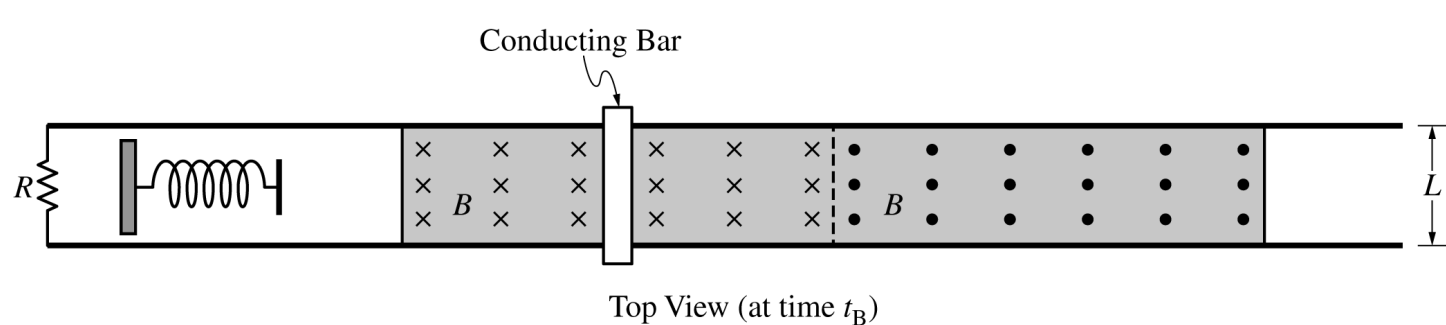




Two horizontal, parallel, conducting rails are separated by distance $L = 0.40$ m. A resistor of resistance $R = 0.30\ \Omega$ connects the rails. A horizontal ideal spring is located between the rails. The right end of the spring is free to move and the left end is fixed in place. A conducting bar of mass $m = 0.23$ kg is placed on the rails and is in contact with the spring, which is initially compressed. Frictional forces and the resistance of the bar and rails are negligible.

- At time $t = 0$, the bar is released from rest and is pushed to the right by the spring.
- At time t_1 , the bar loses contact with the spring and slides to the right.
- At time t_2 , the bar enters and travels through a uniform magnetic field of magnitude $B = 0.50$ T that is directed into the page, as shown.
- At time t_3 , the bar enters a region where the magnitude of the uniform magnetic field is still $B = 0.50$ T but is directed out of the page.
- At time t_4 , the bar enters a region with no magnetic field.

Consider time t_B such that $t_2 < t_B < t_3$.

- (a) On the following diagram of the bar, draw an arrow indicating the direction of the net force F_{net} exerted on the bar at time t_B . If the net force is zero, write $F_{\text{net}} = 0$.



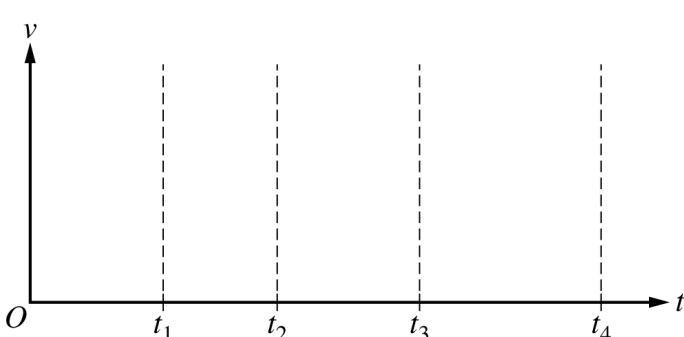
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Continue your response to **QUESTION 2** on this page.

- (b) At time t_B , the speed of the bar is $v = 2.5$ m/s.
- i. Calculate the magnitude of the current in the bar at time t_B .

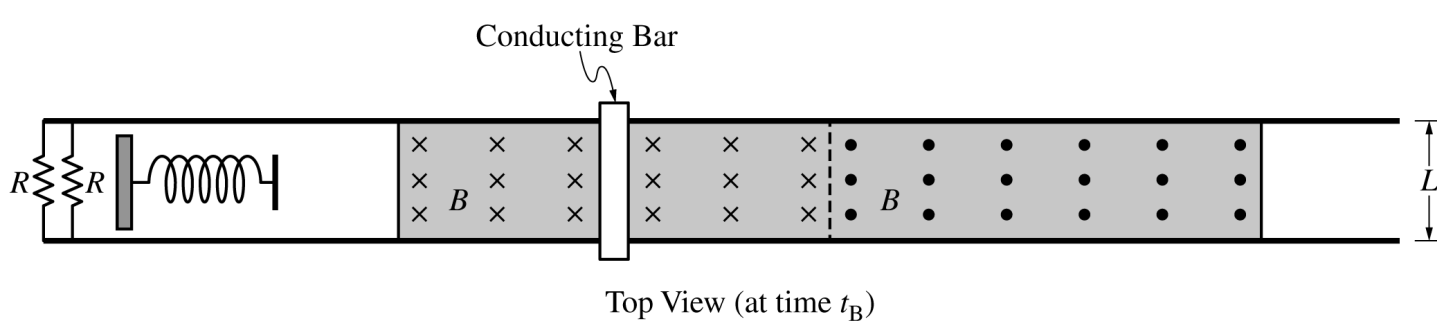
- ii. Calculate the magnitude of the net force F_{net} exerted on the bar at time t_B .

- (c) On the following axes, sketch a graph of the speed v of the bar as a function of time t between $t = 0$ and t_4 .



GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 2** on this page.



- (d) The scenario is repeated but an additional resistor of resistance $R = 0.30\ \Omega$ is connected, as shown.

- i. Determine the total resistance R_{total} of the closed circuit for the new scenario.
- ii. In the original scenario, the magnitude of the acceleration of the bar immediately after the bar enters the first uniform magnetic field is a_{original} . In the new scenario, the magnitude of the acceleration of the bar immediately after the bar enters the first uniform magnetic field is a_{new} . Is a_{new} greater than, less than, or equal to a_{original} ? Justify your answer.

- (e) Describe a modification to m , B , or L that will result in a smaller induced potential difference across the original resistor immediately after the bar enters the first uniform magnetic field. Justify your answer.

GO ON TO THE NEXT PAGE.