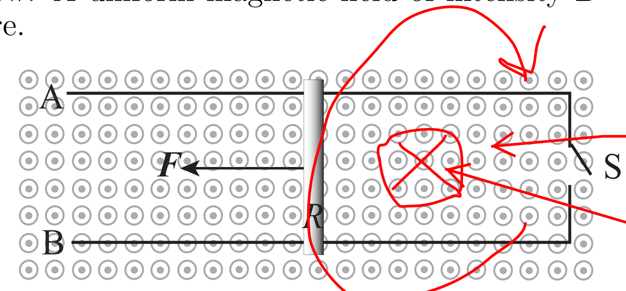
Name: ____________ **Section:** ________ **Score:** ________/20

1. On the horizontal plane (the surface of this page) is a pair of parallel metal rails 3 m apart. Sliding frictionlessly on the rails at a constant speed $v = 25$ m/s is a conducting bar as illustrated below. A uniform magnetic field of intensity $B = 4$ T out of the page is applied as in the figure.

emf = vBL



If S is closed, the area here increases -> upward magnetic flux increases -> Lenz tells us that the circuit hates this and make the magnetic flux in the opposite direction

Initially, the rails are not connected (switch S is open). Under this condition answer the following questions (a1) and (a2).
(a1) What is the voltage difference between rails A and B? Which is at a higher voltage, A or B? [3]

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emf = vBL = 25 x 4 x 3 = 300 V
To determine the sense of the emf, we could use
(1) magnetic force: plus charge is pushed up, so from outside A is PLUS.
(2) Lenz's law: if the circuit is closed, the current flow clockwisely,
so A is higher.
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(a2) To maintain this speed $v = 25$ m/s of the metal bar what force is required? [2]

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Of course, ZERO.  Since there is no current, there is no dissipation,
so you need not do any work!
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(b) Now, **we close the switch**. The mounted metal bar still moves at $v = 25$ m/s as shown. The resistance of the metal bar is $R = 25\ \Omega$. What is the needed force to maintain this speed? Ignore the residual resistances of the rails. [5]

The power is dissipated as V^2/R or I^2R at the resistro. This must be supplied by you as F x v.

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F = V^2/vR = 300^2/25x5 = 144 N.
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You can use the force balance as well.
F = ILB =(V/R)LB

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F = (300/25)3x4 = 144 N,
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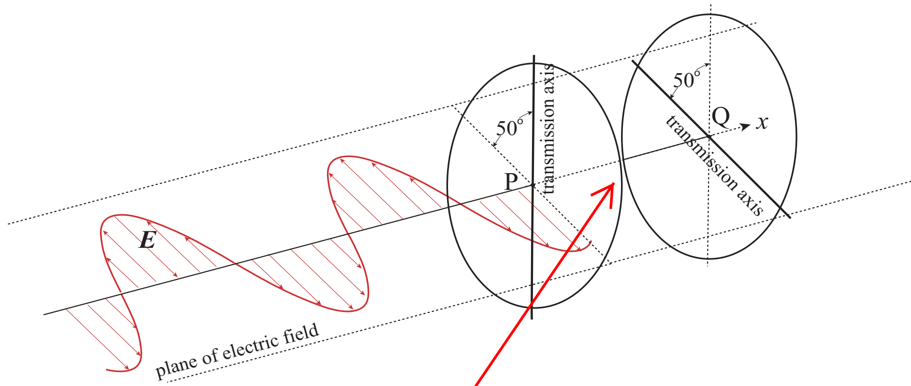
2 A plane electromagnetic wave with electric field amplitude ($= E_{\text{max}}$) 3.3 V/m is incident on a polarizer as depicted in the figure. The 'plane of electric field' indicates the plane in which the electric field of the wave along the x-axis lies. It makes an angle of 50° with the transmission axis of the polarizer at P. The whole system is in a vacuum.



(1) What is the amplitude of the electric field immediately after passing through the first linear polarizer at P? [5]

E projected on the transmission axis

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E = E0cos 50= 3.3 x cos 50 = 2.12 V/m
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Intensity is prop to E^2

(2) What is the intensity I of the light beyond the second polarizer at Q in terms of the intensity I_0 of the incident light? [5]

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Here the intensity is J_0 cos^2 50.
The plane of polarization  here and the transmission axis of the polarizer at Q
make 50 deg again.
I final - I0 (cos 50)^4 = 0.17 I0.
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