ÉRETTSÉGI VIZSGA • 2006. május 15.

FIZIKA
ANGOL NYELVEN
PHYSICS

KÖZÉPSZINTŰ ÍRÁSBELI ÉRETTSÉGI VIZSGA
STANDARD LEVEL WRITTEN EXAMINATION

JAVÍTÁSI-ÉRTÉKELÉSI ÚTMUTATÓ
MARKSCHEME

OKTATÁSI MINISZTÉRIUM
MINISTRY OF EDUCATION

In marking the examination papers follow the instructions of the markscheme, making clear corrections and comments. Do all marking in red ink (in case of the second correction green) using the conventional notations.

PART ONE

In the multiple choice questions, the 2 points are only due for the correct answer as given below. Enter the scores (0 or 2) in the grey rectangles next to the individual questions as well as the total score in the table at the end of the question paper.

PART TWO

The subtotals given in the markscheme cannot be broken up further, unless indicated otherwise. Do not give partial credit.

The lines in the markshceme printed in italics define the steps necessary for the solution. The indicated number of points are due if the activity or operation described in italics can be clearly identified in the work of the candidate, and it is basically correct and complete. Where the activity can be divided into smaller steps, the subtotals are indicated next to each line of the expected solution. The sample solution as given in the markscheme is not necessarily complete. It aims to illustrate what kind of solution (length, types, depth, details, etc.) is expected of the candidate. The remarks in brackets at the end of the unit give further guidance in the judgement of the possible errors, differences and incomplete answers.

Correct solutions using a different reasoning from the one(s) given in the markscheme are also acceptable. The lines in italics help in judging the appropriate proportions, i.e. what part of the full score can be awarded for the correct interpretation of the question, for setting up relationships between quantities, for calculation, etc.

If the candidate combines steps and expresses the results algebraically without calculating quantities shown by the markscheme but not asked for in the original problem, award full mark for these steps, provided that the reasoning is correct. The purpose of giving intermediate results and the corresponding subtotals is to make the marking of the incomplete solutions easier.

Take off points only once for errors not affecting the correctness of reasoning (e.g. miscalculations, slips of the pen, conversion errors, etc.)

If the candidate's response contains more than one solution or more than one attempt without making clear which one they want to be assessed, assume that the last version is the final version (i.e. the one at the bottom of the page if there is no other way to decide the order.) If the candidate's response contains a mixture of elements of two different chains of reasoning, evaluate only one of the two. Select the one that is more favourable for the candidate.

The lack of units during calculation should not be considered a mistake if it does not cause an error in the result. The answers to the questions asked by the problem, however, are only acceptable with the appropriate units.

Graphs, diagrams and notations are considered correct if they can be clearly interpreted (i.e. if it is clear what they show, they contain the necessary notations, unconventional notations are explained, etc.)The labels of the axes in a graph do not need to indicate the units if they are clear from somewhere else. (e.g. if the graph represents quantities given in a table that all have the same unit.)

If the choice of the candidate is not indicated in problem 3, follow the description of the examination.

Enter the appropriate scores in the table at the bottom of each page.

PART ONE

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

Award **2 points** for each correct answer

Total **40 points**

PART TWO

Problem 1

Data: P = 800 W, t = 13 minutes, V = 1.5 dm^3, T_1 = 20 ^{o}C, T_2 = 90 ^{o}C, c = 4.2 kJ/kg·^{o}C, ρ = 1000 kg/m^3.

a)

Finding the mass of water:

$$m = \rho V = 1000 \frac{\text{kg}}{\text{m}^3} \cdot 1.5 \cdot 10^{-3}\,\text{m}^3 = 1.5\,\text{kg}$$

1 point

(The one point is due without showing the calculation.)

