1 **(a) (i)** . . . . .direction of the force on a positive charge B1

(ii) Straight parallel lines from upper to lower plate B1
At least 3 lines drawn. All lines drawn equally spaced, approximately symmetrical with respect to plates B1
Arrows downwards B1

(b) (i) Upward force (on drop) due to electric field / charge on plates B1
= weight of drop B1
Upward force on drop = downward force on drop
OR no resultant / net force on drop
OR forces are balanced (B1)

(ii) Drop moves upwards B1
Weight / mass of drop decreases OR downward force decreases
OR Upward force (due to electric field) > weight of drop B1

[Total: 8]

2 **(a** electrons / negative charges <u>move</u> towards the rod / to R (ignore just "attracted")
ignore any mention of positive charges moving
any mention of positive electrons = 0 [1]

(b) negative charges (are) close(r) (to the rod) [1]
attraction between opposite charges greater than repulsion between like charges [1]

(c) coulomb [1]

3 **(a) (i)** at least three horizontal, parallel lines evenly spaced (ignore edge effects) B1

arrows pointing left to right B1

(b) right hand half of ball has more + signs than – signs
AND left hand half of ball has more – signs than + signs M1

equal numbers of + and – signs A1

(c) $Q = I\,t$ in any form OR (I =) $Q \div t$ OR $2.8 \times 10^{8} \div 0.05$ C1
5.6×10^{7} A OR C/s A1

[Total: 6]

4 **(a** energy transferred per coulomb/<u>unit</u> charge
OR energy supplied in driving coulomb/<u>unit</u> charge around a circuit
ACCEPT p.d./voltage across battery/power supply B1

(b) (i) $V = IR$ in any form OR (I =) $V \div R$ C1

2.0 A OR 2 A A1

(ii) electrons B1

(iii) arrow right to left by heater OR indication of clockwise B1

(c) (E =) VIt OR V^2t/R OR I^2Rt in any form C1

14 000 J A1

5 **(a** (Q =) It OR $4.1 \times 10^{5} \times 1.6 \times 10^{7}$ C1
= 660 C A1

(b) (R =) V / I OR $1.3 / 4.1 \times 10^{5}$ C1
= 32 000 Ω OR 32 kΩ A1

(c) 1st method: (P =) IV OR $4.1 \times 10^{5} \times 1.3$
OR 2nd method: (P =) I^2R OR $(4.1 \times 10^{5})^2 \times 32\,000$
OR 3rd method: (P =) V^2 / R OR $1.3^2 / 32\,000$
OR 4th method: (P =) QV / t OR $660 \times 1.3 / 1.6 \times 10^{7}$ C1

1st and 3rd methods: 5.3×10^{5} W / 0.000053 W
2nd and 4th methods: 5.4×10^{5} W / 0.000054 W A

[Total: 6]

6 **(a** coulomb B1

(b) **(i)** negative charge(s) on left AND positive charge(s) on right M1
equal number of positive and negative charges AND number of each ≤ 7 A1

(ii) electrons / negative charges flow from Earth / on to sphere (NOT protons / positive charges / positive electrons move) B1
total charge negative OR (some) protons / positive charges cancelled B1

(c) metal contains free (delocalised) electrons OR electrons can move about B1
electrons in plastic not free to move / fixed

[Total: 7]

7 **(a (i)** A region in which a force acts upon an (electric) charge/charged object B1

(ii) At least 4 radial straight lines with lines evenly spaced B1
Arrows on lines pointing away from + charge B1

(b) Use positively charged rod B1

Place rod close to surface of sphere B1

Touch sphere (briefly) with finger OR Connect sphere to earth and remove earth connection OR Briefly connect sphere to earth B1

Remove charged rod B1

[Total: 7]

8 **(a** 3rd box only indicated, reverses direction B1

(b) straight line up / down page B1

arrow pointing down page B1

(ii) to the right or left e.c.f. **(b)(i)** B1

to the right e.c.f. **(b)(i)** B1

(c) $F=ma$ in any form or F/m symbols, words or numbers
OR final answer $6 \times 10^{4}\,m/s^{2}$ C1

(a = 0.21 / 0.35 =) $0.6\,m/s^{2}$ A1

[Total: 7]