Név: ..... osztály:.....

ÉRETTSÉGI VIZSGA • 2015. május 18.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA

2015. május 18. 8:00

Az írásbeli vizsga időtartama: 120 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

EMBERI ERŐFORRÁSOK
MINISZTÉRIUMA

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.
Aid allowed: 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. We are standing on a mountain top and observing a storm cloud developing above another, distant mountain peak. Suddenly, we see that a bright lightning strikes the peak and we hear the thunder approximately 15 seconds later. What can we say about the distance between us and the storm cloud that has developed above the distant peak?

A) The distance is about 5 km.
B) The distance is about 10 km.
C) The distance is about 20 km.

2 points	

2. What is the physical unit of the Coulomb force that acts between two electrical charges?

A) N/C^2
B) Nm^2/C^2
C) N

2 points	

3. What is in the box that can be seen on the picture?

A) A generator that replaces the energy losses of the high voltage power line.
B) A transformer that reduces the voltage from that of the power line to that of domestic electric networks.
C) An amplifier that amplifies the current that flows in the power line.

2 points	

4. We sealed an empty glass jar with a lid made of a rubber membrane in a warm room. The membrane thus formed a perfectly horizontal surface. We then took the jar outside to a cold yard and after a few minutes placed a straight wooden rod onto the jar and took the picture shown. The rubber membrane was indented. Why is this? Which statement is true?

A) Some of the enclosed air escaped from the jar.
B) An increase of the outside air pressure can be the only explanation.
C) The pressure of the air inside the jar decreased as it cooled.

2 points	

5. We shine UV light on a positively charged zinc plate placed in vacuum. What happens?

A) It depends on the precise value of the wavelength of the light that we shine on it.
B) The plate becomes negatively charged.
C) The plate remains positively charged.

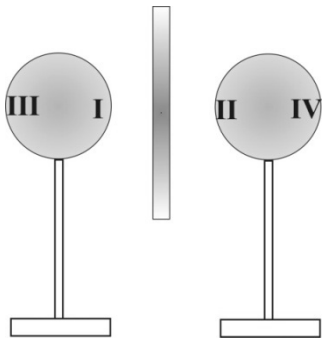
2 points	

6. We place two identical, point-like bodies on two slightly curved slopes that have the same height and length as shown on the figure. We then let them go. Which one will reach the bottom of the slope with a higher speed? (Friction is negligible.)

A) The body on the left, moving along the concave slope will reach the bottom with a higher speed.
B) The body on the right, moving along the convex slope will reach the bottom with a higher speed.
C) The two bodies will reach the bottom of the slopes with the same speed.

2 points	

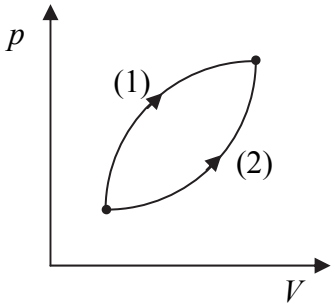
7. We place two uncharged metallic spheres on insulating stands on the table. We place a charged plate of insulator between them, so there is a rearrangement of charges on the spheres. Which statement is true?



A) The charges in regions I. and II. are of opposite sign.
B) The charges in regions I. and II. are of identical sign.
C) The regions I. and II. will be neutral, only regions III. and IV. will be charged. ☐

2 points	

8. A gas enclosed in a container reaches the same final state starting from the same initial state along two different processes as shown on the adjacent figure. During which of the two processes is the work done by the gas greater?



A) During process (1).
B) During process (2).
C) The work done is equal during the two processes. ☐

2 points	

9. What do we mean by the second cosmic velocity on Mercury?

A) The speed by which a body has to be launched from the surface of Mercury to escape the gravitational pull of Mercury and move away an arbitrary distance.
B) This notion has no meaning on Mercury, because it has no atmosphere, so the notion of cosmic velocity is meaningless.
C) The speed by which a body has to be launched from the surface of Mercury to go into orbit around Mercury close to its surface. ☐

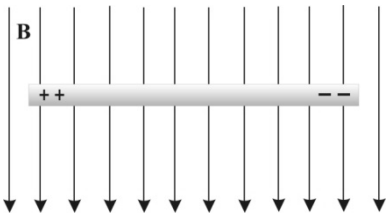
2 points	

10. The accident in the Fukushima nuclear power plant occurred, because the tidal wave destroyed the pumps of the cooling system and thus the fuel in the *already stopped* nuclear reactor could not be cooled properly. Why is it necessary to cool the used, spent fuel in a nuclear power plant?

