

**ÉRETTSÉGI VIZSGA • 2021. május 18.**

**FIZIKA  
ANGOL NYELVEN**

**KÖZÉPSZINTŰ  
ÍRÁSBELI VIZSGA**

**2021. május 18. 8:00**

Időtartam: 150 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

**EMBERI ERŐFORRÁSOK MINISZTERIUMA**

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## Important information

Read the instructions for the problems 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, you may continue the solution on the empty pages of the examination paper or on auxiliary sheets. Please indicate the number of the problem on the pages.

*Please indicate here which of the two problems 3/A and 3/B you have chosen (that is, which one you would like evaluated):*

3/ ☐

## PART ONE

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

**1. Which of the physical units below is the unit of power?**

- A) W/s.
- B) Ws.
- C) J/s.
- D) Js.

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2 points	
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**2. Are there electromagnetic waves emitted by the Sun reaching us, whose wavelength is such that they are invisible to our naked eyes?**

- A) Yes, for example infrared or ultraviolet rays are invisible to our eyes.
- B) No, because due to genetic evolution, humans can perceive the entire spectrum of solar radiation.
- C) No such radiation arrives directly from the Sun, but some are generated when the solar wind interacts with our atmosphere.

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2 points	
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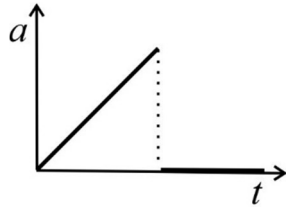
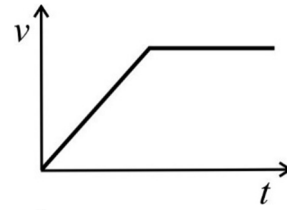
**3. Which radiation has a greater penetration capability?  $\alpha$  radiation or  $\gamma$  radiation?**

- A)  $\alpha$  radiation.
- B)  $\gamma$  radiation.
- C) The penetration capability of these two types of radiation is approximately the same.
- D) The question cannot be decided using the information at hand, it depends on which nucleus has emitted the radiation.

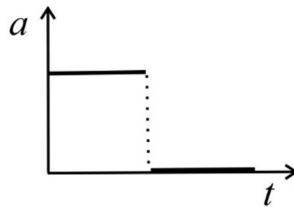
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2 points	
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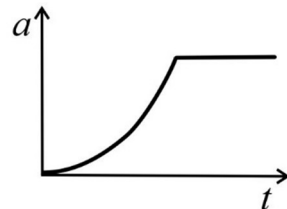
4. The velocity-time graph of a car is shown on the right. Which of the three graphs below is the corresponding acceleration-time graph of the car?



A)



B)



C)

- A) Graph A)  
B) Graph B)  
C) Graph C)

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2 points

5. Can it happen that the temperature of the water in a lake is gradually higher as we descend deeper from the surface?

- A) Only if it is a saltwater lake. Then the salt concentration is greater in warmer water, which makes it descend to the bottom of the lake.  
B) Yes, it is possible also for sweet water if its temperature cools to 4 °C, because it then descends to the bottom even if the surface temperature is colder.  
C) No, it is not possible because the density of warmer water is always less than the density of colder water due to thermal expansion.

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2 points

6. How does the capacitance of a parallel-plate capacitor change if the distance between the capacitor plates is decreased?

- A) The capacitance increases.  
B) The capacitance decreases.  
C) The capacitance does not change.

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2 points

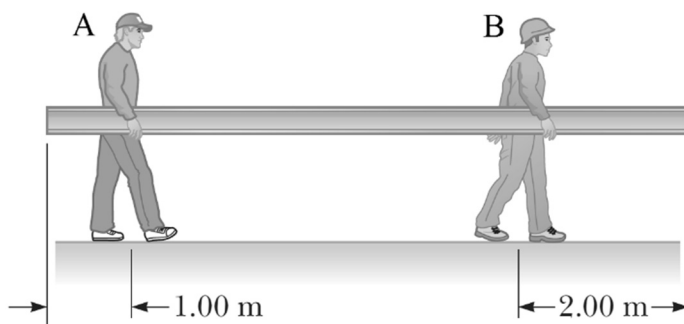
7. Which Hungarian scientist performed extremely accurate measurements of gravitation?

- A) Ányos Jedlik.
- B) Lóránd Eötvös.
- C) Ede Teller.
- D) Jenő Wigner.

