

absolute value of all of its roots are less than $1/3$, and all the coefficients of $p(x)$ are lying in the interval $[-2019a, 2019a]$ for some positive integer a . Prove that if this polynomial is reducible in $\mathbb{Z}[x]$, then the coefficients of one its factors are less than a . (Submitted by *Navid Safaei*, Tehran, Iran) **A. 790.** Andrew and Barry plays the following game: there are two heaps with a and b pebbles, respectively. In the first round Barry chooses a positive integer k , and Andrew takes away k pebbles from one of the two heaps (if k is bigger than the number of pebbles in the heap, he takes away the complete heap). In the second round the roles are reversed: Andrew chooses a positive integer and Barry takes away the pebbles from one the two heaps. This goes on, in each round the two players are reversing the roles. The player that takes the last pebble loses the game. Which player has a winning strategy? (Submitted by *András Imolay*, Budapest)

Problems in Physics

(see page 569)

M. 400. Investigate the position of the centre of mass of a pine branch, which was cut off near the trunk. That is, at what fraction of the length of the branch is the centre of mass? Carry out the measurement with the cut-off side branches as well. Take care, not to bend the branches too much. Compare the results. The pine branch can be a lowest branch of the Christmas tree, which had been cut off before the tree was put into its stand.

G. 725. The winding road in Bükk Mountains, which connects the cities Eger and Miskolc is approximately 50 km long. On a summer Sunday morning the traffic was heavy in both directions. Cars in both directions travelled at an average speed of 35 km/h, the oncoming cars passed each other on an average of one minute. Estimate the number of cars on the road at the same time (travelling in both directions). **G. 726.** The four inner cogwheels shown in the *figure* are moving round, whilst the outer one is at rest. (The motion of the cogwheels can be seen on the homepage.) *a)* Compare the periods of the cogwheels. *b)* Order the speeds of the centres of the cogwheels increasingly. **G. 727.** The length of a train is 93.5 m. The train starts from rest and travels at a constant acceleration along a straight railway. At the starting moment of the train a car, moving along a straight road parallel to the railway at a constant speed, is next to the end of the train, and after 14 seconds the car reaches the front of the train. After another 16 s, the car is again at the end of the train. *a)* What is the speed of the car? *b)* What is the acceleration of the train? *c)* How much distance does the car travel until the train finally passes it? **G. 728.** Some liquids – like raw milk or salad dressing made from olive oil and balsamic vinegar – when left to rest separate to their constituents. The oil will be on the top of the dressing and greasy cream will be on the top of the milk, while the total volume of the liquid does not change. How does the hydrostatic pressure at the bottom of the bottle into which the liquid is poured change when it is left to rest (increases, decreases or does not change) if the bottle *a)* is tapering upward; *b)* has a cylinder shape; *c)* is broadening out upward?

P. 5272. The four inner cogwheels shown in the *figure* are moving round, whilst the outer one is at rest. (The motion of the cogwheels can be seen on the homepage.) What are the values of the number of turns of the cogwheels labelled with the letters *A*, *B* and *C* if the smallest cogwheel labelled with *D* completes a full revolution in each second?

P. 5273. A cuboid of mass $m = 0.5$ kg, base-side $a = 20$ cm and of height $b = 10$ cm is initially held at rest on the top of a right-angled inclined plane of mass M shown in the *figure*. The angle of elevation of the inclined plane is $\alpha = 30^\circ$ and its height is $h = 60$ cm. The cuboid is released at a certain moment. Friction is negligible everywhere. *a)* What is the ratio of the speeds of the two objects when the cuboid touches the ground? *b)* How

long does it take for the cuboid to reach the ground? *c)* How much distance is covered by the cuboid? **P. 5274.** A rigid rod of length $3L$, shown in the *figure* can be rotated frictionlessly in a vertical plane about a horizontal axle, which is at a distance of L from the left end of the rod. The mass of the rod is negligible. Two small objects of masses m and $2m$ are attached to the ends of the rod, and the rod is held horizontally. Then the rod is released at a certain moment. *a)* What is the magnitude of that component of the force exerted on the axle by the rod which is parallel to the rod at the moment when the angle between the rod and the horizontal is α ? *b)* Determine the angle of α at the moment when the magnitude of the total force exerted by the rod on the axle is $4mg$.

P. 5275. One of the fountains in city Kaposvár jets 1 cubic metre of water into the air to a height of 5 m in each minute. *a)* What is the power of the electric motor if the efficiency of pumping is 75%? *b)* At what speed does the water flow out of the nozzle? *c)* What is the diameter of the water flowing out of the nozzle? *d)* What is the diameter of the water at a height of 2.5 m? Do not consider air-drag and that the water is separated to small drops.

P. 5276. With a sphere-shaped balloon of diameter 25 cm we get into the cabin of a cable car and travel up to the top of the peak called Zugspitze. The cabin is not air-tight, but the temperature inside is kept to be the same as it is at the bottom station. The cabin starts at a height of 1000 m above sea level and goes up to a height of nearly 3000 m above sea level. The pressure inside the balloon is only a little greater than the ambient air pressure during the whole the journey. Estimate the diameter of the balloon when we get off.

P. 5277. The focal length of a camera is 50 mm, the diameter of the lens is 20 mm. The lens is adjusted such that it forms the sharp image of an object which is at a distance of 5 m from the lens. What is the smallest and greatest distance of a point-like object from the film, between which the image formed on the film is smaller than a spot of diameter 0.05 mm? How will this interval change if the diameter of the lens is decreased to 10 mm?

P. 5278. How much do the bulbs glow if they are connected in series to a voltage supply of 230 V? The voltage and power ratings of the bulbs are the following: *a)* one bulb rated as 230 V, 25 W and another rated as 230 V, 100 W; *b)* one of them is rated as 110 V, 25 W and the other as 110 V, 100W; *c)* one of them is rated as 110 V, 25 W and the other as 230 V, 100 W; *d)* one of them is rated as 230 V, 25 W and the other is rated as 110 V, 100 W?

P. 5279. Electric current of magnitude I flows in two pieces of a very long parallel wire, which are at a distance of 2ℓ , in the opposite direction. A rectangle-shaped loop of wire is placed in the plane of the two wires at a distance of $d = \ell - b$ from one of the wires, first in position 1 and next in position 2, shown in the *figure*. The sides of the rectangle are a and b , where $0 < a - b < \ell$. In which case will the flux linkage of the loop be greater?

P. 5280. The structure of potassium chloride ion crystal of density 1.98 g/cm^3 is the same as that of rock salt. What is the distance between the centres of the nearest positive and negative ions in this crystal?

P. 5281. What will the maximum charge be on an initially uncharged metal spherical shell of radius 50 mm, which is mounted on an insulating stand, if it is illuminated for a long time with a UV light source? The shortest wavelength of light emitted by the source is 280 nm, and the work function of the metal of the shell is 3.7 eV. Neglect the conducting effect of air.

P. 5282. A magnetic disc is moving on an air-cushioned table above a metal sheet. Due to the generated eddy currents there is a retarding force exerted on the disc, which is proportional to the speed of the disc. Moving above a sheet made of aluminium the disc stops after covering a distance of 30 cm, but when the sheet is made of copper the disc stops after covering only 20 cm. How much distance will the disc cover if first it travels above a piece of copper sheet of width 15 cm, and then continues its motion above an aluminium sheet? (The initial speeds of the disc are the same in all the three cases.)