Azonosító jel:

ÉRETTSÉGI VIZSGA • 2008. május 14.

FIZIKA
ANGOL NYELVEN

EMELT SZINTŰ ÍRÁSBELI VIZSGA

2008. május 14. 8:00

Az írásbeli vizsga időtartama: 240 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

OKTATÁSI ÉS KULTURÁLIS MINISZTÉRIUM

Instructions to Candidates

Time allowed for this examination paper is 240 minutes.

Read the instructions of this question paper carefully, and make sure that you do not run out of time.

You may solve the problems in any order.

Materials allowed calculator, data tables.

If there is not enough space provided for the solution of the problem, you may ask for extra sheets. On the sheets attached please, indicate the number of the problem.

PART ONE

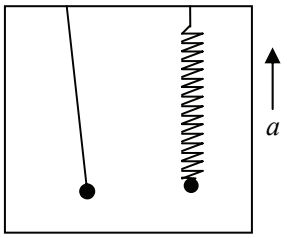
Exactly one of the answers to each of the questions below is correct. Write the appropriate letter in the white square on the right. (If necessary check your answer by calculation, or draw a sketch.)

1. Who was the latest of the four listed scientists?

A) Copernicus.
B) Galileo.
C) Newton.
D) Kepler.

2 points

2. In a lift, which is at rest, the periods of a simple pendulum, the angular displacement of which is small, and an object hanging on a spring and undergoing simple harmonic motion, are the same. The damping is negligible in both cases. Will their periods change if the lift begins to accelerate vertically upward? (Their motion remains harmonic.)



A) None of the periods will change.
B) The period of the pendulum will change, but the period of the oscillating object remains the same.
C) The period of the oscillating object will change, but the period of the pendulum remains the same.
D) Both periods will change.

2 points

3. A spring is shortened by cutting down a piece from one of its ends. What will happen to its spring constant?

A) It decreases.
B) It does not change.
C) It increases.

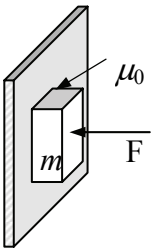
2 points

4. A rectangular block is pushed by a horizontal force F against a vertical wall. The block is at rest. What is the magnitude of force F?

A) $F = mg$

B) $F \geq \mu_0 \cdot mg$

C) $F \geq \frac{mg}{\mu_0}$



2 points

5. Why does the glass window rattle in the iron frame in summer?

A) The iron frame expands more than glass.

B) The motion of the glass particles is more intense in summer.

C) Iron exposed directly to sunshine gets a bit soft.

2 points

6. How does the average speed of the atoms change if the temperature of a sample of monatomic gas, measured in Kelvins, is doubled?

A) It will be doubled.

B) It will increase to a value less than twice of the original speed.

C) It might increase or decrease depending on the change in the pressure and the volume.

2 points

7. **There is some air closed hermetically in a plastic bottle. The wall of the bottle is slowly pushed in. The temperature of the air inside remains the same. What can you state about the heat transfer between the air in the bottle and the environment?**

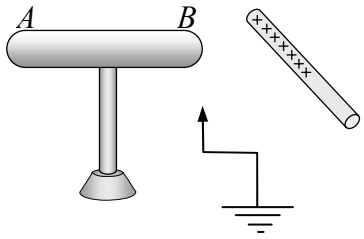
A) There is no heat transfer because the temperature of the air is constant.

B) The air in the bottle absorbs heat from the environment.

C) The air in the bottle releases heat to the environment.

2 points

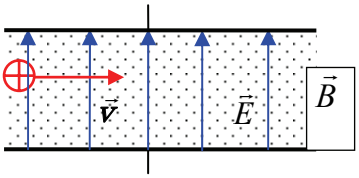
8. A positively charged rod is placed close to a neutral metal object mounted on an insulating stand. Point B is closer to the rod as shown in the figure. What will happen if the object is touched by a grounded wire at point A or at point B?



A) Only if point A is touched electrons will flow to the object.
B) Electrons will flow to the object if it is touched at any point.
C) Electrons will flow to the object only if point B is touched.

