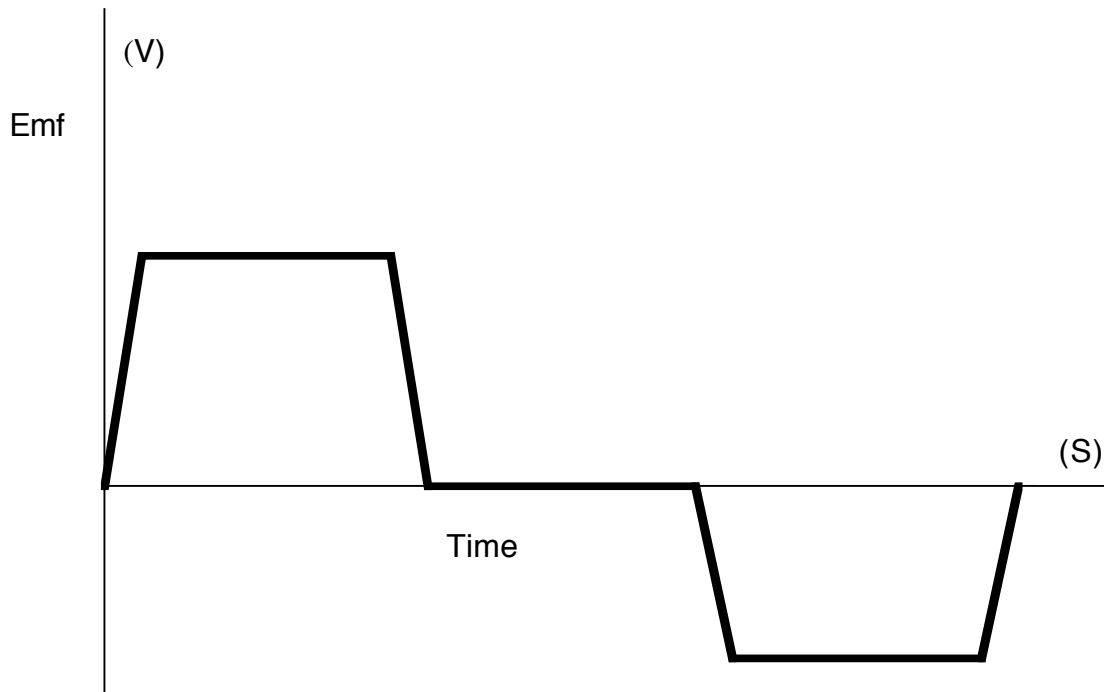


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**EMI 2A: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNET FIELDS-
VOLTAGE**

EMI2A—WBT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

A situation involving a rectangular loop of wire and a uniform magnetic field resulted in the graph below. **Describe a physical situation that could produce this graph.**



Explain:

One possible answer would be: A rectangular wire loop moving at constant speed is about to enter a uniform B with its “surface area” perpendicular to the B . As soon as the wire reaches the B , the induced emf increases from zero to the positive value indicated in the graph. As the wire loop continues to enter the B (but before it is completely in the B), the emf is constant. As the trailing “cross wire” of the loop enters the B , the induced emf falls to zero. When the loop is completely inside the B , the induced emf is zero. As the loop starts to leave the B , the induced emf goes from zero to the constant negative emf indicated in the graph. As the loop is leaving the B , the induced emf is negative and constant. As the trailing “cross wire” of the loop leaves the B , the induced emf goes from the negative constant value to zero.

EMI2A—WWT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

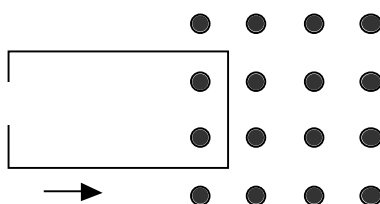
What, if anything, is wrong with the following situation? If something is wrong, identify it and explain how to correct the situation. If nothing is wrong, explain why the situation works as described.

If a rectangular loop of copper with a very small resistor is moved into a region of uniform magnetic field, there will be an emf (V) across the resistor in the loop while the loop is moving into the field, but not once it is completely inside the field region.

This is a correct statement assuming the velocity of the wire loop is not at an angle of 0° or 180° with the uniform magnetic field.

EMI2A—CCT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

Consider the following statements about the open rectangular loop shown below.



Student A: "An open rectangular loop will have an emf across the gap when moving into or out of a uniform magnetic field."

Student B: "An open rectangular loop will have an emf across the gap any time it is anywhere in the region of the magnetic field."

Student C: "An open rectangular loop will have an emf across the gap only when moving inside the field region."

Student D: "An open rectangular loop cannot have an emf across the gap because there is a break in the loop."

With which, if any, student do you agree?

