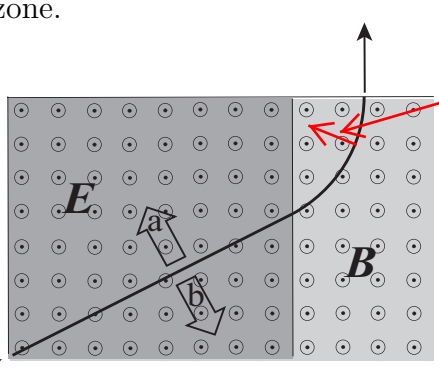
Physics 102 (F16) Q6A

Name: _____ **Section:** _____ **Score:** _____/20

1. In the figure below gray zones have a uniform magnetic field $\boldsymbol{B}$ perpendicular to the page (its direction as noted in the figure). A uniform electric field $\boldsymbol{E}$ perpendicular to $\boldsymbol{B}$ is superposed in the darker gray zone.



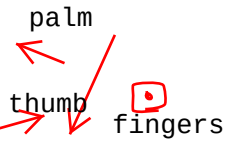
actual magnetic force

(a) The injected charged particle runs straight in the dark gray region and then goes into the pale gray zone with the magnetic field (but no electric field) to rotate as indicated in the figure. What is the sign of the charge? [2]

right-hand rule for magnetic force

Use I instead of the velocity

the current direction



The current and the velocity are in opposite directions, so the charge must be negative.

(b) To realize the trajectory in the figure which $\boldsymbol{E}$ should be chosen, a or b? You must explain your choice. [3]

Notice that this answer does NOT depend on the sign of the charge.

The magnetic force must be in the a direction, so the electric force must kill this. -> a.

(c) The magnitude of the required electric field is 1.2 kV/m. The particle speed is observed to be 1500 m/s at Q. What is the intensity of the magnetic field? [5]

|magnetic force| = qvB (since v is perp to B)
|electric force| = qE

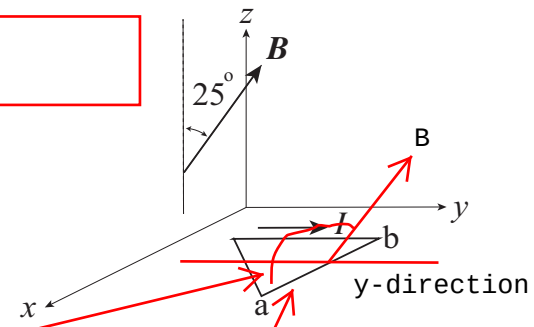
They must agree. -> E = vB -> B = E/v = 1200/1500 = 0.8 T.

2. A metal half square (i.e., isosceles-triangle) with edge 0.5 m lies in the xy-plane. A uniform magnetic field $\boldsymbol{B}$ is parallel to the yz-plane, making an angle 25° with the z-axis as illustrated below.

(a) The metal frame carries a permanent current of $I = 2$ A in the direction of the arrow. The magnitude of the force acting on the edge ab, which is parallel to the x-axis, is 2.5 N. What is the magnitude of the magnetic field $B = |\boldsymbol{B}|$? [5]

Right-hand rule
magnitude: LIB sin theta, where the angle is between I and B.

Notice that in this case theta = 90 deg
F = ILB -> B = F/IL = 2.5/(2 x 0.5) = 2.5 T.



This is theta = 90 deg

This is the direction of the current.

triangle

(b) What is the magnitude of the torque on the ~~square~~ (around its geometrical center)? [5]

tau = IAB sin theta, where theta is the angle between B and the normal

The angle is 180 - 25 = 165 deg.
tau = IAB sin theta
= 2 x (0.5^2/2) x 2.5 x sin 165 = 0.621 N.m.