2 points

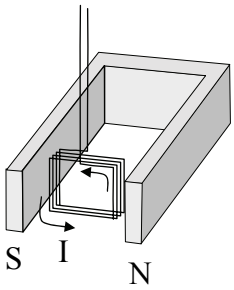
9. A velocity-selector works such that positively charged particles of different velocities $\vec{v}$ enter to a region where they are subject to the combined action of uniform perpendicular electric and magnetic fields $\vec{E}$ and $\vec{B}$ respectively. (The velocity of the particles $\vec{v}$ is also perpendicular to both $\vec{E}$ and $\vec{B}$; $\vec{B}$ points out of the paper, as shown in the figure. Gravitational force is negligible.)
Choose the statement which is *false*.



A) There are some particles moving with certain speed, which will undergo uniform straight-line motion.
B) The line of action of the force exerted by the electric field on the particle, and the line of action of the force exerted by the magnetic field (Lorentz force) coincide.
C) There are some particles whose motion is uniformly decelerated.

2 points

10. A coil of several turns is hanged and placed into the magnetic field of a U-shaped magnet, which can be considered uniform. How will the coil move when current is switched on?



A) The frame does not move, it stays at rest.
B) The frame moves left or right depending on the direction of the current.
C) The frame moves backward or forward depending on the direction of the current.
D) It will turn to some direction depending on the direction of the current.

2 points

11. A beam of red laser enters from water to air. Which of the following properties will change?

A) Its frequency.
B) Its colour.
C) Its energy.
D) Its wavelength.

2 points

12. Balls of uniform density are hanged as shown in the figure. In the first case both balls have the same mass *m* and the same radius *r*. In the second case, the ball on the right hand-side has twice the mass and twice the radius as those of the other. In which case will the gravitational force exerted between the two balls be greater?

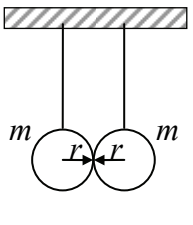


Figure 1.

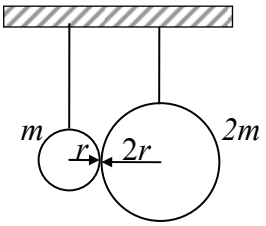


Figure 2.

A) The attractive force is greater in the first case shown in figure 1.
B) The attractive force is greater in the second case shown in figure 2.
C) The attractive forces are the same in both cases.

2 points

13. Which statement is true for the stable elements which have a high number of nucleons?

A) There are no neutrons in their nuclei.
B) They have the same numbers of protons and neutrons in their nuclei.
C) There are more neutrons than protons in their nuclei.
D) There are fewer neutrons than protons in their nuclei.

2 points

14. Which statement is true for the Bohr model of the Hydrogen? (The energy of a free electron at rest is considered to be 0 J, and the energy of the electron in the Hydrogen at the ground state is –2.2 aJ.)

A) The energy of the electron of the hydrogen atom can be anything between –2.2 aJ and 0 J.
B) All the electromagnetic waves emitted by the hydrogen atom are in the region of visible light.
C) The energy of the photon emitted by the exited hydrogen is less than -2.2 aJ.
D) The emission spectrum of the Hydrogen is continuous.

2 points

15. One of the statements about the strong interaction is *not true.* Which one?

A) Strong force has a very small range; it is negligible between the nucleons, which are not next to each other.
B) The strong force exerted between two protons next to each other in the nucleus, is about a hundred times as big as the coulomb force exerted between them.
C) The strong force exerted between two protons next to each other in the nucleus is smaller than the force exerted between two neutrons next to each other in the nucleus.

2 points

PART TWO

Choose one out of the three topics below and develop your opinion in a coherent composition of 1.5-2 pages. Make sure that your essay is clear, accurate and comprehensible, pay attention to the spelling, since these are assessed as well. It is not necessary to expound your opinion in the order of the given aspects. You may write your composition on the next two pages.

