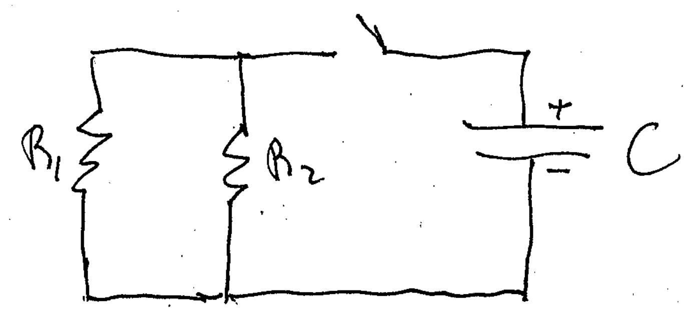
Lecture # 13

Magnetism

1. Consider two identical capacitors with capacitance C. One is charged with a charge Q on its plates and the second with $2Q$. The ratio of the energy stored in the first to second capacitor is:

(a) 1 (b) $1/2$ (c) $1/4$

2.



Just before the switch is closed there is a charge Q_0 on the capacitor. When it is closed the charge decays as

$$Q = Q_0 \exp(-t/\tau)$$

where $\tau = ?$ (a) $(R_1+R_2)C$, (b) $R_1 C$ (c) $R_2 C$

(d) $\dfrac{R_1 R_2}{R_1 + R_2} C$

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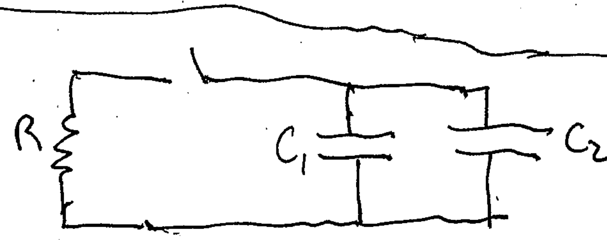
3. 

