Force on Parallel Wires - Answers

1. $F/L = ?$
$I_1 = I_2 = 8.0\,A$
$d = 1.0\,cm = 1.0\times10^{-2}\,m$

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

$$\frac{F}{L} = \frac{(4\pi\times10^{-7})(8.0A)(8.0A)}{2\pi(1.0\times10^{-2}m)}$$

$$\frac{F}{L} = 1.28\times10^{-3}\ \frac{N}{m}$$

$$= 1.3\times10^{-3}\ N/m$$

2. $I_1 = I_2 = ?$
$L = 5.0\,m$
$d = 12\,cm = 12\times10^{-2}\,m$
$F_{max} = 2.0\times10^{-2}\,N$

$$F_{max} = \frac{\mu_0 I_1 I_2 L}{2\pi d} \Rightarrow I^2 = \frac{F 2\pi d}{\mu_0 L}$$

$$I = \sqrt{\frac{(2.0\times10^{-2}N)(2\pi(12\times10^{-2}m))}{(4\pi\times10^{-7})(5.0m)}}$$

$$I = 49\,A$$

3. $d = ?$
$I_1 = 5.0\,A$
$I_2 = 10\,A$
$\frac{F}{L} = 3.6\times10^{-4}\,N/m$

$$F = \frac{\mu_0 I_1 I_2 L}{2\pi d} \Rightarrow d = \frac{\mu_0 I_1 I_2}{2\pi}\left(\frac{L}{F}\right)$$

$$d = \frac{(4\pi\times10^{-7})(5.0A)(10A)}{2\pi(3.6\times10^{-4}N/m)}$$

$$d = 2.8\times10^{-2}\,m$$

4. $F/L = ?$
$d = 2.0\times10^{-3}\,m$
$I_1 = I_2 = 1.0\,A$
$P = 100\,W$

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

$$\frac{F}{L} = \frac{(4\pi\times10^{-7})(1.0A)(1.0A)}{2\pi(2.0\times10^{-3}m)}$$

$$= 1.0\times10^{-4}\ N/m$$

Force on Particles – Answers

1. $\vec{F} = ?$
$\vec{v} = 8.6 \times 10^4$ m/s [N]
$B = 1.2$ T
$\theta = 90°$
$q = +1.602 \times 10^{-19}$ C

By RHR #3, direction is [right]

$F = qvB\sin\theta$
$= (1.602 \times 10^{-19}\text{C})(8.6 \times 10^4 \text{m/s})(1.2\text{T})\sin 90°$
$= 1.6 \times 10^{-14}$ N [right]

2. $\vec{B} = ?$
$\vec{v} = 2.0 \times 10^6$ m/s [out of the page]
$F = 5.1 \times 10^{-14}$ N [left]
$q = -1.602 \times 10^{-19}$ C
$\theta = 90°$

By LHR #3 magnetic field is [N]

$F = qvB\sin\theta \Rightarrow B = \frac{F}{qv\sin\theta}$

$B = \frac{5.1 \times 10^{-14}\text{N}}{(1.602 \times 10^{-19}\text{C})(2.0 \times 10^6 \text{m/s})\sin 90°}$
$= 0.16\text{T}$ [N]

3. $r = ?$
$q = 3.2 \times 10^{-19}$ C
$m = 6.7 \times 10^{-27}$ kg
$v = 1.5 \times 10^7$ m/s
$B = 2.4$ T
$\theta = 90°$

$F_c = F$
$\frac{mv^2}{r} = qvB\sin\theta \Rightarrow r = \frac{mv^2}{qvB\sin\theta}$

$r = \frac{mv}{qB\sin\theta}$

$= \frac{(6.7 \times 10^{-27}\text{kg})(1.5 \times 10^7 \text{m/s})}{(3.2 \times 10^{-19}\text{C})(2.4\text{T})\sin 90°}$

$= 0.13$ m

Force on Particles- Answers

4a) $v = ?$
$q = 1.602 \times 10^{-19} C$
$r = 8.0 cm$
$= 8.0 \times 10^{-2} m$
$B = 1.5 T$
$\theta = 90°$
$m = 1.67 \times 10^{-27} kg$

$\frac{mv^2}{r} = qvB\sin\theta \Rightarrow v = \frac{rqB\sin\theta}{m}$

$v = \frac{(8.0 \times 10^{-2} m)(1.602 \times 10^{-19} C)(1.5 T)\sin 90°}{1.67 \times 10^{-27} kg}$

$= 1.2 \times 10^{7} m/s$

b) $V = ?$
$V_1 = 0$
$V_2 = 1.2 \times 10^{7} m/s$

$m = \frac{qB^2r^2}{2V} \Rightarrow V = \frac{qB^2r^2}{2m}$

$V = \frac{(1.602 \times 10^{-19} C)(1.5 T)^2(8.0 \times 10^{-2} m)^2}{2(1.67 \times 10^{-27} kg)}$

$V = 6.9 \times 10^{5} V$

5. $v = 200 m/s$
$q = 10 C$
$F = ?$
$B = 5.0 \times 10^{-5} T$
$\theta = 90°$

$F = qvB\sin\theta$

$= (10 C)(200 m/s)(5.0 \times 10^{-5} T)\sin 90°$

$= 1.0 N$