27.11

(a) $\Phi_B = \vec{B}\cdot\vec{A} = (0.230\ T)\pi(0.065\ m)^2$

$= 3.05\times10^{-3}\ Wb$

(b) $\phi_B = \vec{B}\cdot\vec{A} = (0.230\ T)\pi(0.065\ m)^2 \cos 53.1°$

$= 1.83\times10^{-3}\ Wb$

(c) $\phi_B = 0$ since $\vec{B} \perp \vec{A}$

27.15

(a) $B = \dfrac{mv}{|q|R} = \dfrac{(9.11\times10^{-31}\ kg)(1.41\times10^{6}\ m/s)}{(1.60\times10^{-19}\ C)(0.0500\ m)}$

$= 1.61\times10^{-4}\ T$

The direction of $\vec{B}$ is into the page. The charge is negative.

(b) The time to complete half a circle is just the distance traveled divided by the velocity:

$t = \dfrac{D}{v} = \dfrac{\pi R}{v} = \dfrac{\pi(0.0500\ m)}{1.41\times10^{6}\ m/s}$

$= 1.11\times10^{-7}\ s$

27.22

(a) $R = \dfrac{mv}{qB}$ $\quad v = \dfrac{qBR}{m} = \dfrac{3(1.60\times10^{-19}\ C)(0.250\ T)\left(\frac{0.950}{2}\ m\right)}{12(1.67\times10^{-27}\ kg)}$

$= 2.84\times10^{6}\ m/s$

Since $\vec{v}\times\vec{B}$ is to the left but the charges bend to the right, they must be negative.

(b) $F_{grav} = mg = 12(1.67\times10^{-27}\ kg)(9.80\ m/s^2)$

$= 1.96\times10^{-25}\ N$

$F_{mag} = qvB = 3(1.6\times10^{-19}\ C)(2.84\times10^{6}\ m/s)(0.250\ T)$

$= 3.41\times10^{-13}\ N$

Since $F_{mag} \simeq 10^{12}\cdot F_{grav}$, we can neglect gravity.

(c) Speed does not change since $\vec{B}$ does no work.

27.42

(a) Magnetic force must be upward so current must be to the right. Therefore "a" must be the positive terminal.

(b) For balance, $F_{mag} = mg$

$$I\ell B \sin\theta = mg$$

$$m = \frac{I\ell B \sin\theta}{g}$$

$$I = \mathcal{E}/R = 175\text{ V}/5.00\,\Omega = 35.0\text{ A}$$

$$m = \frac{(35.0\text{ A})(0.600\text{ m})(1.50\text{ T})}{9.80\text{ m/s}^2} = 3.21\text{ kg}$$

27.55

(a) By inspection, using $\vec{F} = q\vec{v} \times \vec{B}$, $\vec{B} = -B\hat{j}$ will provide the correct direction for each force. Using either force, say F_2, $B = \dfrac{F_2}{q|v_2|}$.

(b) $$F_1 = q|v_1| B \sin 45^\circ = \frac{q|v_2|B}{\sqrt{2}}$$

$$= \frac{F_2}{\sqrt{2}} \quad (\text{since } |v_1| = |v_2|).$$

27.74

(a) $F = ILB$ to the right.

(b) $v^2 = 2ad \Rightarrow d = \dfrac{v^2}{2a} = \dfrac{v^2 m}{2ILB}$

(c) $$d = \frac{(1.12 \times 10^4\ \text{m/s})^2 (25\ \text{kg})}{2(2000\ \text{A})(0.50\ \text{m})(0.80\ \text{T})}$$

$$= 1.96 \times 10^6\ \text{m}$$

$$= 1960\ \text{km}\ !$$

27.84

(a) $$I_u = \frac{dq}{dt} = \frac{\Delta q}{\Delta t} = \frac{q_u v}{2\pi r}$$

$$\therefore\ I_u = \frac{ev}{3\pi r}$$

(b) $$\mu_u = I_u A = \frac{ev}{3\pi r}\pi r^2 = \frac{evr}{3}$$

(c) Since there are two down quarks, each of half the charge of the up quark,

$$\mu_d = \mu_u = \frac{evr}{3}$$

$$\Rightarrow\ \mu_{total} = \frac{2evr}{3}$$

(d) $$v = \frac{3\mu}{2er} = \frac{3(9.66 \times 10^{-27}\ \text{A}\cdot\text{m}^2)}{2(1.60 \times 10^{-19}\ \text{C})(1.20 \times 10^{-15}\ \text{m})}$$

$$= 7.55 \times 10^7\ \text{m/s}.$$