ÉRETTSÉGI VIZSGA • 2023. május 23.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA

a 2012-es Nat-ra épülő vizsgakövetelmények szerint

JAVÍTÁSI-ÉRTÉKELÉSI
ÚTMUTATÓ

OKTATÁSI HIVATAL

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 dividing allocated 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 should also be evaluated. 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 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 the choice is also not immediately obvious from the exam paper, the solution for the first problem of the two optional ones 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. **C**
2. **B**
3. **B**
4. **B**
5. **A**
6. **C**
7. **D**
8. **D**
9. **C**
10. **C**
11. **B**
12. **A**
13. **B**
14. **C**
15. **A**
16. **A**
17. **D**
18. **C**
19. **A**
20. **B**

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

Problem 1

Data: T_1 = 70 °C, T_2 = 15 °C, V_1 = 1 dm^3, V_2 = 0.3 dm^3, $\rho_{\text{rum}} = 0.8 \frac{\text{g}}{\text{cm}^3}$, $\rho_{\text{tea}} = 1 \frac{\text{g}}{\text{cm}^3}$,

$c_{\text{rum}} = 2.6 \frac{\text{kJ}}{\text{kg} \cdot °\text{C}}$, $c_{\text{tea}} = 4.2 \frac{\text{kJ}}{\text{kg} \cdot °\text{C}}$.

Writing down the relationship for the energy exchange between the liquids:

8 points
(may be divided)

$Q_{\text{rum}} = -Q_{\text{tea}}$ (2 points), i.e.:

$V_{\text{rum}} \cdot \rho_{\text{rum}} \cdot c_{\text{rum}} \cdot (T_{\text{k}} - T_2) = V_{\text{tea}} \cdot \rho_{\text{tea}} \cdot c_{\text{tea}} \cdot (T_1 - T_{\text{k}})$ (writing down the right and left hand sides of the equation 2 + 2 points, expressing the temperature changes explicitly with the common temperature 1 + 1 points).

Expressing and determining the common temperature:

7 points
(may be divided)

$$T_{\text{k}} = \frac{V_{\text{tea}} \cdot \rho_{\text{tea}} \cdot c_{\text{tea}} \cdot T_1 + V_{\text{rum}} \cdot \rho_{\text{rum}} \cdot c_{\text{rum}} \cdot T_2}{V_{\text{tea}} \cdot \rho_{\text{tea}} \cdot c_{\text{tea}} + V_{\text{rum}} \cdot \rho_{\text{rum}} \cdot c_{\text{rum}}} = 63 \text{ °C}$$

(rearranging the formula + substitution of data + calculation, 3 + 2 + 2 points)

Total: 15 points

Problem 2

Data: $e = 1.6 \cdot 10^{-19}$ C

a) *Explaining the meaning of the eV unit:*

3 points

1 eV is the energy that an electron at rest acquires in 1 V of accelerating potential.

b) *Determining the energy of the most energetic photon ever detected on Earth in units of Joule:*

3 points
(may be divided)

$1\ \text{eV} = 1.6 \cdot 10^{-19}\,\text{C} \cdot 1\text{V} = 1.6 \cdot 10^{-19}\,\text{J}$ (1 point), from which
$1.4 \cdot 10^{24}\,\text{eV} = 2.24 \cdot 10^{5}\,\text{J}$ (2 points).

c) *Explaining the origin of extreme large energy gamma photons:*

3 points
(may be divided)

They originate from the <u>collision of accelerated particles</u>, which are accelerated in processes associated with <u>exploding stars</u>, and <u>the birth of stars</u>.

d) *Naming an example for the creation of gamma photons under terrestrial conditions:*

3 points

For example, radiation composed of gamma photons may be created by nuclear fission.

e) *Determining the ratio of the energies:*

3 points
(may be divided)

$\text{N} = 1.4 \cdot 10^{24}\,\text{eV} / 10^{18}\,\text{eV} = 1.4 \cdot 10^{6}$ (Obtaining the energies from the text and calculating the ratio 1 + 1 + 1 points)

Total: 15 points

Problem 3/A

a) *Determining the expected energy yield for each season and the corresponding percentage:*

6 points
(may be divided)

