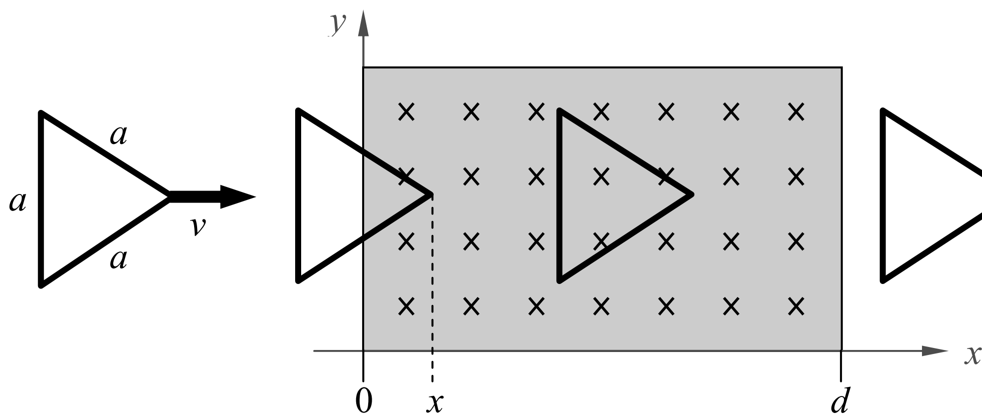
Discussion Question 9C
P212, Week 9
Faraday's Law: Moving Loop

A one-turn current loop in the shape of an equilateral triangle with sides a lies in the xy plane and moves with velocity v in the $+x$ direction. (A magic external force keeps the velocity constant ☺) The loop has a net resistance R . It passes through a region of constant, spatially uniform magnetic field B that points in the $-z$ direction (into the page) and extends from $x = 0$ to $x = d$.



We will specify the loop's position using the x-coordinate of the <u>triangle's tip</u> (as shown in the figure). Now, before we do any calculations, let's think *physically* …

(a) During what part(s) of the loop's trip (i.e. range(s) in x-position) will there be a non-zero current induced in the loop?

Remember, induced EMF only occurs when the magnetic flux through a loop is *changing*.

(b) Sketch the induced current I as a function of x over the full range of motion shown on the figure. Let <u>positive I</u> indicate current flow in the <u>clockwise</u> direction.

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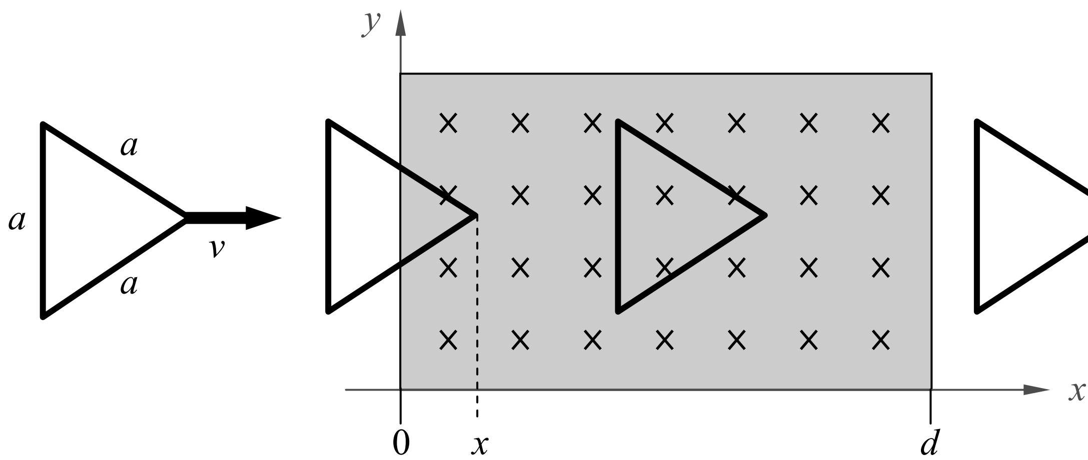

(c) Derive an analytic expression (i.e. no numbers ☺) for the current *I* induced in the loop as a function of the loop's *x*-position. This expression should be valid from the moment the tip of the triangle enters the magnetic field until the base of the triangle enters the field.

(i) To obtain the induced current, you first need an expression for the magnetic flux Φ_B through the loop as a function of the loop's position x. The B-field part of this expression is easy ... the area part requires some thought. (Hint: what is the *height* of an equilateral triangle of side a?)

(ii) Now take the time derivative of your expression, to get an EMF.

(iii) The final step is to turn your induced EMF into a current .