ÉRETTSÉGI VIZSGA • 2024. május 22.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA

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. **B**
2. **D**
3. **A**
4. **C**
5. **C**
6. **A**
7. **B**
8. **B**
9. **A**
10. **C**
11. **D**
12. **B**
13. **A**
14. **A**
15. **C**
16. **A**
17. **A**
18. **B**
19. **A**
20. **A**

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: $d_{\text{min}} = 0.3$ AU, $T = 6766$ years

a) *Determining the time of the aphelion:*

3 points
(may be divided)

As half of the orbital period is 3383 years, the comet will be farthest from the Sun approximately <u>3383 years from now</u>, i.e. in <u>5403</u> (either formulation is acceptable).

b) *A correct figure indicating the major axis:*

2 points
(may be divided)

c) *Writing Kepler's 3rd law and determining the maximum distance in question:*

9 points
(may be divided)

Writing Kepler's 3rd law for the orbits of the comet and Earth:

$$\frac{a^3_{\text{Earth}}}{a^3_{\text{Neowise}}} = \frac{T^2_{\text{Earth}}}{T^2_{\text{Neowise}}} \qquad (3\ \textit{points}) \quad \left(\text{„}a\text{” } \textit{semi-major axis},\ \text{„}T\text{” } \textit{orbital period}\right)$$

Substitution of the data and determining the value for the semi-major axis:

$$\frac{1^3}{a^3_{\text{Neowise}}} = \frac{1^2}{6766^2} \Rightarrow a_{\text{Neowise}} = \sqrt[3]{6766^2} = 357.7\ \text{AU}$$

(substitution of data, rearrangement and calculation, 2 + 1 + 2 points)

Distances were measured in AU, times in years in our calculation, but a calculation using any other units is acceptable if correct.

The length of the major axis is thus <u>715.4 AU</u> (1 points).

d) *Determining the maximum distance between the comet and the Sun:*

2 points
(may be divided)

The greatest distance of the comet from the Sun is 715.4 – 0.3 = 715.1 AU
(formula + calculation, 1 + 1 points)

Total: 16 points

Problem 2

a) *Describing the role of concentration:*

3 points

The greater the number of uranium nuclei in a rock, the more fission tracks are formed in the crystal during a given time interval.

b) *Discussing the role of the elapsed time:*

3 points

The more time has elapsed since the formation of the rock, the more uranium nuclei have already decayed.

c) *Explaining the connection between age determination and concentration:*

3 points

The number of fission tracks is determined by the initial concentration of uranium nuclei in the rock and the time elapsed together. Knowing only one of these data is not enough to determine the age of the rock.

d) *Determining the ratio of the fission track length and the wavelength of visible light:*

5 points
(may be divided)

As the wavelength of visible light is $\lambda \approx 0.5\ \mu m$ (2 points), and the length of the lattice defects is 10–20 μm (1 point), the ratio in question is approximately 20–40 (2 points).

Total: 14 points

Problem 3/A

a) Listing the forces that act upon the objects under water and characterizing them:

5 points
(may be divided)

Objects under water are acted upon by the gravitational force (G) (1 point), which is proportional to their masses (1 point), the hydro-static buoyancy force (F_b) (1 point), which is proportional to the volume of the objects (1 point), and the supporting force (1 point) by the pans of the balance scale.
(Writing the corresponding formula instead of naming the proportionality above is also acceptable.)

b) Analysis of the measurement performed under water:

8 points
(may be divided)

The gravitational force acting on objects under water is unchanged (2 points), but the objects exert only a force G-F_b on the pans (2 points). If the volumes of the objects differ, the buoyancy force will differ (2 points) so the scale will become unbalanced (2 points).

c) Measuring the weight of the crown under water and determining the behavior of the balance scale:

7 points
(may be divided)

