ÉRETTSÉGI VIZSGA ● 2010. október 28.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ 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.

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 may be awarded if the reasoning is 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. **C**
2. **A**
3. **A**
4. **B**
5. **A**
6. **C**
7. **B**
8. **B**
9. **A**
10. **C**
11. **C**
12. **C**
13. **B**
14. **C**
15. **A**
16. **C**
17. **B**
18. **C**
19. **A**
20. **B**

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

Total: 40 points.

SECOND PART

Problem 1

Data: $h = 50\ \text{m}$, $R = 20\ \text{m}$, $F = 5000\ \text{N}$

a) *Interpretation of the problem:*

2 points

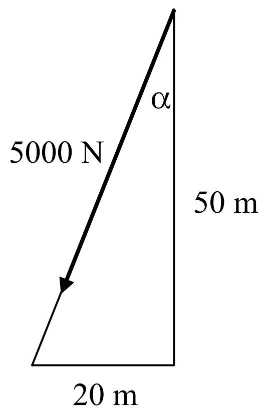
The sum of the vertical components of the tensions arising in the three cables is to be determined.
(If the examinee follows this line of thought during the calculations, or sketches a drawing that makes this clear, the points are to be awarded even in the absence of any textual explanation.)

Determining the angle enclosed by the cables' tension and the vertical direction:

2 points

$$\text{tg}\alpha = \frac{20\ \text{m}}{50\ \text{m}} \Rightarrow \alpha = 22^\circ$$

(It is not necessary to make a drawing, if the calculation of the angle is correct, full points are to be awarded regardless of the absence of a sketch.)



Determining the vertical component of the tension arising in the cables:

2 + 2 points

$$F_{vert} = F \cdot \cos\alpha$$

$$F_{vert} \approx 4640\ \text{N}$$

(The vertical component of the tension can be determined using alternative methods as well. If the calculation is correct, full points are to be awarded even if for example the examinee does not determine the angle at all.)

Calculating the vertical force acting on the antenna:

2 + 1 points

$$F_{total} = 3 \cdot F_{vert}$$

$$F_{total} \approx 13900\ \text{N}$$

b) *Providing the explanation:*

3 points

It is practical to fix the cables to the ground along a circle at equal distances from each other because that is when the antenna will be stable, and a wind blowing from an arbitrary direction will be unable to topple it. (If the examinee only mentions that this way the sum of the horizontal components of the cables' tensions will be zero, only one point is to be awarded. Any correct reference to stability may be rewarded with three points.)

Total 14 points

Problem 2

Data: $U = 230$ V, $P_1 = 1$ kW, $P_2 = 2$ kW

a) *Determining the resistance of the first stage:*

6 points
(may be divided)

$P_1 = \frac{U^2}{R}$ (2 points)

$R = \frac{U^2}{P_1} = \frac{(230\ \text{V})^2}{1\ \text{kW}} = 53\ \Omega$ (Expressing the resistance 1 point, substitution of the numerical values 2 points, calculation 1 point.)

b) *Naming the correct circuit diagram and providing an explanation:*

1 + 3 points

The circuit diagram marked with B) depicts the correct functioning. This is because for two resistors in parallel the voltage on the second stage's resistor will be 230 V as well.
(Any other explanation may be accepted if it is correct.)

c) *Calculating the power of the incorrect circuit diagram:*

6 points
(may be divided)

Figure A) depicts resistors in series, (1 point)

therefore $R_e = 2 \cdot R = 106\ \Omega$ (2 points)

$P_2' = \frac{U^2}{R_e}$ (1 point)

$P_2' = \frac{(230\ \text{V})^2}{106\ \Omega} = 0{,}5\ \text{kW}$ (2 points)

<u>Or:</u>

Figure A) depicts resistors in series. (1 point)

The voltage on a single resistor is only $U' = \frac{U}{2} = 115\ \text{V}$. (2 points)

So the total power is $P_2' = 2 \cdot \frac{U'^2}{R}$. (1 point)

$P_2' = 2 \cdot \frac{(115\ \text{V})^2}{53\ \Omega} = 0{,}5\ \text{kW}$ (2 points)

(A textual argument using these proportionalities is also acceptable.)

Total: 16 points

Problem 3/A

a) *Applying Kepler's third law to the motion of the planets orbiting the star:*

3 points

(If a parametric formula of the law is not presented but it is clear later on that the examinee uses it with the data from the table, full points are to be awarded.)

Substituting the data for Gliese 581b and performing the calculation:

2 + 2 points

Using data from the table:

$$\frac{(3{,}15\ \text{days})^2}{(4{,}5\cdot 10^6\ \text{km})^3} = \frac{T_b^{\,2}}{(6\cdot 10^6\ \text{km})^3},\ T_b = 4{,}8\ \text{days}$$

<u>or:</u>

$$\frac{(66{,}8\ \text{days})^2}{(33\cdot 10^6\ \text{km})^3} = \frac{T_b^{\,2}}{(6\cdot 10^6\ \text{km})^3},\ T_b = 5{,}2\ \text{days}$$

(When calculating the orbital period, it is sufficient to use just one of the known data pairs. Because of the uncertainty of the data, a different value is obtained for the orbital period from each of the two known data pairs, so any value within the 4,5-5,5 day interval is acceptable. The absence of units in writing down the formulas should not be considered an error, but the answer is only acceptable with correct units.)

