placed such that they came into contact. The initial temperature of one of them (denoted by A) is 1.0 K, whilst that of the other (B) is 3.0 K, and the final common temperature is 2.0 K. What will the final common temperature be if the initial temperature values of the metals are $T_A = 1.5$ K and $T_B = 2.5$ K? **P. 5203.** The refractive index of a transparent glass sheet of width $2A$ varies in the direction of axis z, which is perpendicular to the plane of the sheet. At $z = \pm A$ its value is n_0, whilst at $z = 0$ it is n_1. A thin ray of laser enters into the glass (at a "height of" $z = A$) and travels in the direction of axis x. The laser beam is deflected in the glass and travels along the curved path of a cosine function. a) How does the refractive index depend on z? b) What is the wavelength of the path of the laser? *Data:* $A = 1$ cm, $n_0 = 1.5$ and $n_1 = 1.6$. **P. 5204.** Determine the sensitivity of the cathode-ray oscilloscope shown in the *figure* in the unit of mm/volt. *Data:* the length of the deflecting plates is $\ell = 2$ cm, their distance is $d = 0.5$ cm, the distance between the screen and the centre of the plates is $s = 20$ cm, the accelerating voltage is $U_0 = 1000$ V, and the greatest value of the deflecting voltage is $U_{\max} = 100$ V. **P. 5205.** The *figure* shows a loop made of a piece of copper wire. The shape of the loop is two concentric semi-circles and two connecting straight line segments. The loop is on a horizontal tabletop, but initially the smaller semi-circle is in a vertical position. The small semi-circle is turned into the horizontal position in 1 s. The dashed line is the axis of rotation. The whole loop is in uniform vertically upward magnetic field. a) In which case is the flux linkage of the loop greater? b) What is the average value, and the direction of the induced current in the loop, while the smaller loop turns? What is the direction of the current? c) What is the greatest value of the induced current if the small semicircle is rotated at a constant angular speed and it takes exactly $\Delta t = 1$ s to turn from the vertical position to the horizontal position? *Data:* the magnetic induction is $B = 0.35$ T, the resistance of the loop is $R = 0.025$ Ω, the radius of the smaller semi-circle is $r = 0.2$ m. **P. 5206.** Determine the atomic mass number of ionium, which is the daughter element of uranium, after the uranium emits two α and two β particles. Which is the element whose isotope is the ionium? **P. 5207.** Muon (μ^-) is an unstable elementary particle, its mean lifetime is 2.197 μs, its mass is 207 times the mass of an electron, and its charge is the same as the charge of an electron. In a storage ring (a type of circular particle accelerator) there is uniform magnetic field, which is perpendicular to the plane of the ring. At a certain point of the ring, from the direction of the tangent at that point, a mono-energetic muon beam is injected into the storage ring. The muons revolve along the circular path and on average they decay after completing five whole turns. a) What is the (average) speed and kinetic energy of the muons if the radius of the storage ring is 120 m? b) What is the magnetic induction in the storage ring?

Problems of the 2019 Kürschák competition

1. In the acute triangle ABC we have $AB < AC < BC$. Let A_1, B_1 and C_1 be the feet of the altitudes from A, B and C, respectively. The point P is obtained by reflecting C_1 over the line BB_1 and the point Q is obtained by reflecting B_1 over the line CC_1. Prove that the circumcircle of the triangle A_1PQ passes through the midpoint of the side BC.

2. Let n be a positive integer. Find all families $\mathcal{F}$ that consist of certain subsets of $\{1, 2, \ldots, n\}$ and satisfy that for every fixed, nonempty subset $X \subseteq \{1, 2, \ldots, n\}$, the number of sets $A \in \mathcal{F}$ yielding an intersection $A \cap X$ of even, resp. odd cardinality is the same.

3. Is it true that for any bounded subsets H and A of the real line, the set H can be partitioned into pairwise disjoint translates of A in at most one way? (Infinitely many translates may be used.)