# Marking Scheme

**#1**

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 10 | (a) | | Flux linkage, $N\Phi = NBA\cos\theta$ [1]<br>All values substituted correctly e.g.<br>$270 \times 0.042 \times 0.114 \cos 5°$ [1] | 2 | | | 2 | 1 | |
| | (b) | | Change in flux is zero or flux is constant<br>Accept no lines being cut | | 1 | | 1 | | |
| | (c) | | $\dfrac{0.22}{5.8}$ or similar seen [1]<br>Correct answer = 37.9 [V] [1] | | 2 | | 2 | 1 | |
| | | | Question 10 total | 2 | 3 | 0 | 5 | 2 | 0 |

**#2**

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 10 | (a) | | Flux changes in ring as it approaches [or recedes from] magnet (1)<br>Emf induced (1) [or by implication by next marking point]<br>Current induced (complete circuit) (1)<br>[Motor effect force] opposes motion or energy lost or Lenz's law stated(1) | | 4 | | 4 | | |
| | (b) | | Nothing [or equiv](1)<br>Always opposes motion (Lenz) / field in opposite direction / current in opposite [not: the force opposite] (1) | | 2 | | 2 | | |
| | (c) | | Length = $2\pi r$ used (1) [0.157 m] | 1 | | | | | |
| | | | $R = \dfrac{1.59 \times 10^{-8} \times 2\pi \times 0.025}{2.4 \times 10^{-6}}$ seen<br>(or $1.04 \times 10^{-4}$ [$\Omega$] seen) (1) | | 1 | | 2 | 1 | |
| | (d) | | Ohm's law used (1) | 1 | | | | | |
| | | | Emf $= \dfrac{BNA}{t}$ i.e. Faraday's used (1) [= 0.55 mV] | | 1 | | | | |
| | | | [NB c.s.a of wire used → no credit and no ecf]<br>Answer, $\dfrac{B}{t}$ = 0.29 T s$^{-1}$ (or 0.28 depending on rounding)(1) | | 1 | | 3 | 2 | |
| | | | Question 10 total | 2 | 9 | 0 | 11 | 3 | 0 |

#3

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| (a) | (i) | | Answer = 57.3 m[T] | 1 | | | 1 | 1 | |
| | (ii) | | Shape correct (minimum 3 lines) (1)<br>Direction correct (no contradicting arrows) (1) | 2 | | | 2 | | |
| | (iii) | | Iron core | 1 | | | 1 | | |
| (b) | (i) | | Change in flux (1)<br>Complete circuit **OR** low resistance (1)<br>Large rate of change of flux **OR** large flux & small t (1) | | 3 | | 3 | | |
| | (ii) | | Use FRHR **OR** use FLHR on electrons **OR** RH grip (1)<br>on bottom part **OR** in bottom part **OR** induced field opposes (1) | 1 | 1 | | 2 | | |
| | (iii) | | Faraday's law used e.g. 2.18 V **OR** $\frac{BA}{t}$ seen (1) | 1 | | | | | |
| | | | $I = \frac{V}{R}$ used (1) | 1 | | | 3 | 2 | |
| | | | Answer = 323 [A] (1) | | 1 | | | | |
| | (iv) | | Use of $F = BIL$ **ecf** (1)<br>Answer = 205 [N] (1)<br>Opposes motion (1) | | | 3 | 3 | 2 | |
| | | | **Question total** | 7 | 5 | 3 | 15 | 5 | 0 |

#4

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| (a) | (i) | | Emf is induced due to rate of change of flux (or cutting) **or** reference to [Fleming's] RH rule (1) **don't accept** RH grip rule<br>Current can flow **or** circuit is complete (1) | 1 | 1 | | 2 | | |
| | (ii) | | Vertical component is perpendicular to the area swept<br>**or** other components are not cut<br>**Accept** flux due to horizontal field is zero or motion is in plane / parallel to horizontal field<br>**Don't accept** current in the field | | 1 | | 1 | | |
| (b) | | | Induced emf $= \frac{d}{dt}(BA)$ with or without $N$ (accept $\frac{BA}{t}$) (1) | 1 | | | | | |
| | | | $\frac{d}{dt}(A) = \frac{l\,dx}{dt}$ accept $\frac{A}{t} = \frac{lx}{t}$ or $\frac{A}{t} = lv$ (1) | | 1 | | | | |
| | | | $I = \frac{V}{R}$ and reasonable algebra (1) | | 1 | | 3 | 3 | |
| (c) | (i) | | Good method employed e.g. calculating 3× ratio $\frac{v}{I}$, calculating $B$ 3 times, or $I$ is proportional to $v$ etc. (1)<br>Correct calculations e.g. 0.5, 0.5, 0.55, 0.53 / $I$ is roughly $2v$ (1)<br>$B$, $\ell$ and $R$ are constants or equivalent e.g. $\frac{Bl}{R}$ is constant (1)<br>Ok within uncertainties (1) | | | 4 | 4 | 3 | 4 |
| | (ii) | | 80 m s$^{-1}$ and 150 µA used **accept** mean points if 80 m s$^{-1}$ and 150 µA used for uncertainty (1) | | | 1 | | | |
| | | | Rearrangement $B = \frac{RI}{lv}$ (1) | | | 1 | | | |
| | | | Answer = 57.6 µ[T] (1) | | | 1 | | | |
| | | | 1% and 7% used (1.25% and 6.7% ok) **ecf** accept first principles (1) | | 1 | | | | |
| | | | Percentages added (8%) **ecf** (1) | | 1 | | | | |
| | | | $B = (58 \pm 5)$ µT **ecf** accept $(57.6 \pm 4.6)$ µT unit mark and with consistent sig figs allow a max of 2 sig figs for the uncertainty (1) | | 1 | | 6 | 6 | 6 |
| | | | **Question total** | 2 | 7 | 7 | 16 | 12 | 10 |