) Explaining the role of the transformer, presenting a practical example:

2 points

c) Describing the structure of the electrical network:

2 points

(The circuit breaker is connected in series with the electrical meter in the main branch. The appliances are connected in parallel with each other in the subsidiary branches.)

d) Determining and explaining the effect of the load on the network current:

2 points

e) Defining the short-circuit and explaining its effect on the current strength:

3points

(Defining the short-circuit: 1 point, its effect on the current strength: 2 points.)

f) Explaining the dangers of short-circuits:

1 point

(Mentioning the thermal effect of current.)

g) Explaining the role of the circuit breaker:

1 point

h) Describing the functioning of the automatic circuit breaker, explaining its principle of operation:

4 points

Total 18 points

Evaluation of the style of the presentation based on the exam description, for all three topics:

Lingual correctness: ***0–1–2 points***

- The text contains accurate, comprehensible, well structured sentences;
- there are no errors in the spelling of technical terms, names and notations.

The text as a whole: ***0–1–2–3 points***

- The review as a whole is coherent and unified;
- individual parts, subtopics relate to each other along a clear, comprehensible train of thought.

No points may be awarded for the style of presentation if the review is no more than 100 words in length.

If the student's choice of topic is ambiguous, the content of the last one written down should be evaluated.

PART THREE

Problem 1

Data: $g = 10$ m/s^2, $h = 5$ m, $v_{max} = 2$ m/s.

a) *Interpreting the problem, determining the temporary magnitude and switch-on time of the artificial gravitation:*

7 points
(may be divided)

The magnitude and the switch-on time of the artificial gravitation are determined by two constraints. On the one hand, the artificial gravitation may not accelerate the bodies to a velocity greater than v_{max} , so $g' \cdot t_{on} = v_{max}$ (2 points). On the other hand, even bodies floating in the greatest possible "height" must reach the floor due to its effect, that is: $\frac{g'}{2} \cdot t_{on}^2 = h$ (2 points). (These two facts need not be written down in text; full points are to be awarded for the correct formulas. In the absence of formulas, textual explanations are worth 1 point each.)

Expressing the switch-on time from the first formula and substituting it into the second one:

$\frac{v_{max}^2}{2g'} = h \Rightarrow g' = 0.4 \frac{\text{m}}{\text{s}^2}$ (formula + calculation, 1 + 1 points).

Using this: $t_{on} = \frac{v_{max}}{g'} = \frac{2}{0.4} = 5\,\text{s}$ (1 point).

b) *Calculating the collision speed of the rubber ball:*

5 points
(may be divided)

If the rubber ball reached its initial location by the end of the switch-on interval, then it reached the ground in a time of $t_{on}/2$ (1 point), so it started from a height of

$h' = \frac{g'}{2} \cdot \left(\frac{t_{on}}{2}\right)^2 = 1.25\,\text{m}$ (1 point).

Since during the second fall it moved with an acceleration of g,

$h' = \frac{g}{2} \cdot t_2^2 = \frac{v_2^2}{2g} \Rightarrow v_2 = \sqrt{2g \cdot h} = 5 \frac{\text{m}}{\text{s}}$ (formula + transformation + calculation, 1 + 1 + 1 points).

Total: 12 points

Problem 2

Data: $R_E = 1$ AU, $R_C = 3$ AU.

a) *Determining the orbital period:*

4 points
(may be divided)

We can apply Kepler's third law using the orbital data of Earth and Ceres, measuring distances in AU and time in terrestrial years. Thus:

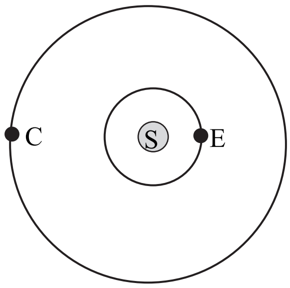
$$\frac{R_E^3}{R_C^3} = \frac{T_E^2}{T_C^2} \rightarrow T_C = \sqrt{\frac{T_E^2 \cdot R_C^3}{R_E^3}} = 5.2 \text{ years}$$ (formula + transformation + calculation:

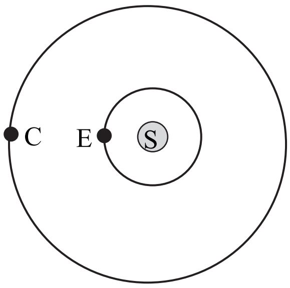
2 + 1 + 1 points)

b) *Determining the possible distances between Ceres and Earth:*

4 points
(may be divided)

The greatest distance is 4 AU (2 points), the smallest is 2 AU (2 points) as shown in the figures. (It is not necessary to prepare a drawing, justifying the answer in text is acceptable as well. However, the correct values on their own, without any justification or drawing are only worth 1 point each.)





c) *Calculating the time between the positions closest to Earth:*

4 points
(may be divided)

Starting from a position when Ceres is at its closest to Earth and using the orbital periods we may write the following equation:

$$\frac{2\pi}{T_C} \cdot t + 2\pi = \frac{2\pi}{T_E} \cdot t \rightarrow t = \frac{1}{\frac{1}{T_E} - \frac{1}{T_C}} = 1.24 \text{ years}$$

(formula + transformation + calculation, 2 + 1 + 1 points).

