P24.11 $\Phi_E = \frac{q_{in}}{\epsilon_0}$

Through S_1 $\quad \Phi_E = \frac{-2Q+Q}{\epsilon_0} = \boxed{-\frac{Q}{\epsilon_0}}$

Through S_2 $\quad \Phi_E = \frac{+Q-Q}{\epsilon_0} = \boxed{0}$

Through S_3 $\quad \Phi_E = \frac{-2Q+Q-Q}{\epsilon_0} = \boxed{-\frac{2Q}{\epsilon_0}}$

Through S_4 $\quad \Phi_E = \boxed{0}$

P24.13 The flux through the curved surface is equal to the flux through the flat circle, $\boxed{E_0 \pi r^2}$.

P24.24 (a) $E = \frac{k_e Qr}{a^3} = \boxed{0}$

(b) $E = \frac{k_e Qr}{a^3} = \frac{(8.99 \times 10^9)(26.0 \times 10^{-6})(0.100)}{(0.400)^3} = \boxed{365 \text{ kN/C}}$

(c) $E = \frac{k_e Q}{r^2} = \frac{(8.99 \times 10^9)(26.0 \times 10^{-6})}{(0.400)^2} = \boxed{1.46 \text{ MN/C}}$

(d) $E = \frac{k_e Q}{r^2} = \frac{(8.99 \times 10^9)(26.0 \times 10^{-6})}{(0.600)^2} = \boxed{649 \text{ kN/C}}$

The direction for each electric field is $\boxed{\text{radially outward}}$.

P25.17 (a) $E = \frac{|Q|}{4\pi \epsilon_0 r^2}$

$V = \frac{Q}{4\pi \epsilon_0 r}$

$r = \frac{|V|}{|E|} = \frac{3\,000 \text{ V}}{500 \text{ V/m}} = \boxed{6.00 \text{ m}}$

(b) $V = -3\,000 \text{ V} = \frac{Q}{4\pi \epsilon_0 (6.00 \text{ m})}$

$Q = \frac{-3\,000 \text{ V}}{(8.99 \times 10^9 \text{ V} \cdot \text{m/C})}(6.00 \text{ m}) = \boxed{-2.00\ \mu\text{C}}$

P29.7 $F_B = qvB\sin\theta$ so $8.20 \times 10^{-13} \text{ N} = (1.60 \times 10^{-19} \text{ C})(4.00 \times 10^6 \text{ m/s})(1.70 \text{ T})\sin\theta$

$\sin\theta = 0.754$ and $\theta = \sin^{-1}(0.754) = \boxed{48.9° \text{ or } 131°}$.

P30.2 $B = \frac{\mu_0 I}{2\pi R} = \frac{(4\pi \times 10^{-7} \text{ T} \cdot \text{m/A})(1.00 \times 10^4 \text{ A})}{2\pi(100 \text{ m})} = 2.00 \times 10^{-5} \text{ T} = \boxed{20.0\ \mu\text{T}}$

P30.25 (a) One wire feels force due to the field of the other ninety-nine.

$$B=\frac{\mu_0 I_0 r}{2\pi R^2}=\frac{\left(4\pi\times10^{-7}\ \text{T}\cdot\text{m/A}\right)(99)(2.00\ \text{A})\left(0.200\times10^{-2}\ \text{m}\right)}{2\pi\left(0.500\times10^{-2}\ \text{m}\right)^2}=3.17\times10^{-3}\ \text{T}$$

This field points tangent to a circle of radius 0.200 cm and exerts force $\mathbf{F}=I\boldsymbol{\ell}\times\mathbf{B}$ toward the center of the bundle, on the single hundredth wire:

$$\frac{F}{\ell}=IB\sin\theta=(2.00\ \text{A})\left(3.17\times10^{-3}\ \text{T}\right)\sin 90°=6.34\ \text{mN/m}$$

$$\frac{F_B}{\ell}=\boxed{6.34\times10^{-3}\ \text{N/m inward}}$$

(b) $B\propto r$, so B is greatest at the outside of the bundle. Since each wire carries the same current, F is $\boxed{\text{greatest at the outer surface}}$.

