Azonosító jel:

ÉRETTSÉGI VIZSGA • 2012. május 17.

FIZIKA
ANGOL NYELVEN

EMELT SZINTŰ
ÍRÁSBELI VIZSGA

2012. május 17. 8:00

Az írásbeli vizsga időtartama: 240 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

NEMZETI ERŐFORRÁS MINISZTÉRIUM

Instructions for the examinee

The time allowed for the examination is 240 minutes.

Read the instructions for the problems very carefully and use your time wisely.

You may solve the problems in arbitrary order.

Allowable materials: pocket calculator, data tables

Should the space provided for the solution of a problem be insufficient, ask for an extra sheet.

Please indicate the number of the problem on the extra sheet.

PART ONE

Precisely one of the possible solutions for each of the following questions is correct. Write the letter corresponding to the answer you think is correct in the white square on the right. You may write calculations or draw figures on this problem sheet if necessary.

1. The acceleration of a body at a given moment points east. Can its velocity at the same moment point south?

A) No, its velocity can only point east.
B) No, its velocity can only point west or east.
C) Yes, its velocity can point south but it may not point north.
D) Yes, its velocity can point in any direction.

2 points

2. How does the capacitance of a parallel-plate capacitor change, if the full thickness of the gap between its plates is filled by an iron slab?

A) It is reduced approximately by half.
B) It is approximately doubled.
C) Its capacitance is reduced to zero.
D) Its capacitance does not change.

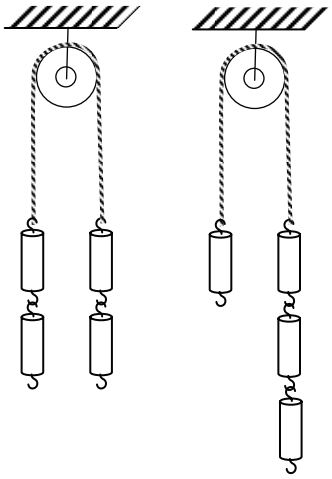
2 points

3. What would happen, if we would shrink the Sun to a thousandth of its original size while maintaining its original mass?

A) Earth and the rest of the planets would continue their motion along their orbits.
B) Earth and the rest of the planets would plunge towards the Sun.
C) Earth and the rest of the planets would escape.

2 points

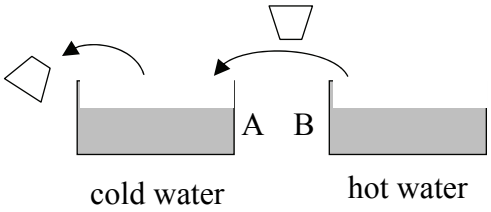
4. We hang a pulley, pass a rope over it and place identical weights on both ends of the rope, two on each side. We let go of the weights and measure the tension force in the rope supporting the pulley. We then move a weight from one side to the other one and let the system go. How does the tension in the rope supporting the pulley change?



A) The tension in the rope increases.
B) The tension in the rope does not change.
C) The tension in the rope decreases.

2 points

5. In container A we have 10 liters of 0 °C water, while in container B we have 10 liters of 100 °C water. Using a small cup we remove some water from container A, and then replace the missing quantity using water from container B. We repeat the process until the hot water in container B is completely exhausted. What will the temperature of the water in container A be at this point?



A) It will be colder than 50 °C.
B) It will be precisely 50 °C.
C) It will be warmer than 50 °C.

2 points

6. We change the current of a solenoid at a uniform rate of 1 A/s. When is the voltage induced in the solenoid greater?

A) While the strength of the current increases from zero to 1 A.
B) While the strength of the current increases from 1 A to 2 A.
C) The voltage induced in the solenoid is the same in the above two cases.
D) The information at hand is not sufficient to resolve the question.

2 points

7. The Guiness record for long-distance egg throwing is over 98 meters. The fresh egg must be caught on arrival of course, it must not break. What could be the key to achieving such a record?

