Correction to a motional emf homework problem (ch21-h3-001)

There is an error in the problem statement of ch21-h3-001. Below is the correction

Now have: …. Which diagram “correctly” shows the distribution of charge on the bar

Change to: Which diagram “best” shows the distribution of charge on the bar.

Discussion related to this problem.

This homework problem was intended to be a variation on the textbook problem 21.X.74 on page 890. The explanation on the choice among the diagrams of Fig21.114 is the following.

Within the vertical conducting bar of Fig21.114, the magnetic force on a positive test charge $q$ is given by $F = qvxB$. This magnetic force leads to a separation of positive and negative charges. Among the diagrams shown in Fig 21.114, diagram 4 illustrates the best on the charge separation.

However, this diagram 4 is not in an equilibrium state. At equilibrium, the downward magnetic force $qvB$, which is a constant force, must be balanced by an upward coulomb force from the surface charges, i.e. $|F_c| = qE_c = qvB$. Here the surface charges are expected to automatically adjust their positions until such an equilibrium state is reached.

Qualitatively, at equilibrium the surface charge distribution is expected to have following behavior. It should decrease monotonically from the positive end to the negative end. See the discussion related to Fig 19-18, on p760 in our textbook.