Student A X Student B Student C Student D

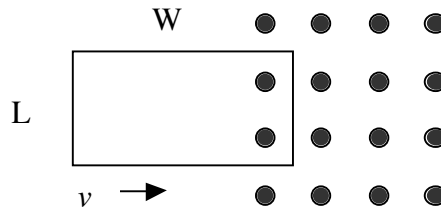
None of them

Carefully explain your reasoning.

Student A is correct. The flux is changing and it is possible to have a potential difference without a current.

EMI2A—PET1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

A rectangular loop of wire with a small resistor(not shown) is connected to a voltmeter. The loop is going to be moved into, through, and out of a uniform magnetic field at a constant speed. The plane of the loop will be perpendicular to the direction of the magnetic field.



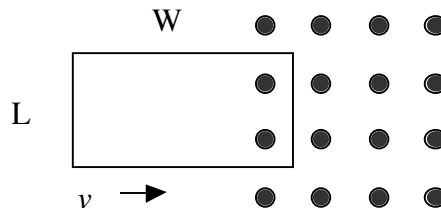
Predict what the reading(s) on the voltmeter will be from before the loop is in the field until it passes completely out of the field.

As the loop moves at a constant speed, there will be a constant voltage reading as it enters the field region. Once the loop is completely inside the field the voltage reading will drop to zero. As the loop leaves the region, the voltage reading will be the negative of its reading as the loop entered. The voltmeter reading will drop to zero after the loop has left the field region.

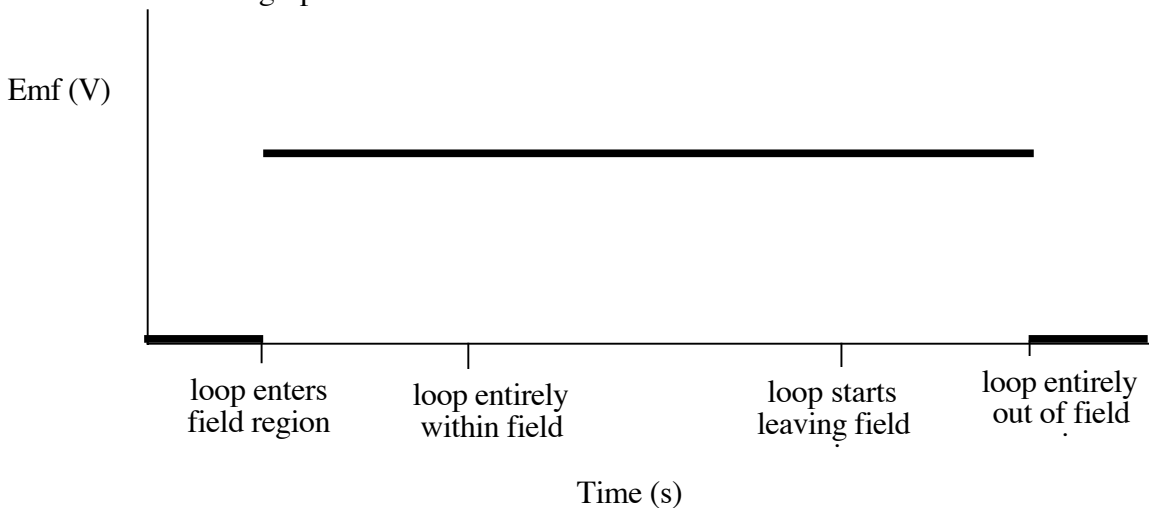
EMI2A—TT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

There is something wrong in the following situation. **Identify the problem and explain how to correct it.**

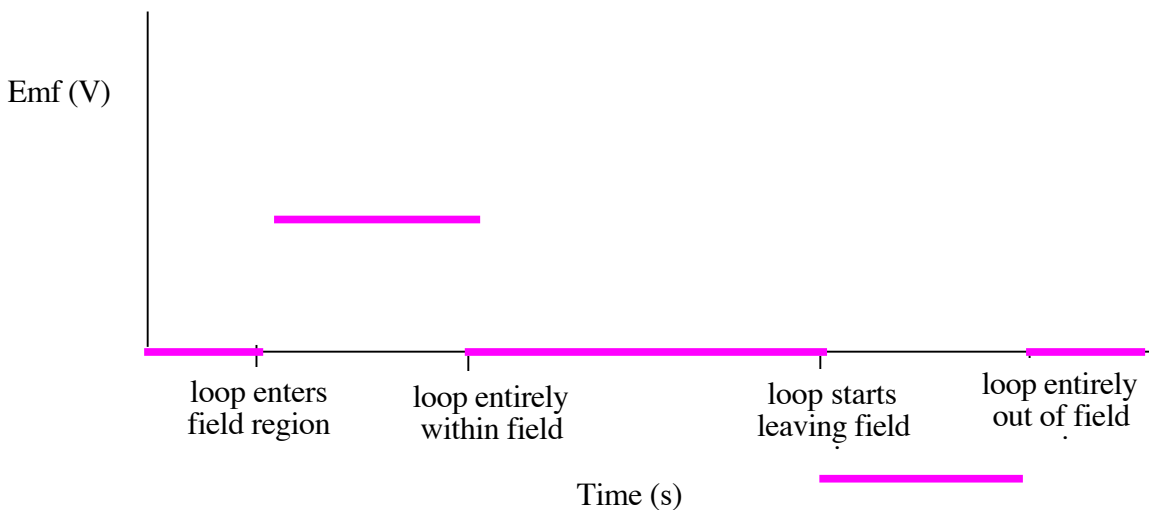
A rectangular loop with a very small resistor (not shown) is moved into, through, and out of a uniform magnetic field at a constant rate. The plane of the loop is perpendicular to the magnetic field.