A) Because the fuel reaches such high temperatures from the energy released during use that it has to be cooled for months or years afterward.
B) Because the fission products of uranium in spent fuel are strongly radioactive and they release a lot of heat as they decay.
C) Because even though the chain reaction was stopped, it continues to go on in the fuel even after use, releasing heat.

2 points	

11. In a homogeneous magnetic field, the lines of magnetic induction are parallel to the plane of the paper. (See the figure.) In the magnetic field, we move a metal rod that is perpendicular to the lines of induction. Because of this, there is a separation of charges in the rod as shown in the figure. In which direction does the rod move?



A) Perpendicular to the plane of the paper, towards the paper (away from us).
B) Perpendicular to the plane of the paper, outwards from the paper (towards us).
C) In the plane of the paper, to the left.

2 points	

12. The front cogwheel of a bicycle has 30 cogs while the rear one has 15 cogs. Which statement is true?

A) The tangential velocity of the two cogwheels is the same.
B) The angular velocity of the two cogwheels is the same.
C) The revolutions per second of the two cogwheels are the same.

2 points	

13. The chemical energy released when the fuel is burned in an internal combustion engine is partially transformed to translational motion of the car (mechanical work), and partially heats the engine and the exhaust gases (heat losses). Which of the definitions below gives the efficiency of the engine?

A) The ratio of the mechanical work to the chemical energy.
B) The ratio of the mechanical work to the heat loss.
C) The ratio of the chemical energy to the mechanical work.

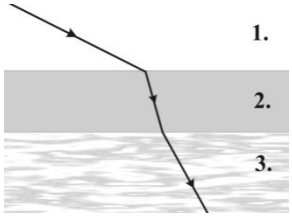
2 points	

14. Which one of the 1 MeV energy α-, β-, and γ-particles has the greatest speed?

A) The α-particle.
B) The β-particle.
C) The γ-particle.

2 points	

15. A glass plate with parallel interfaces (medium 2.) separates two materials with different indices of refraction. A laser beam is directed at the plate from material 1., the route it traces is shown in the figure. In which one of the three materials is the speed of light the greatest?



A) The speed of light is the greatest in material 1.
B) The speed of light is the greatest in material 2.
C) The speed of light is the greatest in material 3.

2 points	

16. A small, agile squirrel climbs to the top of the tree very quickly. A fat, slow cat follows it. Which one does more work?

A) The squirrel.
B) The cat.
C) The work they do is equal; it is the power they exert that will be different.

2 points	

17. A UV lamp and an infrared lamp emit an identical number of photons during the same time interval. The power of which lamp is greater?

A) The power of the UV lamp, because the energy of UV photons is greater than that of infrared photons.
B) The power of the infrared lamp, because at an identical power level, the infrared lamp emits more photons.
C) Their power is the same, because the number of photons is identical in both cases. ☐

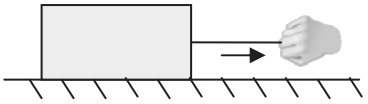
2 points

18. We drop cold (-18 °C) ice cubes into hot (95 °C) tea. The ice cubes emit a crackling sound. What is the explanation of this phenomenon?

A) The hot tea makes the ice cubes shrink so they crack, that is what makes the crackling sound.
B) The hot tea makes the ice cubes expand so they crack, that is what makes the crackling sound.
C) The ice cubes freeze a little tea around them that is what makes the crackling sound. ☐

2 points

19. We are pulling a body towards the right with a horizontal force using a rope as shown in the figure. What is the direction of the force in the rope?