Calculating the heat absorbed by the water:

$$Q = cm\Delta T = cm(T_2 - T_1)$$

2 points

$$Q = 4200 \frac{\text{J}}{\text{kg}\cdot{}^o\text{C}} \cdot 1.5\,\text{kg} \cdot (90\ {}^o\text{C} - 20\ {}^o\text{C}) = 441\,000\,\text{J}$$

2 points

b)

Calculating the heat released by the resistive heating element:

$$Q_ö = Pt$$

2 points

$$Q_ö = 800\,\text{W} \cdot 13 \cdot 60\,\text{s} = 624\,000\,\text{J}$$

2 points

Finding the efficiency of heating:

$$\eta = \frac{Q}{Q_ö} \cdot 100\ \%$$

2 points

$$\eta = \frac{441000\,\text{J}}{624000\,\text{J}} \cdot 100\ \% = 70.7\ \%$$

1 point

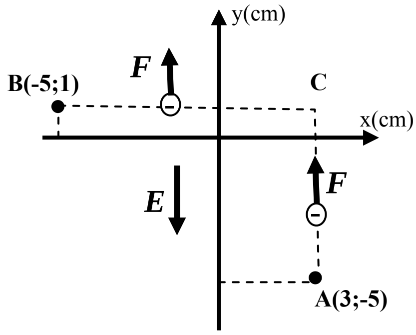
(In case of the last two questions the maximum points are also due if the candidate uses decimals instead of percentage.)

Total **12 points**

Problem 2

Data: E = 2000 N/C, A(3 cm; -5 cm), B(-5 cm; 1 cm),

$q = 1.6 \cdot 10^{-19} C$



a)

Determining the magnitude and the direction of the force exerted on the electron:

$F = qE$

2 points

$$F = 1.6 \cdot 10^{-19}\ \mathrm{C} \cdot 2000 \frac{\mathrm{N}}{\mathrm{C}} = 3.2 \cdot 10^{-16}\ \mathrm{N}$$

2 points

The direction of the force is opposite the direction of the electric field.

2 points

(Both verbal reasoning or a sketch can be accepted.)

b)

Realising that the work done is independent of the path taken:

2 points

(Both verbal explanation or an equation like: $W_{AB} = W_{AC} + W_{CB}$ can be accepted.)

Calculating the works done on the different paths:

$W_{AC} = Fd_{AC}$

2 points

$W_{CB} = 0$

2 points

Calculating the questioned work:

$$W_{AB} = 3.2 \cdot 10^{-16}\ \mathrm{N} \cdot 0.06\ \mathrm{m} = 1.92 \cdot 10^{-17}\ \mathrm{J}$$

2 points

c)

Finding the voltage between points A and B:

$$U_{AB} = \frac{W_{AB}}{q_{electron}}$$

2 points

$$|U_{AB}| = \frac{1.92 \cdot 10^{-17}\ \mathrm{J}}{1.6 \cdot 10^{-19}\ \mathrm{C}} = 120\ \mathrm{V}$$

2 points

(It is sufficient to calculate the magnitude of the voltage.)

Another solution for questions b) and c):

b)

Finding the voltage from the electric field:

$$\left|U_{AB}\right| = Ed_{AC}$$

4 points

(This equation is acceptable without the absolute value symbol as well.)

Referring to the uniformity of the field:

2 points

(A sketch showing the equipotential surfaces is acceptable as well.)

Calculating the voltage:

$$\left|U_{AB}\right| = 2000\,\frac{\mathrm{N}}{\mathrm{C}} \cdot 0.06\ \mathrm{m} = 120\ \mathrm{V}$$

2 points

c)

Finding the work done:

$$\left|W_{AB}\right| = \left|qU_{AB}\right|$$

2 points

$$\left|W_{AB}\right| = 1.6 \cdot 10^{-19}\ \mathrm{C} \cdot 120\ \mathrm{V} = 1.92 \cdot 10^{-17}\ \mathrm{J}$$

2 points

Total **18 points**

Problem 3/A

a)

Determining the characteristics of the motion between points P_1 *and* P_4

Uniform motion.

1 point

Explaining that the motion is uniform:

The cyclist covers the same distances during the same time intervals.

1 point

(v = constant is also acceptable.)

Determining the speed between points P_1 and P_4*:*

During $\Delta t = 1\,\mathrm{s}$ the cyclist covers $\Delta s = 4\,\mathrm{m}$ Thus its speed is:

$$v = \frac{\Delta s}{\Delta t} = 4\,\frac{\mathrm{m}}{\mathrm{s}}.$$

1 point

b)

Determining the characteristics of the motion between points P_{11} *and* P_{14}

Uniformly accelerated motion.

1 point

(Uniformly decelerated can be accepted as well.)

Reasoning that the acceleration is constant:

Between points P_{11} and P_{14} the distance between two adjacent drops constantly increases [$d(P_{11}, P_{12}) < d(P_{12}, P_{13}) < d(P_{13}, P_{14})$]. This means that in the course of the motion the distance covered during the same time increases, thus the cyclist continually increases his speed.

