

Azonosító  
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**ÉRETTSÉGI VIZSGA • 2014. május 19.**

# **FIZIKA ANGOL NYELVEN**

## **EMELT SZINTŰ ÍRÁSBELI VIZSGA**

**2014. május 19. 8:00**

Az írásbeli vizsga időtartama: 240 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

**EMBERI ERŐFORRÁSOK  
MINISZTERIUMA**

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## Important information

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.

Resources that may be used: pocket calculator, data tables

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

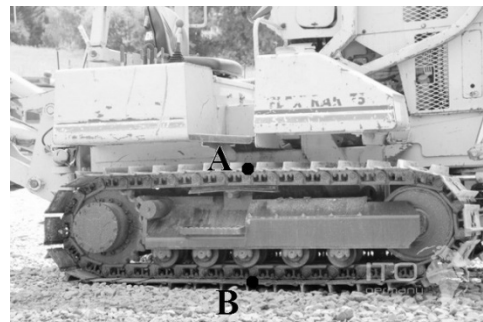
Please indicate the number of the problem on the extra sheet.

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## 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. A tracked vehicle is moving forward with a velocity of 2 m/s. How fast do point “B” of the track, (which is in contact with the ground,) and point “A” of the track, (which is located on the upper horizontal section of the track,) move relative to the ground?



- A) The velocities of points A and B are both 2 m/s.  
B) The velocity of point A is -2 m/s, the velocity of point B is 2 m/s.  
C) The velocity of point A is 4 m/s, the velocity of point B is 0 m/s.  
D) The velocity of point A is 2 m/s, the velocity of point B is 0 m/s.

☐

2 points

2. Which one of the following statements about cyclic processes of ideal gases is true?

- A) The work done by the gas on the environment during the cyclic process equals the work done by the environment on the gas.  
B) The heat transferred to the gas during the cyclic process is always equal to the amount of heat released by the gas in the process.  
C) The increase of the energy of the gas on particular sections of the cyclic process altogether is equal to the decrease on the rest of the sections altogether.

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2 points

3. What physical phenomenon is the basis of operation of the optical fiber?

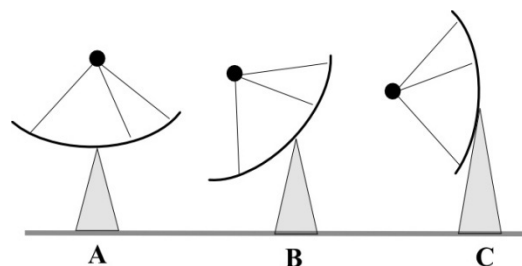
- A) Polarization.  
B) Refraction.  
C) Interference.  
D) Diffraction.

☐

2 points

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4. A satellite dish was mounted on a house and directed towards a geostationary satellite. The satellite is located at the same longitude as the house, which lies close to the Equator. How is the satellite dish positioned?

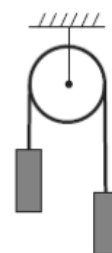


- A) It is positioned as shown in figure A.  
 B) It is positioned as shown in figure B.  
 C) It is positioned as shown in figure C.  
 D) Any one of the depicted settings may occur.

☐

2 points

5. Two loads of different weight are fixed on a stationary pulley. The mass of the upper one is 1 kg, the mass of the lower one is 3 kg. With what force does the ceiling support the pulley, if the weights can move freely? The rope and the pulley are both ideal.



- A) The pulley exerts a 50 N force on the ceiling.  
 B) The pulley exerts a 40 N force on the ceiling.  
 C) The pulley exerts a 30 N force on the ceiling.

☐

2 points

6. The organs of the human body can be damaged by radioactive radiation. What does the amount of damage suffered by an organ depend on?

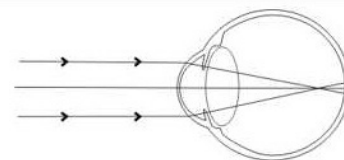
- A) Only on the energy absorbed per unit mass.  
 B) On the energy absorbed and the organ's nature of operation.  
 C) Only on the organ's nature of operation.

