

**ÉRETTSÉGI VIZSGA • 2017. május 22.**

**FIZIKA  
ANGOL NYELVEN**

**KÖZÉPSZINTŰ  
ÍRÁSBELI VIZSGA**

**2017. május 22. 8:00**

Időtartam: 120 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

**EMBERI ERŐFORRÁSOK MINISZTERIUMA**

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## Important information

The time available for the solution of the problems is 120 minutes.

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 one of the empty sheets at the end of the examination paper. Please indicate the number of the problem on the sheet.

*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. (Check your answer with calculations if necessary.)*

1. A boy with a mass of 60 kg and one with a mass of 80 kg staged a race to get up to level 10 from the ground floor. They started out at the same time and finally, they reached level 10 precisely at the same time as well. What can we say about the mechanical power they exerted during the race?

- A) The power of the 60 kg boy was greater.  
B) The power of the 80 kg boy was greater.  
C) The powers of the two boys were equal.  
D) The question cannot be decided using the information at hand.

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2 points

2. The following data is inscribed upon a household iron: 230 V, 2300 W. What is the current flowing in the iron when it is operated in the domestic electric network?

- A) 0.1 A.  
B) 10 A.  
C) 23 A.

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2 points

3. Can the magnitude of the equivalent resistance of two resistors connected in parallel be the arithmetic mean of the two resistances?

- A) Yes, if the magnitudes of the two resistances are equal.  
B) Yes, this is the case for any two resistors connected in parallel.  
C) No, because the equivalent resistance of resistors connected in parallel is smaller than any of the two constituent resistances.

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2 points

4. We submerge a  $10\text{ cm}^3$  ball of solid lead and a  $10\text{ cm}^3$  stone in water. Is the buoyancy force acting on the lead ball, or that on the stone greater?

- A) The force on the lead ball is greater, because it is heavier.  
B) The force acting on the stone is greater, because it is lighter.  
C) The magnitudes of the buoyancy forces on the two bodies are equal.  
D) This can be decided only if the shapes of the bodies are known precisely.

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2 points

5. Which of the two images below depicts a concave mirror and which a convex one?



image source: <http://iskolaellato.hu>

- A) Both mirrors are convex.  
B) Both mirrors are concave.  
C) The mirror on the left is concave, the mirror on the right is convex.  
D) The mirror on the left is convex, the mirror on the right is concave.

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2 points

6. Electric and magnetic fields are used in a cyclotron to accelerate charged particles and to keep them on a circular trajectory. What is the role played by each of the fields?

- A) The electric field is used to increase the kinetic energy of the particles, the magnetic field keeps them on a circular trajectory.  
B) The magnetic field is used to increase the kinetic energy of the particles, the electric field keeps them on a circular trajectory.  
C) Both fields may increase the kinetic energy of the particles and play a role in keeping them on a circular trajectory.

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2 points

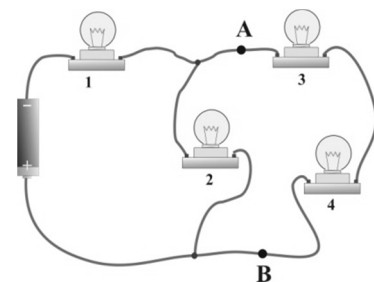
7. We displace a body suspended on a spring slightly in a vertical direction. Because of this, the body starts oscillating with a simple harmonic motion. At which point is the magnitude of its acceleration greater? At the lower, or at the upper turning point?

- A) At the lower turning point, when the spring is stretched the most.  
B) At the upper turning point, where the spring is stretched the least.  
C) The magnitude of the acceleration is the same at both turning points.

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2 points	
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8. A light bulb burned out in the circuit depicted, and consequently all the light bulbs went out. Which one burned out?



- A) Number 1.  
B) Number 2.  
C) Number 3.  
D) Number 4.

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2 points	
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9. In the chain reaction in nuclear reactors, fission of uranium nuclei is initiated mostly by thermal neutrons. What does the expression “thermal neutron” mean?

- A) Neutrons are heated to high temperature so they move faster and split uranium nuclei easier.  
B) Neutrons are made neutral so that they split uranium nuclei easily.  
C) Neutrons are slowed down to thermal velocities so that they split uranium nuclei easier.

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2 points	
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**10. We would like to list the following planets in the order of decreasing orbital period. Which sequence is correct?**

- A) Neptune, Jupiter, Saturn.
- B) Jupiter, Neptune, Saturn.
- C) Neptune, Saturn, Jupiter.

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2 points	
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**11. We remove an electron from an oxygen atom. What do we obtain?**

- A) An isotope.
- B) A bare atomic nucleus.
- C) An excited atom.
- D) An ion.