The total charge on C_1 and C_2 is Q_0 before switch is closed

After swith is closed, Q decays as

$\tau =$: (a) $R(C_1+C_2)$; (b) RC_1 (c) RC_2 (d) $R\dfrac{C_1 C_2}{C_1 + C_2}$

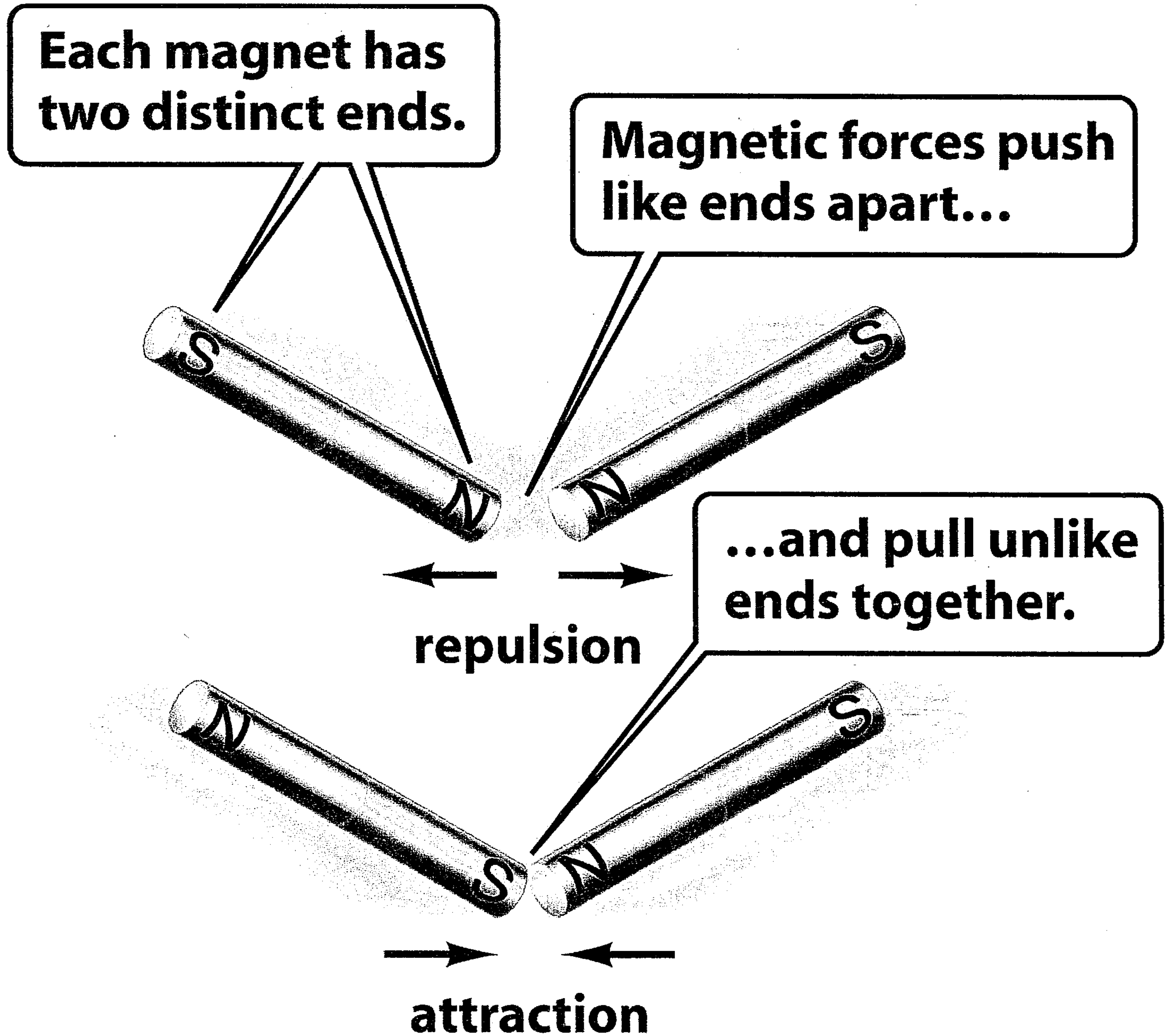


Figure 29-1 Physics for Engineers and Scientists 3/e

Magnetism

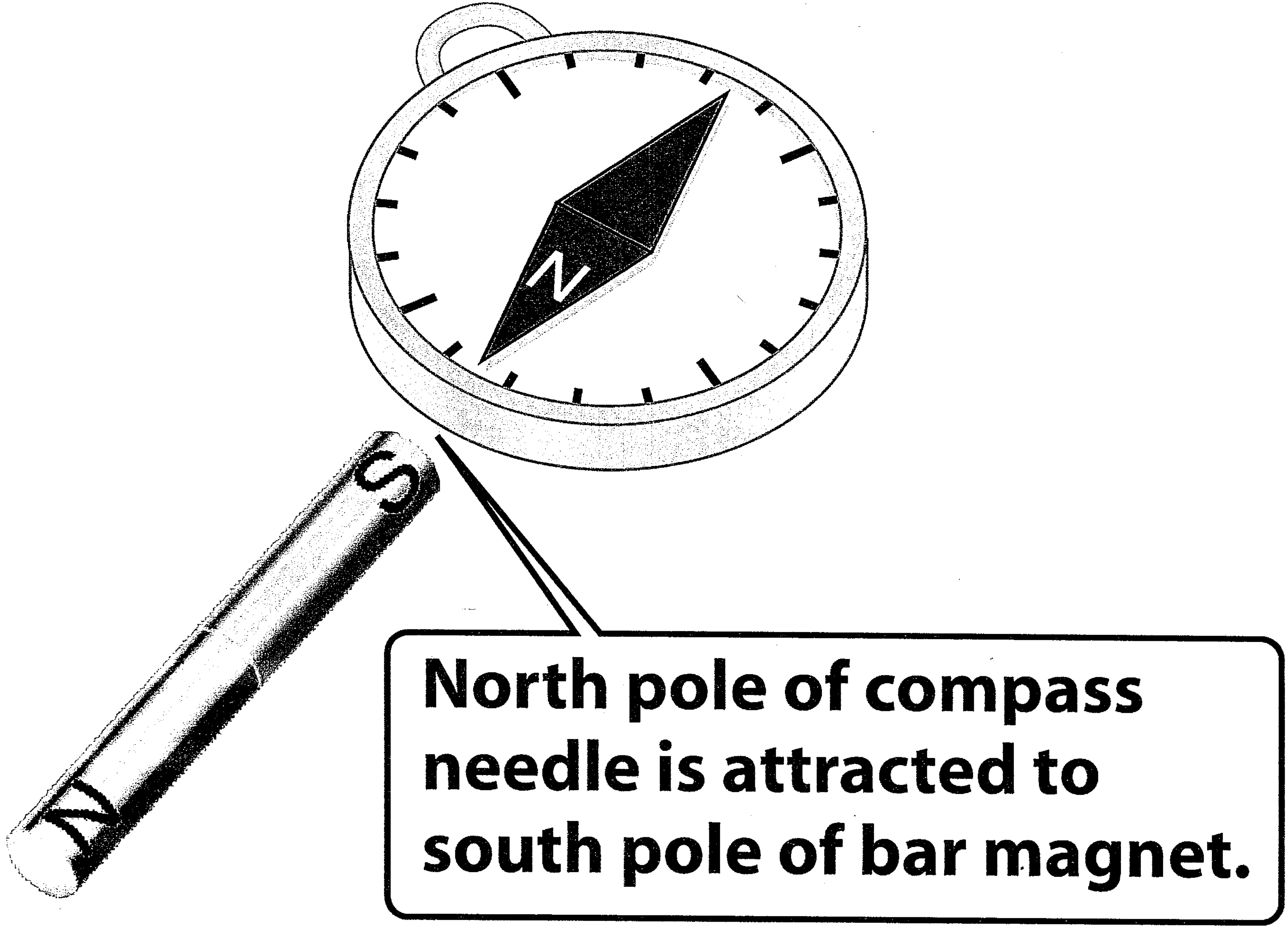


Figure 29-2 Physics for Engineers and Scientists 3/e

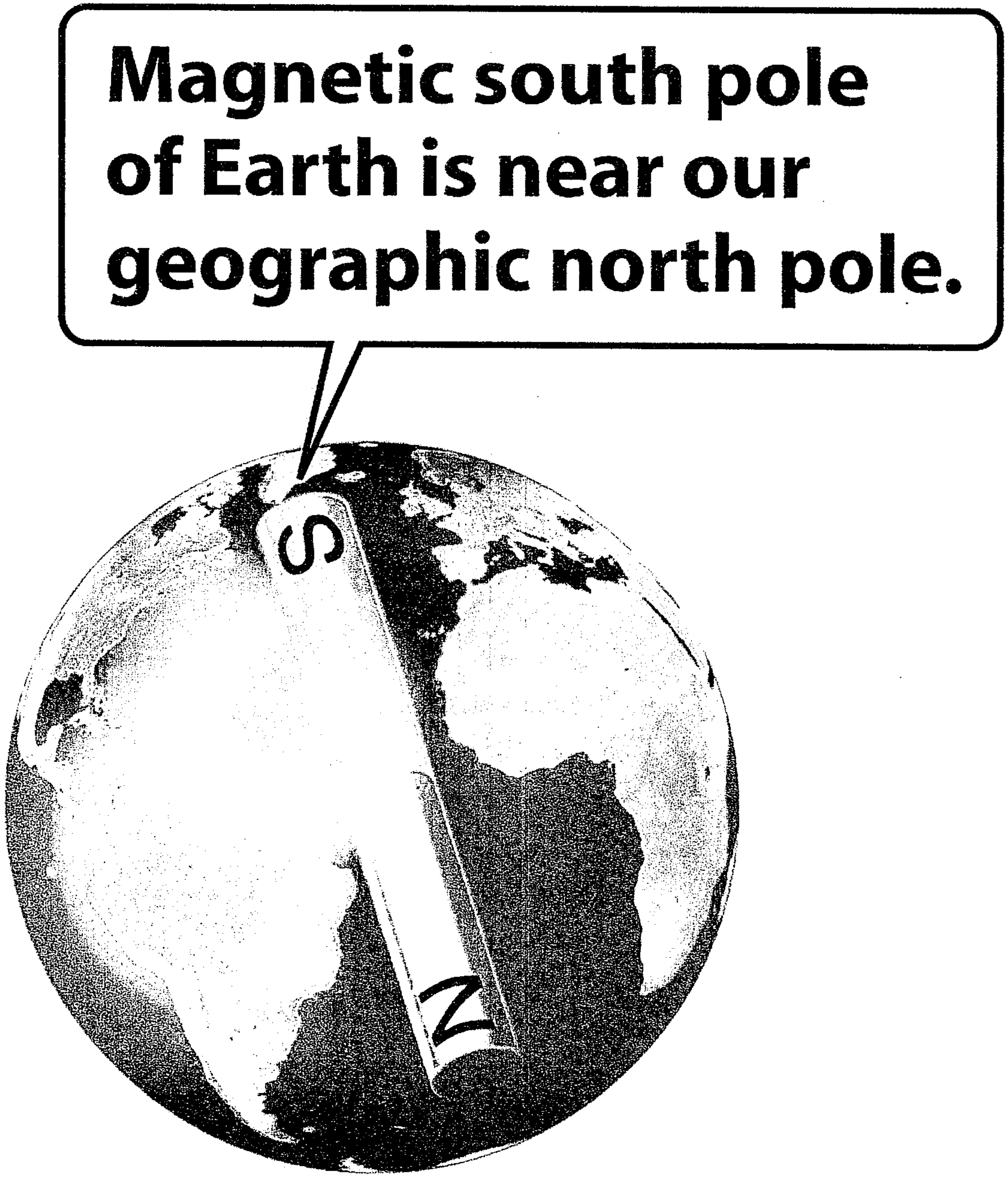


