Azonosító jel:

ÉRETTSÉGI VIZSGA • 2007. május 14.

FIZIKA
ANGOL NYELVEN
PHYSICS

2007. május 14. 8:00

EMELT SZINTŰ
ÍRÁSBELI VIZSGA
HIGHER LEVEL
WRITTEN EXAM

Az írásbeli vizsga időtartama: 240 perc
Time allowed for the examination: 240 minutes

Pótlapok száma / Number of extra sheets	
Tisztázati / Final version	
Piszkozati / Draft	

OKTATÁSI ÉS KULTURÁLIS MINISZTÉRIUM
MINISTRY OF EDUCATION AND CULTURE

Instructions to candidates

Time allowed for this question paper is 240 minutes.

Read the instructions of the problems 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 a problem ask for an extra sheet. On the sheet attached indicate the number of problem**.**

Part one

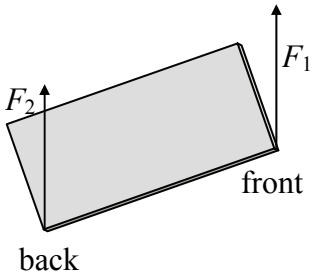
Exactly one of the answers to each of the following questions below is correct. Write the appropriate letter in the white square on the right. (If necessary you may write your calculations or draw figures on this sheet.)

1. Two boats travel on a lake. They both have a speed of 5 m/s with respect to the water. A passenger on one of the boats observes that the other boat moves with a 5 m/s speed with respect to him. Find the angle between the two velocities with respect to the water.

A) The angle between the velocities is 45^o
B) The angle between the velocities is 60^o
C) The velocities are perpendicular to each other.
D) The angle between the velocities is 120^o

2 points	

2. A rectangular sheet of glass is carried up the stairs by two men. They hold the sheet at its two lower corners, and they both exert vertically upward forces as shown in the figure. Which man exerts the greater force the one in the front or the other behind him?



A) The man in the front.
B) They exert the same force.
C) The man in the back.

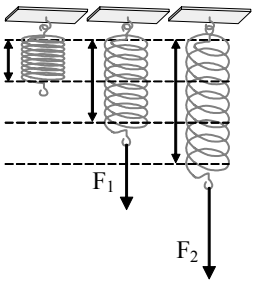
2 points	

3. **If an electron with negligible initial speed is accelerated in a chatode-ray tube through a potential difference of U=200 kV, then according to classical physics its final speed is v_o =2.6·108 m/s. What can you state about the real speed of the electron if relativistic effects are not neglected?**

A) The real velocity is greater than v_o.
B) The real velocity is equal to v_o.
C) The real velocity is smaller than v_o.

2 points	

4. **A spring is elongated to twice and three times to its unstretched length. (The spring is considered to be ideal for these elongations as well.) Find F_2 in terms of F_1.**



A) $F_2 = 1.5 \cdot F_1$
B) $F_2 = 2 \cdot F_1$
C) $F_2 = 3 \cdot F_1$

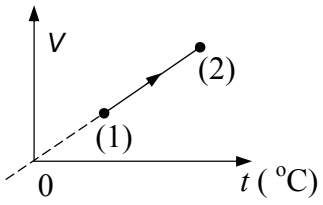
2 points	

5. **Why can you pour hot water into a pot made of heat-resistant glass, without breaking the glass?**

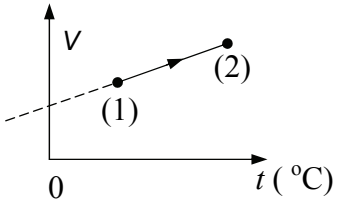
A) Because specific heat capacity of heat-resistant glass is so small that it will not be heated much.
B) Because the linear expansivity of heat-resistant glass is very small, therefore no high stresses arouse in the glass.
C) Because the heat-resistant glass is a type of material which is very hard to break.

2 points	

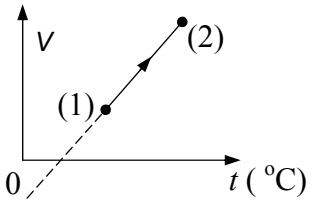
6. **The diagrams below show the volume of a sample of gas as a function of the temperature, measured in Celsius, in different thermodynamic processes. Which one is the graph of an isobaric process.**



Graph 3.



Graph 2.



Graph 3.

A) Graph 1.
B) Graph 2.
C) Graph 3.

