20. Magnetic Fields

20.2 Force on a current-carrying conductor

Paper 4

Marking Scheme

Q1.

(a)	• force per unit length • force per unit current • length / current perpendicular to field *1 mark for any two points, 2 marks for all three points*	**B2**

Q2.

(b)(v)	force (on spoke) must be anticlockwise, so current is from A to X (by Fleming's left hand rule), so X is at the higher potential	**B1**

Q3.

(c)(i)	$F = BIL$	**C1**
	force per unit length $= BI$ $= 2.6 \times 10^{-3} \times 5.0$ $= 0.013\ \text{N m}^{-1}$	**A1**
(c)(ii)	to the right	**B1**

Q4.

(c)	current (in disc) is perpendicular to magnetic field **or** current causes force to act on disc	**B1**
	force opposes rotation of disc	**B1**
	left-hand rule indicates current is from rim to axle	**B1**

Q5.

(a)	there must be a current (in the wire)	**B1**
	(wire) must be at a non-zero angle to the magnetic field	**B1**

Q6.

(a)	force per unit current	**M1**
	force per unit length	**M1**
	current / wire is perpendicular to (magnetic) field (lines)	**A1**
(b)(i)	current (in coil) is perpendicular to magnetic field (so force on wire)	**B1**
	force (on wire) is perpendicular to current and field (so is vertical) **or** current and field are both horizontal (so force is vertical)	**B1**
(b)(ii)	$NBIL = mg$	**C1**
	$B = (2.16 \times 10^{-3} \times 9.81) / (40 \times 3.94 \times 0.0300)$	**C1**
	$= 4.48 \times 10^{-3}\ \text{T}$	**A1**
(b)(iii)	(magnetic) forces (on balance and newton meter) are (equal and) opposite	**B1**
	reading $= 0.563 - (2.16 \times 10^{-3} \times 9.81)$ $= 0.542\ \text{N}$	**A1**

Q7.

(a)	newton per ampere per metre	**M1**
	where current/wire is perpendicular to magnetic field	**A1**
(b)(i)	$F = BIL\sin\theta$	**C1**
	$B = 1.0 / (5.0 \times 0.060 \times \sin 50°)$ $= 4.4$ mT	**A1**
(b)(ii)	(from Fleming's left-hand rule) force on wire is upwards, so reading decreases	**B1**
(b)(iii)	frame will rotate (so that PQ becomes perpendicular to the field)	**B1**

Q8.

(a)	magnetic field normal to current	**B1**
	newton per ampere	**B1**
	newton per metre	**B1**
(b)(i)	current in wire QL gives rise to a force **or** wire QL is perpendicular to the magnetic field	**B1**
	force on wire QL is vertical	**B1**
	force does not act through the pivot	**B1**
(b)(ii)	forces act through the same line **or** forces are horizontal	**B1**
	forces are equal (in magnitude) and opposite (in direction)	**B1**
(c)(i)	change $= mg \times (\Delta)L$	**C1**
	$= 1.3 \times 10^{-4} \times 9.81 \times 2.6 \times 10^{-2} = 3.3 \times 10^{-5}$ N m^{-1}	**A1**
(c)(ii)	change $= B \times (\Delta)I \times L \times x$	**C1**
	$3.3 \times 10^{-5} = B \times 1.2 \times 0.85 \times 10^{-2} \times 5.6 \times 10^{-2}$	**C1**
	$B = 0.058$ T	**A1**

Q9.

(b)(ii)	$F = BIL$ **or** $F / L = BI$	**C1**
	$F / L = 4.0 \times 10^{-5} \times 8.5$ $= 3.4 \times 10^{-4}$ N m^{-1}	**A1**

Q10.

(a)	using Fleming's left-hand rule force on wire is upwards	**B1**
	by Newton's third law, force on magnet is downwards	**B1**
(b)(i)	$F = BIL$	**C1**
	$= 3.7 \times 10^{-3} \times 5.1 \times 8.5 \times 10^{-2}$ $= 1.6 \times 10^{-3}$ N	**A1**
(b)(ii)	$F = 1.6 \times 10^{-3}$ N	**A1**
(c)	sketch: sinusoidal wave with two cycles	**B1**
	amplitude 2.3×10^{-3} N	**B1**
	period 0.05 s	**B1**

Q11.

(a)	force per unit current	**B1**
	force per unit length (of wire)	**B1**
	current normal to (magnetic) field	**B1**
(b)(i)	forces (on PQ and RS) are horizontal	**B1**
	(hence they create) no moment about the pivot	**B1**
	or	
	forces (on PQ and RS) are equal and opposite	**(B1)**
	(hence there is) no net force (on the two sections)	**(B1)**
(b)(ii)	realisation of the need to apply moments	**C1**
	$BILx = mgy$ $B \times 2.7 \times 1.2 \times 10^{-2} \times 7.5 = 45 \times 10^{-6} \times 9.81 \times 8.8$	**C1**
	$B = 1.6 \times 10^{-2}$ T	**A1**