☐

2 points

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7. The image formation of a deficient human eye is sketched in the adjacent figure. Which of the following statements is true?



- A) This is a farsighted eye, glasses with positive diopter can correct it.  
 B) This is a farsighted eye, glasses with negative diopter can correct it.  
 C) This is a nearsighted eye, glasses with positive diopter can correct it.  
 D) This is a nearsighted eye, glasses with negative diopter can correct it.

☐

2 points

8. The skater in the picture rotates his 50 kg partner on a circular path with a 1.2 m radius, with a frequency of 0.75 1/s. What is the work performed by the skater on his partner during one full revolution? (Friction can be neglected.)



- A) The work performed on her is 2500 J.  
 B) The work performed on her is 200 J.  
 C) The work performed on her is 0 J.  
 D) The work performed on her is 3768 J.

☐

2 points

9. A column of liquid encloses a given amount of gas in a vertical tube that is closed on its bottom end and open on its top end as shown in the figure. We heat the gas, so its volume increases by 20 %, with some of the liquid overflowing the top of the tube. What can we say about the temperature change of the gas?



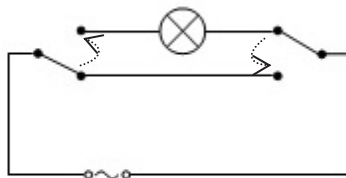
- A) The temperature of the gas increased by less than 20 %.  
 B) The temperature of the gas increased by precisely 20 %.  
 C) The temperature of the gas increased by more than 20 %.

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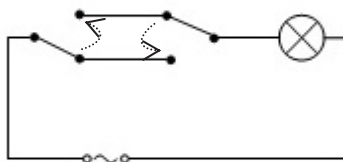
2 points

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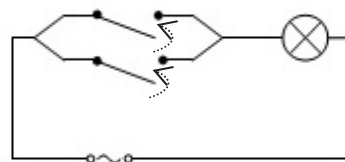
10. So-called alternating switches are often used in the lighting of large rooms. With their use, a lamp can be switched on or off at two different places. For example, the lamp can be switched on or off using any of the switches at the two ends of a long corridor, irrespective of the position of the other switch. Which of the circuit diagrams below depict the way to construct an alternating switch?



1.



2.



3.

- A) Circuit diagram 1.  
B) Circuit diagram 2.  
C) Circuit diagram 3.

☐

2 points

11. Approximately what is the overall mass of the electrons in the matter that a 75 kg man consists of?

- A) About 2 kg.  
B) About 0.2 kg.  
C) About 20 g (2 dkg).  
D) About 200 mg.

☐

2 points

12. Is it possible to heat a building by cooling the water of a lake?

- A) Yes, it is possible, but work must be done to extract heat from a place of lower temperature and transfer it to a place of higher temperature.  
B) No, it is impossible according to the second law of thermodynamics.  
C) It is possible only if the temperature of the lake's water is higher than the temperature of the building.

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2 points

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13. The adjacent drawing is fantasy, but it depicts the real event when the spacecraft Huygens landed on the solid surface of a celestial body in our Solar System. Which one could it be?



- A) Jupiter.  
B) A moon of Jupiter.  
C) Saturn.  
D) A moon of Saturn.

☐

2 points

14. The density of lead is 4.2 times greater than that of aluminum, although the atoms in the elementary crystal lattice are about the same distance from each other in both metals. How can this be?

- A) This is because the lead nucleus is much heavier than the aluminum nucleus.  
B) This is because the density of the lead nucleus is much greater than that of the aluminum nucleus.  
C) This is because the binding energy of the lead nucleus is much greater than that of the aluminum nucleus.

☐

2 points

15. Which phenomenon do we *never experience* in the case of sound waves propagating in air?

- A) Diffraction.  
B) Interference.  
C) Beating.  
D) Polarization.

