ÉRETTSÉGI VIZSGA • 2020. május 19.

FIZIKA
ANGOL NYELVEN

KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA

2020. május 19. 8:00

Időtartam: 150 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

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. **The adjacent graph depicts the velocity of an object moving along a straight line as a function of time. How far did the object move from the initial position where it was at $t = 0$ s during the 10 s time interval?**
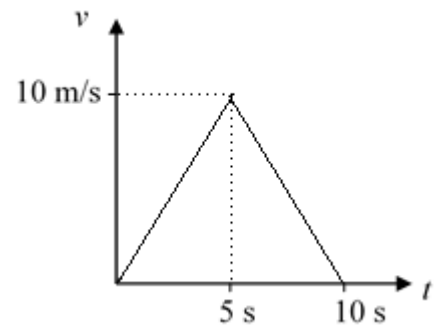
   A)   100 meters.
   B)   50 meters.
   C)   10 meters.
   D)   0 meters.
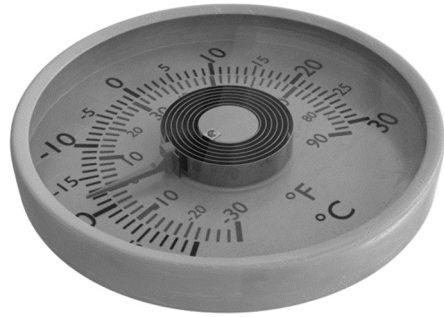
   2 points

2. **The adjacent picture was taken of a swimmer underwater. What optical phenomenon can we observe on the picture?**

   A)   Dispersion.
   B)   Total internal reflection.
   C)   Polarization.

   2 points

3. **The adjacent picture depicts a thermometer where the pointer is fixed to metal strip shaped into a spiral. What could the metallic strip be in the thermometer?**

   A) The metallic spiral is a bimetallic strip, its deformation due to thermal expansion moves the pointer.

   B) The metallic spiral is for the flexible suspension of the pointer. For thermometers on moving machines or vehicles, the oscillation of the pointer caused by the vibrations of the machine or vehicle can be reduced this way.

   C) The metallic strip is a spring, this thermometer must be "wound up", i.e. the spring must be tensed for operation, similar to mechanical clockworks.

   2 points

4. **Which one of the planets of the Solar system mentioned below moves with the greatest acceleration along its orbit around the Sun?**

   A) Mercury, because that is the one closest to the Sun.

   B) Jupiter, because that one has the largest mass.

   C) Neptune, because that one has the longest orbit around the Sun.

   2 points

5. **A current carrying coil made of copper wire and a bar magnet are placed (fixed) adjacent to each other as shown by the drawing. What is the force that arises between the two objects that are at rest?**
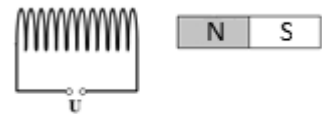
   A) An attractive force because the magnet attracts the metal.

   B) A repulsive force because, according to Lenz's law, the coil generates a magnetic field that repels the magnet.

   C) An attractive or a repulsive force may both arise depending on the direction of the current in the coil.

   2 points

6. **A piece of wood is floating on water. We first place an object on top of it, then tie the same object to its underside. The object on its own would sink, but the piece of wood together with the object remains afloat in both cases. In which case does the wood sink deeper into the water?**
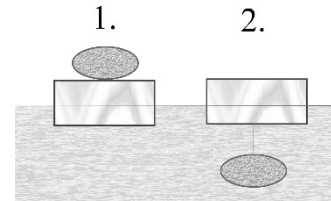
   A) The piece of wood sinks deeper in case 1.
   B) The piece of wood sinks into the water by the same amount, because the same object was placed onto or tied underneath it.
   C) The piece of wood sinks deeper in case 2.

