ÉRETTSÉGI VIZSGA ● 2012. május 17.

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ANGOL NYELVEN

EMELT SZINTŰ ÍRÁSBELI
ÉRETTSÉGI VIZSGA

JAVÍTÁSI-ÉRTÉKELÉSI
ÚTMUTATÓ

NEMZETI ERŐFORRÁS
MINISZTÉRIUM

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 examinee should present 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 examinee 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 the evaluation. 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 examinee 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 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 writing down 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 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 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 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 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.

PART ONE

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

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

Total: 30 points.

PART TWO

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

1. The quantum hypothesis and the photoelectric effect

Reviewing the content and the creation of the quantum hypothesis:

6 points

Light is composed of portions or quanta of energy. (1 point)
The energy of a photon is proportional to the frequency of light. (1 point)
Writing down the relationship. (1 point)
Planck formulated the hypothesis of the quantization of energy. (1 point)
Einstein applied it to light (1 point) and confirmed it for the photoelectric effect (1 point).

Explaining the photoelectric effect:

6 points

Delineating the effect. (1 point)
A possible experimental setup. (1 point)
The relationship between the change in frequency and the emission of electrons. (1 point)
The relationship between the intensity of light (the power of the light source) and the emission of electrons. (1 point)
Summarizing and interpreting the observations. (2 points)

The basic equation for the photoelectric effect:

4 points

Writing down the equation. (1 point)
The concept of the work function. (2 points)
The velocity of the emitted electrons. (1 point)

Mentioning applications:

2 points

1 point for each application.

Total: 18 points

2. Generator and motor

Explaining how the generator creates electric current:

10 points

The correct indication of the magnetic field on the sketch. (1 point)

Indicating the rotating frame (coil) on the sketch. (1 point)

Indicating the Lorentz force acting on the charges of the conducting frame. (2 points)

(2 points may only be awarded if the examinee indicates the Lorentz force at several different sections on the frame, at different locations in the magnetic field.)

Stating the direction of the induced current correctly. (1 point)

(The 3 points due for the two previous steps may also be awarded if the examinee justifies the creation of current with the changing of the magnetic flux through the frame instead of the charge separation induced by the Lorentz force and states the direction of the current correctly.)

Formulating Lenz's law. (1 point)

Applying it to the current situation. (1 point)

Analyzing its manifestation in the case of the generator. (2 points)

The induced current is such that the secondary Lorentz force acting on it in the magnetic field hampers the rotation of the coil. Or the interaction between the magnetic field of the induced current and the external magnetic field hampers rotation.

An example for an application. (1 point)

Reviewing how the electric motor works:

8 points

A sketch showing the functioning of a type of electric motor. (2 points)

Stating the direction of the current. (1 point)

Indicating the forces that create rotation. (2 points)

Explaining how a persistent rotation is sustained. (2 points)

Presenting an application. (1 point)

Total: 18 points

3. The whistle sounds

Explaining the concept of the standing wave:

2 points

The explanation must contain a mentioning of nodes and antinodes.
(A drawing is also acceptable for an explanation; illustration with a transversal wave is of full value.)

Creation of standing waves:

2 points

The sound created in a whistle:

7 points

The concepts of frequency, speed of propagation and wavelength, and defining the relationship between them (1+1+1+1 points)

Mentioning the longitudinal nature of sound waves (1 point)

The relationship between the pitch of the sound and the frequency (2 points)

Introducing the open and the closed whistle:

4 points

Presenting an open whistle and defining nodes, antinodes and wavelength of the sound created in it. (2 points)

Presenting a closed whistle and defining nodes, antinodes and wavelength of the sound created in it. (2 points)

Stating he role of harmonics:

3 points

The sound of the whistle contains a number of harmonics in addition to the fundamental frequency. These create the characteristic sound of the whistle together.
(The detailed analysis of the nature of the harmonics is not necessary.)

Total: 18 points

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

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 is a cohesive, unified whole;
- individual parts, subtopics relate to each other along a clear, comprehensible train of thought.

If the review is no more than 100 words in length, no points may be awarded for the style of expression.

If the examinee's choice of topic is ambiguous, the style of expression of the last one written down should be evaluated.

PART THREE

Problem 1

Data: f_1 = 7200 RPM, d = 30 nm/bit, D_1 = 3.5”, R_2 = 3 cm, R_3 = 1.0 – 4.45 cm

a) *Realizing that at a given radius on the platter, the tangential velocity and the distance between two grains are the two factors that define the maximum rate at which data can be read:*

2 points

As the magnetic grains on the platter pass before the head one after another because of the platter's rotation, the maximum possible rate at which data may be read is given by the ratio of the tangential velocity belonging to the given radius on the platter and the d distance between two grains: $\eta = \frac{v_R}{d}$ (If the examinee does not write this recognition down, but later carries on calculations according to this formula, the two points should be awarded.)