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2 points

8. An 8 meter long, straight, homogeneous wooden beam is carried by two workers as shown on the adjacent figure. Worker A holds the beam closer to its end, worker B holds it farther from its other end, while the beam remains horizontal all along. Which of the two workers has to exert a greater vertical force?

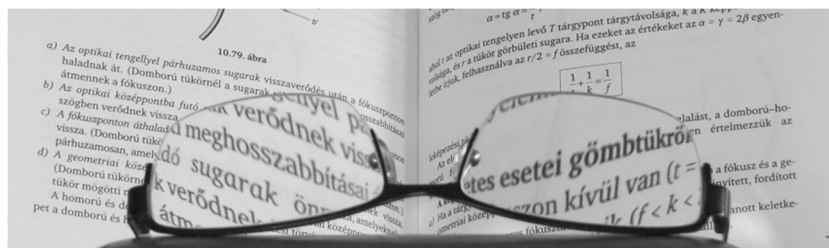


- A) Worker A.
- B) Worker B.
- C) The forces they have to exert are equal.
- D) The question cannot be decided using the information at hand.

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2 points

9. A student forgot his/her glasses on a physics textbook. Using the photograph, determine whether the lenses are converging lenses or diverging lenses.



- A) They are converging lenses.
- B) They are diverging lenses.
- C) It is not possible to decide from the picture whether they are converging or diverging lenses.

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2 points

**10. An ideal spring is stretched by 2 cm. How does the spring constant change if we stretch it by another 2 cm?**

- A) The spring constant decreases.
- B) The spring constant increases.
- C) The spring constant remains the same.

2 points	
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**11. Technetium 99 isotope is used for tracing blood circulation of the heart. What is the half-life of this isotope if the radiation in the patient's body decreases to 1/16th its initial value 24 hours after injection?**

- A) 6 hours.
- B) 1.5 hours.
- C) 4 hours.

2 points	
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**12. How does the velocity of a meteorite, that is bound to crash into Earth's surface, change as it nears the center of Earth, still outside the atmosphere?**

- A) The velocity of the meteorite is constant.
- B) The velocity of the meteorite grows at a constant rate.
- C) The velocity of the meteorite grows at an increasing rate.

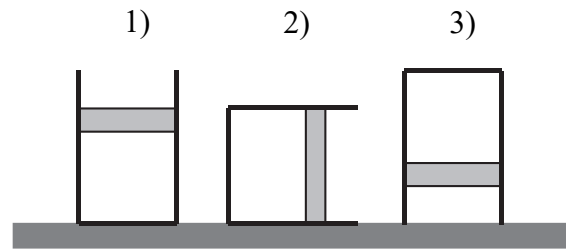
2 points	
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**13. A regular bar magnet is cut in half precisely at the center. What properties will the two resulting pieces possess?**

- A) They will not be magnetic, because a magnet needs two poles, a north and a south and the two separate pieces only have one pole each.
- B) They will be magnetic, both pieces will have a north pole and a south pole as well.
- C) They will be magnetic, but the separate pieces will only have one pole each, one of them a north pole, the other a south pole.

2 points	
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14. An equal amount of helium is enclosed in three identical cylinders by three identical pistons which can move without friction and have a non-negligible mass. The cylinders are placed on a table in three different positions as shown by the figures. In which position will the pressure of the enclosed gas be the greatest? (Temperature is constant, the table does not seal the opening of the cylinder in an airtight manner.)

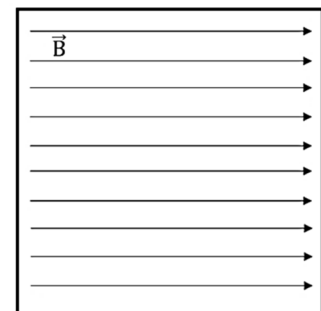


- A) In the position shown on figure 1.  
B) In the position shown on figure 2.  
C) In the position shown on figure 3.  
D) The pressure is equal in the three positions.

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2 points

15. A particle with charge  $+Q$  and velocity  $v$  enters the homogeneous magnetic field shown on the figure. How does its velocity change? (There is no other force field, gravity is negligible.)



- A) The particle's velocity increases.  
B) The particle's velocity decreases.  
C) The particle's velocity does not change.  
D) The direction of the particle's velocity changes, its magnitude remains constant.

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2 points

16. Gravitational acceleration on Moon's surface is six times smaller than on Earth's surface. Two projectiles are launched vertically upwards with the same initial velocity; one on Earth, the other on the Moon. What is the height attained by the projectile on the Moon, if the one on Earth reaches a height of 120 m? (Air drag is negligible.)