Figure 29-3 Physics for Engineers and Scientists 3/e

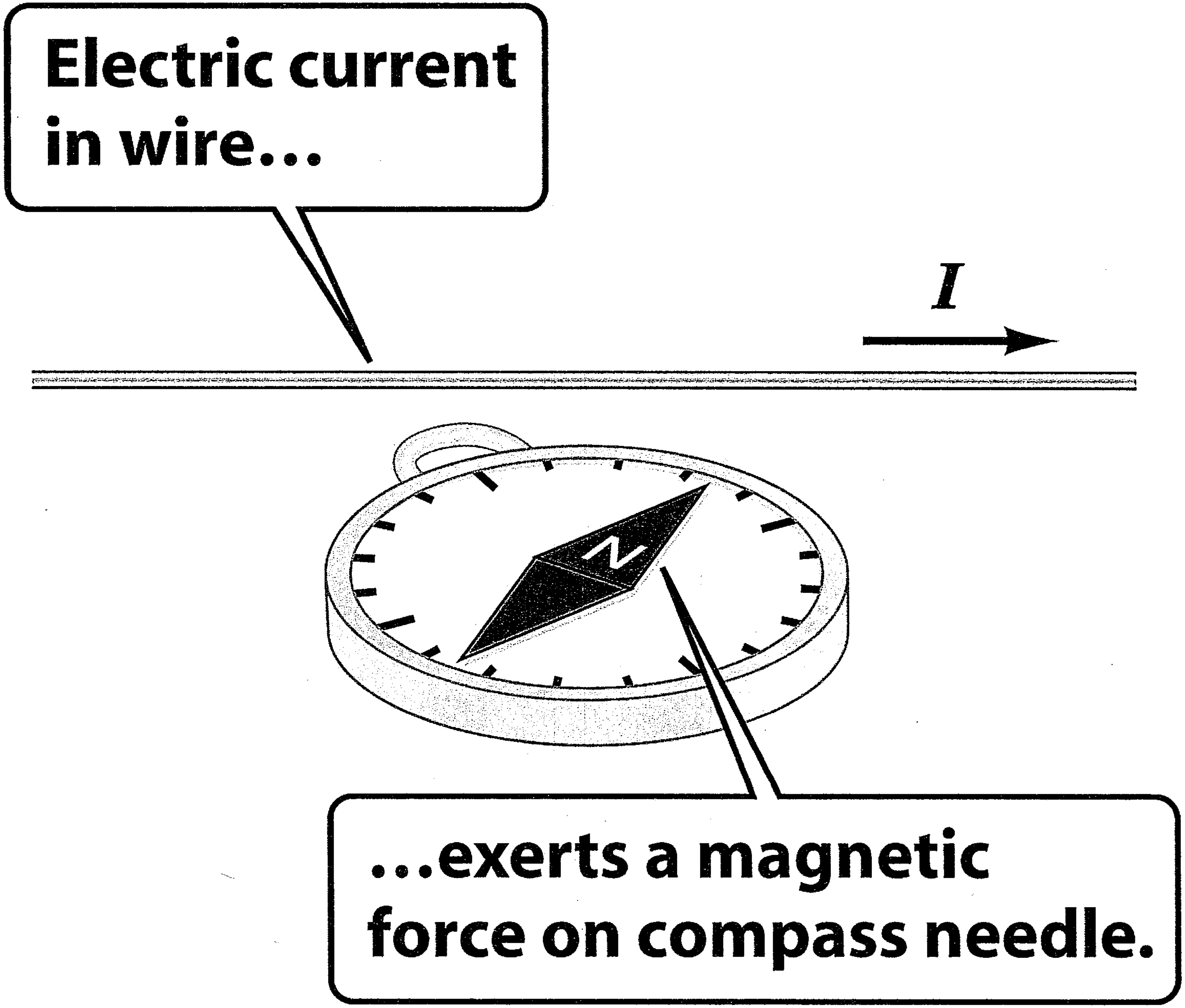


Figure 29-4 Physics for Engineers and Scientists 3/e

TABLE 29.1 SOME MAGNETIC FIELDS

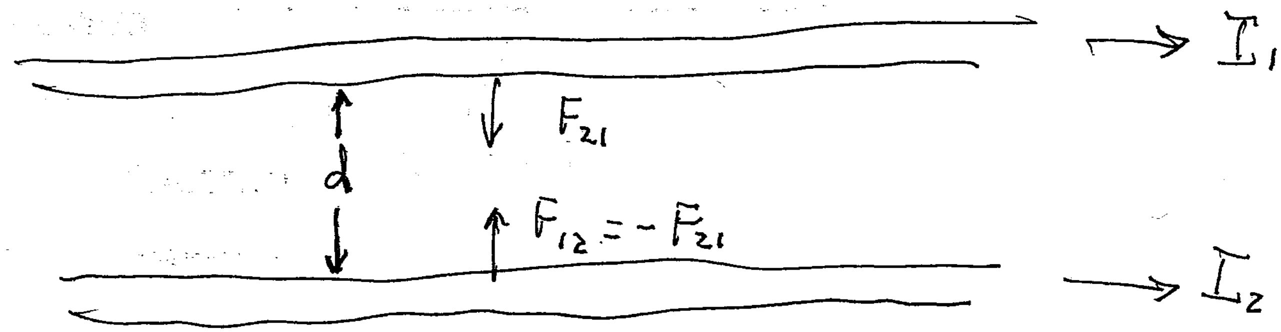
At surface of pulsar	$\approx 10^8$ T
Maximum achieved in laboratory:	
Explosive compression of field lines	1×10^3
Steady	45
In particle accelerator magnet	8
In large bubble-chamber magnet	2
In MRI magnet (a)	1.5
In sunspot (b)	≈ 0.3
Near small ceramic magnet	$\approx 2 \times 10^{-2}$
At surface of Sun	$\approx 10^{-2}$
Near household wiring (c)	$\approx 10^{-4}$
At surface of Earth	$\approx 5 \times 10^{-5}$
In sunlight (rms)	3×10^{-6}
In Crab Nebula (d)	$\approx 10^{-8}$
In radio wave (rms)	$\approx 10^{-9}$
In interstellar galactic space	$\approx 10^{-10}$
Produced by human body.	3×10^{-10}
In shielded antimagnetic chamber	2×10^{-14}

