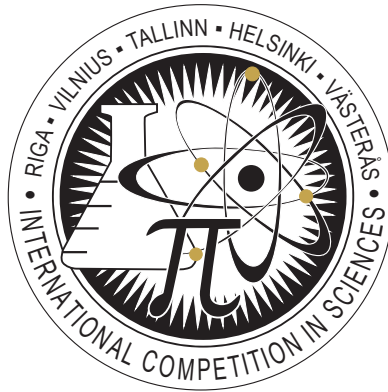


The 36th International Science Olympiad for Young Mathematicians, Physicists and Chemists



PHYSICS

GRADE 11

December 11-13, 2023
Munkkiniemen yhteiskoulu,
Helsinki Finland



Physics Olympiad 2023

Grade 11

1. Archimedes' principle

A thin-walled conical funnel stands tightly on a horizontal table, as shown in the Figure 1. A liquid of density ρ is poured into the funnel through a nozzle. When the liquid fills the entire conical cavity of the funnel, the liquid lifts the funnel and begins to flow out from beneath. Determine the mass of the funnel, if the radius of its base is R , and the height of the conical part is H .

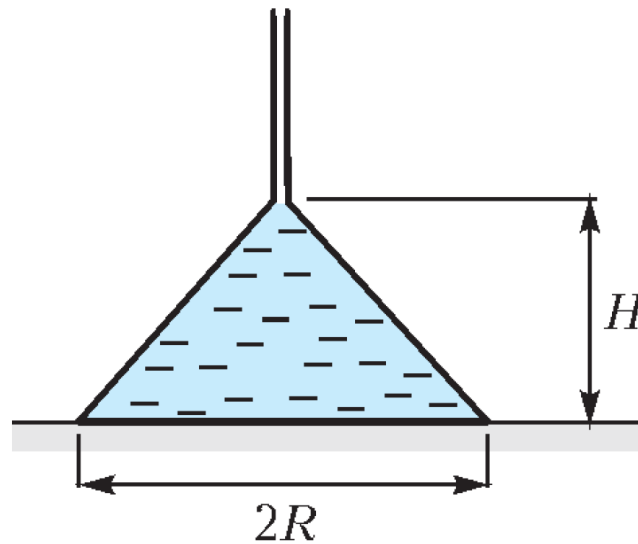


Figure 1: Conical funnel.

2. Newton's laws

A plank rests on a smooth table. A brick is brought in tight contact with the plank. The friction coefficient between the brick and the plank is $\mu = 0.1$. The plank is being moved without rotation at an angle of α to the plane of the plank with a uniform acceleration a , as shown in Figure 2. At which minimal value α_{MIN} of the angle the brick will still not slide along the plank?

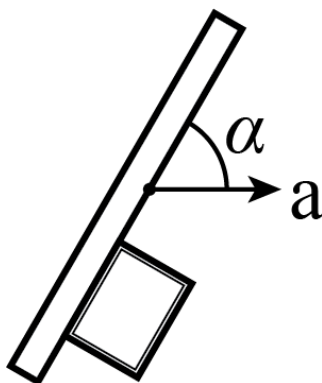


Figure 2: Plank on the table

3. Circuits

A student has connected 10 identical electric fuses as shown in Figure 3. Each fuse melts when the current that flows through it exceeds the value of $I_0 = 12$ A. Find the threshold current value I_m which means that the points A and B become mutually electrically isolated (no current flows from point A to B).

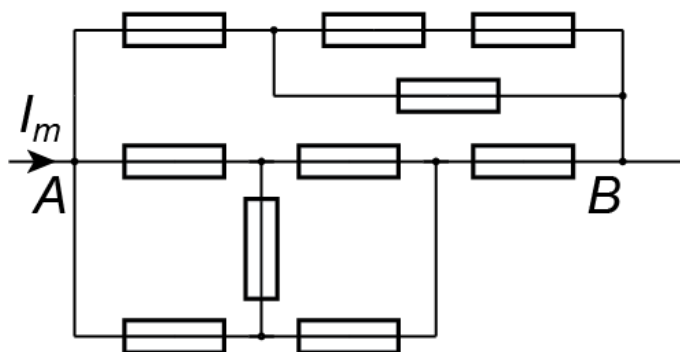


Figure 3: Ten fuses.



4. Work and energy

A brick of mass m is lying on a smooth horizontal surface, Figure 4. A massless unstretchable thread of length L connects the brick with a bead of mass $3m$. At some moment of time, the thread is displaced by some angle and then freed without any initial velocity. When the thread then gets vertical, its angular velocity equals ω . Find the velocity of the brick at that moment of time.

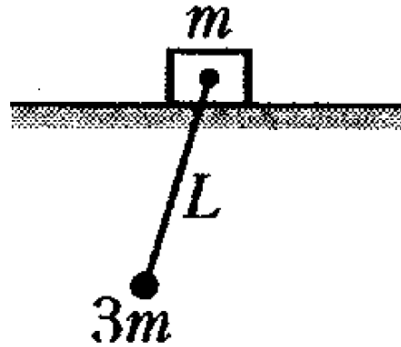


Figure 4: The brick and the bead.