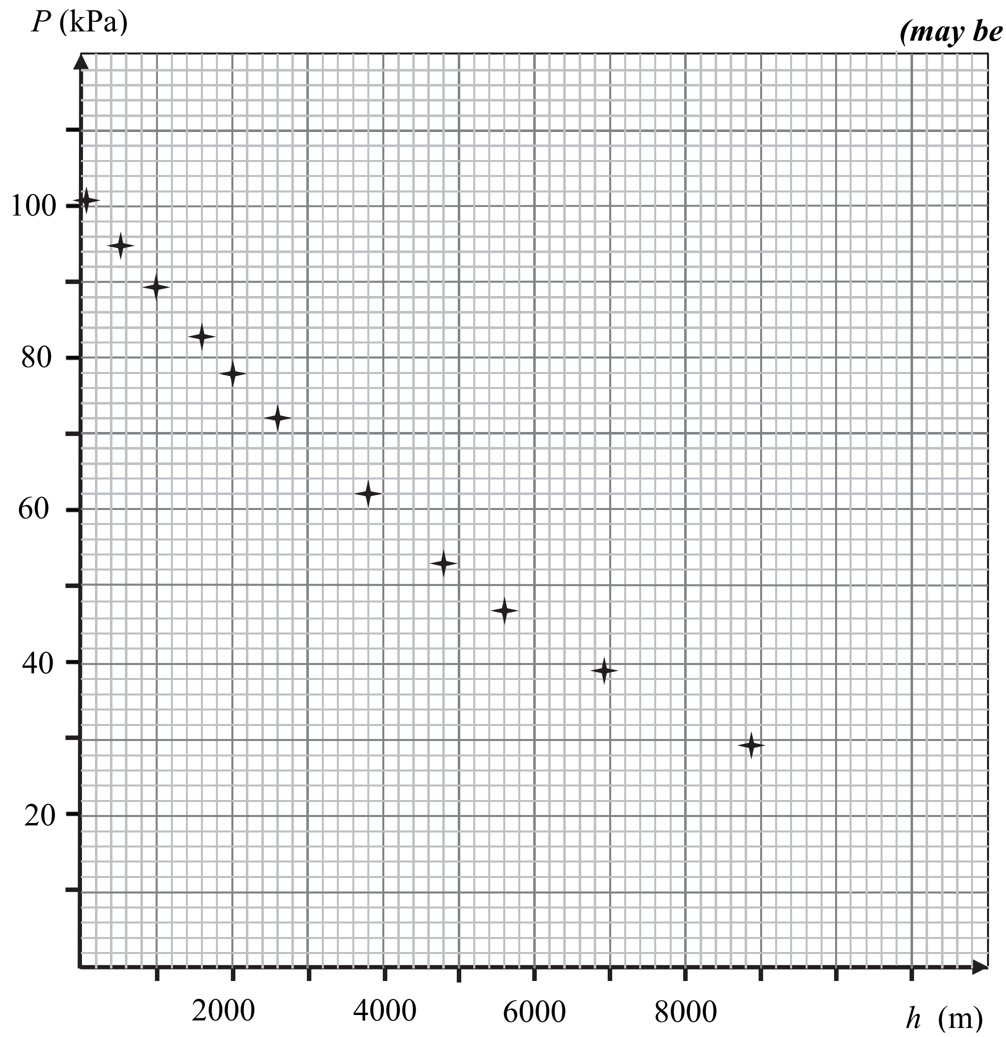
As the goldsmith replaced part of the gold in the crown with a different metal having the same weight (1 point), but a smaller density, the volume of the crown was greater (2 points) than that of the pure gold in the other pan. The buoyancy force on the crown was thus greater (2 points), so the force it exerted on the pan was smaller, so the balance scale tipped to lower the side with the pure gold (2 points).

Total: 20 points

Problem 3/B

a) Plotting the pressure data on a graph:

5 points (may be divided)



Plotting 10-11 data points correctly is worth 5 points, that of 8-9 data points is worth 4, 6-7 data points is worth 3, 4-5 data points is worth 2, 2-3 data points is worth 1 point.

b) Determining the altitude in question:

4 points (may be divided)

The pressure that corresponds to a boiling point of 80 °C can be found in the second table to be $p \approx 47$ kPa (2 points), which is approximately the same as the pressure quoted for the summit of Mount Elbrus in the first table, whose height is $h \approx 5600$ m (2 points).

c) Determining the approximate value of the boiling point in question:

6 points (may be divided)

As the atmospheric pressure on top of Mont Blanc is $p \approx 53.5$ kPa (2 points), which is about half-way between the data points in the second table for 80 °C with 47.7 kPa and 85 °C with 57.8 kPa (2 points), the boiling point is question is $t \approx 83$ °C (2 points). (Any temperature value is acceptable between 81 °C and 84 °C.)

d) Determining the ratio of the air densities at the two altitudes:

5 points
(may be divided)

At a given temperature, density is directly proportional to the pressure. (2 points – This score is to be awarded only if the student makes it clear – by stating this fact or writing down the relevant formula – that he/she performs the calculation accordingly.)

Therefore, reading the two pressures from the first table:
101325 Pa / 29246 Pa ≈ 3.5, so the density of air is about 3.5 times lower at the top of Mount Everest.
(Reading the two pressure data is worth 1 points each, calculating the ratio 1 point.)

Total: 20 points