A) The egg should be thrown spinning, because it is much easier to catch a spinning egg.
B) The egg should be slowed down gradually over the longest possible path when catching it.
C) The egg should be thrown at a very sharp angle (almost horizontally), so it does not drop from a great height. ☐

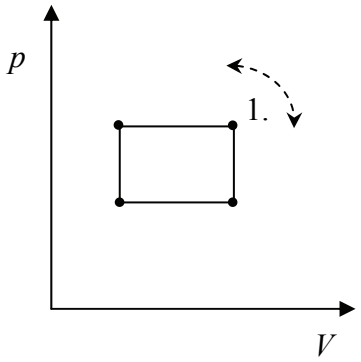
2 points

8. The ^{235}U isotope is radioactive, i.e. it decays spontaneously – yet it can still be found naturally. What is the reason for that?

A) Its half-life is very long, so the time that elapsed since it was created was not sufficient for all of it to decay.
B) It is continuously being created by cosmic radiation in the upper atmosphere.
C) It was scattered in great quantities by nuclear tests in the 50-s, that is what can still be found in nature today. ☐

2 points

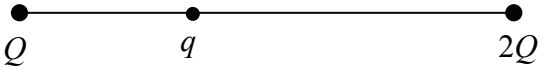
9. An enclosed gas is taken twice through the cyclic process shown on the figure. From the same initial state, it is taken through the process in one direction first, then in the other direction. What is the difference between the two processes?



A) At the end of one process, the temperature of the gas will be higher than the initial temperature, at the end of the other it will be lower.
B) During the course of one process, more energy is transferred by heat to the gas than from the gas, whereas in the other process more energy is transferred by heat from the gas than to the gas.
C) There is no difference between the two processes. ☐

2 points

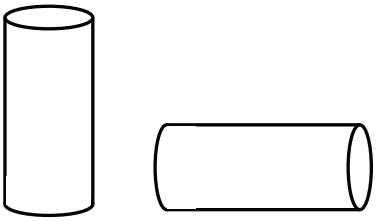
10. We fix two positive point charges of magnitude Q and $2Q$ on the two ends of a section. Then we first try to place a positive q charge somewhere on the section so that it is in equilibrium. After that (removing the q charge) we try to place a $-q$ charge on the section such that it is also in equilibrium. What can we say about the two equilibriums?



A) The two equilibriums are at the same position.
B) The two equilibriums are not at the same position.
C) Only the q charge can be placed so that it is in equilibrium.
D) Only the $-q$ charge can be placed so that it is in equilibrium.

2 points

11. A thick concrete column of height h and mass m falls over. How much does its potential energy change compared to its initial state after it comes to rest on the ground?



A) $\Delta E < mgh/2$
B) $\Delta E = mgh/2$
C) $\Delta E > mgh/2$

2 points

12. A point charge is moving in vacuum in a homogeneous magnetic field in a plane perpendicular to the lines of magnetic induction. Which quantity will be constant?

A) The vector of velocity.
B) The vector of acceleration.
C) Both quantities will be constant.
D) Neither of the two will be constant.

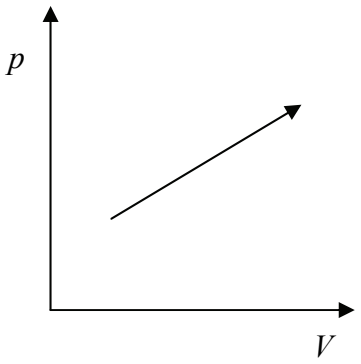
2 points

13. What does an anti-hydrogen atom consist of?

A) A proton and an electron.
B) A proton and a positron.
C) An antiproton and an electron.
D) An antiproton and a positron.

2 points

14. What kind of process does the arrow on the adjacent *p* – *V* diagram depict?



A) An adiabatic process.
B) An isothermal process.
C) Neither one of the two.