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2 points	
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**12. Which of the following concepts characterizes the state of a gas, i.e. which one is a state variable?**

- A) Heat absorption
- B) Work
- C) Internal energy

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2 points	
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**13. The lander Philae of the spacecraft Rosetta reached the surface of the Churyumov-Gerasimenko comet recently. Unfortunately, the landing was not perfect. The lander that descended slowly bounced back from the surface and reached it again about an hour later. Why did such a long time pass before it reached the surface again?**

- A) Because the lander had to wait until the comet completed a full orbit around the Sun and was in the same position again.
- B) Because large parachutes slowed its descent so it does not break up during the landing.
- C) Because gravitation on the comet is very small, so the lander fell back very slowly.

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2 points	
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**14. We shine light onto a photocell. What determines whether electrons are emitted from the cathode of the photocell as a result of the illumination?**

- A) The intensity of the illuminating light.
- B) The wavelength of the illuminating light.
- C) The velocity of the illuminating light in vacuum.

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2 points

**15. The passengers of the rollercoaster on the adjacent picture cannot fall out of their seats even when it is travelling upside down at the top of the loop. What is the direction of the net force acting on them at this point if the rollercoaster is travelling with constant speed?**

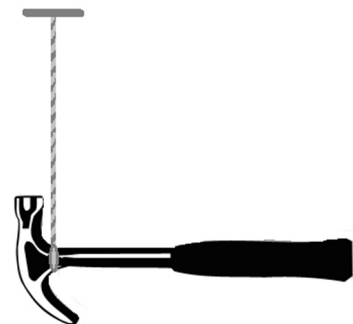


- A) The net force is pointing upwards.
- B) The net force is pointing downwards.
- C) The net force is zero.

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2 points

**16. We suspend a hammer balanced carefully as depicted. The line of action of the force in the string divides the hammer into two parts. Which part has a greater mass?**



- A) The part that contains the head of the hammer (the left part).
- B) The part that contains most of the shaft of the hammer (right part).
- C) The masses of the two parts are equal.

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2 points

**17. What is used to examine our bodies when we attend a medical ultrasound examination?**

- A) Mechanical waves.
- B) Radio waves.
- C) X-rays.

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2 points

**18. We boil water in a pot without a lid. Compare the boiling point of water in Mexico City (at an elevation of 2200 m above sea level) and Amsterdam (at an elevation of 2 m above sea level).**

- A) The boiling point in Mexico City is higher.
- B) The boiling point in Amsterdam is higher.
- C) The two temperatures are equal.

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2 points	
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**19. We measured the pressure and volume of a given amount of enclosed helium gas multiple times. At which measurement was its temperature the highest?**

- A) When its volume was 4 liters and its pressure was  $0.5 \cdot 10^5$  Pa.
- B) When its volume was 3 liters and its pressure was  $0.75 \cdot 10^5$  Pa.
- C) When its volume was 0.9 liters and its pressure was  $2 \cdot 10^5$  Pa.

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2 points	
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**20. We observe a small oil slick on a puddle and find that it shines with the colors of the rainbow. Why do we see it so colorful?**

- A) Because light reflected from the surface of the oil and light reflected from the surface of the water below the layer of oil create interference.
- B) Because the index of refraction of oil depends on the color of light, so refraction creates a spectrum reminiscent to that of a prism.
- C) Because oil mixes with water and changes its color.

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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. Light with a wavelength of  $\lambda = 680$  nm enters from the air into a slab of glass which has an index of refraction  $n = 1.52$  .**

- a) What will its frequency and wavelength be in the glass?  
b) What is the critical angle at which the light can just still exit the glass?