Summing the data in the first graph every three months and dividing by the overall annual yield for southern orientation from the table:
winter (December-February): 157.5 kWh → 13.3%
spring (March-May): 362.6 kWh → 30.7%
summer (June-August): 395.5 kWh → 33.5%
autumn (September-November): 264.3 kWh → 22.4%
(Demonstrating the correct method of calculation is worth 2 points in itself. The correct determination of the percentages corresponding to the seasons is worth 1 point each.)

b) *Naming two possible reasons:*

2 + 2 points

Naming any two factors is sufficient, e.g. the days are shorter in winter, the Sun is lower (the angle of incidence of the rays is less steep), the sky is cloudy more often, snow may cover the roof temporarily, etc.

c) *Naming the ideal orientation and determining the decrease in yield for the other orientation:*

3 points
(may be divided)

Southern orientation is better (1 point).

For eastern orientation the energy yield will be smaller by $\frac{1180-884}{1180}=0.251\rightarrow 25.1\%$ (2 points).

d) *Determining the electric energy yield for eastern orientation in summer and in winter, comparison of the two orientations and answering the question:*

4 points
(may be divided)

For eastern orientation, the summer yield is 358.9 kWh (1 point), winter yield is 75.7 kWh (1 point).
The <u>difference between the two orientations is less in summer, than in winter</u> (1 point), so <u>ideal orientation has a higher significance in winter</u> (1 point).
(It is also possible to argue based on the ratios or percentages of the yields in summer and winter.)

e) *Determining the required number of solar panels for eastern orientation:*

3 points
(may be divided)

Because for eastern orientation, the energy yield is 75 % of that for southern orientation (1 point),

$N=\frac{12}{0.75}=16$ panels are required (formula + calculation, 1 + 1 points).

Total: 20 points

Problem 3/B

a) *Naming the forces acting on the test tube:*

1 + 1 points

gravitational force (G), and the hydrostatic buoyancy force (F_{buoy}).

b) *Naming the consequence of the pressure increase:*

3 points

If we press on the rubber sheet, the pressure in the water will increase everywhere (1 point) according to Pascal's law (1 point). If the pressure in the system increases, the volume of the enclosed air decreases. (It is not necessary to write down the formal relationship $p \cdot V$ = constant.) (1 point)

c) *Explaining why the diver sinks:*

3 points
(may be divided)

If, because of the pressure increase, the air volume decreases, the volume of water in the diver increases (1 point), so the weight of the diver also increases **or:** the density of the diver increases (1 point). When $G > F_{buoy}$ the diver sinks **or:** when the diver's density reaches the density of water, the diver sinks (1 point).

d) *Explaining why the diver rises to the surface:*

4 points
(may be divided)

If the pressure decreases, the volume of air increases again (1 point), the volume of water in the diver decreases (1 point), so the diver's weight also decreases (1 point).
When $G < F_{buoy}$ (1 point) the diver rises to the surface again.
(An argument based on the relationship between the densities is worth full points here as well.)

e) *Explaining why the diver will not surface from a deep cylinder:*

4 points
(may be divided)

The pressure on the diver at the bottom of the cylinder is due not only to the surplus pressure we create, but also to the hydrostatic pressure at the given depth (2 points). If we cease to apply the surplus pressure, but, due to the hydrostatic pressure at the bottom of the cylinder the air enclosed in the test tube cannot expand sufficiently (2 points) the diver will not rise to the surface.

f) *Determining the behavior of the diver and justifying it for the experiment in oil:*

4 points
(may be divided)

The density of oil is smaller than that of water and $F_{buoy} \sim \rho$ (1 point), but the weight of the test tube and the air inside did not change (1 point), so the diver will sink already at a smaller decrease in volume (1 point), so a smaller surplus pressure is sufficient (1 point).
(An argument based on the relationship between the densities is worth full points here as well.)

Total: 20 points

The origin of the sources for the problem sheet (pictures, drawings, data):

II/ 2. http://english.ihep.cas.cn/lhaaso/chnl/218/index.html
II/ 3/A: https://re.jrc.ec.europa.eu/pvg_tools/en/
Last downloaded on 10 January 2022.