Given: Three conductors (same length, \( L \)) have the shape of an equilateral triangle (whose sides are of length \( \ell_3 \)), a ring (whose radius is of length \( r \)), a square (whose sides are of length \( \ell_4 \)).

These conductor’s lengths are all equal (perimeters: \( L = 3 \ell_3 = 2 \pi r = 4 \ell_4 \)). All conductors carry the same current \( I \).

Select the correct comparison for the magnitude of the magnetic field at the center points \( P \) of the current loops shown above.

A) \( B_{\text{square}} > B_{\text{triangle}} > B_{\text{ring}} \) \quad B) \( B_{\text{triangle}} > B_{\text{ring}} > B_{\text{square}} \)

C) \( B_{\text{ring}} > B_{\text{triangle}} > B_{\text{square}} \) \quad D) \( B_{\text{triangle}} > B_{\text{square}} > B_{\text{ring}} \)

E) \( B_{\text{square}} > B_{\text{ring}} > B_{\text{triangle}} \)

Using \( B = \frac{\mu_0 I}{4 \pi a} \int_{\theta_1}^{\theta_2} \sin \theta \, d\theta \), at point \( P \), we have

**Triangle:** \( B_{\text{triangle}} = \frac{9}{2 \pi} \frac{\mu_0 I}{\ell_3} \approx 1.4324 \frac{\mu_0 I}{\ell_3} \), largest

**Square:** \( B_{\text{square}} = \frac{8 \sqrt{2}}{3 \pi} \frac{\mu_0 I}{\ell_3} \approx 1.2004 \frac{\mu_0 I}{\ell_3} \)

**Ring:** \( B_{\text{ring}} = \frac{\pi}{3} \frac{\mu_0 I}{\ell_3} \approx 1.0472 \frac{\mu_0 I}{\ell_3} \), smallest

Therefore, \( B_{\text{triangle}} > B_{\text{square}} > B_{\text{ring}} \).

Note: We expect \( B \) to be smallest at its center point for the wire ring since the wire is farthest from its center point.

Note: We expect \( B \) to be largest at its center point for the wire triangle since the wire is (on average) the closest to its center point.

Answer D.

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