"Fizika Üzrə Respublika Fənn Olimpiadası"
Azerbaijan Physics Olympiad 2020 Finals
Senior Level

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Problem 1. There are two conductive rods with length ℓ and resistance R are initially at rest on two parallel friction-less rails. Initially there's a distance d between the rods. There also exists a magnetic field B perpendicular to the plane of the rods and the rails. Masses of the both the rods are equal to m. Initially, a speed v was given to the right rod. Find the distance between the rods after a long time.

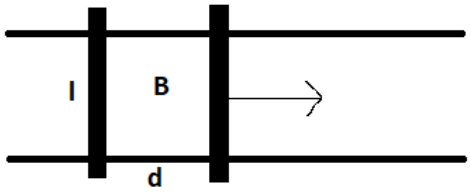

Figure 1: Problem 1

Problem 2. There's an athlete at point S. He can run on the ground with v and swim on the water twice less. Find the minimal time for going from point S to F. Picture is symmetric. Give your answer in terms of α, h, L, and v.

Problem 3. A light beam with frequency ω_0 falls to a mirror that possesses mass m and a velocity of v. Find the frequency of the light beam that reflected from mirror. Light beam falls normal to the mirror. The mirror's velocity is the same direction with speed of the light (in other words, the velocity vectors are parallel).

Problem 4. There's a one mole ideal gas doing some process. The process consists of an isotherm $(1, 2)$, an isochore $(2, 3)$, a polytropic process $(3, 4)$, and an isobar $(4, 1)$. The molar capacity of gas during polytropic process is $C = 0.5R$. Minimal temperature of the gas during the whole cycle is $T_{\min} = 300$ K. Find the efficiency of this cycle.

Problem 5. There's a ring with radius R and a uniform charge q. Also, there's a semi infinite rod having linear charge density λ and length ℓ. The beginning point of the rod is on the center of the ring. Find the mutual interaction force between the bodies.

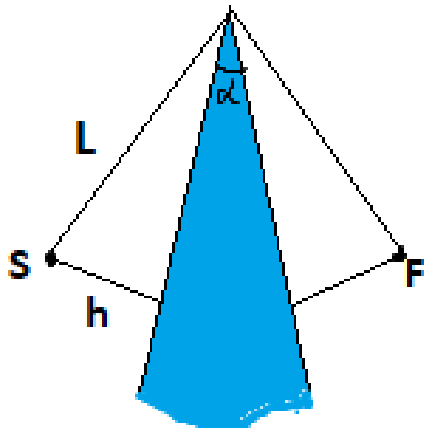

Figure 2: Problem 2

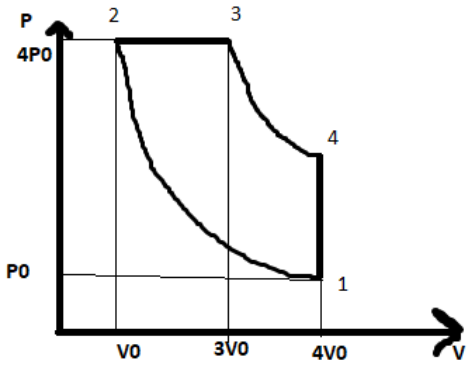

Figure 3: Problem 4

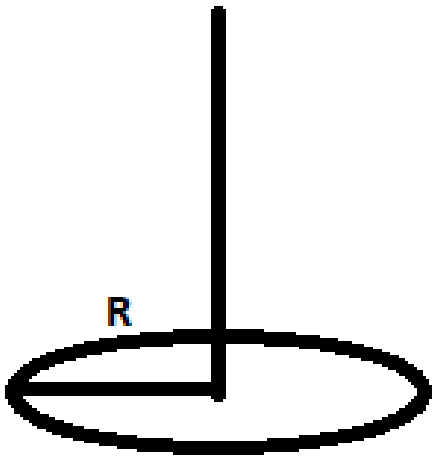

Figure 4: Problem 5