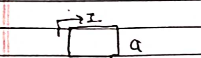
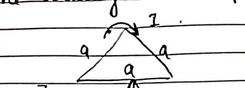
a) Find the force on a square loop placed as shown in the figure near an infinite straight strange wire. Both the loop and wire carry a steady current I.

b) Find the force on the triangular loop





(a) the forces on the two sides cancel each other. So, we are just left with the top and bottom part of the loop,

Now,

~~B~~ Magnetic field on the top of the loop will be $B = \frac{\mu_0 I}{2\pi(s+a)}$

So, force $= F_{top} = \left(\frac{\mu_0 I}{2\pi(s+a)}\right) I a = \frac{\mu_0 I^2 a}{2\pi(s+a)}$

Now,

Magnetic field on the bottom ~~of~~ part of the loop $= B = \frac{\mu_0 I}{2\pi s}$

and so,

force $= F_{bottom} = \left(\frac{\mu_0 I}{2\pi s}\right) I a = \frac{\mu_0 I^2 a}{2\pi s}$ //

(b) Now, in the b part we are given with the triangular loop

So,

the force on the bottom part will be same as the last part (i.e) $\frac{\mu_0 I^2 a}{2\pi s}$

Magnetic field on the left side will be $\frac{\mu_0 I}{2\pi y}\hat{z}$

$$dF = I(dl \times B) = I(dx\,\hat{x} + dy\,\hat{y} + dz\,\hat{z}) \times \left(\frac{\mu_0 I \hat{z}}{2\pi y}\right)$$

$$= \frac{\mu_0 I^2}{2\pi y}(-dx\,\hat{y} + dy\,\hat{x})$$

the x component cancels the corresponding terms ~~from~~ from the right side

$$F_y = -\frac{\mu_0 I^2}{2\pi}\int_{s/\sqrt{3}}^{s/\sqrt{3}+a/2} \frac{1}{y}\,dx$$

here $y = \sqrt{3}x$

So, $F_y = \frac{\mu_0 I^2}{2\sqrt{3}\pi} \ln\left(\frac{s/\sqrt{3} + a/2}{s/\sqrt{3}}\right)$

$$= -\frac{\mu_0 I^2}{2\sqrt{3}\pi} \ln\left(\frac{1+\sqrt{3}a}{2s}\right)$$

the force on the right side is same

so,

the net force on the triangle is

$$\frac{\mu_0 I^2}{2\pi}\left[\frac{a}{s} + \frac{2}{\sqrt{3}}\ln\left(\frac{1+\sqrt{3}a}{2s}\right)\right]$$

//