Problem 2.1 Follow the way in which the transformation for $B_2$, $B_3$, and $E_1$ have been derived (see Lecture notes) and obtain transformations for $B_1$, $E_2$, $E_3$.

Problem 2.2 Calculate the field created by an electrical charge moving with a constant velocity $u$ (as shown in the figure).

Problem 2.3.1. Prove that for any particle $P^2 = mc^2$. This relation also holds for photons.

Problem 2.3.2. Elastic collisions preserve the rest masses of all involved particles. Prove that for elastic collisions $P_b^2 = P_a^2$, where $a$ and $b$ refer to “before collision” and “after collision”, holds for any involved particle.

Problem 2.3.3. Prove that if two particles collide elastically then $P_{b1} \cdot P_{b2} = P_{a1} \cdot P_{a2}$.

Problem 2.3.4. Prove that the relative velocity of two elastically colliding particles does not change after collision.

Problem 2.4. A particle of mass $M_b$ splits at rest in two parts one of which is a light article of mass $m \ll M_b$ and the second part is a heavy particle of mass $M_a$. The light particle moves with a relativistic velocity $\nu$. The massive part moves with velocity $u \ll c$ and $u \ll \nu$. All velocities are in the reference frame where the original particle was at rest.

Prove that the classical momentum conservation law in the form $\Delta M \nu + M_a u = 0$, $\Delta M = M_b - M_a$ holds for any value of $\nu$ (even for $\nu = c$).