A) The force in the rope is directed towards the right, because we are pulling the body towards the right.
B) The force in the rope is directed towards the left, because the rope is pulling our hand backward.
C) That depends whether we consider the force that the rope exerts on our hand or on the body. ☐

2 points

20. Which force is greater? The gravitational force exerted by the Sun on comet Haley, or the gravitational force exerted by comet Haley on the Sun?

A) The force exerted by the Sun, because the mass of the Sun is much greater.
B) The force exerted by the Sun, because comets do not exert a gravitational force on other bodies.
C) The two forces are precisely equal in magnitude. ☐

2 points

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. A capsule is dropped with zero initial speed into NASA's 132 m deep drop tube, evacuated of air. At the same time, another one is shot upward from the bottom. The two capsules meet precisely halfway in the tube.

a) What is the speed of the capsule that was dropped from above when the capsules meet?
b) What initial speed did the capsule shot from below need to have so that the capsules meet exactly halfway in the tube?
c) What was the speed of the capsule that was shot upward from below when the capsules met?

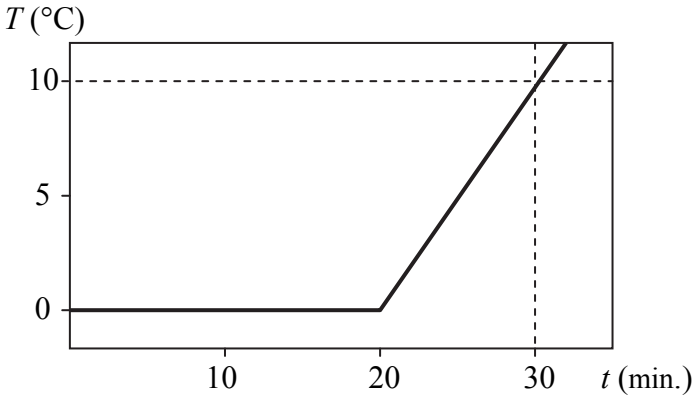
$g = 9.8 \frac{\mathrm{m}}{\mathrm{s}^2}$

a)	b)	c)	Total
4 points	8 points	3 points	15 points

2. There is a mixture of ice and water in an insulated vessel (calorimeter). The overall mass of the mixture is 1 kg. At an instant $t = 0$ we begin heating the mixture in the vessel using an electrode. The graph below depicts the temperature of the material in the vessel as a function of time.

a) Using the graph, determine the instant at which all of the ice in the calorimeter has just melted. Justify your answer.
b) Determine the power of the electrode using the section of the graph between $t = 20$ minutes and $t = 30$ minutes.
c) What was the mass of the water in the vessel at $t = 0$?

(The specific heat of water is $c_{water} = 4200 \frac{\text{J}}{\text{kg} \cdot \text{K}}$, the heat of fusion of ice is $L_{ice} = 334 \frac{\text{kJ}}{\text{kg}}$, the heat capacity of the calorimeter is negligible.)



a)	b)	c)	Total
4 points	5 points	6 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.