2 points	

7. **Windows used in construction nowadays are mostly double layered, with 4 mm glass, 16 mm air filled gap and then another 4 mm glass. Which is a better heat insulator: this 4-16-4 mm composite structure, or a solid glass pane 24 mm thick?**
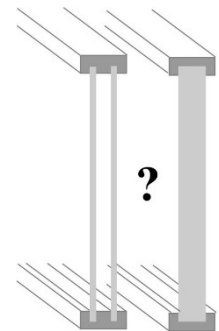
   A) The 4-16-4 mm structure is the better insulator, because air is a bad conductor of heat.
   B) The 4-16-4 mm structure is the better insulator, because air is a good conductor of heat.
   C) Heat conduction is the same, the 4-16-4 structure is used only because it weights less.

2 points	

8. **We would like to operate a 4 kW electric oven in the kitchen using a 230 V electric socket protected by a 13 A circuit breaker. Does the circuit breaker disengage in this case?**

   A) Yes because the current would be too large during the operation of the stove.
   B) No, because although the current will be larger than 13 A, but voltage remains stable.
   C) No, because the current drawn by the stove does not reach 13 A.

2 points	

9. **A small cart is shoved from horizontal ground onto first a 5° slope, then a 10° degree slope. The initial speed of the cart is the same in both cases, friction and air drag are negligible. On which slope will the cart attain a greater height above the ground? (The slopes and the level ground are connected in a smoothly changing manner.)**

    A) On the 5° slope.
    B) On the 10° slope.
    C) The cart attains the same height on the two slopes.

    2 points

10. **The helium nucleus is composed of protons and neutrons. What can we say about the overall mass of the free protons and neutrons (not bound by nuclear forces) compared to the mass of the helium nucleus?**

    A) The overall mass of the free protons and neutrons equals the mass of the helium nucleus.
    B) The overall mass of the free protons and neutrons is greater than the mass of the helium nucleus.
    C) The overall mass of the free protons and neutrons is less than the mass of the helium nucleus.

    2 points

11. **For relatively slow motions, the drag force in a medium is proportional to the speed the body moves with relative to the medium, i.e. we can write: $F = k \cdot v$ where F is the drag force, k is a constant of proportionality, and v the speed. What is the physical dimension of k if force is measured in newtons and speed in m/s?**

   **A)** kg · m/s.
    B) kg · m.
    C) kg/s.

    2 points

12. **If two objects are involved in thermal interaction, their temperatures equalize. Which object transfers some of its energy to the other?**

   A) The one that has a higher temperature.
   B) The one that has more internal energy.
   C) Both of the above conditions is required for the transfer of energy.

   2 points

13. **The adjacent drawing depicts the railway track map of a railway station. On which track can the same locomotive be allowed to move with the greatest speed, if the load on the tracks in the transverse direction must not exceed a certain value?**
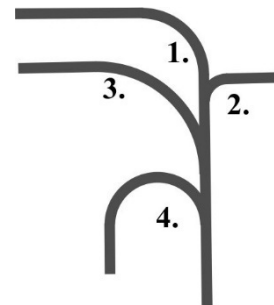
   A) On track 1.
   B) On track 2.
   C) On track 3.
   D) On track 4.

   2 points

14. **The leaves of the electroscope shown in the adjacent figure are spread apart, the electroscope indicates charge, as an electrically charged object is held close to it. Are the leaves of the electroscope charged with positive or negative charges?**

   A) They can only be positive, because if they were negative, the leaves would stick together.
   B) They can only be negative, because only electrons move in conductors.
   **C)** They may be both positive or negative as well.

   2 points

15. We know that a certain spherical mirror creates a real, magnified image of an object. Compare the image distance (k) to the object distance (t)!

    A) $t > k$.
    B) $t < k$.
    C)   It is not possible to decide using the information at hand.

2 points	

16. Three empty glasses are placed upright on the table, all of the same height. The glasses marked with A and B have a thicker bottom than the one marked with C. Which glass has to be revolved around the edge of its bottom by the greatest angle for it to topple over (i.e. which one is the most stable)?

