Azerbaijan Physics Olympiad 2020 Semi-Finals(5 problems) Senior Level

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Problem 1

Find the charge of the conductor. Let $\epsilon_1 = \epsilon_2 = 100V$, $\epsilon = 60V$, $R_1 = 100\Omega$, $R_2 = 300\Omega$, and $C = 1mF$. Neglect the internal resistance of the voltage sources.
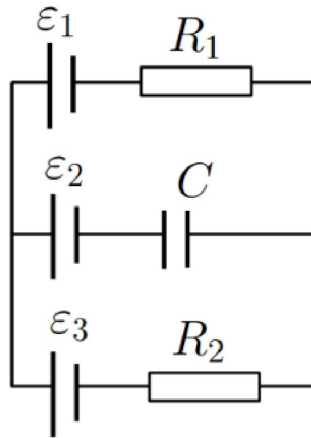

Figure 1: Problem 1

Problem 2

There is one mole of monoatomic ideal gas and a heat engine. The heat engine has a cycle of (1)1-2-3-1 and (2)1-3-4-1. The coordinates of 1, 2, 3, 4 are given on the diagram. The efficiency of 1st cycle is η_1 and the efficiency of 2nd cycle is η_2. Find $\frac{\eta_1}{\eta_2}$.
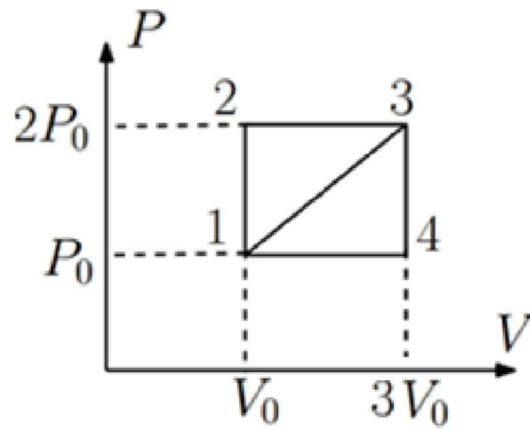
Figure 2: Problem 2

Problem 3

There is a thin ring made of nonconducting material with radius R. This ring has charge density given by $\lambda = \lambda_0 \cos \phi$.Find the Electric field $\vec{E}$ at the center of the ring.
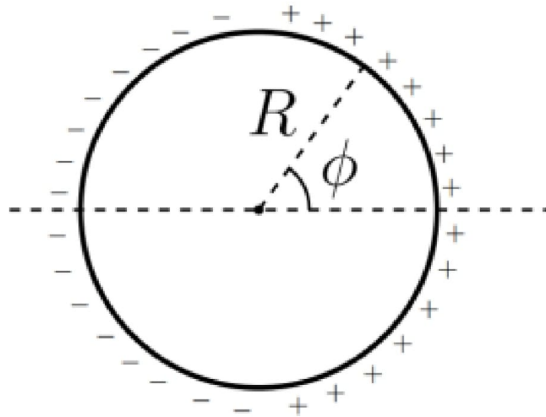

Figure 3: Problem 3

Problem 4

A proton at rest combines with another proton whose kinetic energy is $2m_p c^2$ and a new particle appears. Find the rest mass of the new particle. (Note that m_p is the rest mass of the proton, and c is the speed of light).

Problem 5

There is a mine created from one point of the Earth to the other point of the Earth along its diameter.Find the period of oscillation of an object which falls into this mine. Let $R_{Earth} = 6400$km, $g = 10\mathrm{m\,s^{-2}}$, and $\pi = 3.14$.