12. MAGNETIC FIELD: The Biot-Savart Law (superposition principle) - answers

12.1. $B = \frac{\mu\mu_0 I}{2\pi x}$

12.2. $B = 2\sqrt{2}\frac{\mu\mu_0 I}{\pi a}$

12.3. $B = \sqrt{5}\frac{\mu\mu_0 I}{2\pi a}$

12.4. $B = \frac{\mu\mu_0 I}{2R}$

12.5. $B = \frac{\mu\mu_0 e^2}{8\pi r^2\sqrt{\pi\varepsilon\varepsilon_0 r m_e}}$

12.6. $\alpha = 45°;\ B_I = \frac{\mu\mu_0 I}{2R}\sqrt{2};\ B_{2I} = \frac{\mu\mu_0 I}{2R}\sqrt{5}$

12.7. $B = \frac{\mu\mu_0 I R^2}{2(R^2+x^2)^{3/2}}$

12.8. $B = \frac{\mu\mu_0 nq}{R}$

12.9. $B = \frac{\mu\mu_0 nq}{R_1+R_2}$

12.10. $I_1 = I_2\left(\frac{R_2}{R_1}\right)^2\left(\frac{R_1^2+\frac{h^2}{4}}{R_2^2+\frac{h^2}{4}}\right)^{3/2}$

12.11. $B = \frac{\mu\mu_0 I R^2}{2}\left[\frac{1}{(R^2+x^2)^{3/2}} + \frac{1}{(R^2+(x-R)^2)^{3/2}}\right]$; where *x* – distance from ring center

12.12. e.g. in the middle of the conductor ring: $B = \frac{\mu\mu_0}{2}\sqrt{\left(\frac{I_1}{\pi d}\right)^2 + \left(\frac{I_2}{R}\right)^2}$

12.13.* $B = \frac{\mu\mu_0 nI}{\sqrt{l^2+d^2}}$

12.14.* $B = \frac{\mu_0 nI}{2}(\cos\alpha - \cos\beta)$

12.15.* $\frac{l}{D} \geq 7$. Hint: $\cos\alpha = \frac{1}{\sqrt{1+\left(\frac{D}{l}\right)^2}} = 1 - \frac{D^2}{2l^2}$ (from expanding in series)