The graph of emf (V) across the resistor in the loop versus time for this whole time period would look as shown in the graph below.



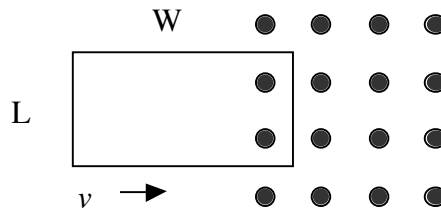
The graph is incorrect-the correct one is shown below



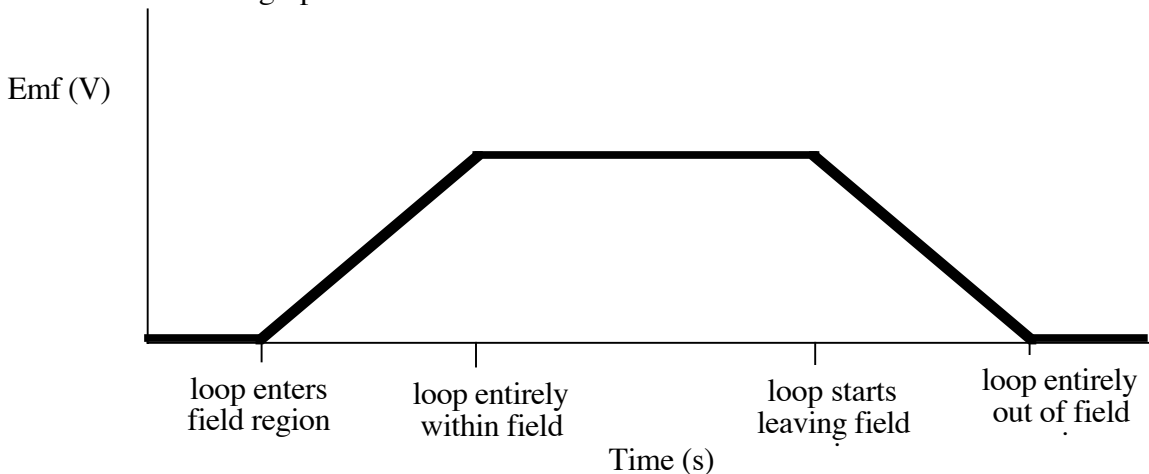
EMI2A—TT2: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS-VOLTAGE

There is something wrong in the following situation. **Identify the problem and explain how to correct it.**

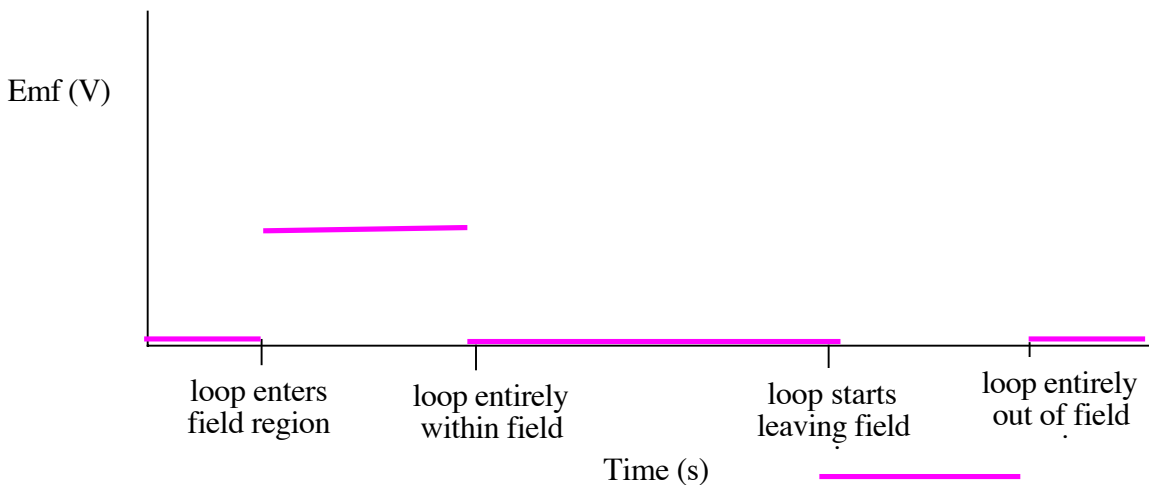
A rectangular loop with a very small resistor (not shown) is moved into, through, and out of a uniform magnetic field at a constant rate. The plane of the loop is perpendicular to the magnetic field.