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2 points

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## PART TWO

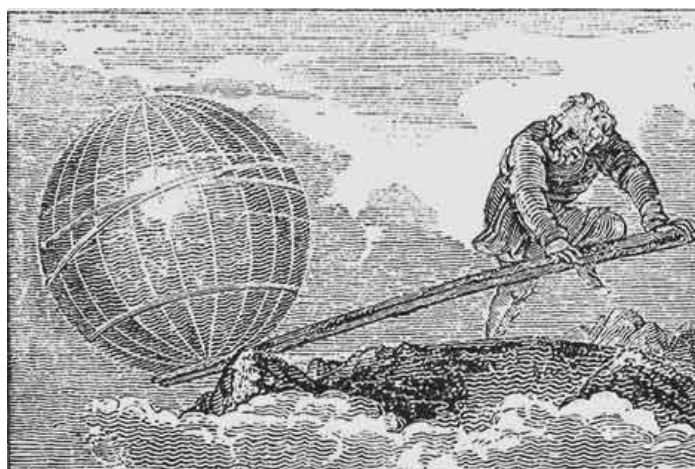
*Choose one of the three topics below and write a coherent, 1.5-2 page long essay about it. Make sure that the phrasing is accurate and clear, the train of thought is logical and pay attention to the spelling, as this will also affect the evaluation. You do not necessarily have to formulate your thoughts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

### Torque, equilibrium, levers

„δῶς μοι πᾶ στῶ καὶ τὰν γᾶν κινάσω”

Give me a place to stand (outside Earth) and I shall move the earth.

Archimedes



Review the notion of torque, presenting the quantities that occur in the definition on a suitable figure.

Discuss the conditions of equilibrium for extended, rigid bodies using forces and torques.

Apply the principles introduced to explain the operation of second-class levers and first-class levers. Prepare a drawing to illustrate the forces and the geometric relationships. Examine the transmission of force and energy in second-class levers and the first-class levers. Give one example of a second-class lever and one of a first-class lever in household use.

Explain why we can say that a fixed pulley is a simple machine of the same type as a first-class lever, while a movable pulley is a simple machine of the same type as a second-class lever.

Specify the time period when Archimedes was active and discuss the relation of his sentence quoted above to simple machines. What kind of a simple machine does Archimedes use in the picture?

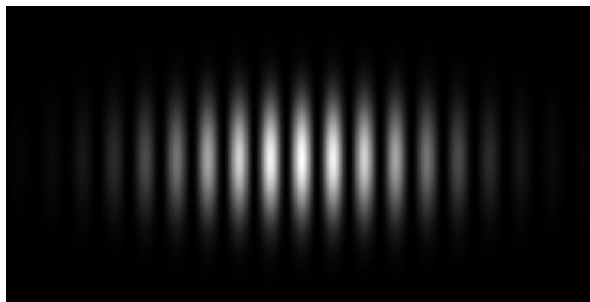


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## The interference of light

*And if a hill collides with a valley, as soon as the line connecting the topmost point of the former with the lowest point of the latter becomes vertical, both will cease to exist and the surface of the wave will be one with the surface of the water. This phenomenon is called the loss of the wave.*

Schirkehuber Móricz: The foundations of theoretical and experimental natural science – Pest, 1851.



Discuss the phenomenon of interference for the case of two waves that originate from point sources. At which locations do we observe amplification and at which ones extinction? Under what condition can interference be observed?

Review the interference of light created by an optical grating. In which directions do we observe amplification? Explain how an optical grating can be used to measure the wavelength of monochromatic light.

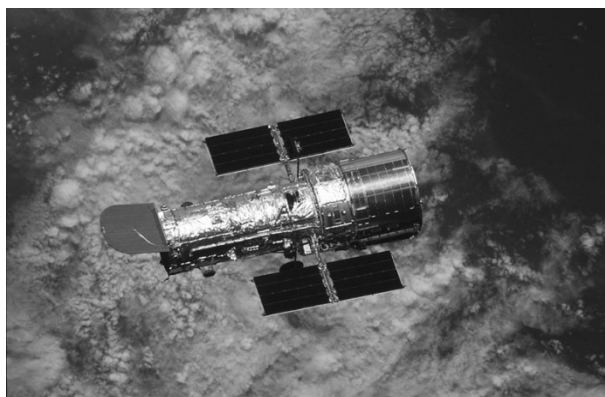
Explain why a grating will decompose white light into the colors of its spectrum. Compare the spectrum obtained with a grating to that obtained with a prism.