1. Uniform Circular Motion

The robotic spacecraft (probe) called Mars Odyssey was placed in orbit about the Mars in October 2001. Initially its trajectory was an elongated ellipse, then in January when the spacecraft was close to the Mars its engine was used once to place the space probe to a circular orbit, then it underwent uniform circular motion and began the exploration of the planet.

Describe the motion of the space probe, compare its speeds when it was close to the Mars and when it was far from it, referring to Kepler's second law. Compare the times of revolution (periods) of the probe when it was on elliptical and when it was on circular orbits. How can you calculate the time of revolution and the centripetal acceleration of the spacecraft undergoing uniform circular motion?
What is the condition of the uniform circular motion? Write an equation for the gravitational force, which is exerted on the spacecraft undergoing uniform circular motion.

2. Lightning Conductor

"To demonstrate, in the completest manner possible, the sameness of the electric fluid with the matter of lightning, Dr Franklin, astonishing as it must have appeared, contrived actually to bring lightning from the heavens, by means of an electrical kite, which he raised when a storm of thunder was perceived to be coming on. This kite had a pointed wire fixed upon it, by which it drew the lightning from the clouds. This lightning descended by the hempen string, and was received by a key tied to the extremity of it;"

(PRIESTLEY: *The History and Present State of Electricity)*

The quotation above describes the basic experiment of Benjamin Franklin, the inventor of the lightning conductor.
Outline the behaviour of metal conductors, which are in static electric field. Answer the following questions:
What happens if an uncharged uniform metal sphere is placed to electric field? Where are the charges, what are their quantities, what are the characteristics of the electric field formed? Draw a sketch as well to illustrate.
How are the excess charges distributed on a charged metal body? Describe point discharge at sharp edges or corners. What is the protection from lightning? Explain Franklin's method. Explain how the body of the car can protect the people in the car from the electric shock caused by the lightning.

3. Speed of Light and Relativity

There is hardly any doubt that Einstein's theory of special relativity made one of the greatest impressions in the history of physics. The roots of the theory go back to classical physics. The birth of the theory is that Einstein extended Galileo's principle of relativity applied in the classical mechanics and replaced Galileo's velocity-addition method.

What is Galileo's principle of relativity? How can you determine the relative velocities of moving objects with respect to each other according to the classical mechanics? Which experiment implied that the classical velocity-addition law fails in some cases?
What is the experience of the observers who travel with constant speed with respect to each other about the velocity of light in vacuum? How are their measurements affected by their relative motion? How can it be consequent with Einstein's theory of relativity?

a)	b)	c)	d)	e)	f)	Presen-tation	Content	Total
						5 points	18 points	23 points

PART THREE

Solve the following problems. Justify your answers by means of explanations, diagrams or calculations, depending on the nature of the problem. Make sure that the meaning of all notations used is clear.

1. Examine a helium-neon laser of wavelength $630 \cdot 10^{-9}$ m and of power output 2 W.

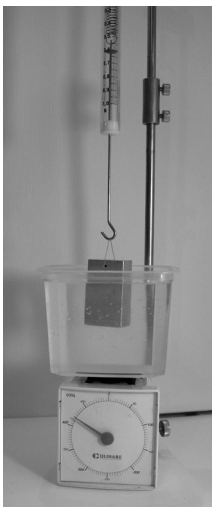
a) Find the energy of the photon emitted by the laser.

b) Find the number of photons emitted in each second.

(Speed of light: $c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$, Planck constant: $h = 6.63 \cdot 10^{-34}$ Js.)

a)	b)	Total
4 points	6 points	10 points

2. 400 g water is poured to a plastic container of negligible mass. (The container is on a scale as shown in the figure.) A small Aluminium object hanging on a spring balance is immersed to the water. The scale reads 420 g and spring balance reads 0.6 N.