Table 29-1 Physics for Engineers and Scientists 3/e

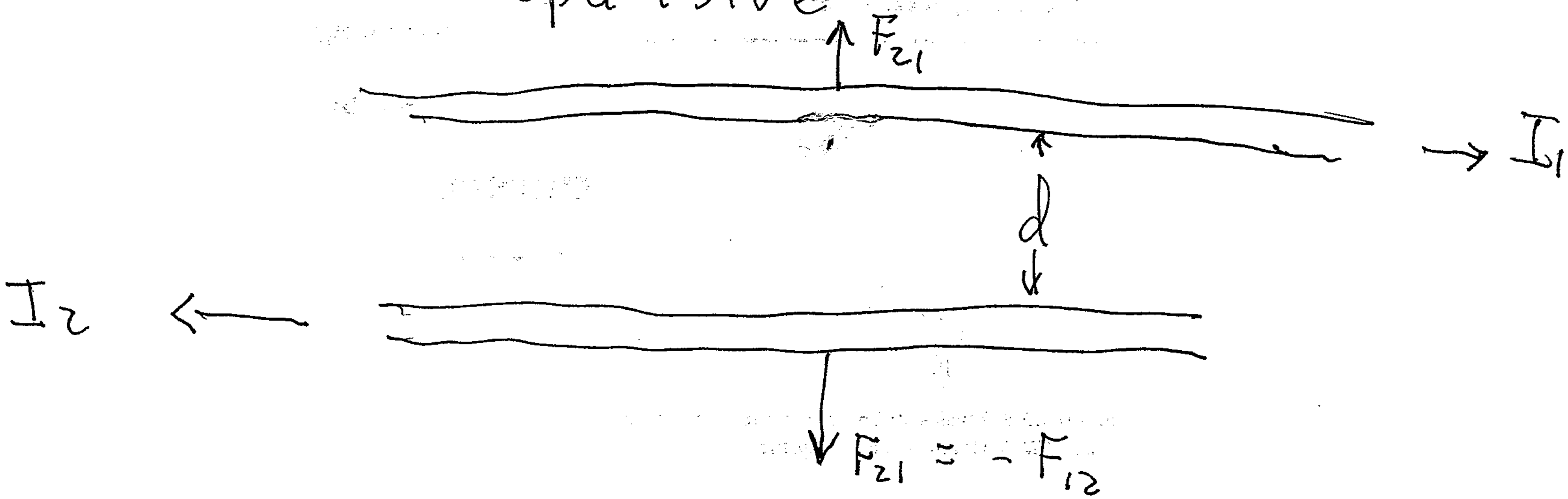
Interaction of currents together

$$F_{21} \propto \frac{I_1 I_2}{d}$$

attractive



repulsive



Interaction of charge with current

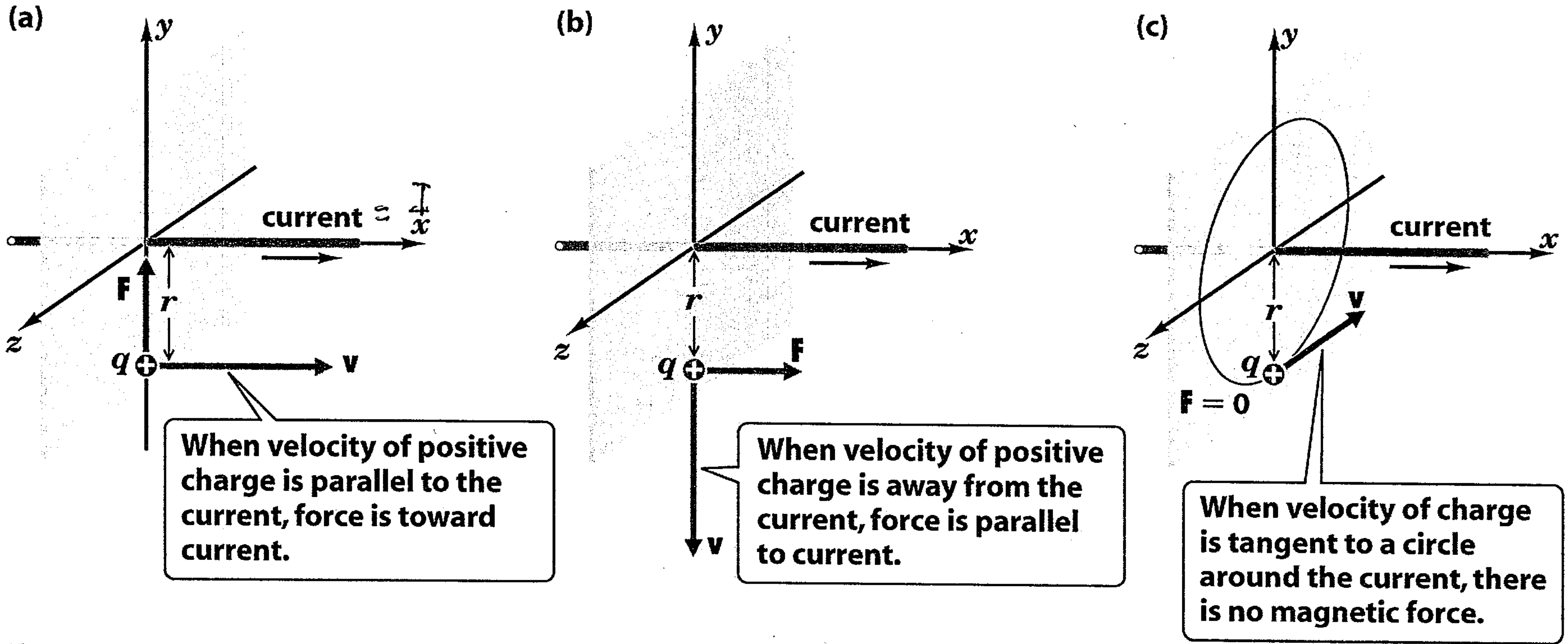
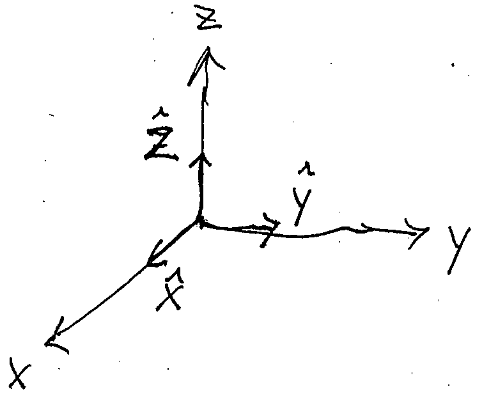


Figure 29-6 Physics for Engineers and Scientists 3/e

$$F \propto Iqv/r$$

$$F = \frac{\mu_0}{2\pi} q \frac{v}{r} \quad , \quad \mu_0 = 4\pi \times 10^{-7} \ Ns/C$$

Cross Product



$$\hat{x} \times \hat{x} = \hat{y} \times \hat{y} = \hat{z} \times \hat{z} = 0$$

$$\hat{x} \times \hat{y} = \hat{z} \; ; \quad \hat{y} \times \hat{x} = -\hat{z}$$

$$\hat{y} \times \hat{z} = \hat{x} \; ; \quad \hat{z} \times \hat{y} = -\hat{x}$$

