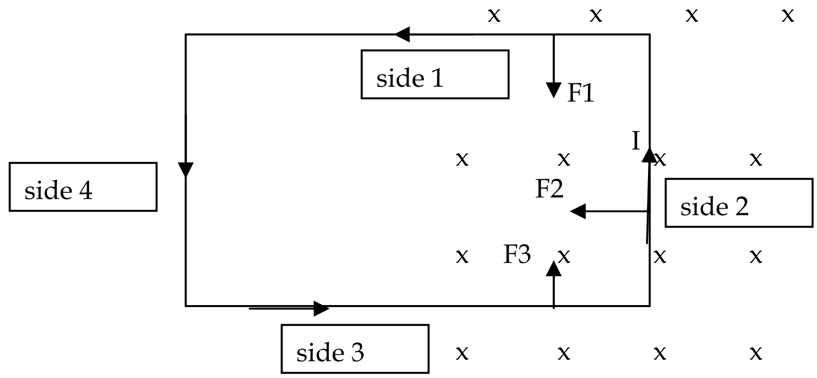
31.29



When the coil enters the external magnetic field region, a current is induced in the CCW direction so that the induced magnetic field is out of the page opposing the increasing external magnetic flux into the page.
This current in the three sides of the coil now in the external field results in forces F1, F2 and F3 due to the interaction between the current and the external field (the current can not interact with its own induced magnetic field.) F1 and F3 are equal and opposite and cancel each other. So the net force on the coil is F2 acting the side of the coil entering the field (side 2).

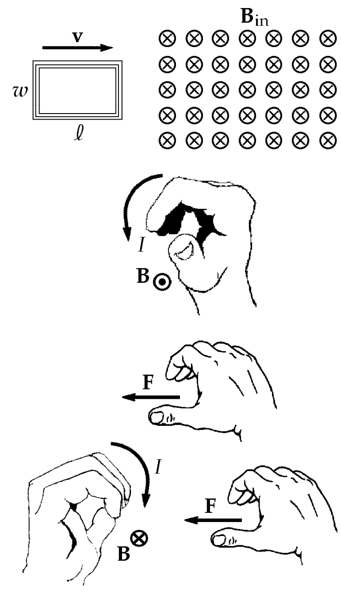


FIG. P31.29

(a)The total net force on the coil (consisting of *N* wires) is

$$F = N\left(ILB\right) = N\left(IwB\right).$$

The induced emf in the coil is

$$|\varepsilon| = N\frac{d\Phi_B}{dt} = N\frac{d\left(Bwx\right)}{dt} = NBwv.$$

so the current is $I = \frac{|\varepsilon|}{R} = \frac{NBwv}{R}$ counterclockwise.

The force on the leading side of the coil is then:

$$F = N\left(\frac{NBwv}{R}\right)wB = \boxed{\frac{N^2B^2w^2v}{R} \text{ to the left}}.$$

(b) Once the coil is entirely inside the field,
$\Phi_B = NBA = \text{constant},$

so $\varepsilon = 0,\ I = 0,$ and $F = \boxed{0}$.

(c) As the coil starts to leave the field, the flux *decreases* at the rate *Bwv*, so the magnitude of the current is the same as in part (a), but now the current is clockwise. Thus, the force exerted on the trailing side of the coil is:

$$F = \boxed{\frac{N^2B^2w^2v}{R} \text{ to the left again}}.$$