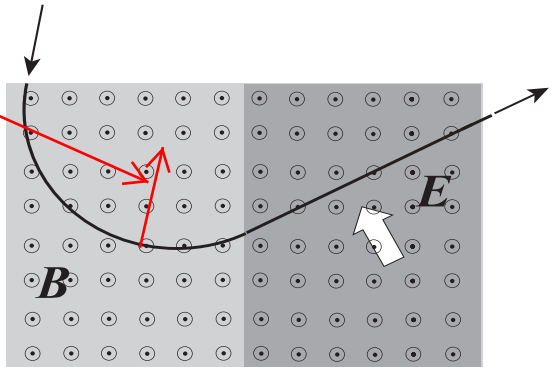
Physics 102 (S15) **Q5B**

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

1. In the figure below a uniform magnetic field $\boldsymbol{B}$ perpendicular to the page is applied in gray zones, and a uniform electric field $\boldsymbol{E}$ perpendicular to $\boldsymbol{B}$ is applied in the darker gray zone as denoted by the broad arrow.

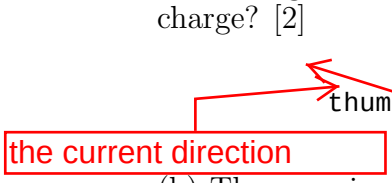
actual magnetic force



(a) After rotating 112 degrees in the uniform magnetic field $\boldsymbol{B}$, the injected charged particle runs straight through the darker gray region where $\boldsymbol{E}$ exists as well. What is the sign of the charge? [2]

right-hand rule for magnetic force

Use I instead of the velocity



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

(b) The experimenter claims that the electric field is imposed in the direction of the white arrow. Is she right? You must justify your judgement. [3]

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

The magnetic force must be in the direction of the white arrow, so the electric force in the opposite direction must kill this. Our charge is negative, so indeed the electric field must be as illustrated.
She is right.

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

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

They must agree. -> E = vB -> E = 1.2 x 1500 = 1800 V/m

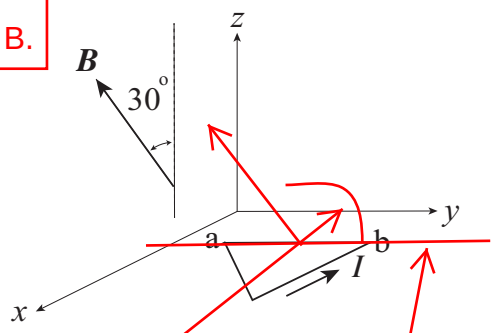
2. A metal half square (i.e., isosceles-triangle) with edge 0.8 m lies in the xy-plane. A uniform magnetic field $\boldsymbol{B}$ is parallel to the xz-plane, making an angle 30° with the z-axis as illustrated below.

(a) The metal frame carries a permanent current of $I = 3$ A in the direction of the arrow. The magnitude of the force acting on the edge ab, which is parallel to the y-axis, is 4.2 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 = 4.2/(3 x 0.8) = 1.75 T.

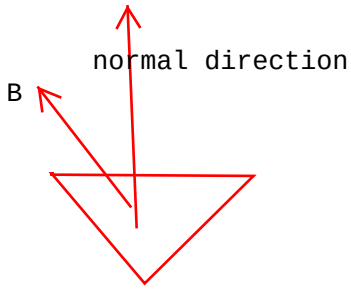


This is theta = 90 deg

This is the direction of the current.

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

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



The angle is 30 deg.
tau = IAB sin theta
= 3 x (0.8^2/2) x 1.75 x sin 30 = 0.84 N.m.