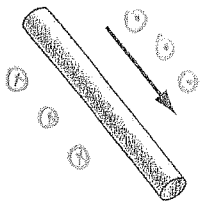
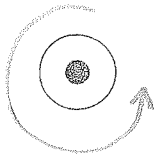
R.H.R. #1 Homework

1. Copy the following images into your notebook. For each current-carrying conductor, sketch a view of the magnetic field, based on the direction of current flow shown.

a) Fig.9.21a

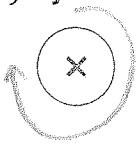


b) Fig.9.21b

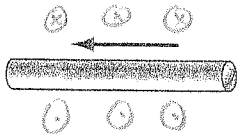


c) Fig.9.21c

d) Fig.9.21d

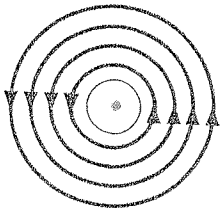


e) Fig.9.21e

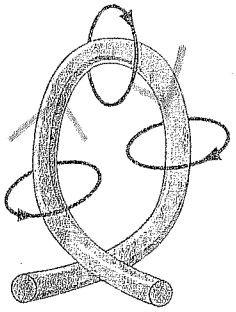


2. Copy the following images into your notebook. For each current-carrying conductor, show the direction of current flow, based on the structure of the magnetic field shown.

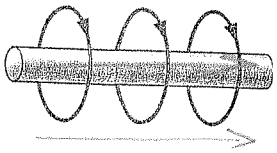
a) Fig.9.22a



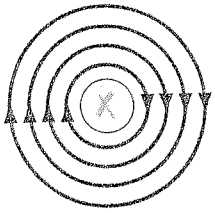
b) Fig.9.22b



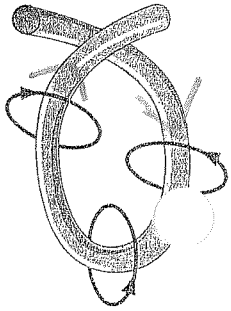
c) Fig.9.22c



d) Fig.9.22d



e) Fig.9.22e



3. What is the magnetic field strength 20 cm from a long, straight conductor with a current of 60 A flowing through it? (6.0×10^{-5} T)

4. What current is flowing through a straight wire if the magnetic field strength 10 cm from the wire is 2.4×10^{-5} T? (12 A)

5. At what distance from a straight conductor, with a current of 200 A flowing through it, is the magnetic field intensity 8.0×10^{-4} T? (5.0×10^{-2} m)

6. What is the magnetic field strength at a point midway between two long, parallel wires, 1.0 m apart, carrying currents of 10 A and 20 A respectively, if the currents are
   a) in opposite directions? (1.2×10^{-5} T)
   b) in the same direction? (4.0×10^{-6} T)

7. A long, solid, copper rod has a circular cross-section of radius 5.0 cm. It carries a current of 1000 A, uniformly distributed across its area. Calculate the magnetic field strength at these four positions:
   a) at the centre of the rod. (0 T)
   b) 2.5 cm from the centre. (2.0×10^{-3} T)
   c) 5.0 cm from the centre. (4.0×10^{-3} T)
   d) 7.5 cm from the centre. (2.7×10^{-3} T)

   Hint: Remember, the current in Ampere's Law is the current flowing through the enclosed area.

RIGHT HAND RULE #1 ANSWERS

3. $B = ?$
$r = 20\,cm = 0.20\,m$
$I = 60\,A$

$$B = \frac{\mu_0 I}{2\pi r}$$
$$= \frac{(4\pi \times 10^{-7})(60\,A)}{2\pi(0.20\,m)}$$
$$= 6.0 \times 10^{-5}\,T$$