Name an everyday phenomenon where we can see colors due to the interference of light.

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## The Hubble Space Telescope orbiting around Earth

The Hubble Space Telescope was named after the astronomer Edwin Hubble. The space telescope is one of the best known and most popular spacecraft. In English speaking countries it is also known as *The People's Telescope*. Its planned successor is the James Webb Space Telescope which is destined to go into orbit in 2014.



Wikipedia

What was the most important scientific discovery of Edwin Hubble, the astronomer that the space telescope was named after? What scientific theory is Hubble's discovery the foundation of in connection with the birth of the Universe? Why is it advantageous to install a telescope in space, what is the benefit compared to telescopes on the ground? What physical laws govern the orbiting of the space telescope? What is the approximate value of its acceleration? The space telescope plays a major role in discovering the history of the early Universe. The Hubble Space Telescope is able to photograph extremely distant objects. How can pictures of distant objects help us understand our Universe's past?

What purpose do the rectangular objects on the sides of the telescope serve? The spectrograph is part of the telescope's basic instrumentation. How does this instrument work? What is it for, what can we learn about the observed objects with its use? Emphasize one of these.

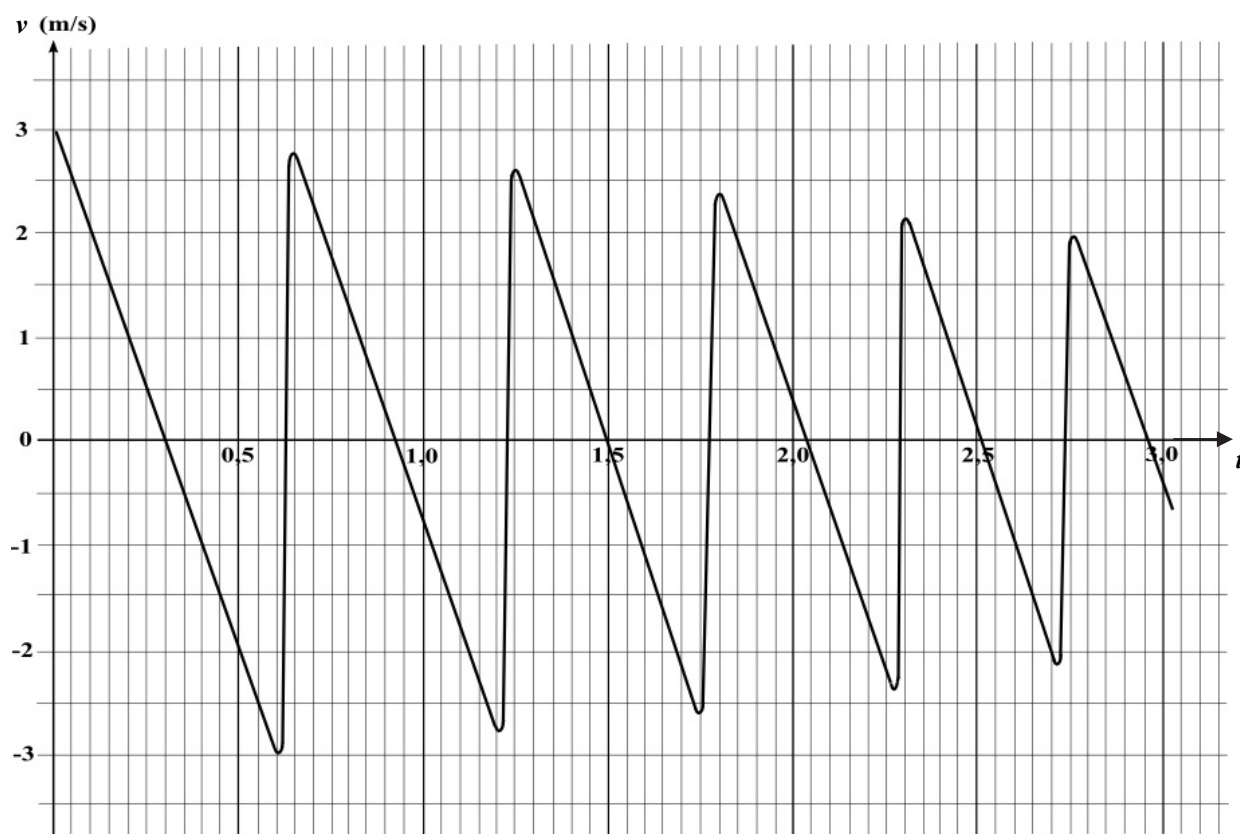
Content	Presentation	Total
18 points	5 points	23 points