A   **B**   **C**
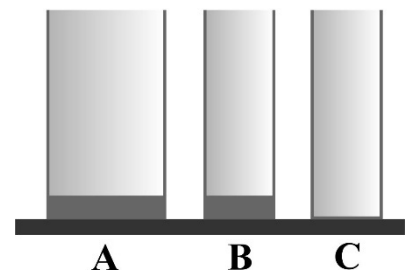
    A)   Glass A.
    B)   Glass B.
    C)   Glass C.
    D)   All three must be revolved by the same amount.

2 points	

17. According to the inscription, a battery produces 9 V tension. We want to operate a light bulb designed for 1.5 V-s using it. How can we avoid burning the bulb out?

    A)   We connect a resistor parallel to the bulb, so some of the current flows through that.
    B)   We connect a resistor in series with the bulb, so some of the voltage falls on that.
    C)   The task cannot be accomplished, the bulb will burn out in any case.

2 points	

18. When do we say that two atomic nuclei are each other's isotopes?

   A) If the neutron numbers of the two atomic nuclei are equal.
   B) If one atomic nucleus has surplus electrons, while the other one has a deficit of electrons.
   C) If both atomic nuclei are radioactive.
   D) If the proton numbers of the two atomic nuclei are equal.

2 points	

19. What is the energy of a photon in vacuum?

   A) It is always exactly the same amount, one quantum, i.e. one unit as defined by the Planck constant.
   B) Variable depending on the frequency of the photon.
   C) Variable, depending on the speed of the photon.

2 points	

20. Why is there a thick layer of dust on the Moon?

   A) Because of the winds as shown by the flag of the first astronauts on Moon.
   B) It is caused by volcanoes still active today.
   C) Because rocks break up due to large temperature differences.

2 points	

Név: .... osztály:......

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. **The engine of a relatively modern car consumes 6 liters of petrol while the car covers 100 km distance with a constant speed of 120 km/h. The power delivered by the engine during this time is 26 kW.**

   What percent of the heat released during combustion does the engine use for keeping the car in motion? (The density of petrol is 0.75 kg/dm^3, its combustion heat is 44 MJ/kg.)

Total
14 points

2. **The Galilei thermometer.** *The Galilei thermometer is a closed glass cylinder filled with some liquid, in which small spheres of slightly different average density are placed. A small copper plate is hanged from each sphere with a number inscribed on it. The density of the fluid decreases considerably as the temperature increases, while the density of the spheres is essentially unchanged. As the temperature increases, the spheres sink to the bottom of the cylinder one by one. For every two degrees of temperature increase, another sphere sinks. The temperature of the liquid can be read from the plate hanging on the lowest sphere still afloat. The density of the liquid in a given temperature range is shown on the graph below. It is possible to buy thermometers with 10 spheres, and also larger ones containing 25 spheres. These too are constructed such that one additional sphere sinks for every 2 degrees.*
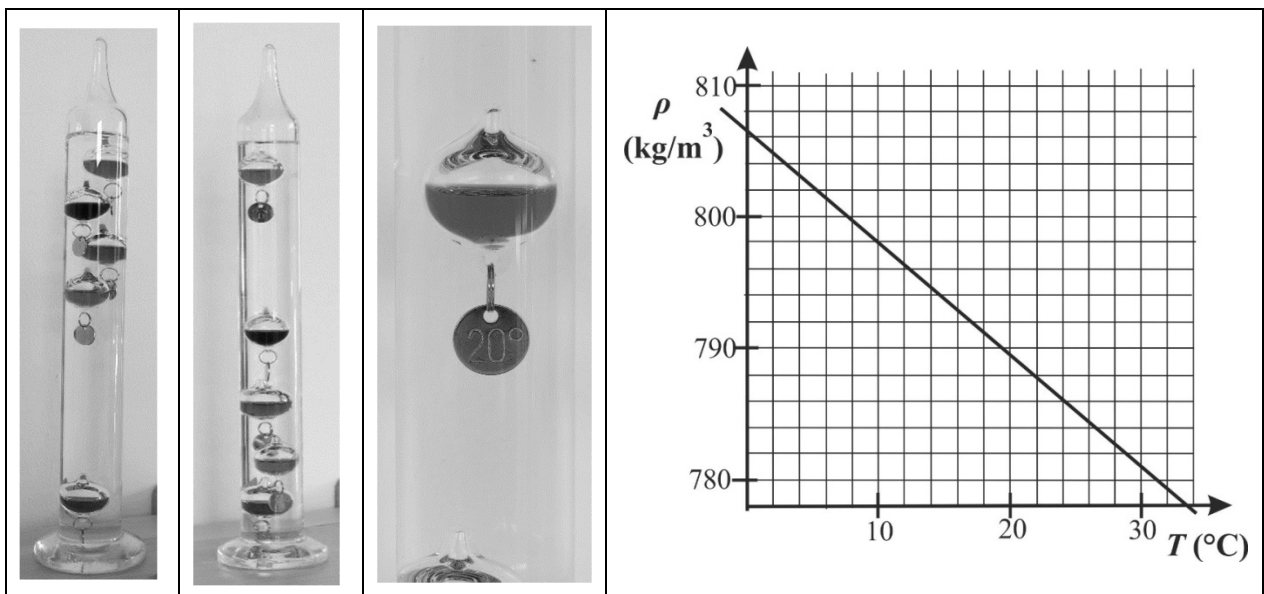