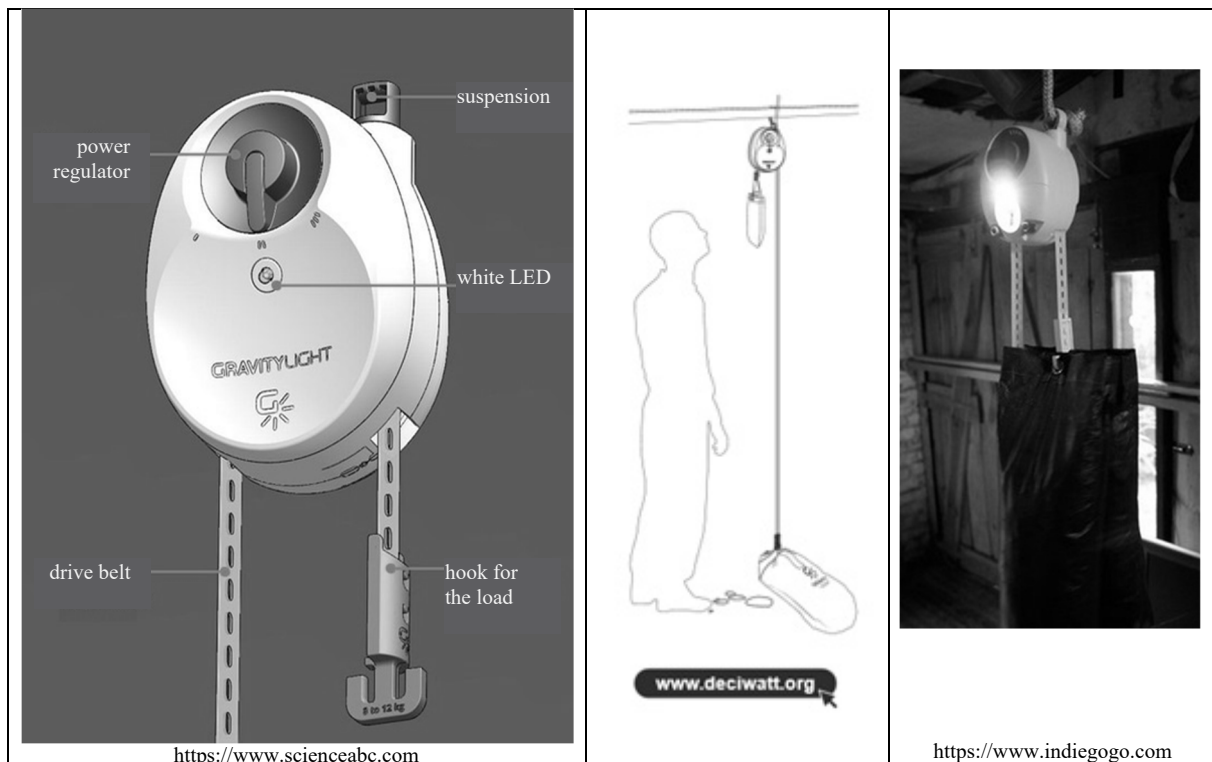
$$(c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}})$$

a)	b)	Total
9 points	6 points	15 points

2. Read the text below carefully and answer the following questions using the information contained in it.

### *Light from gravity*

About one and a half billion families in the world live without electricity. An English engineer has devised a new, cheap solution for lighting in the dark for them, putting gravity in the service of lighting. The source of energy for the lamp is a 10 kg sack filled with sand or rocks and hanging from a chain, which must be raised to a height of 1.8 meters. As the sack descends slowly turning a large cogwheel, it drives a small direct current generator at several thousand revolutions per minute through a tricky transmission. The generator operates a variable power LED light. The power level of the light can be 0.1 W, 0.075 W or 0.05 W. In the middle level, the lamp will function for 30 minutes. During this time, the sack will descend to the ground with uniform motion and the lamp “runs out”, but the machine can be set into operation again if the sack is raised.



- Discuss the operation of the lamp from the point of view of energy transfer. What kind of useful energy conversions take place during operation?
- Using the data given for the middle power level, determine the efficiency of the lamp.
- Assuming that the efficiency of the lamp is the same at every power level, how long does the light operate at each level?

$$(g = 9.81 \text{ m/s}^2)$$

a)	b)	c)	Total
6 points	5 points	4 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 We heat air enclosed in a vessel with a piston at a constant normal atmospheric pressure. We measure the volume of the gas at different temperatures.**

