

|           |                                                                                                                                                                                                                          |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7(a)      | <ul style="list-style-type: none"> <li>force per unit length</li> <li>force per unit current</li> <li>length / current perpendicular to field</li> </ul> <p>1 mark for any two points, 2 marks for all three points.</p> |
| 7(b)(i)   | $F = BQv$                                                                                                                                                                                                                |
| 7(b)(ii)  | arrow at Y pointing vertically upwards                                                                                                                                                                                   |
| 7(b)(iii) | upwards deflection showing circular path                                                                                                                                                                                 |
| 7(c)(i)   | electric field applied vertically downwards (may be shown on a labelled diagram)                                                                                                                                         |
|           | electric force on particle in opposite direction to magnetic force (may be shown on a labelled diagram)                                                                                                                  |
|           | particle undeflected when magnitudes of electric and magnetic forces are equal                                                                                                                                           |
| 7(c)(ii)  | $EQ = BQv$                                                                                                                                                                                                               |
|           | $v = E / B$                                                                                                                                                                                                              |

|           |                                                                                                                                  |
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| 6(a)(i)   | $F = BIL$                                                                                                                        |
|           | force on QR = $5.2 \times 10^{-3} \times 1.2 \times 0.054 \times 190$                                                            |
|           | = 0.064 N                                                                                                                        |
| 6(a)(ii)  | torque = force $\times$ perpendicular distance between forces                                                                    |
|           | = $0.064 \times 0.025 \cos \theta = (1.6 \times 10^{-3}) \cos \theta \text{ N m}$                                                |
| 6(a)(iii) | one complete cycle of a sinusoidal curve between 0 and $360^\circ$                                                               |
|           | $\tau$ axis labelled to show maximum and minimum torques at $\pm 1.6 \times 10^{-3} \text{ N m}$                                 |
|           | maximum at 0 and $360^\circ$ and minimum at $180^\circ$ (or vice versa), with torque shown as zero at $90^\circ$ and $270^\circ$ |
| 6(b)      | (ferrous core) increases magnetic flux density                                                                                   |
|           | amplitude of torque increases                                                                                                    |

|           |                                                                                                                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6(a)      | <ul style="list-style-type: none"> <li>• force per unit length</li> <li>• force per unit current</li> <li>• length / current perpendicular to field</li> </ul> <p>1 mark for any two points, 2 marks for all three points</p>              |
| 6(b)(i)   | into the page                                                                                                                                                                                                                              |
| 6(b)(ii)  | $F = Bqv$<br>$= 4.8 \times 10^{-3} \times 1.6 \times 10^{-19} \times 1.7 \times 10^7 = 1.3 \times 10^{-14} \text{ N}$                                                                                                                      |
| 6(b)(iii) | arrow at point X pointing down the page                                                                                                                                                                                                    |
| 6(b)(iv)  | $F = mv^2 / r$<br>$1.3 \times 10^{-14} = (9.11 \times 10^{-31}) \times (1.7 \times 10^7)^2 / r$<br>$(r = 0.020 \text{ m})$<br>$d = 2r$<br>$d = 0.040 \text{ m}$                                                                            |
| 6(c)      | <p>path shows upwards deflection such that the curvature is always anticlockwise within the field</p> <p>circular path with larger radius</p> <p>line enters field at X and leaves field at distance <math>2d</math> vertically from X</p> |