a) What are the forces acting on the spheres in the fluid? What determines whether a sphere sinks or floats?

b) Why do the spheres sink one after another as the temperature increases? Which sphere has the greater average density: the one marking the lowest temperature or the one marking the highest temperature?

c) What is the accuracy of the thermometer and what determines its measurement range?

d) What is the mass of the sphere which has a volume of 4.5 cm^3 and which just floats in the liquid at the temperature of 20 °C (i.e. it floats but is just about to sink)?

a)	b)	c)	d)	Total
3 points	5 points	4 points	4 points	16 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.
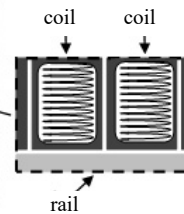
3/A
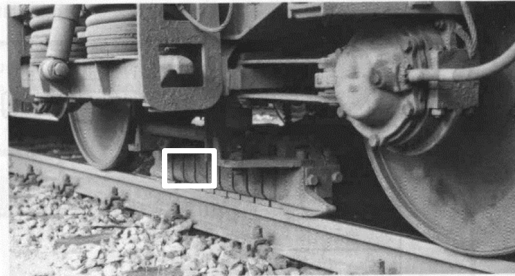
Rail brake type 1   **Rail brake type 2**

Magnetic rail brakes are used to brake trains or trams. There are two types. Both types contain a series of electromagnets with vertical axes close to the railway rail, enclosed by housing as depicted on the figures. In one case (type 1.) the driver actuates strong direct current in the coil to break. The coils are attracted to the rail overcoming a spring force and the friction surface on their underside is pressed against the rail to break the vehicle.
In the other case (type 2.) current is started in the coil when breaking, but it is not pressed against the rail. The magnetic field of the coils generates eddy currents in the metallic rail due to the motion of the train. This is what slows the train down.

a) Explain the operation principle of the type 1 brake by analysis of the forces acting between the rail and the brake system.
b) Why is the braking force increased if we increase the magnitude of the current in the coils?
c) Explain the operation principle of the type 2 brake. Which physical phenomenon is the basis of its principle of operation?
d) Would the type 1 or the type 2 brake system work on rails made of copper or stone?

