M1.(a) (i) meter deflects then returns to zero ✓
current produces (magnetic) field / flux ✓
change in field / flux through Q induces emf ✓
induced emf causes current in Q (and meter) ✓

Deflection to right (condone left) then zero is equivalent to 1st mark.

Accept momentary deflection for 1st point.

"Change in field / flux induces current in Q" is just ✓ from the last two marking points.

max 3

(ii) meter deflects in opposite direction (or to left, or ecf) ✓
field / flux through P is reduced ✓
induces emf / current in opposite direction ✓

Ignore references to magnitude of deflection.

max 2

(b) (i) flux linkage (= $n\Phi = nBA$) = 40 × 0.42 × 3.6 × 10^{-3}
= 6.0(5) × 10^{-2} ✓

Unit mark is independent.

Allow 6 × 10^{-2}.

Wb turns ✓

Accept 60 mWb turns if this unit is made clear.

Unit: allow Wb.

2

(ii) change in flux linkage = $\Delta(n\Phi)$= 6.05 × 10^{-2} (Wb turns) ✓

induced emf $\left(=\frac{\Delta(n\phi)}{\Delta t}\right)$ = $\frac{6.05 \times 10^{-2}}{0.50}$ = 0.12(1) (V) ✓

Essential to appreciate that 6.05 × 10^{-2} is change in flux linkage for 1st mark. Otherwise mark to max 1.

2

[9]

M2.(a) emf = $\Delta(BAN) / t$

Change in flux = $A \times \Delta B$ or $12 \times (23 - 9)$ seen

C1

Substitution ignoring powers of 10

C1

1.2 V

A1

3

(b) Reduced

M0

Magnet will move (with the case)

A1

Increased

M0

Flux linkage increases or emf is proportional to N

A1

2

(c) (i) Formula used $\frac{4\pi^2 \times 8 \times 10^{-3}}{2.6}$ seen

B1

0.348 / 0.349 seen to at least 3 sf

B1

2

(ii) Period consistent at 0.35 s or V_o = 8 V

B1

Shape shows decreasing amplitude

M1

At least 3 cycles starting at 8 V

A1

3

[10]

M3.(a) Induced current such as to opposes the change producing it✓

Switch on current increases the flux through Y✓

Current opposite direction / anticlockwise to create opposing flux✓

Switch off flux thorough Y due to X decreases so current travels clockwise to create flux to oppose the decrease✓

one marks for Lenz's law statement

*two for explaining what happens at switch on **OR** switch off adequately*

one for completing the argument for switch on and off adequately

4

(b) Determines correctly in the calculation two of V_{pk}(5.6±1 μV) , A (0.096 m^2) and ω(9.4 rad s^{-1})β✓

Substitutes all three in $v = BAn\omega$ ignoring powers of 10 and calculation errors for A and / or ω provided they have been attempted with working shown✓

B_H = 12.4 nT✓

Allow 2 or 3 sf

3

[7]

M4.B

[1]

M5.C

[1]

M6.D

[1]

M7.D

[1]

M8.B

[1]

M9.D

[1]

M10.(a) (i) 60 (degrees) ✓

1

(ii) angle required is 150° ✓

which is 5π / 6 [**or** 2.6(2)] (radians) ✓

Correct answer in radians scores both marks.

2

(b) (i) (magnitude of the induced) emf ✓

Accept "induced voltage" or "rate of change of flux linkage", but not "voltage" alone.

1

(ii) frequency $\left(=\frac{1}{T}\right)=\frac{1}{40\times10^{-3}}$ ✓ (= 25 Hz)

no of revolutions per minute = 25 × 60 = 1500 ✓

1500 scores both marks.

Award 1 mark for 40s → 1.5 rev min^{-1}.

2

(iii) maximum flux linkage *(=BAN)* = 0.55 (Wb turns) ✓

angular speed $\omega\left(=\frac{2\pi}{T}\right)=\frac{2\pi}{40\times10^{-3}}$ ✓ (= 157 rad s^{-1})

peak emf (= *BANω*) = 0.55 × 157 = 86(.4) (V) ✓