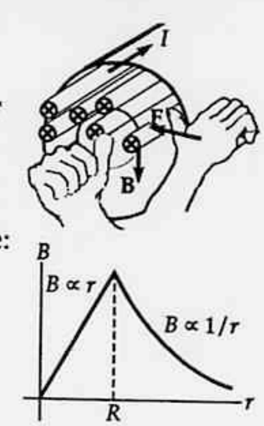

FIG. P30.25

P30.26 (a) $$B_{\text{inner}}=\frac{\mu_0 NI}{2\pi r}=\frac{\left(4\pi\times10^{-7}\ \text{T}\cdot\text{m/A}\right)(900)\left(14.0\times10^{3}\ \text{A}\right)}{2\pi(0.700\ \text{m})}=\boxed{3.60\ \text{T}}$$

(b) $$B_{\text{outer}}=\frac{\mu_0 NI}{2\pi r}=\frac{\left(2\times10^{-7}\ \text{T}\cdot\text{m/A}\right)(900)\left(14.0\times10^{3}\ \text{A}\right)}{1.30\ \text{m}}=\boxed{1.94\ \text{T}}$$

P34.4 $\frac{E}{B}=c$

or $\frac{220}{B}=3.00\times10^{8}$

so $B=7.33\times10^{-7}\ \text{T}=\boxed{733\ \text{nT}}$.

P35.37 $\sin\theta_c=\frac{n_2}{n_1}$: $\theta_c=\sin^{-1}\left(\frac{n_2}{n_1}\right)$

(a) Diamond: $\theta_c=\sin^{-1}\left(\frac{1.333}{2.419}\right)=\boxed{33.4°}$

(b) Flint glass: $\theta_c=\sin^{-1}\left(\frac{1.333}{1.66}\right)=\boxed{53.4°}$

(c) Ice: Since $n_2>n_1$, $\boxed{\text{there is no critical angle}}$.

38.10 (a) Double-slit interference maxima are at angles given by $d\sin\theta = m\lambda$.

For $m = 0$, $\theta_0 = \boxed{0°}$.

For $m = 1$, $(2.80\ \mu\text{m})\sin\theta = 1(0.501\,5\ \mu\text{m})$: $\theta_1 = \sin^{-1}(0.179) = \boxed{10.3°}$.

Similarly, for $m = 2, 3, 4, 5$ and 6, $\theta_2 = \boxed{21.0°}$, $\theta_3 = \boxed{32.5°}$, $\theta_4 = \boxed{45.8°}$,

$\theta_5 = \boxed{63.6°}$, and $\theta_6 = \sin^{-1}(1.07) =$ nonexistent.

Thus, there are $5 + 5 + 1 = \boxed{\text{11 directions for interference maxima}}$.

(b) We check for missing orders by looking for single-slit diffraction minima, at $a\sin\theta = m\lambda$.

For $m = 1$, $(0.700\ \mu\text{m})\sin\theta = 1(0.501\,5\ \mu\text{m})$ and $\theta_1 = 45.8°$.

Thus, there is no bright fringe at this angle. There are only $\boxed{\text{nine bright fringes}}$, at $\boxed{\theta = 0°,\ \pm 10.3°,\ \pm 21.0°,\ \pm 32.5°,\ \text{and}\ \pm 63.6°}$.

(c) $$I = I_{max}\left[\frac{\sin(\pi a\sin\theta/\lambda)}{\pi\sin\theta/\lambda}\right]^2$$

At $\theta = 0°$, $\dfrac{\sin\theta}{\theta} \to 1$ and $\dfrac{I}{I_{max}} \to \boxed{1.00}$.

At $\theta = 10.3°$, $\dfrac{\pi a\sin\theta}{\lambda} = \dfrac{\pi(0.700\ \mu\text{m})\sin 10.3°}{0.501\,5\ \mu\text{m}} = 0.785\ \text{rad} = 45.0°$

$$\frac{I}{I_{max}} = \left[\frac{\sin 45.0°}{0.785}\right]^2 = \boxed{0.811}.$$

Similarly, at $\theta = 21.0°$, $\dfrac{\pi a\sin\theta}{\lambda} = 1.57\ \text{rad} = 90.0°$ and $\dfrac{I}{I_{max}} = \boxed{0.405}$.

At $\theta = 32.5°$, $\dfrac{\pi a\sin\theta}{\lambda} = 2.36\ \text{rad} = 135°$ and $\dfrac{I}{I_{max}} = \boxed{0.090\,1}$.

At $\theta = 63.6°$, $\dfrac{\pi a\sin\theta}{\lambda} = 3.93\ \text{rad} = 225°$ and $\dfrac{I}{I_{max}} = \boxed{0.032\,4}$.