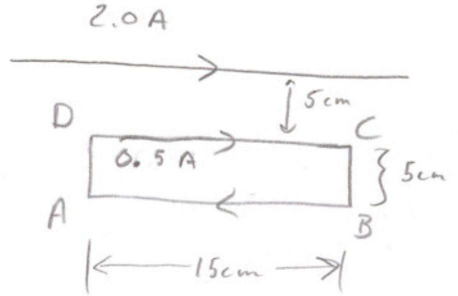
5.6 Magnetic fields (345)

(10)



$$F = \frac{\mu_0}{2\pi} \frac{I_1 I_2 L}{r}$$

$$F_{CD} = \frac{(4\pi \times 10^{-7})(2A)(.5A)(.15m)}{2\pi\ (.05\ m)} = 6 \times 10^{-7} N \text{ attractive (up)}$$

$$F_{AB} = \frac{(4\pi \times 10^{-7})}{2\pi} \frac{(2A)(.5A)(.15m)}{(.10\ m)} = 3 \times 10^{-7} N \text{ repulsive (down)}$$

$$F_{net} = 6 \times 10^{-7} N - 3 \times 10^{-7} N = \underline{3 \times 10^{-7} N \text{ up}}$$

If the current was reversed, the force will be down.

(11) (a) $F_{AB} = BIL$

$= (0.05\,T)(2A)(.2\,m) = \underline{0.02\,N \text{ into the page.}}$

$F_{CD} = \underline{0.02\,N \text{ out of the page}}$

$F_{AD} = F_{BC} = 0$

(b) $F_{net} = F_{AB} + F_{CD} + F_{AD} + F_{BC} = 0.02N - 0.02N = \underline{0}$

(12) $B = \mu_0 \frac{NI}{L}$

$N = \frac{BL}{\mu_0 I}$

length of wire $= N(2\pi r)$

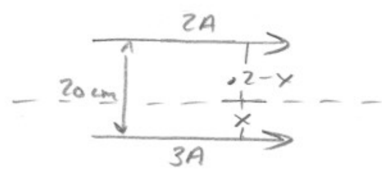
$= \frac{BL(2\pi r)}{\mu_0 I}$

$= \frac{(2.26 \times 10^{-3} T)(0.3m)(2\pi)(.12m)}{(4\pi \times 10^{-7} NA^{-1})(15A)}$

$= \underline{27.1\,m}$

(14) (a) must be between wires for opposite directions

$$B = \frac{\mu_0}{2\pi}\frac{I}{r}$$



$$B_3 = B_2$$

$$\frac{\mu_0}{2\pi}\frac{(3A)}{x} = \frac{\mu_0}{2\pi}\frac{(2A)}{(.2-x)}$$

$$2x = 3(.2-x)$$

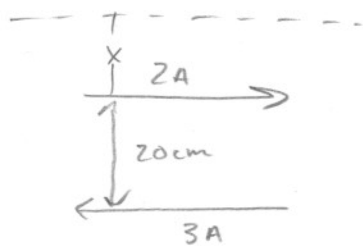
$$2x = .6 - 3x$$

$$5x = .6$$

$x = 0.12$ m above the wire carrying 3A

(b) must be above 2A wire for opposite directions

$$B_3 = B_2$$



$$\frac{\mu_0}{2\pi}\frac{(3A)}{(.2+x)} = \frac{\mu_0}{2\pi}\left(\frac{2A}{x}\right)$$

$$3x = 2(.2+x)$$

$$3x = .4 + 2x$$

$x = .4$ m above the 2A wire

(15) (a) $F_E = F_B$

$$qE = qvB$$

$$\frac{V}{x} = vB$$

$$B = \frac{V}{vx} = \frac{120\,V}{(2\times10^5\,ms^{-1})(.05m)} = 0.012\,T$$ into the page.

(b) yes

(c) no, the magnetic force would then be greater than the electric force, resulting in a net force and thus a deflection.

(17) $F = BIL\sin\theta$

$= (5\times10^{-5}\,T)(3000\,A)(30\,m)\sin(30°)$

$= \underline{2.25\,N}$

(18) yes, there will be a force.

The rings will attract (current flowing in same direction)

(20) $F = qvB = \frac{mv^2}{r}$ $v = \frac{2\pi r}{T}$ $T = \frac{1}{f}$

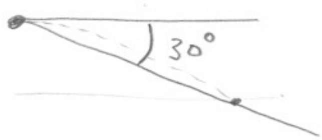
$v = 2\pi r f$

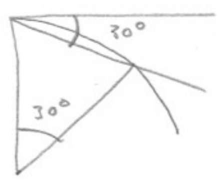
$qB = \frac{m(2\pi \cancel{r} f)}{\cancel{r}}$

$f = \frac{qB}{2\pi m}$

If the electron is replaced by a proton, the direction of the circular path changes.

(22)





$F = qvB \cancel{\sin\theta} = \frac{mv^2}{r}$ $v = \frac{2\pi r}{T}$

$qB = \frac{m2\pi}{T}$

$T = \frac{2\pi m}{qB} = \frac{2\pi(9.11\times10^{-31}\,kg)}{(1.6\times10^{-19}\,C)(0.5\,T)} = 7.155\times10^{-11}\,s$ (for whole circle)

$\frac{360°}{30°} = 12$

So... $\frac{7.155\times10^{-11}\,s}{12} = \underline{5.96\times10^{-12}\,s}$

(23) $B = \frac{\mu_0}{2\pi}\frac{I}{r}$

4.0 A

$B = \frac{(\cancel{4}^{2}\cancel{\pi} \times 10^{-7})(4.0A)}{\cancel{2\pi}\ (.15m)}$

$= 5.3 \times 10^{-6}$ T down

2.0 A

$B = \frac{(\cancel{4}^{2}\cancel{\pi} \times 10^{-7})(2A)}{\cancel{2\pi}\ (.10m)}$

$= 4 \times 10^{-6}$ T up

1.0 A

$B = \frac{(\cancel{4}^{2}\cancel{\pi} \times 10^{-7})(1A)}{\cancel{2\pi}\ (.05m)}$

$= 4 \times 10^{-6}$ T up

$B_{net} = -5.3 \times 10^{-6}\,T + 4 \times 10^{-6}\,T + 4 \times 10^{-6}\,T$

$= \underline{2.7 \times 10^{-6}\ T\ \text{up}}$

(31) (a) net magnetic field from the wires P and Q must be down at R.

∴ both currents must be out of the page

(b) left (increasing the current will increase the field at point, R if R moves left, then the field will decrease)