2 points	

7. **A 100 J heat is to be added to a sample of gas in order to increase its temperature by 1 °C while its volume is kept constant. If the gas is heated at constant pressure 140 J heat is needed to increase its temperature by 1 °C. Find the work done by the gas if it is heated at constant pressure and its temperature increases by 1 °C.**

A) 40 J.
B) 60 J.
C) 100 J.
D) 110 J.

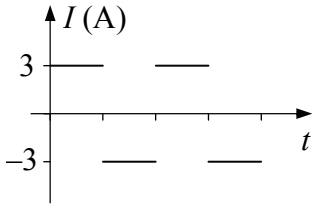
2 points	

8. **A small charged metal ball is placed near a neutral metal sphere on an insulating stand. What kind of electric forces can be observed?**

A) Attractive forces.
B) No forces can be observed.
C) Repelling forces.

2 points	

9. **The graph of the current in a wire as a function of time is shown in the figure. Find the root-mean-square value of the current**.



A) 0 A.
B) $\frac{3}{\sqrt{2}}$ A.
C) 3 A.
D) $3 \cdot \sqrt{2}$ A.

2 points	

10. **The Aura borealis (northern light) can be explained with**

A) the gravitational field of the Earth.
B) the magnetic field of the Earth.
C) the fact that the temperature decreases towards the poles.

2 points	

11. **A plain mirror is on a vertical wall. What is the least height of the mirror if you want to see yourself from top to toe?**

A) It has to be as high as the level of your eye.
B) It depends how far you are.
C) At least half of your height.

2 points	

12. **A blue and a red laser have the same power. Which ejects more photons in a unit of time.**

A) The blue laser ejects more photons.
B) The red laser ejects more photons.
C) They eject the same number of photons.

2 points	

13. **Examine the following process: An exited electron of a hydrogen atom jumps back to its ground state, while the atom emits a photon. In which case will the frequency of the emitted photon be greater: if the principal quantum number of the exited state is 2, or if the principal quantum number of the exited state is 3?**

A) The frequencies of the emitted photons are the same in both cases.
B) If the principal quantum number of the exited state is 2.
C) If the principal quantum number of the exited state is 3.

2 points	

14. **The nucleus of $^{14}_{6}C$ undergoes β-decay. What is the resulted new nucleus?**

A) $^{14}_{7}\mathrm{N}$
B) $^{14}_{5}\mathrm{B}$
C) $^{10}_{6}\mathrm{Be}$
D) $^{15}_{6}\mathrm{C}$

2 points	

15. Geostationary satellites revolve about the Earth such that they are always above the same point of the Earth. (They have the same position with respect to the Earth.) What can be the possible position of this type of satellite?

A) It can be above any point of the Earth.
B) It can only be above the equator.
C) It can only be above the poles.

2 points	

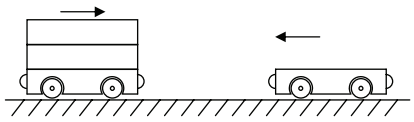
Part two

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. Collisions

The conservation laws are the basic theories of physics, which reflect certain symmetry of nature. Generally in Newtonian mechanics collisions are described by applying one or more conservation laws. Summarise the main features of collisions along straight lines.

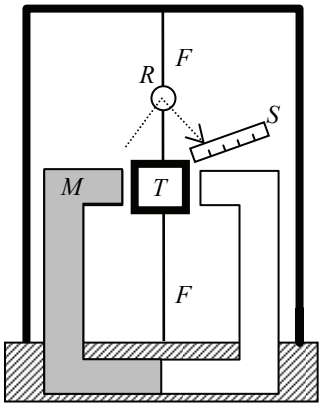
State which collisions are considered totally inelastic, and describe them from the point of view of the conservation of energy and linear momentum.
Explain the validity of the conservation of linear momentum and energy in case of completely elastic collisions, and the applications of these laws.
Describe the three parts of the elastic collision of the two carts shown in the figure. The carts have elastic bumpers. (The three parts: before collision, during collision, after collision.)



2. Forces in Magnetic Field

The magnetic field exerts a force on a charged particle, which is moving in it or on a piece of wire carrying current. This is the force, which rotates the armature of a motor, electromagnets can be explained with this force, or using this force we can make an ammeter as well.

Describe the force exerted on a piece of wire carrying current in uniform magnetic field, and the force exerted on a charged particle, which moves in magnetic field. Write down the characteristics of the torque exerted on a coil carrying current, which is in uniform magnetic field.
Carefully observe the figure, which shows the sketch of an ammeter (the so called: torsion wire galvanometer, which is a type of moving coil galvanometer). Using the sketch describe how the galvanometer works.



