9 Marking scheme: Worksheet 1

1 A current-carrying conductor creates a magnetic field around itself. [1]

2 The magnetic field around the current-carrying conductor 'interacts' with the external magnetic field – just like two interacting bar magnets. [1]

3 The second finger points in the direction of <u>conventional</u> <u>current</u>. [1]

4 **a** The conductor is pushed to the left. [1]
b The conductor is pushed to the left. [1]
c The conductor is pushed out of the plane of the paper. [1]

5 $B = \frac{F}{IL}$ [1]

$[B] = \frac{\text{N}}{\text{A m}} = \text{N A}^{-1}\ \text{m}^{-1}$ [1]

6 $F = BIL$ [1]
$F = 0.12 \times 3.5 \times 0.01$ (length = 1.0 cm) [1]
$F = 4.2 \times 10^{-3}$ N [1]

7 **a** $F = BIL$ [1]
$F = 4.5 \times 10^{-3} \times 2.5 \times 0.07$ [1]
$F = 7.88 \times 10^{-4} \approx 7.9 \times 10^{-4}$ N [1]
b The magnetic field is parallel to the current (or the wire). [1]
c From Fleming's left-hand rule, **PQ** experiences a force out of the plane of the paper and **RS** a force into the plane of the paper. [1]
Hence, the frame starts to rotate in a clockwise direction (when viewed from the end **PS**) [1]

8 **a** $F = BIL \propto I$ (force $\propto$ current) [1]
Hence, the force increases by a factor of 3.0 to a value of 1.41×10^{-2} N. [1]
b $F = BIL \propto B$ (force $\propto$ magnetic flux density) [1]
Hence, the force is halved to a value of 2.35×10^{-3} N. [1]
c $F = BIL \propto L$ (force $\propto$ length of wire in the field) [1]
Hence, the force is reduced to 40% of its initial value to 1.88×10^{-3} N. [1]

9 **a** Left to right [1]
b Force = weight of paper tape

$F = mg = 60 \times 10^{-3} \times 10^{-3} \times 9.81$ [1]

milli factor changing grams into kilograms

$F = 5.89 \times 10^{-4}\ \text{N} \approx 5.9 \times 10^{-4}$ N [1]

c $B = \frac{F}{IL}$ [1]

$B = \frac{5.89 \times 10^{-4}}{8.5 \times 0.052}$ [1]

$B = 1.33 \times 10^{-3}\ \text{T} \approx 1.3$ mT [1]

10 It is the component of the magnetic flux at right angles to the current that provides the force on the conductor. [1]

Component of B at right angles to current = $B_{\perp}$, where $B_{\perp} = B \sin \theta$.
The force F on conductor is given by $F = B_{\perp}IL$ [1]
Hence $F = (B \sin \theta)IL$ or $F = BIL \sin \theta$ [1]

11 Force experienced by **PQ** = force experienced by **RS** (but in opposite direction). [1]

No force experienced by **QR** and **PS** (since current is parallel to the field). [1]

torque = one of the forces × perpendicular distance between forces = $(BIL)x$ [1]

torque = $BI(Lx)$, Lx = area of loop = A [1]

torque = $BIA \propto A$ [1]

The torque is directly proportional to the area of the loop.