Substituting the data for Gliese 581c and performing the calculation:

2 + 2 points

$$\frac{(3{,}15\ \text{days})^2}{(4{,}5\cdot 10^6\ \text{km})^3} = \frac{(12{,}9\ \text{days})^2}{A_c^{\,3}},\ A_c = 11{,}5\cdot 10^6\,\text{km}$$

<u>or</u>:

$$\frac{(66{,}8\ \text{days})^2}{(33\cdot 10^6\ \text{km})^3} = \frac{(12{,}9\ \text{days})^2}{A_c^{\,3}},\ A_c = 11\cdot 10^6\,\text{km}$$

(When calculating the distance from the star, it is again sufficient to use just one of the known data pairs. Because of the uncertainty of the data, any value is acceptable within the 10,5 – $12{,}1\cdot 10^6$ km interval. The absence of units in writing down the formulas should not be considered an error, but the answer is only acceptable with correct units.)

b) *Giving the correct answer and justifying it:*

2 + 3 points

From the existence of water in a liquid state it <u>does not follow</u> that the temperature is below 100ºC, because <u>the boiling point of water depends on the pressure of atmosphere on the surface as well.</u>

c) *Giving the correct answer:*

4 points
(may be divided)

Because the star is about 20 light-years away and <u>radio signals travel with the speed of light</u> (1 point), the signals traveling in space <u>reach their destination in about 20 years</u> (1 point) and any possible response <u>also takes 20 years to return</u>. Therefore we may expect an answer in <u>no sooner than 40 years</u> (1 point).

Total: 20 points

Problem 3/B feladat

a) *Filling in the missing proton numbers in the table:*

2 points

(The two points may be awarded only if the number of protons is 19 everywhere.)

Filling in the missing neutron numbers in the table:

3 points
(may be divided)

(1 point is to be awarded if at least 7 out of 14 are correct, 2 points if at least 10 out of 14 are correct, and 3 points if at least 13 values are correct.)

Isotope	Number of protons	Number of neutrons	Half-life
^{33}K	19	14	<25 ns
^{35}K	19	16	178 ms
^{37}K	19	18	1,226 s
^{38}K	19	19	7,636 minutes
^{39}K	19	20	STABLE
^{40}K	19	21	$1,248\cdot10^9$ years
^{41}K	19	22	STABLE
^{42}K	19	23	12,36 hours
^{44}K	19	25	22,13 minutes
^{46}K	19	27	105 s
^{48}K	19	29	6,8 s
^{50}K	19	31	472 ms
^{52}K	19	33	105 ms
^{54}K	19	34	10 ms

b) *Naming the non-radioactive isotopes:*

1 + 1 points

The ^{39}K and ^{41}K isotopes.
(If the examinee also names the ^{40}K isotope, which is not stable, but can be found in nature due to its long half-life, the two points may still be awarded. However, if the examinee names only this isotope, only one point is to be awarded.)

c) *Naming an artificial radioactive potassium isotope:*

2 points

(Any isotope may be named with the exception of ^{39}K, ^{40}K and ^{41}K. If the examinee names the ^{40}K isotope, which is not stable but can be found in nature due to its long half-life, one point is to be awarded. For a correct answer it is actually necessary to know that the particular isotope given is not created continuously on Earth, but it is not expected of the examinee to refer to this fact. Solely mentioning the shortness of the half-life is sufficient for the two points to be awarded.)

d) *Describing the tendency of change in the half-life:*

3 points
(may be divided)

The half-life decreases as we get further away from the proton to neutron ratio of the stable ^{39}K and ^{41}K isotopes in either direction. (Full points are to be awarded only if the examinee relates the half-life of the isotopes to that of the stable ones /20-22 neutrons/ and interprets the change using the proton-neutron ratio or the neutron number.)

e) *Naming a possible application of radioactive isotopes:*

2 points

f) *Calculating the ratio of the half-life of the ^{46}K isotope and the 7 minute time interval given:*

2 points

The 7 minutes = 420 s time interval is exactly four times the $T_{1/2}$ = 105 s given in the table.

Calculating the mass of the isotopes that have decayed:

4 points
(may be divided)

Half of the isotopes decay during $T_{1/2}$. (1 point)
(If the examinee does not actually write down the meaning of the half-life but uses it correctly during the calculation, the point is to be awarded.)
The amount of isotopes that decay during each consecutive 105 s time interval are the following:
1. t = 0–105 s: 0,5 mg
2. t = 105–210 s: 0,25 mg
3. t = 210–315 s: 0,125 mg
4. t = 315–420 s: 0,0625 mg (2 points altogether)

So altogether 0,9375 mg of the isotopes have decayed . (1 point)

Or:

After $T_{1/2}$ has passed, half the isotopes remain. (1 point)
(If the examinee does not actually write down the meaning of the half-life but uses it correctly during the calculation, the point is to be awarded.)

The amount of isotopes that remain after $\Delta t = 4 \cdot T_{1/2}$ has passed is

$$\left(\frac{1}{2}\right)^4 \cdot 1\,\text{mg} = \frac{1}{16} \cdot 1\,\text{mg} = 0{,}0625\,\text{mg} \quad \text{(2 points)}$$

So 0,9375 mg have decayed. (1 point)

(A calculation using the law of radioactive decay is acceptable as follows:
Writing down the law of radioactive decay 1 point, substitution of numerical data 2 points, performing the calculations 2 points, giving the answer 1 point, i.e. 6 points altogether.)

Total: 20 points