1 point

(It is acceptable if the reasoning is stated in other words.)

Comparing the direction of the acceleration and the velocity:

Because the cyclist moves along a straight line, with increasing speed therefore his acceleration has the same direction as his velocity.

1 point

(This can be accepted without reasoning.)

Determining the characteristics of the motion between points P_4 and P_7 *:*

Uniformly accelerated motion.

1 point

Reasoning that the acceleration is constant:

Between points P_4 and P_7 the distance between two adjacent drops constantly decreases [$d(P_4, P_5) > d(P_5, P_6) > d(P_6, P_7)$].This means that in course of the motion the distance covered during the same time decreases, thus the cyclist continually decreases his speed.

1 point

(It is acceptable if the reasoning is stated in other words.)

Comparing the direction of the acceleration and the velocity:

Because the cyclist moves along a straight line, with decreasing speed therefore his acceleration and his velocity are oppositely directed.

1 point

(This can be accepted without reasoning.)

c)

Determining the characteristics of the motion between points P_7 and P_{11} *:*

Uniform circular motion.

1 point

Reasoning that the motion is uniform and circular:

The path of the motion is a circle.

1 point

The speed is constant. (The cyclist covers the same length of arcs (distances) during the same time intervals)

1 point

Calculating the speed:

Calculating the radius:

$r = 5\,\text{m}$

1 point

Finding the corresponding values of distances and times:

1 point

Calculating v:

$$v = \frac{\frac{1}{2} r\pi}{\Delta t} = \frac{0.5 \cdot 5\,\mathrm{m} \cdot 3.14}{4\,\mathrm{s}} = 1.96\,\frac{\mathrm{m}}{\mathrm{s}}$$

1 point

Finding the acceleration between the points P_7–P_{11}:

The cyclist has centripetal acceleration.

1 point

$$a_{cp} = \frac{v^2}{r}$$

2 points

$$a_{cp} = \frac{\left(1.96\,\frac{\mathrm{m}}{\mathrm{s}}\right)^2}{5\,\mathrm{m}} = 0.77\,\frac{\mathrm{m}}{\mathrm{s}^2}$$

2 points

Total: 20 points

3/B

(In this problem all subtotals can be broken up.)

a)

Investigation of the decay:

Applying the conservation of linear momentum for the decay process:

The conservation of the linear momentum holds true for the β^- -decay of a nucleus.

2 points

Reason:

The external forces are negligible with respect to the internal ones.

1 point

(Acceptable reasoning: the system can be considered closed.)

Finding the values of linear momentum before and after the decay process:

Before the decay the linear momentum of the nucleus at rest is zero, therefore the total linear momentum of the decay elements (after decay) must be zero as well.

3 points

Reasoning the existence of the third particle:

The total momentum of the two visible particles cannot be zero.

3 points

Reason:

The sum of the two linear momentum vectors is not zero (The velocities (thus the two momenta) are not oppositely directed, the angle between them is smaller than 180^{o} so the total momentum can only be zero if another particle is emitted, whose track is not visible in the photograph.

3 points

b) Determining the characteristics of the "mother-element".

The mass number of the nucleus does not change during the β^- decay.

1 point

The atomic number increases by one.

1 point

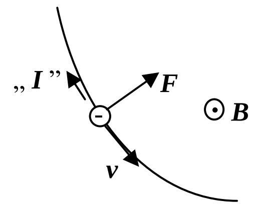
Characteristics of the initial nucleus: A = 6, Z=2.

$${}^{6}_{2}\mathrm{He} \rightarrow {}^{6}_{3}\mathrm{Li} + e^{-} + \bar{\nu}$$

2 points

c) *Determining the direction of the magnetic field:*

The force exerted on the electron points towards the concave part of the path.



1 point

(Drawing the force is sufficient.)

When considering the forces, the negatively charged electron moving with a velocity of $\vec{v}$ behaves similarly as a current which flows into the direction of $-\vec{v}$ (a positive charge moving in the direction of $-\vec{v}$).

1 point

The direction of the magnetic force exerted on the current can be found by using the right-hand grip rule. (The right hand rule determines the direction of the Lorentz-force exerted on a moving charge.).The magnetic field points out of the plane of the paper.

2 points

Total **20 points**