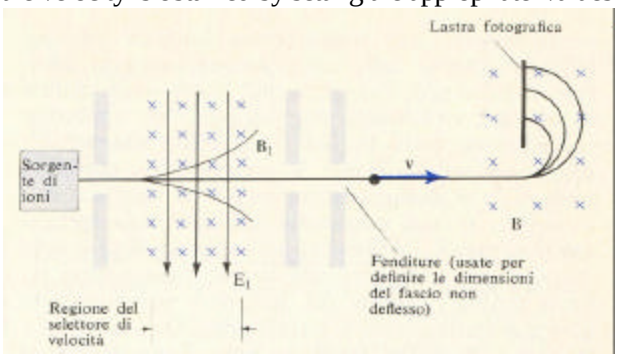
1) In a mass spectrometer positive ions ($q = +e = 1.60 \times 10^{-19}$ C) of the same velocity v are filtered using a device with cross electric and magnetic fields as shown in the figure; the desired value for the velocity is obtained by setting the appropriate values for E_1 and B_1.



$B_1 = 0.60$ T
$E_1 = 10^5$ V/m
$B = 0.80$ T

a) Find the relation between $\mathbf{v}$, $\mathbf{B}_1$ and $\mathbf{E}_1$ and compute the velocity of the filtered ions. Ions with the same velocity are then deflected by a magnetic field $\mathbf{B}$ on a circular trajectory of radius R according to their mass m and strike a photographic plate after one-half a revolution.

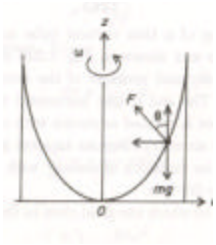
b) Find the relation between m and R and the distance between the impact points on the photographic plate for the isotopes Ne-20 and Ne-22 (u.a. = 1.66×10^{-27} kg).

2) Given the 4-potential:

$$A^m = (j/c, \mathbf{A}) = (e^{ipct}, 0, e^{ipx}, 0),$$

where p is a constant. Compute the charge density ρ and the current density J generating the electromagnetic field described by A^μ.

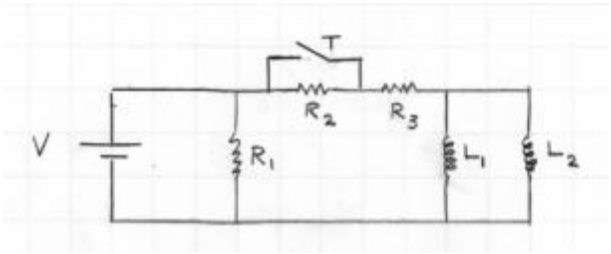
3) A bucket of water is rotated at constant angular velocity w about its symmetry axis in the earth's gravitational field **g.** Determine the shape of the surface of the water.



4) A particle with rest mass m and velocity v = 0.9 c is absorbed by a second particle of mass m'=2m at rest. Determine the rest mass M and the velocity V of the final particle.

5) For a diatomic gas near room temperature, what fraction of the heat supplied is available for external work if the gas is expanded (a) at constant pressure, (b) at constant temperature?

6) In the circuit shown below the switch T is initially open. Describe the current flowing in the circuit after the switch is closed.



V = 20 V
$R_1 = 20\ \Omega$
$R_2 = 8\ \Omega$
$R_3 = 12\ \Omega$
$L_1 = 1.2$ H
$L_2 = 1.2$ H