Calculating the radius and tangential velocity belonging to the outermost part of the platter:

1 + 2 points

As $D_1 = 3.5'' = 8.9\ \text{cm}$ so R_1 =4.45 cm (1 point).

$v_R = R \cdot \omega = R \cdot f \cdot 2\pi = 4.45\ \text{cm} \cdot 7200\ \text{RPM} \cdot 2\pi = 4.45\ \text{cm} \cdot 120\frac{1}{\text{s}} \cdot 2\pi = 33.6\frac{\text{m}}{\text{s}}$ (2 points)

Calculating the maximum possible rate of reading data:

1 point

The rate of reading data: $\eta_1 = \frac{v_R}{d} = 1.12\frac{\text{Gbit}}{\text{s}}$.

b) *Calculating the rate of reading data in the second case:*

2 points
(may be divided)

As the rate of reading data is proportional to the tangential velocity, which is, in turn, proportional to the radius, the quantity we seek may be calculated from the previous data reading rate using the ratio of radii, or by using the new tangential velocity:

$\eta_2 = \eta_1 \cdot \frac{R_2}{R_1} = 0.75\frac{\text{Gbit}}{\text{s}}$ or

$v_R = R_2 \cdot \omega = 3\ \text{cm} \cdot 120\frac{1}{\text{s}} \cdot 2\pi = 22.4\frac{\text{m}}{\text{s}}$ and $\eta_2 = \frac{v_R}{d} = 0.75\frac{\text{Gbit}}{\text{s}}$

c) *Calculating the amount of data that may be stored:*

3 points
(may be divided)

As the approximate distance between grains that store one bit is 30 nm, the “space” required for one bit is
$A_{bit} = d^2 = 900\ \text{nm}^2 = 9 \cdot 10^{-16}\ \text{m}^2$ (1 point).

The effective area of the platter (between the radii 1.0 cm and 4.45 cm):

$A_{platter} = (4.45)^2\ \text{cm}^2 \cdot \pi - 1.0\ \text{cm}^2 \cdot \pi = 59\ \text{cm}^2 \approx 6 \cdot 10^{-3}\ \text{m}^2$ (1 point)

From which the number of bytes that may reside on the platter:

$C_{platter} = \dfrac{A_{platter}}{8 \cdot A_{bit}} = 838\ \text{Gbyte}$. (1 point)

If it is known to the examinee that in computer science 1 Gbyte is not simply 10^9 bytes, but rather $(1024)^3$ bytes, the result for the capacity of the disk will be 780 Gbyte, so this value must also be accepted.

Total: 11 points

Problem 2

Data: U_0 =13.2 V, P = 54 W, U_1 = 10.8 V

Formulating and calculating the current of the battery under load:

3 points (may be divided)

As the power of the battery is $P = I \cdot U_1$ (1 point),

so $I = \dfrac{P}{U_1} = 5\ \text{A}$ (transforming and calculation 1 + 1 points).

Determining the voltage drop on the total internal resistance of the battery:

1 point

$U_{internal} = U_0 - U_1 = 2.4\ \text{V}$

Formulating and calculating the total internal resistance of the battery:

2 points

$R_i = \dfrac{U_{internal}}{I} = 0.48\ \Omega$

Recognizing that with cells connected in series the total internal resistance of the battery is equal to the sum the internal resistances of all six cells:

2 points

(Should the examinee fail to write down this recognition, but carries on with calculations in accordance with it, the two points are to be awarded. The recognition may also be expressed with a schematic drawing of the battery, provided that all six cells connected in series are drawn with the internal resistance indicated separately for each cell.)

Calculating the internal resistance for one cell:

1 point

$6 \cdot R_i = \dfrac{U_{internal}}{I} = 0.48\ \Omega \Rightarrow R_i = 0.08\ \Omega$

Formulating and calculating the short-circuit current for the battery:

1 + 1 points

$I_{short} = \dfrac{U_0}{R_i} = 27.5\ \text{A}$

Total: 11 points

Problem 3

Data: V = 200 dm^3 , t_0 = -123 ºC, t_1 = 27 ºC, A = 5 cm^2 , F = 25 N, $p_0 = 10\dfrac{\text{N}}{\text{cm}^2}$,

$R = 8300\dfrac{\text{J}}{\text{K}\cdot\text{kmol}}$, $M = 4\dfrac{\text{kg}}{\text{kmol}}$.

a) *Formulating and calculating the mass of the helium gas filled into the container:*

3 points
(may be divided)

$p\cdot V = \dfrac{m}{M}\cdot R\cdot T \Rightarrow m = \dfrac{p\cdot V\cdot M}{R\cdot T}$ from which m = 64 g. (Writing down the ideal gas law 1 point, substituting the corresponding data into it 1 point, calculation of the mass in question 1 point.)

b) *Formulating and calculating the pressure at which the safety valve opens:*

3 points
(may be divided)

The valve opens when the force on the plate from the inside just exceeds the sum of the forces due to outside atmospheric pressure and the spring.

