Solutions

Each answer shows the steps, then the **result**.

2.1

- closed loops

2.2

- because there are no magnetic monopoles for them to start or end on

2.3

- ferromagnetic

2.4

- the net magnetic flux through any closed surface is zero, $\oint \vec{B} \cdot d\vec{A} = 0$
- there are no isolated magnetic poles (monopoles): every north pole comes with a south pole

2.5

- $\mu_0 = \mathbf{4}\pi \times \mathbf{10^{-7}}$ T m A^{-1}

3.1 B

- closed loops.

3.2 C

- ferromagnetic.

3.3

(a)

- each piece is a complete magnet with its own north and south pole

(b)

- magnetic poles only exist in pairs – no monopoles – so a new north-south pair forms at the cut

3.4

(a)

- P paramagnetic, Q diamagnetic, R ferromagnetic

(b)

- the external field induces dipoles in bismuth that align opposite to it, so the sample is pushed away from the pole

3.5

- the coil's field aligns the magnetic dipoles (domains) in the iron, which add their own field
- iron has a permeability far greater than μ_0, so for the same current the field is much stronger

3.6 A

- the field of a magnetic dipole decreases with increasing distance