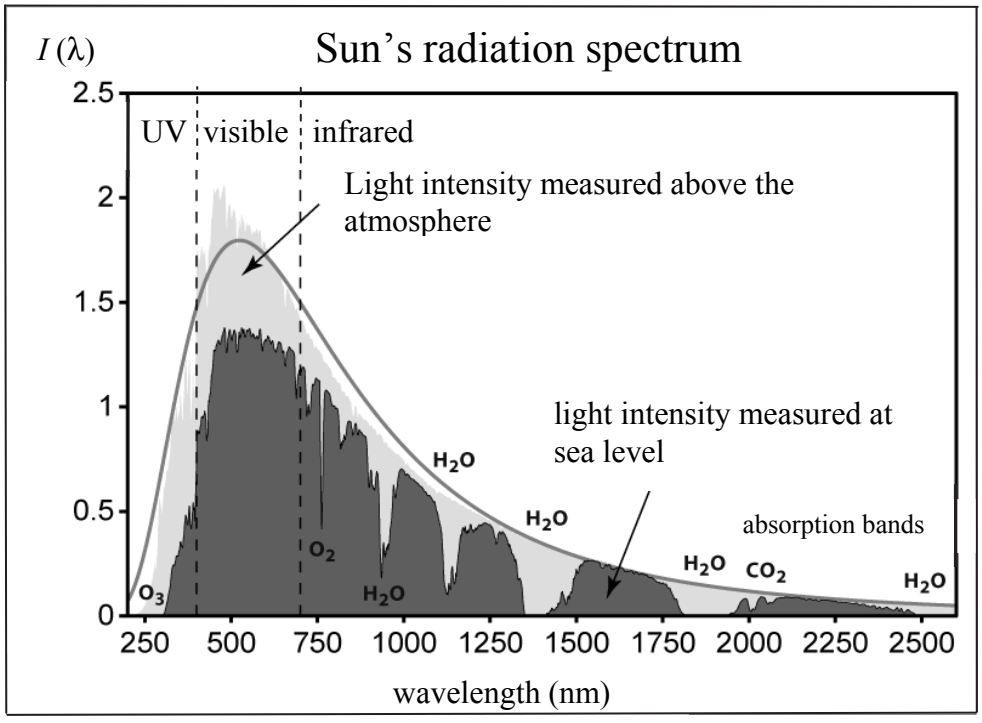
3/A We place an empty, open wine bottle into the freezer. About half an hour later we take it out, place it upright on the table, wet the opening a little and place a coin over it. We then place our hands on the side of the bottle standing on the table. We observe that the coin on the opening will start to make small jumps at short time intervals, emitting an audible popping sound and falling back onto the bottle each time.

a) Explain why the coin starts jumping when we place our hands on the bottle. What is the force that raises the coin? Why does it fall back down and why does it jump up again?
b) How long will the coin keep jumping on the bottle?
c) What will be different if we use a bigger, heavier coin to close the bottle?
d) What happens if we don't place our hands on the bottle, just leave it to stand on the table by itself?
e) What role does wetting the opening of the bottle play?

a)	b)	c)	d)	e)	Total
10 points	2 points	4 points	2 points	2 points	20 points

3/B The graph below depicts the radiation spectrum of the Sun. The wavelength of the radiation is along the horizontal axis, while the quantity *I(λ)* on the vertical axis shows the energy carried per second by the part of the radiation in the wavelength interval [*λ, (λ+1) nm*] onto an area of 1 m^2 perpendicular to the radiation. The lighter area depicts data measured above the atmosphere, at the boundary of space, while the darker area depicts data measured at Earth's surface in sunny weather. (The thin gray line shows the theoretical expectation obtained using Planck's law of radiation.) One can deduce from the graph for example, that the part of the radiation whose wavelength is between 500 nm and 501 nm, arriving onto an area of 1 m^2 above the atmosphere, carries a power of approximately 2 W. The table below shows the frequency ranges for the notable types of electromagnetic radiation. Answer the questions below using the graph and the table.

a) The radiation intensity measured at Earth's surface is less than that measured at the top of the atmosphere for all wavelengths. Why is this?
b) How can it be, that for certain wavelength ranges, only a small fraction of the radiation reaches the Earth's surface, while for other wavelength ranges, this reduction is much smaller? What materials are responsible according to the diagram?
c) Approximately which radiation frequency does the carbon-dioxide molecule absorb well? Which notable frequency range does this radiation belong to?
d) Approximately which radiation frequency does the ozone (O_3) molecule protect the surface from? Which notable frequency range does this radiation belong to?



Type of radiation:	Frequency range:
Far infrared	300 GHz–3 THz
Infrared	3 THz–30 THz
Near infrared	30 THz–0,4 PHz
Visible light	0,4 PHz–0,8 PHz
Ultraviolet	0,8 PHz–3 PHz

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

To be filled out by the examiner evaluating the paper!

	maximum score	score attained
I. Multiple-choice questions	40	
II. Complex problems	50	
Total score of the written exam	**90**	

examiner

Date: .....

	Score attained rounded to the **nearest integer** (elért pontszám **egész számra** kerekítve)	**Integer** score entered in the program (programba beírt **egész** pontszám)
I. Multiple-choice questions (Feleletválasztós kérdéssor)		
II. Complex problems (Összetett feladatok)		

examiner (javító tanár) notary (jegyző)

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