2 points

15. What does the de Broglie wavelength of an atom depend on?

A) On the type of the atom – each atom has a set of characteristic de Broglie wavelengths, which can be found in its emission spectrum.
B) On its momentum – the de Broglie wavelength of an atom decreases if its speed or mass increases.
C) On its mass – the heavier an atom is, the greater is its de Broglie wavelength.

2 points

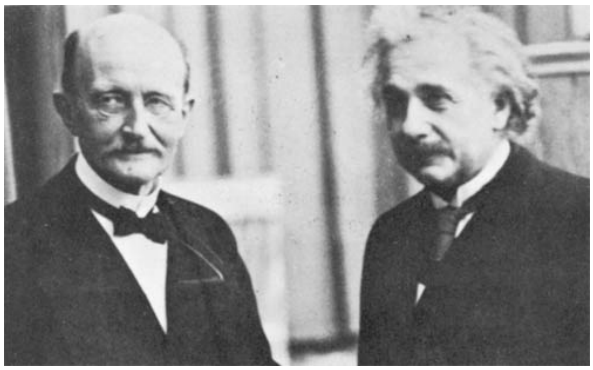
PART TWO

Choose one of the three topics below and write a coherent, 1.5-2 page long essay about it. Make sure that the phrasing is accurate and clear, the train of thought is logical and pay attention to the spelling, as this will also affect the evaluation. You do not necessarily have to formulate your thoughts in the exact order of the aspects given. The essay may be written on the following pages.

The quantum hypothesis and the photoelectric effect

My futile experiments to somehow reconcile the quantum of action with classical theory lasted several years and required a lot of effort. Some of my colleagues saw something of a tragedy in this. My opinion is different. For me, the gain I obtained from the thorough exploration was more valuable. I now knew that the role played by the quantum of action in physics is more significant then I tended to assume at first...

Max Planck



Planck and Einstein

Review the hypothesis of the quantization of light, and the role of Planck and Einstein in the creation and the verification of the hypothesis. Present the photoelectric effect and, sketching a specific experimental arrangement, explain how experimental evidence supports the hypothesis of the quantization of light. Write down the basic equation for the photoelectric effect, name and explain the physical quantities that appear in it. Write at least two areas of application for the photoelectric effect.

Generator and motor

When I created the apparatus for electric rotations discussed previously before the years 1827 and 1828 with good results, no similar conceptions could be found or read in the journals or works available to me. Because of these circumstances, it was my opinion that I am the inventor of the electric apparatus described and its method of application...

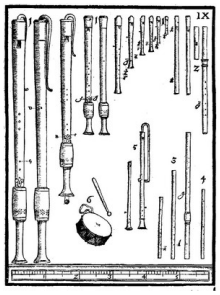
Jedlik Ányos

The electric motor of Jedlik Ányos.

Explain how a generator creates electric current via doing mechanical work. Sketch a drawing of the system design and explain the theoretical background along with role of Lenz's law. Mention an application for the generator.
Explain the functioning of a type of electric motor of your choice. Present the physical laws and interactions that are required to understand its functioning. In the course of your explanation, sketch a drawing that illustrates the motor's functioning and mention an application for the electric motor.

The whistle sounds

The whistle is a cylindrical tube closed at the top end and open at the bottom end and is made of wood, bone or glass. It has a sharp-edged opening for the mouth under its closed end and has several smaller side-holes along it. If the air is blown towards the sharp edge of the opening for the mouth in an oblique direction, while the side-holes are all closed, the oscillation with a node at its middle that is generated is the lowest sound for the whistle.



Schirkhuber Móricz: Elméleti és tapasztalati természettan alaprajza (1851)

Review the concept of standing waves and how they are created. Review the most important physical properties of the sound created in a whistle, their relationship, the type of wave created and the factors affecting the pitch of the sound. Explain the properties of the sound created in an open whistle and in a closed whistle, the relationship between the wavelength and the length of the whistle. Explain the role of the harmonics in the forming of the sound of the whistle.