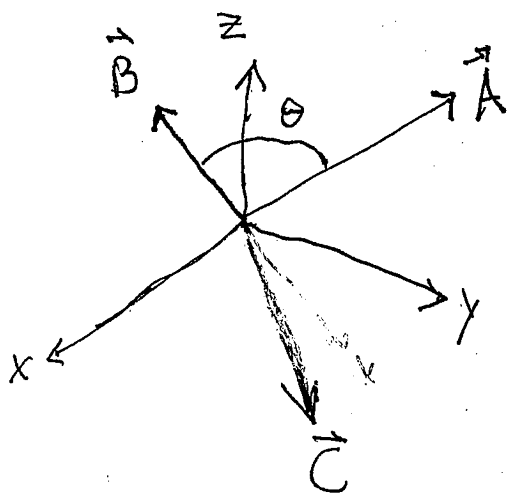
$$\hat{z} \times \hat{x} = \hat{y} \; ; \quad \hat{x} \times \hat{z} = -\hat{y}$$

$$\vec{C} \equiv \underset{\sim}{\vec{A}} \times \underset{\sim}{\vec{B}} = (A_x \hat{x} + A_y \hat{y} + A_z \hat{z}) \times (B_x \hat{x} + B_y \hat{y} + B_z \hat{z})$$

$$= (A_y B_z - A_z B_y) \hat{x}$$

$$+ (A_z B_x - A_x B_z) \hat{y} \qquad \equiv C_x \hat{x} + C_y$$

$$+ (A_x B_y - A_y B_x) \hat{z}$$



$$|\vec{C}| = |\vec{A}| \, |\vec{B}| \sin\theta$$

$\vec{F}$

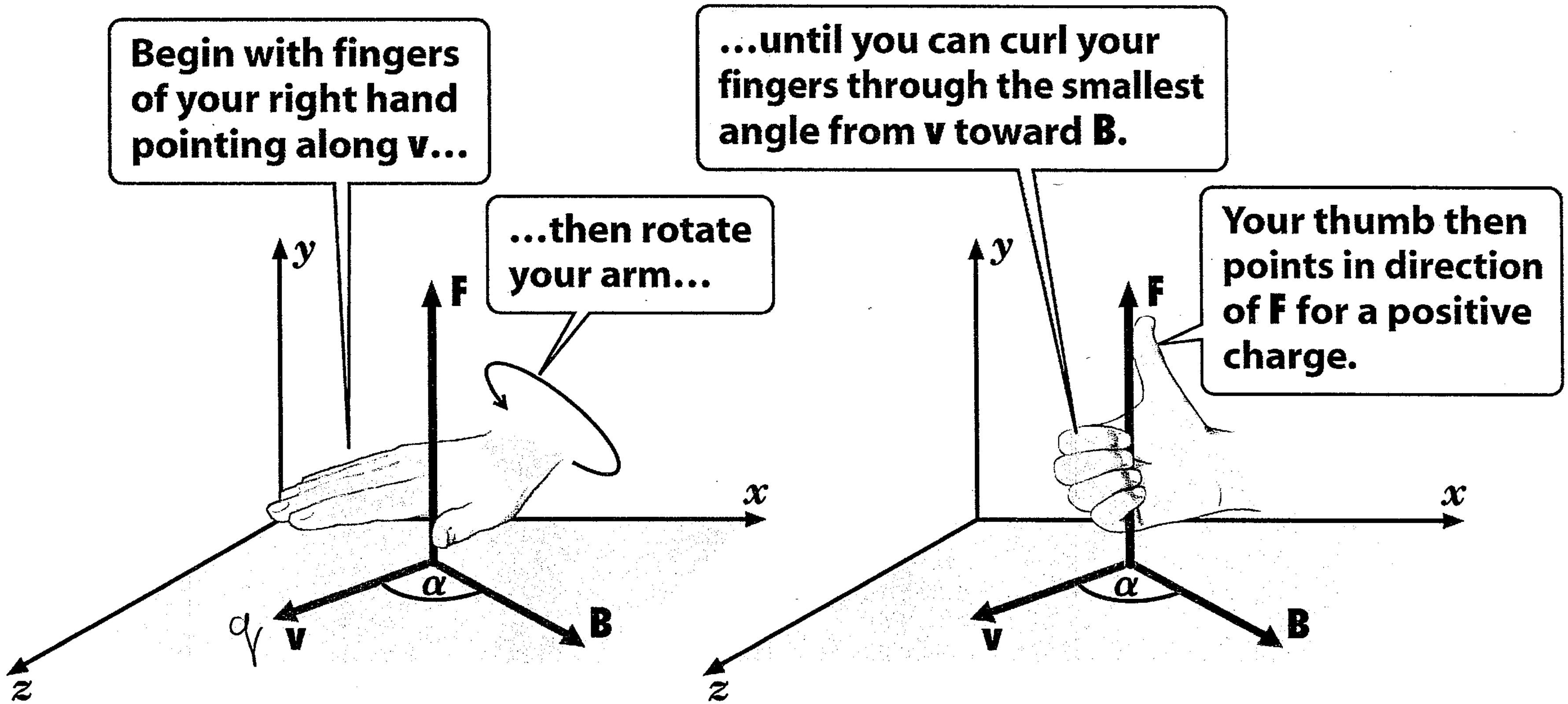
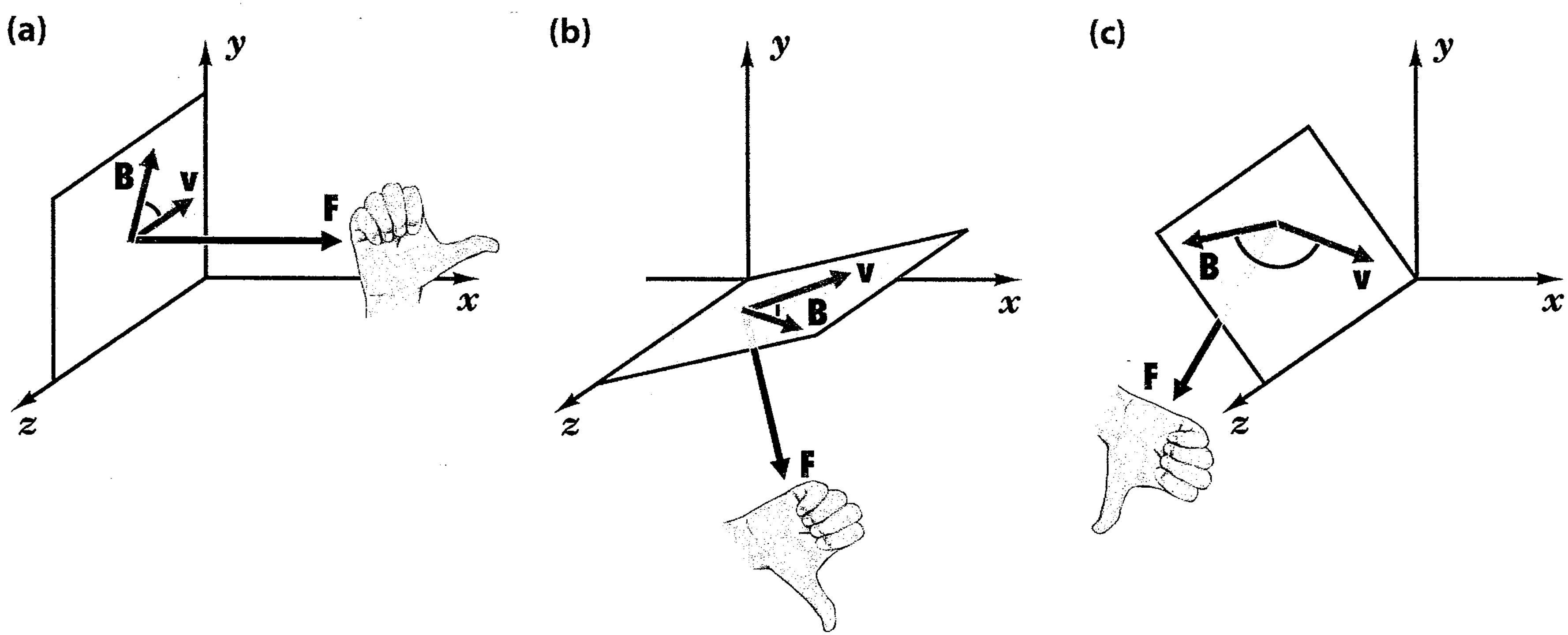