4. $I = ?$
$r = 10\,cm = 0.10\,m$
$B = 2.4 \times 10^{-5}\,T$

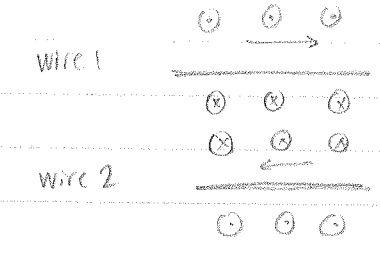
$$B = \frac{\mu_0 I}{2\pi r} \Rightarrow I = \frac{B 2\pi r}{\mu_0}$$
$$I = \frac{(2.4 \times 10^{-5}\,T)(2\pi)(0.10\,m)}{4\pi \times 10^{-7}}$$
$$= 12\,A$$

5. $I = 200\,A$
$B = 8.0 \times 10^{-4}\,T$
$r = ?$

$$B = \frac{\mu_0 I}{2\pi r} \Rightarrow r = \frac{\mu_0 I}{2\pi B}$$
$$r = \frac{\mu_0 (200\,A)}{2\pi (8.0 \times 10^{-4}\,T)}$$
$$r = 5.0 \times 10^{-2}\,m$$

6. $r = 0.50\,m$
$I_1 = 10\,A$
$I_2 = 20\,A$
$B_{NET} = ?$

a)



← magnetic field in the same direction
$\therefore B_{NET} = B_1 + B_2$

RIGHT HAND RULE #1 ANSWERS

60 cm

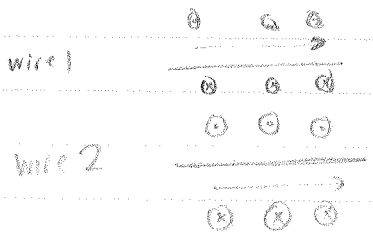
$$B_{NET} = \frac{\mu_0 I_1}{2\pi r} + \frac{\mu_0 I_2}{2\pi r}$$

$$= \frac{\mu_0}{2\pi r}(I_1 + I_2)$$

$$= \frac{(4\pi \times 10^{-7})}{2\pi (0.50\,m)}(10A + 20A)$$

$$= 1.2 \times 10^{-5}\ T$$

b)



← magnetic field in opposite direction ∴ $B_{NET} = B_2 - B_1$

$$B_{NET} = \frac{\mu_0 I_2}{2\pi r} - \frac{\mu_0 I_1}{2\pi r}$$

$$= \frac{\mu_0}{2\pi r}[I_2 - I_1)$$

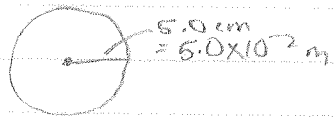
$$= \frac{(4\pi \times 10^{-7})}{2\pi (0.50m)}[20A - 10A)$$

$$= 4.0 \times 10^{-6}\ T$$

RIGHT HAND RULE #1 ANSWERS

7. $I = 1000\,A$

$B = ?$



a) $r = 0\,m$

$I = 0$

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

$$= \frac{(4\pi \times 10^{-7})(0\,A)}{2\pi\,(0\,m)}$$

$$= \infty = 0\,T$$

b) $r = 2.5\,cm = 2.5\times10^{-2}\,m$

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{but} \quad I = (1000\,A)\frac{\pi(2.5\times10^{-2}\,m)^2}{\pi(5.0\times10^{-2}\,m)^2}$$

$$= 2.5\times10^{-2}\,A$$

$$= \frac{(4\pi\times10^{-7})(2.5\times10^{-2}\,A)}{2\pi(2.5\times10^{-2}\,m)}$$

$$= 2.0\times10^{-3}\,T$$

c) $r = 5.0\,cm = 5.0\times10^{-2}\,m$

$I = 1000\,A$

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

$$= \frac{(4\pi\times10^{-7})(1000\,A)}{2\pi(5.0\times10^{-2}\,m)}$$

$$= 4.0\times10^{-3}\,T$$

d) $r = 7.5\,cm = 7.5\times10^{-2}\,m$

$I = 1000\,A$

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

$$= \frac{(4\pi\times10^{-7})(1000\,A)}{2\pi(7.5\times10^{-2}\,m)}$$

$$= 2.7\times10^{-3}\,T$$