- A) The height reached is  $60 \cdot \sqrt{6}$  m  $\approx 147$  m.  
B) The height reached is 720 m.  
C) The height reached is 20 m.

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2 points

**17. How does relative humidity change in a room if the window is opened?**

- A) It will always decrease.
- B) If the air is warmer outside, it will certainly increase.
- C) It is not possible to decide using the given information.

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2 points	
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**18. Below we list various types of electromagnetic radiation. The photons of which type on the list have the greatest energy?**

- A) Infrared radiation.
- B) Radio waves.
- C) UV radiation.

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2 points	
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**19. The net force on a point-like body is not zero. Does the body's state of motion change?**

- A) Yes, it certainly does.
- B) Not necessarily, for example if the force is always perpendicular to the direction of motion and of constant magnitude, the body will undergo uniform circular motion.
- C) Only if the body is not fixed in space.

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2 points	
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**20. A ray of light is incident on the optical center of a concave mirror, at an angle of  $30^\circ$  with the optical axis. In what direction will it travel after reflection?**

- A) Parallel to the optical axis.
- B) It travels through the focal point.
- C) It travels on enclosing an angle of  $30^\circ$  with the optical axis.

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2 points	
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## PART TWO

*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. In a sample containing radioactive isotopes, there were isotopes with mass  $m_0$  and a half-life of 5 days initially. During the time from day 10 to day 20, the mass of the isotopes that decayed was 6 mg.**

- a) What was the mass of the isotopes initially?
- b) How much of the isotopes remained by the end of day 20?

a)	b)	Total
10 points	5 points	15 points

## 2. Ice cave

*Ice caves are caves where temperatures are below 0 °C all year and in which there is permanent ice. The reason for this is usually that the annual mean temperature in the vicinity of the entrance is below freezing point. For example this can be the case for a cave whose steep entrance resembles that of a sack and lies in a north facing valley. In winter, the cold air descending the valley “flows” easily into the cave and is trapped there in the summer if there is no draft. The water that the ice formations consist of seeps into the cave through the cracks of the rock in the summer. Thus the ice gains mass during the summer, whereas in winter – when it is freezing outside – its quantity does not change.*



mountain side – hegyoldal  
cave entrance – barlangbejárat  
cave endpoint without draft – szellőzésmentes végpont

- Why could it be important for the entrance of the cave to be in a north facing valley?
- Why does cold air “flow into” the cave during winter?
- How is cold air trapped in the cave during the summer as the temperature of the air outside increases?
- Why would an air draft destroy ice formation?
- Why do the ice formations in the cave gain weight during the summer and why does the process stop during the winter?
- How does water entering the cracks and freezing widen the cracks of the ice cave’s walls?

a)	b)	c)	d)	e)	f)	Total
2 points	3 points	3 points	2 points	2 points	3 points	15 points

*You need to solve only one of the two problems 3/A and 3/B. Indicate your choice on the inside of the front cover.*

**3/A Excerpt from the introduction of the ELI-ALPS, home of the super laser systems at Szeged:** *“The primary mission of the ELI Attosecond ( $10^{-18}$  s) Light Pulse Source research facility built at Szeged is to make a wide range of ultrashort light sources accessible to the various user groups of the international scientific community. The secondary purpose of the facility is to contribute to the necessary scientific and technological developments required for high peak intensity and high power lasers.”*

**The homepage also contains the most important parameters (to be) of the five primary laser sources. Some of these parameters are summarized in the table below:**

Laser	Repetition rate:	Pulse energy:	Pulse duration:	Light power:
High repetition rate laser (HR)	$10^5$ Hz	$5 \cdot 10^{-3}$ J	$6 \cdot 10^{-15}$ s	$8.3 \cdot 10^{11}$ W
Terahertz pump laser (TP)	$10^2$ Hz	1 J	$5 \cdot 10^{-13}$ s	
High intensity laser (HF)	10 Hz		$10^{-14}$ s	$2 \cdot 10^{15}$ W
Mid-infrared laser (MIR)	$10^4$ Hz	$10^{-2}$ J	double of period	

**The data in the columns of the table is as follows: the time duration of the laser pulses (laser radiation that lasts for a very short time) supplied by each device, and the energy of the pulses. The repetition rate is also indicated, i.e. the frequency with which the device emits the pulses and the light power attained during the very short time duration of the pulse. However, the information is incomplete, some data is missing. Furthermore, the duration of a single pulse of the MIR laser is given as a multiple of the cycle period of the light wave that the laser pulse contains.**