M: the fixed horseshoe magnet
T: coil carrying the current, which is to be measured
F: thin torsion wires fixed to the bottom and to the top, which are to support the coil and also carry in and out the current.
If the coil turns then the twisted wires exert torque on the coil, proportional to the angle of turning, to oppose the twist.
R: mirror and the reflected ray of light
S: scale illuminated by the ray of light

3. Wave-particle Duality

Quantum physics brought basically new ideas into physics. We gained not a descriptive but a logical interpretation of the world, which united those classic concepts, that seemingly had no connection. Like the wave-like and particle-like behaviours.

Describe two experiments, one, which shows the manifestation of wave-like, and another, which shows the manifestation of particle-like behaviour of light.
Describe two experiments, one, which demonstrates the wave-like, and another, which manifests the particle-like behaviour of an electron. Using your examples summarise what the wave-particle duality of matter means?

a)	b)	c)	d)	e)	f)	g)	Presentation	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 are clear.

1. **A stone is dropped from the top of a 25-m tall building. When the stone passes the observer at a height of 20 m, the observer drops another stone. How much time elapses between the two instants at which the stones reach the ground? (Air drag can be neglected and** $g = 10\ \frac{\text{m}}{\text{s}^2}$ **.)**

Total
10 points

2. In order to carry out an experiment a 50-cm long glass tube is needed, which is closed at one end and in which there is a 10-cm long glass piston. We would like to achieve that the piston is 4 cm away from the open end of the tube (as shown in figure 2), when the tube is in the laboratory where the pressure is the normal atmospheric pressure and the temperature is 20°.

Figure 1.

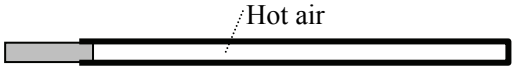
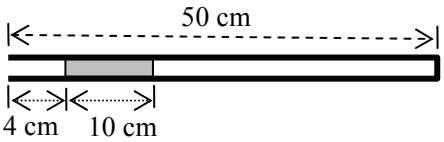


Figure 2



In order to move the piston into its position prescribed above, the air in the open tube is heated, then a small part of the glass piston is placed into the tube (as shown in figure 1.), and the tube is left to cool down.

Calculate the temperature to which the air in the tube should be heated, such that after the cooling of the confined air, the piston moves into its desired position.

(Assume that the piston firmly closes the tube, whereas the friction between the piston and the tube is negligibly small, and the expansion of glass is also negligible.)

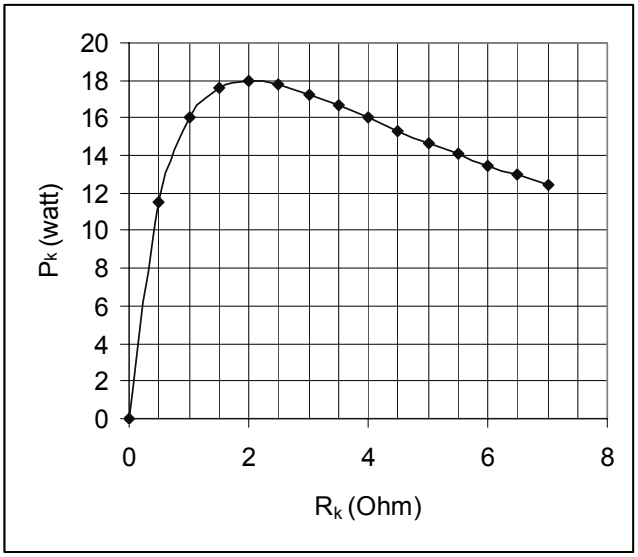
Total
10 points

3. **Calculate the binding energy of an α-particle using the following data: the mass of an α-particle is $6.6429 \cdot 10^{-27}$ kg, the mass of a free proton is $1.6726 \cdot 10^{-27}$ kg, the mass of a free neutron is $1.6749 \cdot 10^{-27}$ kg, and the speed of light in vacuum is $3 \cdot 10^{8}$ m/s.**

Total
13 points

4. Different resistors of resistance R_k are connected to a voltage supply, which has internal resistance, and the power P_k dissipated in the different resistors is measured. The measured data are shown in the graph below.

a) Find the internal resistance of the voltage supply.
b) Find the electromotive force of the voltage supply.



a)	b)	Total
1 point	3 points	14 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: .....

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

Javító tanár / Examiner

Jegyző / Registrar

Dátum / Date: .....

Dátum / Date: .....