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

3/B

In an experiment, we investigated the effective range of α-radiation of an americium-241 sample in air. To this end, we placed a radiation detector at different *r* distances from the sample and measured the number of particles hitting the detector per second. As the emitted α-particles will collide with the molecules of air with a high probability after a certain distance, the radiation cannot be detected beyond a certain distance. The table below contains the values measured during the experiment.

r (cm)	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
N (1/s)	2400	1540	1040	740	540	400	300	240	180	140	120

a) Plot the number of particles detected per second as a function of the distance.
b) What is the approximate value of the particle number at a distance of 1.3 cm from the sample?
c) Is it true that if we double the distance the measured particle number is reduced by half? Justify your answer using experimental data.
d) Is it true that the measured particle number decreases linearly with increasing distance? Justify your answer using experimental data.
e) To reduce radiation exposure, radioactive samples are often placed in containers made of lead with thick walls. Why is this measure more effective than having radiation being absorbed in air?
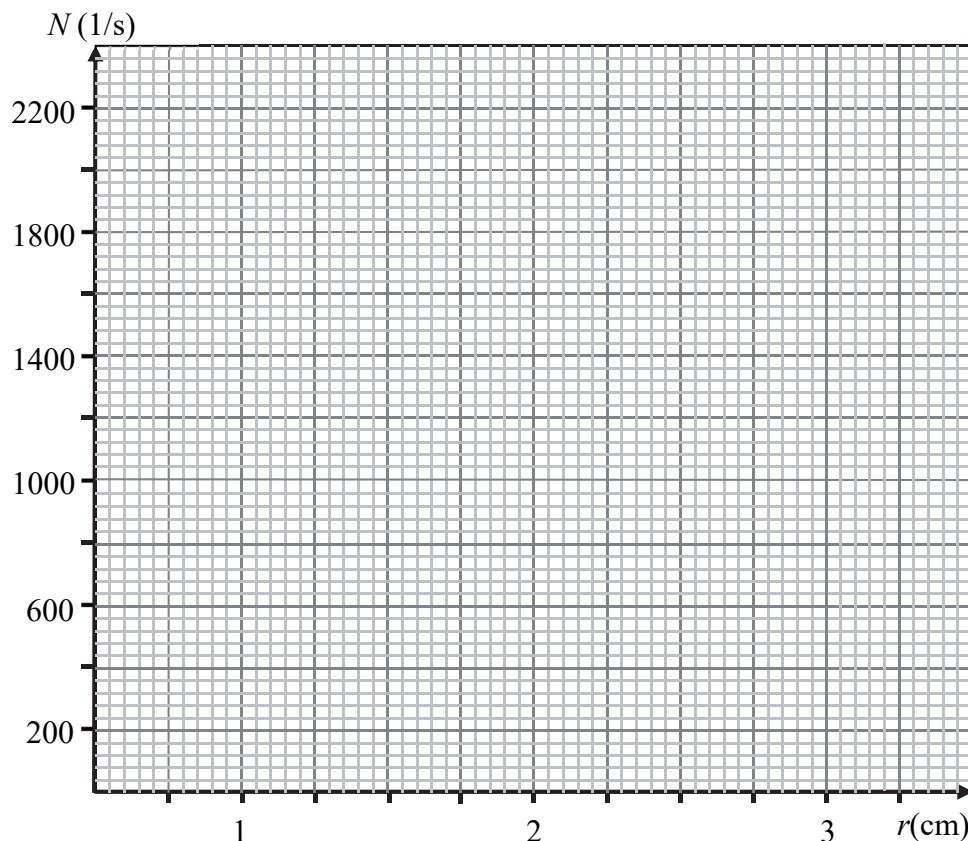
a)	b)	c)	d)	e)	Total
5 points	3 points	4 points	4 points	4 points	20 points

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

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                date   examiner

	pontszáma **egész számra** kerekítve	
	elért	programba beírt
I. Feleletválasztós kérdéssor		
II. Összetett feladatok		

———————————————   ———————————————
             dátum   dátum

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          javító tanár   jegyző