Figure 29-12 Physics for Engineers and Scientists 3/e

$$F = q \underset{\sim}{v} \times \underset{\sim}{B}$$



Unnumbered 29 pg 936 Physics for Engineers and Scientists 3/e

There is a "magnetic field" B associated with the current in the indicated directions of the figure

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

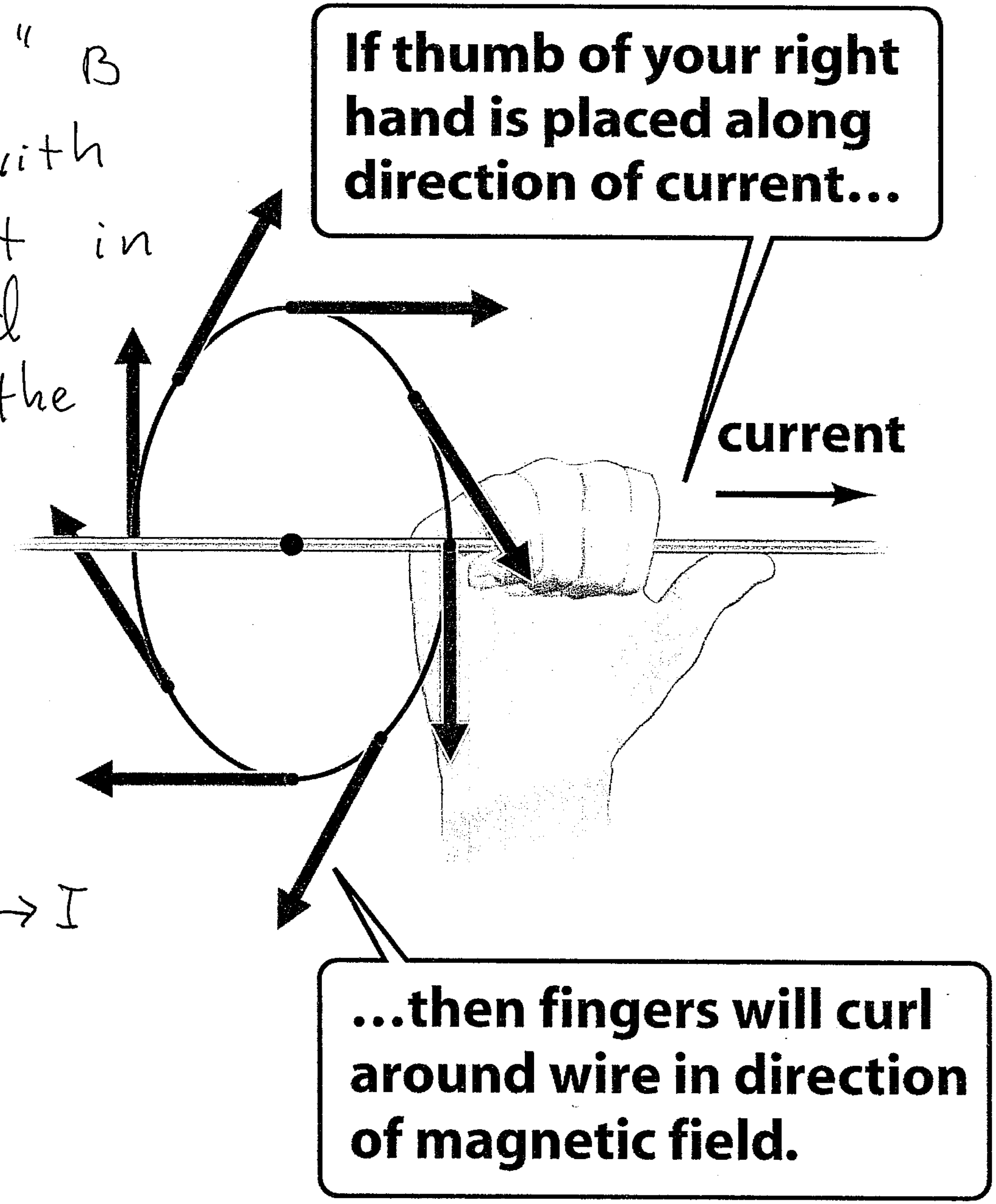
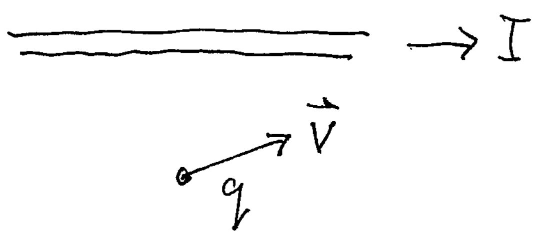


