1.	Force per unit positive charge			B1	
					[1]
2.	(a)	(i)	flux = B × A (normal to B) with symbols explained	B1	
		(ii)	linkage = N × flux	B1	
			A = x^2 so linkage = NBx^2	B1	
	(b)	(i)	Statement of Faraday's law or indication		
			e.g. V = d(NBx^2) / dt from (a)(ii)		
			V = NB x^2dx/dt or V = NBxv / argue area swept out per second as xv	B1	
			V = 1250 × 0.032 × 0.02 × 0.1	B1	
			= 0.08 or 80 mV	B1	
				A0	
		(ii)	equal positive and negative regions	B1	
			equal positive and negative values of 'maxima' labelled on y-axis	B1	
			value changes within correct time zones, t = 0.2 to 0.4, 0.6 to 0.8 s	B1	
			'square pulse' shape	B1	
			sinusoidal graphs score zero marks		
					[10]

3. magnetic flux = BA — 1

meanings of B and A, i.e. flux density or field strength and area ⊥ to it — 1

magnetic flux linkage refers to the flux linking/passing through a coil; — 1

and equals N × flux where N is the number of turns (of the coil) — 1

Faraday's law: induced e.m.f./voltage is proportional to rate of change of flux linkage through it /correct mathematical formulation/AW — 1

Lenz's law: the direction of the induced e.m.f./voltage is such as to oppose the motion/change that produced it — 1

relationship of Lenz's law to conservation of energy or other valid explanation/discussion/description — 2

max 5 marks

quality of written communication — 2

[7]

4. (a) B = F/Il with symbols explained or appropriate statement in words; (1)
explicit reference to I and B at right angles/define from F = BQv etc (1) — 2

(b) (i) arrow towards centre of circle — 1

(ii) field out of paper; Fleming's L.H. rule/moving protons act as conventional current — 2

(iii) $F = Bev$ *allow BQv* 1

(iv) $F = mv^2/r$; $Bev = mv^2/r$; (2)
$B = mv/er = 1.67 \times 10^{-27} \times 1.5 \times 10^7/(1.6 \times 10^{-19} \times 60)$; = 0.0026; T (3) 5
allow Wb m^{-2}

(v) the field must be doubled; (1)
$B \propto v$ (as m, e and r are fixed)/an increased force is required
to maintain the same radius (1) 2

[13]

5. (a) appropriate shape; lines perpendicular to and touching plate and sphere; (2)
arrows towards negative sphere (1) 3

(b) (i) By moments, e.g F cos 20 = W sin 20 / by triangle of forces /
by resolution of forces / other suitable method; *i.e. justification needed* (1)
$F = 1.0 \times 10^{-5}$ tan 20; $= 1.0 \times 10^{-5} \times 0.364$; ($= 3.64 \times 10^{-6}$ N) (2)
triangle of forces gives W/F = tan 70, etc (1) 3

(ii) $E = F/Q$; $= 3.64 \times 10^{-6} / 1.2 \times 10^{-9} = 3.0 \times 10^3$;N C^{-1} / V m^{-1} 3

(c) $E = (1/4\pi\varepsilon_o)Q/r^2$; $3.0 \times 10^3 = 9 \times 10^9 \times 1.2 \times 10^{-9}/r^2$; (2)
or use $F = (1/4\pi\varepsilon_o)Q^2/r^2$; $r^2 = 3.6 \times 10^{-3}$ giving $r = 6 \times 10^{-2}$ (m) (1) 3

(d) field line sketch *minimum of 5 lines symmetrical about line joining centres with arrows*; (1)
Fig 1 sketch matches RHS of Fig 2/plate analogous to mirror/AW
relating to symmetry (1) 2

[14]

6. (i) $I = V/R = 12/50$ (1)
= 0.24 A (1) 2

(ii) Power in primary = power in secondary / $I_pV_p = I_sV_s$ (1)
$I_p = 0.24 \times 12 / 230 = 0.0125$ A (1) 2

[4]

7.	(a)	(i)	F is towards ‘open’ end of tube; using Fleming’s L.H. rule	2
		(ii)	F = BIw	1
		(iii)	F = 0.15 × 800 × 0.0025; = 3.0 (N)	2
	(b)	(i)	A voltage is induced across moving metal as it cuts lines of flux/AW; (1) voltage is proportional to flux change per second/AW; (1) the flux change per second is Bwv / is proportional to the area of metal moving through the field per second / is proportional to v (1) **or** Faraday’s law fully stated; with reasonable attempt to; (2) relate flux linkage per second proportionally to speed (1)	3
		(ii)	flux (linkage) doubles; so using Faraday’s law V doubles/AW	2

[10]