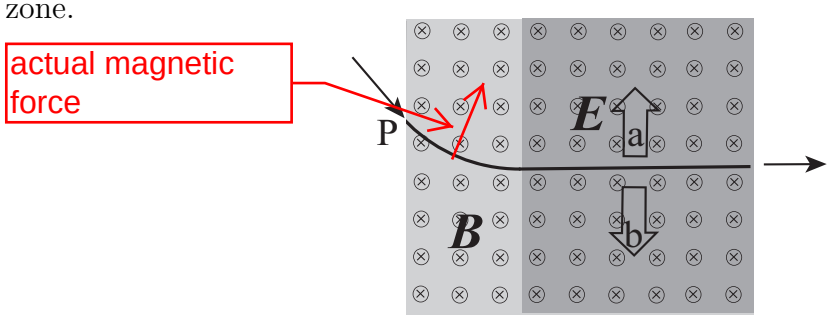
Physics 102 (S15) **Q5C**

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.

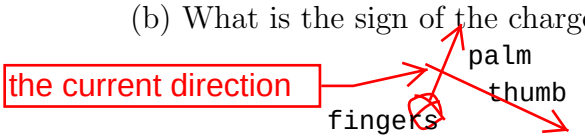


(a) The injected charged particle rotates by 50 degrees in the pale gray zone, and then runs straight through the darker gray zone. Which is the correct uniform $\boldsymbol{E}$ field direction, a or b? You must justify your choice. [3]

Notice that this answer does NOT depend on the sign of the charge. So to solve this you may simply assume the charge is positive

b to oppose the magnetic force upward (for a positive charge).
Try to do the same, assuming the charge is negative.

(b) What is the sign of the charge? [2]



The current and the velocity are in the same directions, so the charge must be positive.

(c) The magnitude of the required magnetic field is 1.2 T and that of the electric field is 1.8 kV/m. What is the speed of the particle at P, the injection point? [5]

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

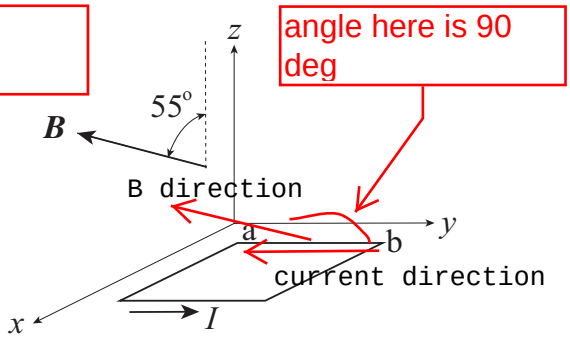
They must agree. -> E = vB -> v = E/B = 1800/1.2 = 1500 m/s.

2. A metal square frame with edge 0.5 m lies in the xy-plane. A uniform magnetic field $\boldsymbol{B}$ of magnitude 1.5 T is parallel to the xz-plane, making an angle 55° 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. What is the magnitude of the total force acting on the edge ab, which is parallel to the y-axis? [5]

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

angle here is 90 deg

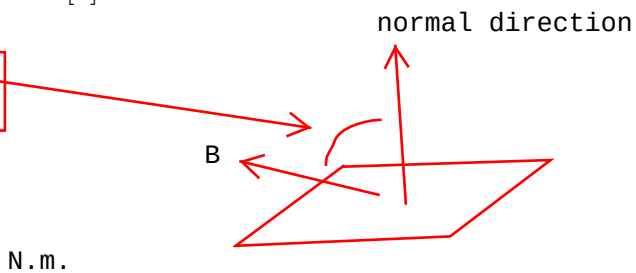


Notice that in this case theta = 90 deg

F = ILB = 2 x 0.5 x 1.5 = 1.5 N.

(b) What is the magnitude of the torque on the square? [5]

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



The angle is 55 deg.
tau = IAB sin theta
= 2 x 0.5^2 x 1.5 x sin 55 = 1.23 N.m.