20. Magnetic Fields

20.4 Magnetic fields due to currents

Paper 4

Marking Scheme

Q1.

(b)	concentric circles around the wire (at least two circles needed)	**B1**
	spacing between circles increases with distance from wire (at least four circles needed)	**B1**
	arrows showing direction of field is clockwise	**B1**
(c)(i)	(each) wire sits in the (magnetic) field created by the other	**B1**
	current (in one wire) is perpendicular to (magnetic) field (due to other wire) so (magnetic) force acts (on wire)	**B1**
(c)(ii)	arrow drawn, starting from X and pointing towards Y, labelled F	**B1**
(c)(iii)	(forces have) equal magnitudes	**B1**
	(forces are in) opposite directions	**B1**
(c)(iv)	no change (in the direction of the force) since both the current in X and the field due to Y have reversed	**B1**

Q2.

(b)	concentric circles around the wire	**B1**
	spacing between circles increases with distance from wire	**B1**
	arrows showing direction of field is clockwise	**B1**
(c)(iii)	force (per unit length) has the same magnitude due to Newton's 3rd law	**B1**
	$0.013 = 1.5 \times 10^{-3} \times I$ current = 8.7 A	**A1**

Q3.

(b)(i)	arrow from X pointing horizontally to the left	**B1**
	arrow from Y pointing diagonally upwards and to the left at about 45°	**B1**
	arrow from Z pointing horizontally to the right	**B1**
(b)(ii)	(flux densities at W and X are approximately) equal	**B1**
	(flux density at) Y greater than (flux density at) Z	**B1**
(c)	current in wire creates magnetic field around wire	**B1**
	(each) wire sits in the magnetic field created by the other	**B1**
	(for each wire,) current / wire is perpendicular to magnetic field (due to other wire), (so) experiences a (magnetic) force	**B1**

Q4.

(b)	magnetic field around each coil is circular **or** each coil is normal to magnetic field due to adjacent coils	**B1**
	current in coil interacts with (magnetic) field to exert force (on coil)	**B1**
	force is normal to both coil and magnetic field **or** force parallel to axis (of coil)	**B1**
	forces between coils are attractive so spring contracts	**B1**

Q5.

(a)(i)	arrow from Q pointing downwards, labelled B	**B1**
(a)(ii)	arrow from Q pointing towards P, labelled F	**B1**
(b)(i)	force is proportional to product of both currents (I and $2I$) **or** Newton's third law	**B1**
	forces are equal	**B1**
(b)(ii)	opposite	**B1**

Q6.

(a)	concentric circles centred on the wire	**B1**
	separation of lines increasing with distance from wire	**B1**
	arrows show anti-clockwise direction	**B1**
(b)(i)	current in (each) wire creates a magnetic field (at the other wire)	**B1**
	current (in wire) at 90° to field causes force	**B1**
(b)(ii)	force on each wire towards other wire/attractive	**B1**
(c)	Newton's third law pair of forces so yes (forces are equal) **or** force proportional to product of both currents so yes (forces are equal)	**B1**

Q7.

(a)(ii)	arrow on axis of solenoid pointing downwards labelled P	**B1**

Q8.

(a)	concentric circles (around the wire)	**M1**
	at least 3 circles shown, all with increasing separation	**A1**
	direction anticlockwise	**B1**
(c)	correct application of Newton's 3rd law to the forces **or** F / L is proportional to the product of the two currents	**M1**
	so same magnitude	**A1**