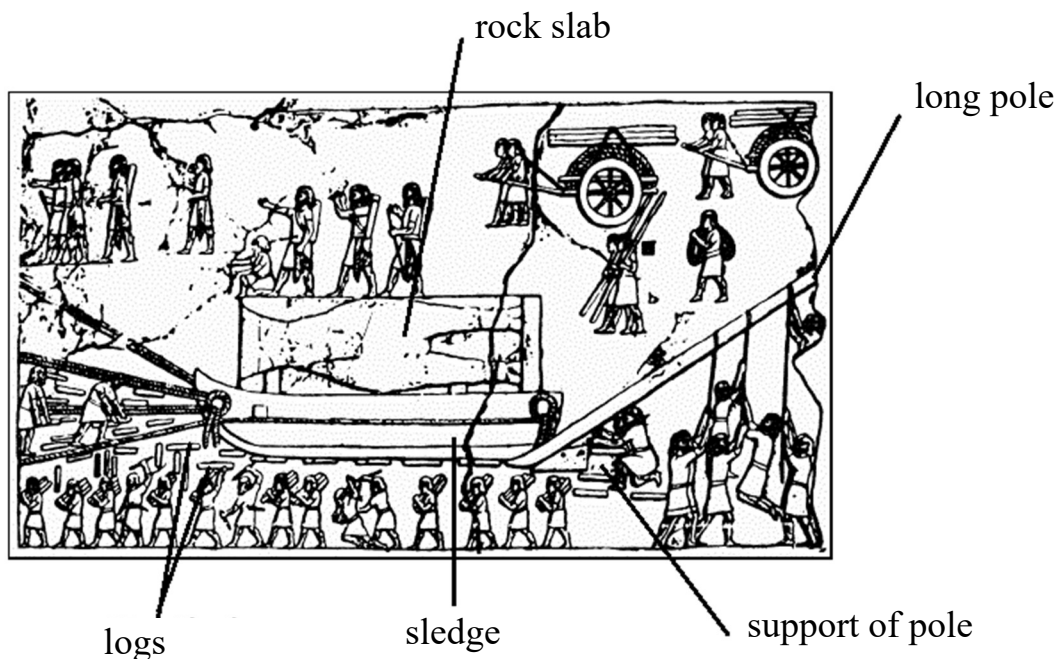
The speed of light:  $c = 3 \cdot 10^8$  m/s.

- Determine the data missing from rows 2-3 in the table.
- What is the length of a single pulse of the HR laser in space, if the speed of the pulse equals the light speed?
- Let us assume, that the wavelength of the light of the MIR laser in row four in vacuum is 6 micrometers. What is its pulse duration and light power?
- Which laser emits the least number of pulses per second and how many does it emit?
- Which laser has the largest pulse energy?
- What is the average power of the HR laser, i.e. how much energy does it emit in one second in the form of laser pulses?

a)	b)	c)	d)	e)	f)	Total
5 points	3 points	4 points	2 points	1 point	5 points	20 points

**3/B The picture below of an ancient Assyrian stone carving depicts the transportation of a huge rock slab. The carving attests that the wheel has already been invented, but the slab is being transported on a sledge. We do not see whether animals or humans drag the sledge, we see only the ropes probably used to pull it. Little wooden logs with a smooth surface are carried by many people to be placed under the sledge. At the rear of the sledge, a long pole is wedged underneath it which is supported behind the sledge. Numerous people are pulling on the other end of the pole.**

(Image source: <https://www.catchpenny.org/movebig.html>)



- Review the kinetic friction force (that occurs when the rock slab is being moved). What factors does its magnitude depend on and what is its direction?
- What kind of simple machine is the long pole depicted on the carving? What is the role of the support of the pole? Why is the pole supported close to the sledge? Why are people pulling on the pole close to its other end?
- The methods seen on the picture and mentioned in the text serve to decrease the friction force. What is the role of each of the methods?

a)	b)	c)	Total
8 points	8 points	4 points	20 points



**To be filled out by the examiner evaluating the paper.**

	score	
	maximum	attained
I. Multiple-choice questions	40	
II. Complex problems	50	
<b>Az írásbeli vizsgarész pontszáma</b>	<b>90</b>	

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date

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examiner

	pontszáma <b>egész</b> <b>számra</b> kerekítve	
	elért	programba beírt
I. Feleletválasztós kérdéssor		
II. Összetett feladatok		

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