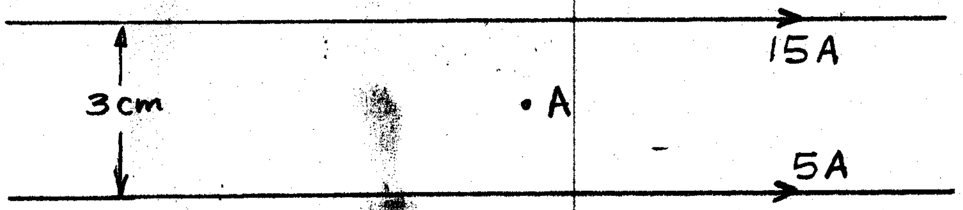
1.) Two infinitely long, straight wires run carry currents as shown below. The top wire is 3 cm above the bottom wire and point A is midway between the wires.



a.) (20 pts.) What is the magnitude of the magnetic field at point A?

$$\vec{B} = \frac{\mu_0}{2\pi}\left(\frac{I_1}{r_1} - \frac{I_2}{r_2}\right) = 2\times10^{-7}\frac{Tm}{A}\left(\frac{15A}{.015m} + \frac{5A}{.015m}\right) = 2\times10^{-7}(1000 - 333)\,T$$

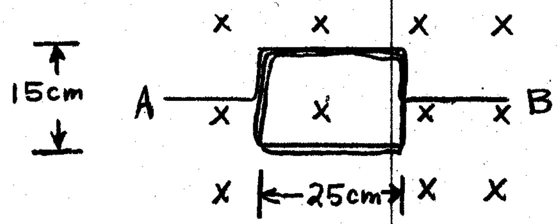
into page

$$= 1.33\times10^{-4}\,T$$

b.) (10 pts.) What is the direction of the magnetic field at point A? (Circle one.)

up down left right [✓ into page] out of page

2.) A rectangular frame with dimensions 15 cm by 25 cm is mounted on an axle so that it can rotate about line AB, which passes through its center. A wire starts at point A, comes to the frame and then goes around the perimeter of the frame 30.5 times before coming out at point B. A uniform magnetic field with strength 0.2 T is directed into the page.



a.) (20 pts.) When the frame is held still in the plane of the page, what is the total magnetic flux through the coil of wire encircling the frame?

$$\Phi_0 = NBA = (30.5)(0.2T)(0.15m)(0.25m) = 0.229\ Wb$$

b.) (20 pts.) When the frame is rotated at 60 revolutions per second, determine the voltage difference between points A and B on the wire as a function of time, t.

$$\mathcal{E} = -\frac{d\Phi}{dt}, \quad \Phi = \Phi_0 \cos\omega t \qquad \omega = 2\pi(60) = 377\ rad/sec$$

$$\text{so } \mathcal{E} = \omega\Phi_0 \sin(\omega t) = \left(377\frac{rad}{sec}\right)(.229\ Wb)\sin(377t)$$

$$\mathcal{E} = 86\ V \sin(377t)$$