$A\cdot p_{\max} = A\cdot p_0 + F$ (2 points)

The pressure of the gas in the container is then $p_{\max} = p_0 + \dfrac{F}{A} = 15\dfrac{\text{N}}{\text{cm}^2}$. (1 point)

Formulating and calculating the temperature in question:

3 points
(may be divided)

Because the volume does not change during the process, Gay-Lussac's law is applicable: $\dfrac{p_0}{T_0} = \dfrac{p_{\max}}{T'}$ (1 point), from which $T' = \dfrac{p_{\max}\cdot T_0}{p_0} = 225\ \text{K}$ i.e. t' = -48 ºC (transformation and calculation 1 + 1 point). (The temperature in question need not be transformed to degrees Celsius, if the temperature given in Kelvin is correct, full points are to be awarded.)

c) *Recognizing that heating the gas further does not increase the pressure any more, because some of the gas continuously escapes through the safety valve:*

2 points

If the examinee does not write this recognition down, but expresses it with a formula somewhere (e.g. $p_{final} = p_{\max}$ or using $p_{\max}$ later as the final pressure in the calculation), the two points are to be awarded.

Formulating and calculating the mass of the helium gas remaining in the container:

1 + 1 point

As the final pressure of the gas in the container is $p_{\max}$ at the end of the temperature change $p_{\max}\cdot V = \dfrac{m_1}{M}\cdot R\cdot T_1 \Rightarrow m_1 =$ 48 g.

Should the examinee use the outside pressure as the final pressure of the enclosed gas (saying that the valve has “opened”), at most two points may be awarded for question c).

Total: 13 points

Problem 4

Data: $P = 10$ W, $\lambda = 450$ nm, $d = 4$ mm, $R = 2$ m, $c = 3\cdot 10^8\ \frac{\text{m}}{\text{s}}$, $h = 6.62\cdot 10^{-34}$ Js .

Determining the number of photons emitted by the light source in a second:

6 points
(may be divided)

The power of the light source is equal to the product of the number of photons emitted in a second and the photon energy: $P = N\cdot E$ (2 points).

The energy of one photon $E = \frac{h\cdot c}{\lambda} = 4.4\cdot 10^{-19}$ J (formulation and calculation, 1 + 1 points),

From which the number of photons emitted in a second: $N = \frac{P}{E} = 2.27\cdot 10^{19}\ \frac{1}{\text{s}}$ (formulation and calculation, 1 + 1 point). Calculating the photon energy is not essential. Should the examinee write the expression for the photon energy directly into the $N = \frac{P}{E}$ formula and the final result is correct, full points are to be awarded. However, if the expression for the photon energy does not appear somewhere explicitly, only four points are to be awarded for this question even if the final answer is correct.

Determining the number of photons passing through our pupil in a second:

6 points
(may be divided)

The number of photons passing through our pupil in a second is that part of the full photon number, which leaves the light source in the direction of our pupil. That is, the product of the full photon number and the ratio of the area of our pupil and the surface area of a full sphere with a radius of 2 meters:

$N' = N\frac{A_{pupil}}{A_{sphere}}$ (3 points).

The area of the pupil: $A_{pupil} = \left(\frac{d}{2}\right)^2\cdot\pi = 12.6\cdot 10^{-6}\ \text{m}^2$ (1 point).

The area of the sphere's surface: $A_{sphere} = 4\cdot R^2\cdot\pi = 50.3\ \text{m}^2$ (1 point).

The photon number in question is therefore: $N' = 5.68\cdot 10^{12}\ \frac{1}{\text{s}}$ (1 point).

(The numerical calculation of the areas is not necessary. Should the examinee use the formal expressions and the final result is correct, full points are to be awarded.)

II. solution:

The problem may also be solved in a reverse order. The examinee may first calculate the power of the light passing through the pupil using the quotient of the areas, and then calculate the corresponding photon number.

In this case $P' = P\frac{A_{pupil}}{A_{sphere}} = 2.5\cdot 10^{-6}$ W (6 points overall, which may be divided in the same manner as in the previous case),

and $N' = \frac{P'}{E} = 5.68\cdot 10^{12}\ \frac{1}{\text{s}}$ (6 points overall, which may be divided in the same manner as in the previous case).

Total: 12 points