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)
$V = NB\, x^2 dx/dt$ 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 ∞ 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]