Total: 12 points

Problem 3

Data: λ = 444 nm, E = 10 N/C, $s_{\max}$ = 2.8 cm, $m_e = 9.1\cdot 10^{-31}$ kg , $q = -1.6\cdot 10^{-19}$ C ,
$c = 3\cdot 10^8 \, \frac{\text{m}}{\text{s}}$, $h = 6.63\cdot 10^{-34}$ J $\cdot$ s .

a) *Determining the maximum speed of the ejected electrons:*

5 points
(may be divided)

The relationship between the kinetic energy of the ejected electrons and the slowing distance:

$E_{kin} = \frac{1}{2} m \cdot v^2 = -E \cdot q \cdot s_{\max}$ (2 points),

Expressing the maximum velocity from this we obtain $v = \sqrt{\frac{-2E \cdot s_{\max} \cdot q}{m}} = 3.14\cdot 10^5 \, \frac{m}{s}$
(transformation + calculation, 1 + 2 points).

b) *Determining the work function:*

5 points
(may be divided)

Writing Einstein's formula for the energy of the ejected electrons:
$h \cdot f = h \cdot \frac{c}{\lambda} = W + \frac{1}{2} m \cdot v^2$ (2 points), from which
$W = h \cdot \frac{c}{\lambda} - \frac{1}{2} m \cdot v^2 = 4.48\cdot 10^{-19}\ \text{J} - 0.45\cdot 10^{-19}\ \text{J} = 4.03\cdot 10^{-19}\ \text{J}$
(transformation + calculation, 1 + 2 points).

c) *Determining the metal in question:*

2 points
(may be divided)

Because the work function expressed in electronvolts is $W = 4.03\cdot 10^{-19}\ \text{J} = 2.52\ \text{eV}$
(1 point), the material of the illuminated surface is barium (1 point) according to the table.

Total: 12 points

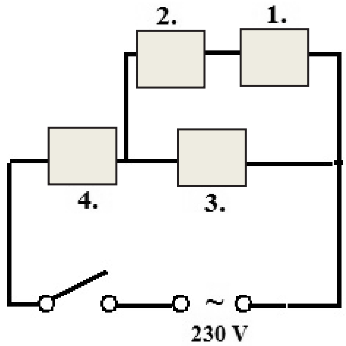
Problem 4

Data: R = 100 Ω, U = 230 V.

a) *Preparing the circuit diagram:*

3 points
(may be divided)

From the circuit diagram it must be clear that resistor 4 is connected in series with all others (1 point), resistors 1 and 2 are connected in series with each other (1 point), while resistor 3 is connected parallel to the two of them together (1 point).



b) *Determining the equivalent resistance:*

3 points
(may be divided)

The equivalent resistance of resistors 1 and 2 is 200 Ω (1 point), so the equivalent resistance is

$$R_e = R_4 + \frac{1}{\frac{1}{R_3} + \frac{1}{R_{1,2}}} = 100\,\Omega + \frac{1}{\frac{1}{100\,\Omega} + \frac{1}{200\,\Omega}} = 167\,\Omega$$

(formula + calculation, 1 + 1 points).

c) *Determining the current flowing through the resistors:*

3 points
(may be divided)

In the main branch and thus through resistor 4 the current is $I_4 = \frac{230\text{ V}}{167\,\Omega} = 1.38$ A (1 point)

Because the current in the parallel branches is inversely proportional to the resistances of the branches, the current through resistor 3 will be twice the current through resistors 1 and 2:

$I_3 = \frac{2}{3} \cdot I_4 = 0.92$ A (1 point), and $I_2 = I_1 = \frac{1}{3} \cdot I_4 = 0.46$ A (1 point).

d) *Giving the ranking of the powers on the resistors:*

2 points
(may be divided)

Because the power on a resistor increases with the current flowing through it (1 point), the ranking of the powers is 4 > 3 > 2 = 1 (1 point).

Total: 11 points