Total	Presentation
18 points	5 points

PART THREE

Solve the following problems. Justify your statements using calculations, diagrams or explanations, depending on the nature of the questions. Make sure that the notations you use are unambiguous.

1. A hard disk used in computers nowadays consists of one or more platters rotating at a high speed and a reading head that moves close to the surface of the platter. The data is contained on the platter in tiny magnetic grains; the head interprets the alignment of the tiny magnets as a bit of information, a "1" or a "0". The machinery of the drive moves the head in a radial direction and the bits at the current radius are read by the head sequentially as they pass before it because of the rotation of the platter. In a particular type of hard disk, the distance between two tiny magnetic grains both representing a bit is about 30 nm.

a) What is the maximum rate at which the head may possibly be able to read data from the outermost edge of the platter of a hard disk, whose platter diameter is 3.5" (inch) and speed of rotation is 7200 RPM (rounds per minute)? (1 inch = 2.54 cm, the rate for reading data is usually given in Gbit/s nowadays.)

b) What maximum rate may be attained for reading data which are located at a distance of 3 cm from the center of rotation?

c) Approximately how many Gbytes of information may the disk be able to store, if the data is located between a distance of 1 cm and 4.5 cm from the center of rotation on the platter and one byte is composed of eight bits?

a)	b)	c)	Total
6 points	2 points	3 points	11 points

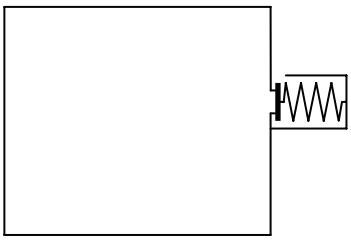
2. A car battery is composed of six identical cells connected in series. The open circuit voltage (electromotive force) of the battery is 13.2 V. When the load on the battery is 54 W, the terminal voltage decreases to 10.8 V.

What is the internal resistance of a single cell? What is short-circuit current of the battery?

Total
11 points

3. We fill a V=200 dm^3 container, whose walls are thin, with helium gas of temperature t_0= -123 ºC. There is a safety valve on the side of the container. This is basically a small hole with an area of A=5 cm^2, onto which a small plate is pressed by a spring. The force in the spring is F=25 N. The initial pressure of the gas is $p_0 = 10\frac{\mathrm{N}}{\mathrm{cm}^2}$. The temperature of the gas slowly increases to that of its environment t_1=27 ºC.

($R = 8300\frac{\mathrm{J}}{\mathrm{K}\cdot\mathrm{kmol}}$)



a) What is the mass of the helium gas enclosed in the container initially?
b) What is the temperature of the gas when the safety valve opens?
c) What is the mass of the helium gas enclosed in the container when the temperature reaches that of the environment?

a)	b)	c)	Total
3 points	6 points	4 points	13 points

4. We are looking at a point-like light source which is located at a distance of 2 meters from us and radiates light in all directions evenly. The power of the light source is 10 W, the wavelength of the emitted light is λ = 450 nm.

Approximately how many photons pass through our pupil in a second, if the diameter of our pupil at the time of the observation is 4 mm?

$c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$, $h = 6.62 \cdot 10^{-34}$ Js.

Total
12 points

To be filled out by the examiner evaluating the paper!

	maximum score	score attained
I. Multiple choice questions	30	
II. Essay: content	18	
II. Essay: presentation	5	
III. Complex problems	47	
Total score for the written exam	**100**	

examiner

Date: .....

	Score attained rounded to the **nearest integer** (elért pontszám **egész számra** kerekítve)	**Integer score** entered in the program (programba beírt **egész** pontszám)
I. Multiple choice questions (Feleletválasztós kérdéssor)		
II. Essay: content (Esszé: tartalom)		
II. Essay: presentation (Esszé: kifejtés módja)		
III. Complex problems (Összetett feladatok)		

examiner (javító tanár) notary (jegyző)

Date (Dátum): ..... Date (Dátum): .....