The graph of emf (V) across the resistor in the loop versus time for this whole time period would look as shown in the graph below.



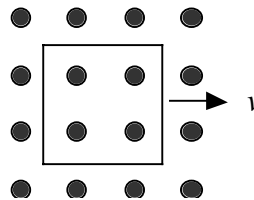
The graph is incorrect-the correct one is shown below



EMI2A—M/MCT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

A square wire loop is moving through a uniform magnetic field, of strength B , at a constant rate v . The loop is fully in the field, and the loop has side length of l . Is the calculation below meaningful or meaningless for this situation?

$$\mathcal{E} = (v)(B)(l)$$

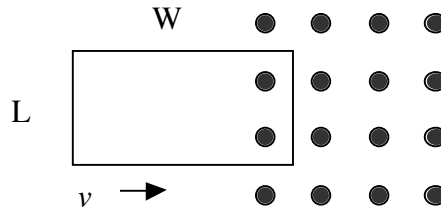


Explain fully.

The calculation is meaningless since the loop is completely within the field, i.e., the induced emf should be zero.

EMI2A—LMCT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

A rectangular wire loop with a very small resistor (not shown) has its leading edge just moving into a uniform magnetic field. The loop has dimensions of L by W , and is moving at a constant speed.



Described below are a variety of changes to this initial situation. (ALL OF THE CHANGES DESCRIBED ARE MODIFICATIONS OF THIS INITIAL SITUATION.)

For each change, identify how the change will affect the emf across the loop. The possible effects on emf are:

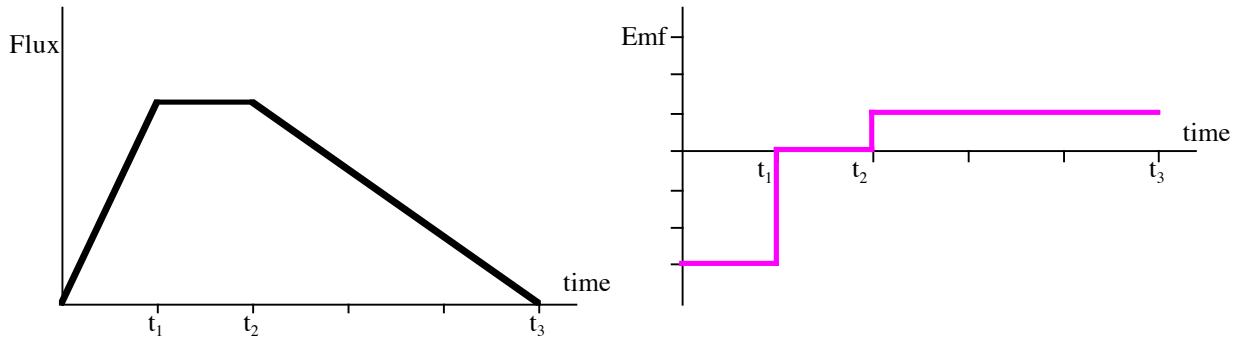
- a) It will increase.
- b) It will decrease.
- c) It will reverse polarity.
- d) It will increase and reverse polarity.
- e) It will decrease and reverse polarity.
- f) There will be no effect on the emf.

Changes in the situation are:

- 1) The magnetic field is doubled in strength. _____ *A* _____
- 2) The velocity of the loop is reduced. _____ *B* _____
- 3) The W side of the loop is tripled in length. _____ *F* _____
- 4) The direction of the magnetic field is reversed. _____ *C* _____
- 5) The L side of the loop is doubled in length. _____ *A* _____

EMI2A—CRT1: MOVING RECTANGULAR LOOPS AND UNIFORM MAGNETIC FIELDS - VOLTAGE

The flux of a conducting wire that is moving into, through, and out of a region in which there is a uniform magnetic field is shown in the graph below. **For the time period shown in the given graph, draw the corresponding emf versus time graph at the right.**



The induced emf is a constant from $t=0$ s to $t=t_1$ since the slope of the changing flux is constant. The induced emf after $t=t_1$ should be zero since the flux is not changing.