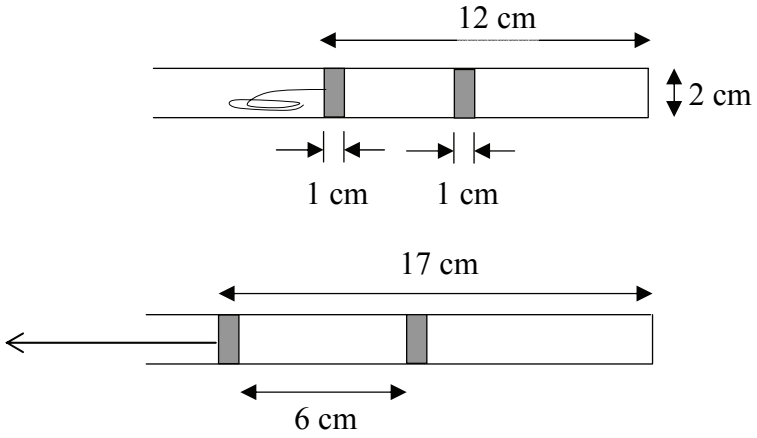


a) Find the force exerted by the water on the object.
b) Calculate the mass of the object.

$(g = 10 \frac{\mathrm{m}}{\mathrm{s}^2})$

Total
10 points

3. There are two pistons of width 1 cm in a long thin glass tube closed at one end. The pistons confine some air at atmospheric pressure as shown in the figure. The internal diameter of the tube is 2 cm. If by means of a thread the piston closer to the open end of the tube is pulled out very slowly by 5 cm, then the length of the air column between the two pistons will be 6 cm.



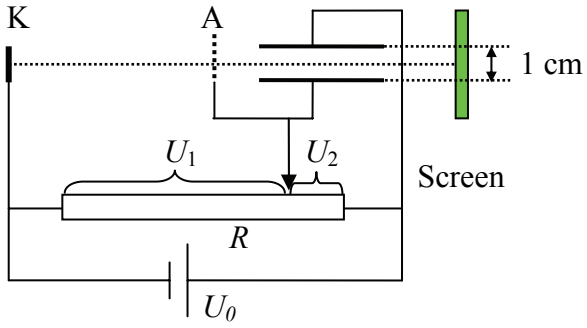
(Friction between the tube and the pistons is negligible and the atmospheric pressure is: $p_0 = 10^5$ Pa)

a) Find the values of the pressure in the two closed parts of the tube after pulling out the piston.
b) What is the tension in the thread attached to the outer piston, when the pistons are at rest in the position described above.
c) Initially, what was the distance between the pistons ?

a)	b)	c)	Total
5 points	4 points	3 points	12 points

4. The cathode of the device shown in the figure, denoted by K, is heated, thus electrons of negligible initial speed are emitted and accelerated towards the anode A. This anode is a grid through which the electrons pass, and then travelling with constant horizontal velocity, they enter to the uniform vertically upward electric field of a capacitor. After passing the electric field of the capacitor, the electrons hit a screen.

The pointer of the variable resistor divides the voltage U_0 to : U_1 = 45.5 V and U_2 = 4 V.
The distance between the plates of the capacitor is 1 cm.
(The speed of the electrons is much smaller than the speed of light, the effect of gravity is neglected. m_{el}= 9.1·10^{-31} kg, e = –1.6·10^{-19} C)



a) Calculate the final speed of the electrons.
b) What should be the direction and the magnitude of the magnetic field applied between the plates of the capacitor such that the electrons pass the capacitor without being deflected?

a)	b)	Total
6 points	9 points	15 points

	Maximum score	Score attained
I. Multiple Choice Questions	30	
II. Essay: Content	18	
II. Essay: Presentation	5	
III. Extended Response problems	47	
TOTAL	**100**	

Examiner

Date: .....

	Score attained Elért pontszám	Score input for the program Programba beírt pontszám
I.Multiple Choice Questions I. Feleletválasztós kérdéssor		
II. Essay: Content II. Esszé: tartalom		
II. Essay: Presentation II. Esszé: kifejtés módja		
III. Extended Response Problems III. Összetett feladatok		

Examiner / javító tanár

Date / Dátum: .....

Registrar / jegyző

Date / Dátum: .....