Figure 29-10 Physics for Engineers and Scientists 3/e

B - field is directed in same direction compass needles would point



$$\vec{F}_q = q\,\vec{v} \times \vec{B}$$

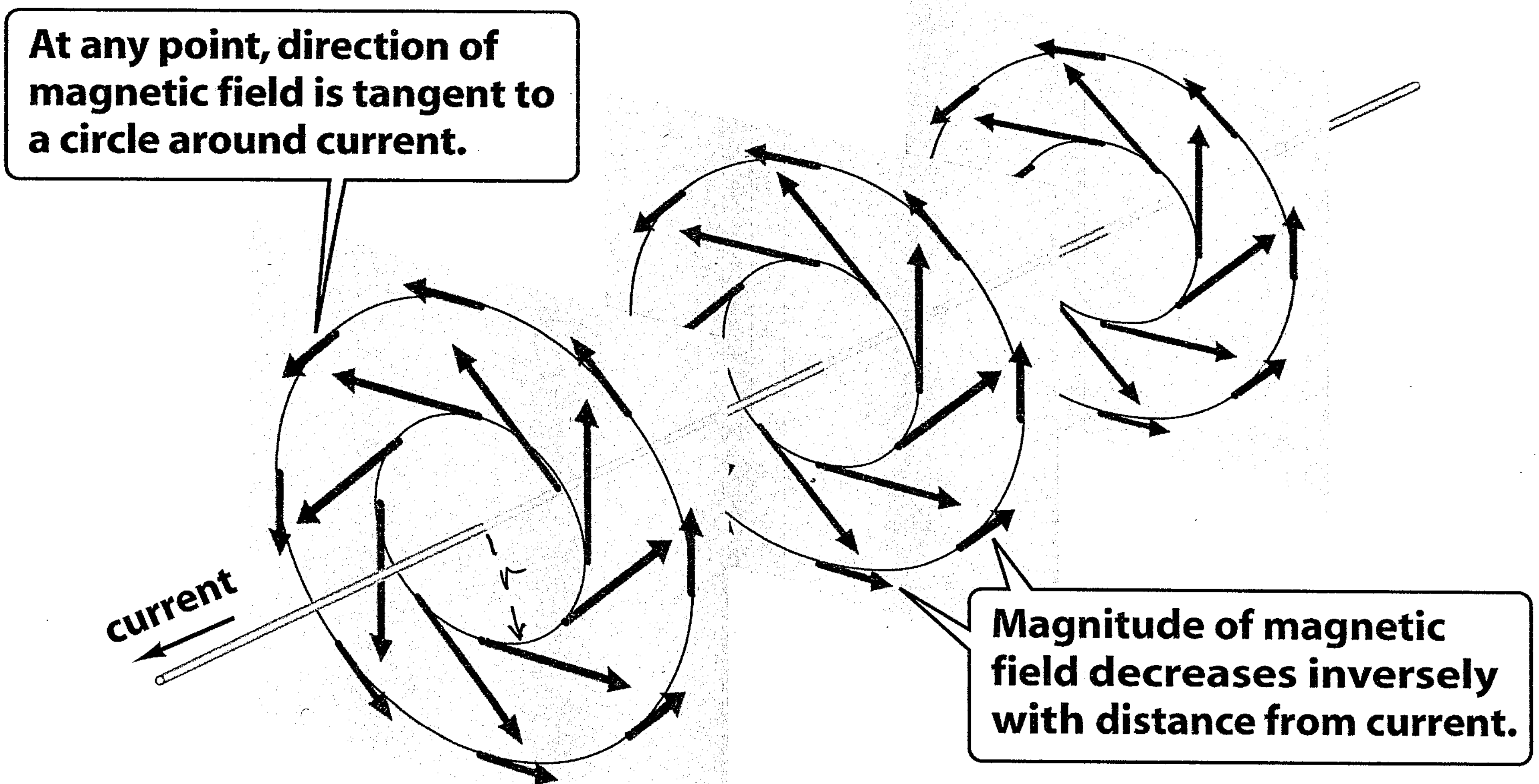


Figure 29-9 Physics for Engineers and Scientists 3/e

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