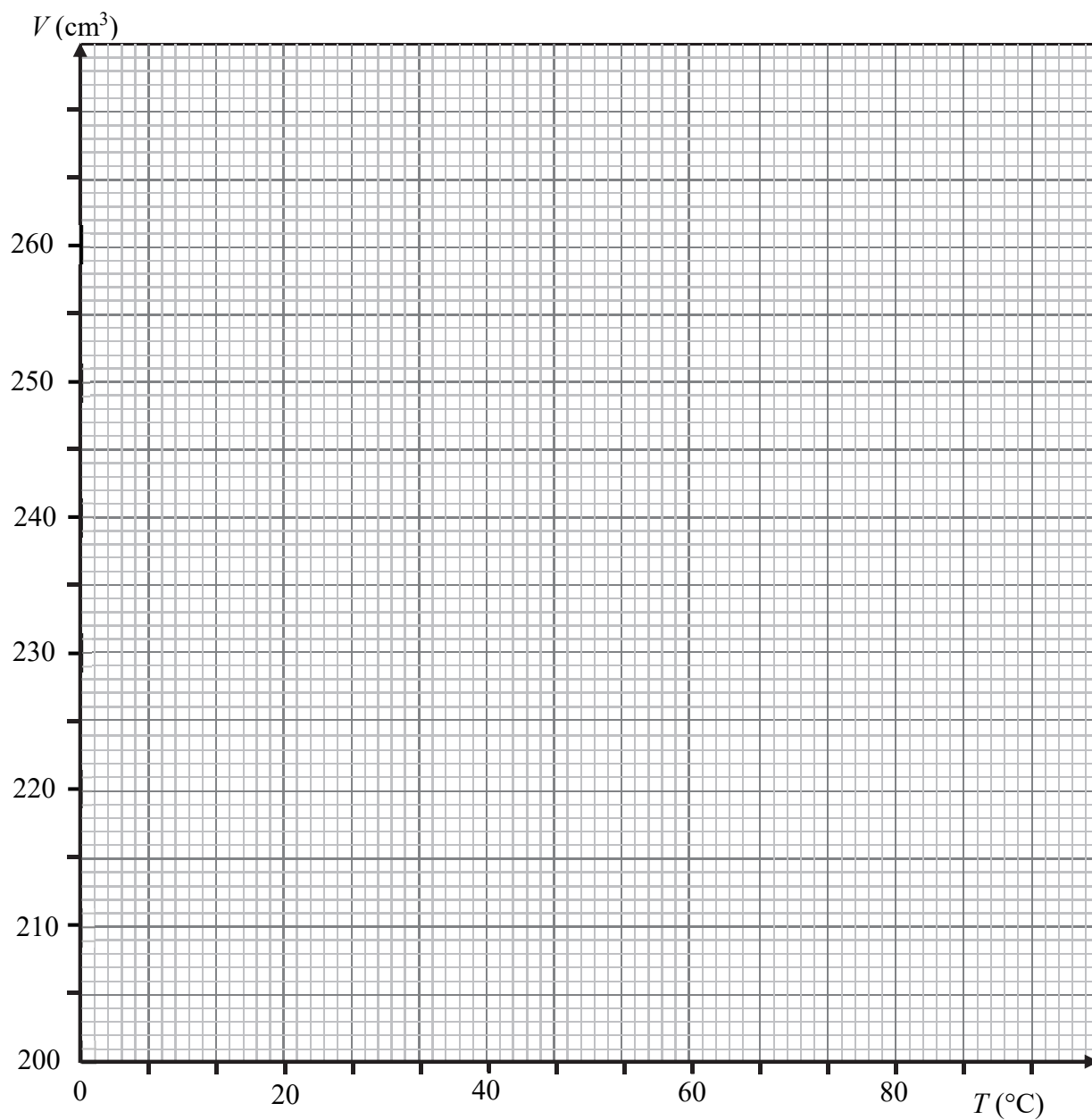
- a) Plot the volume of the gas as a function of its temperature measured in °C.

Answer the questions below using the measurement data (using a linear fit or calculations).

- b) Estimate the temperature at which the volume of the gas would become zero assuming that the trend of the graph remains the same for any temperature. (Where is the beginning of the Kelvin scale according to the measurement?)
- c) What is the volume of the air at 0 °C?
- d) What is the mass of the air enclosed?

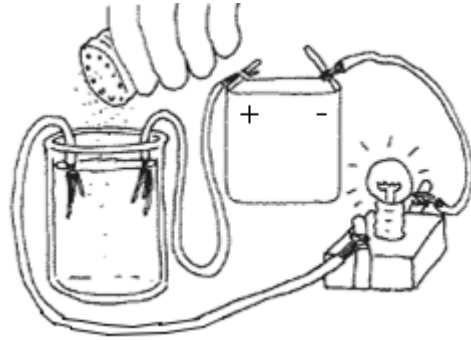
temperature in °C	volume (cm <sup>3</sup> )
20	216
30	222
40	229
50	237
60	244
70	251
80	259

$$(R = 8.31 \frac{\text{J}}{\text{mol} \cdot \text{K}}, p_0 = 10^5 \text{ Pa}, M = 29 \frac{\text{g}}{\text{mol}})$$



a)	b)	c)	d)	Total
4 points	6 points	4 points	6 points	20 points

**3/B** If we cut the wire of an electric circuit containing a battery and a light bulb and immerse the broken ends of the wire into distilled water, the light will not operate. However, if we pour common salt (NaCl) into the water, the light will start operating again – though possibly somewhat dimmer than before.



Source: <http://www.labbe.de/zzzebra/index.asp?themaId=684&titelId=5491>

- a) Explain why the light does not operate when the wires are immersed in distilled water.
- b) Explain why the light will operate when we pour salt into the water.
- c) What kind of particles move toward the wires connected to the positive and the negative poles of the battery in the salt solution?
- d) How does increasing the concentration of the salt solution affect the electric resistance of the solution and the light power of the light bulb?

a)	b)	c)	d)	Total
6 points	8 points	2 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>Total score of the written exam</b>	<b>90</b>	

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date

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examiner

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

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