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## 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. The graph below depicts the vertical component of the center-of-mass velocity of a small, 20 g (2 dkg) bouncing ball as a function of time. Answer the following questions using the graph.



- At which moment does the ball attain the greatest height? How high is it at this moment?
- What is the average acceleration of the ball the first time it is in contact with the ground and what is the average force exerted by the ground on the ball during this collision?
- Let us assume that the coefficient of restitution is constant while the ball bounces, i.e. the ball loses the same fraction of its velocity with each collision. After how many collisions will the maximum height attained by the ball be less than half of the first maximum?

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

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a)	b)	c)	Total
3 points	5 points	6 points	14 points

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## 2. Tires are installed on the wheels of cars in a garage and are inflated.

- Once in winter, the mechanic installs tires on a car, whose manufacturer prescribes that the tire pressure should be 200 000 Pa higher than the atmospheric pressure. To what pressure should the mechanic inflate the tires in the +15 °C garage, in order to attain precisely the prescribed tire pressure outside on the −20 °C road?
- What fraction of its internal energy does the air in the tire lose when the car exits the +15 °C garage onto the −20 °C road? Where does this energy go?
- An apprentice always inflates all tires to a pressure of exactly 200 000 Pa. In summer, the temperature in the garage is 26 °C, in winter it is only 15 °C. In which case will the internal energy of the air in the tire be higher, when it is cold in the garage, or when it is warm?

The volume of the tires can be taken to be the same in all cases ( $V = 25$  liters) the atmospheric pressure is always  $10^5$  Pa, the energy of the air can be approximated with the

formula  $E = \frac{5}{2} \frac{m}{M} R \cdot T$ .

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

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**3. An  $\alpha$ -particle moves along a circular orbit of 0.5 m radius in a  $10^{-4}$  T homogeneous magnetic field.**

Determine the speed and the de Broglie wavelength of the  $\alpha$ -particle.

(The mass of an  $\alpha$ -particle is  $m_\alpha = 6.64 \cdot 10^{-27}$  kg, the elementary charge is  $e = -1.6 \cdot 10^{-19}$  C,  $h = 6.62 \cdot 10^{-34}$  J·s)

<b>Total</b>
<b>10 points</b>

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**4. The power of the 670 nm wavelength laser of a laser printer is about 1 mW.**

- a) What is the momentum and energy of the photons emitted by the laser?
- b) How many photons does the laser emit in a second?
- c) What force does the laser beam exert on the laser apparatus that emits it?

$$(c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}, \quad h = 6.62 \cdot 10^{-34} \text{ J} \cdot \text{s})$$

a)	b)	c)	Total
4 points	3 points	4 points	11 points

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**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	
<b>Total score for the written exam</b>	<b>100</b>	

\_\_\_\_\_  
examiner

Date: .....

	Score attained rounded to the <b>nearest integer</b> (elért pontszám <b>egész számra kerekítve</b> )	<b>Integer score</b> entered in the program (programba beírt <b>egész</b> 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)

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notary (jegyző)

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