

- 1 (a) release of electrons due to heating/high temperature/heater B1
- (b) X- and Y-plates labelled B1
 anodes either order, labelled, either plates/cylinders with holes B1
 closed tube of sensible shape
 AND cathode AND anode(s) AND X- & Y- plates, all three features in correct order
 labels not needed for last mark but if given must be correct B1
- (c) change current in filament/cathode/heater IGNORE limit
 OR change temperature/heat/power/energy of filament/cathode/heater
 OR change cathode-anode p.d./voltage
 OR change charge/voltage of grid B1
- (d) $(I=)Q/t$ in any form C1
 0.0019 A OR 1.9×10^{-3} A OR 1.9 mA A1
- (ii) $(E=)VI$ OR VQ in any form, words, symbols, numbers (accept $t=5s$) C1
 190 J OR candidate's $I \times 100\,000$ correctly evaluated A1 [9]
- 2 (a) energy supplied / work done (per unit charge) to drive charge round a (complete) circuit B1
 OR B1
 p.d. / voltage across battery / power sour B1
- (b) (i) $P = IV$ OR $(I =) P/V$ OR $(I =) 60/240$ C1
 = 0.25 A OR $\frac{1}{4}$ A A1
- (ii) $I = V/R$ OR other version OR $(R =)VI$ C1
 OR $(R =)240/0.25$
 OR $P = V^2/R$ or other version e.g. $(R =) V^2/P$
 OR $(R =) 240^2/60$
 $R = 960 \Omega$ A1
- (c) current in series circuit = $240 / 972 = 0.247$ A B1
- current suits both bulbs, (so both light up so Y is correct) B1
 OR
 p.d. across bulb A = $240 \times (960/972) = 237$
 p.d. across bulb B = $240 \times 12/972 = 2.96$ B1
 p.d. suits both bulbs, (so both light up so Y correc B1 [8]

- 3 (a) (i) 1. resistance is constant / doesn't vary B1
 2. resistance increases B1
- (ii) 7V B1
- (b) resistance of resistor = $4/2.6 (= 1.54 \Omega)$ C
 resistance of lamp = $4/3.6 (= 1.11 \Omega)$ C
 $1/R = 1/R_1 + 1/R_2$ OR $(R =) R_1 R_2 / (R_1 + R_2)$ OR either eq. with numbers C1
 0.645 or 0.65Ω A1
 OR
 current through resistor = 2.6 A (C1)
 current through lamp = 3.6 A (C1)
 total current = $2.6 + 3.6 = 6.2 \text{ A}$ (C1)
 0.645Ω OR 0.65Ω OR $R = 4/\text{sum of candidate's currents}$ (A1) [7]
 accept R value based on no. of sig. figs. for resistors used by candidate
- 4 (a) (i) 4Ω B1
- (ii) IVt OR I^2Rt OR V^2t/R in any form or words or numbers
 Condone $t = 9$ if substituted possible ecf from (i) C1
 540 (s) C1
 437.4 J possible ecf if 4Ω from (i) used A1
- (b) $R = \rho L/A$ OR $R \propto L/A$ OR $R \propto L$ and $R \propto 1/A$ or $1/d^2$ or $1/r^2$ C1
- $A_2 = \frac{1}{4}A_1$ OR $A_2 = 0.25A_1$ C1
 $R_2 = (0.45/0.3) \times R_1$ OR $(3/2) \times R_1$ C1
 $\frac{3}{8}$ OR 0.375 OR 37.5% A1
 OR
 $R = \rho L/A$ OR $R \propto L/A$ OR $R \propto L$ and $R \propto 1/A$ or $1/d^2$ or $1/r^2$ C1
- Resistance of thinner wire with same length as thicker wire = $4 \times 4 = 16 \Omega$ C1
- Actual resistance of thinner wire = $1.8 / 0.3 = 6.0 \Omega$ C1
- Ratio: L of thinner wire / L of thicker wire = $6.0 / 16 = 3/8 = 0.375 = 37.5 \%$ A1 [8]

- 5 (a) same/like/similar charges repel (ignore poles repel) B1
 unlike/opposite/different charges attract (ignore poles attract) B1
- (b) idea of car/person (being) charged (by friction) B1
 idea of charge/electrons going to/from/through person B1
- (c) (i) electrons / -ve charges move towards the rod / to R (ignore just “attracted”)
 ignore any mention of +ve charges moving
 any mention of +ve electrons gets B0 B1
- (ii) opposite charges attract OR electrons / -ve charges attracted to +ve / rod B1
 attraction between opposite charges > repulsion between like charges
 OR – ve charges (are) close(r) (to the rod) B1
- (iii) electrons / -ve charges flow (up) from earth/wire no e.c.f. from (i) B1
 ignore +ve charges moving, NOT +ve electrons
 ball becomes –vely charged B1 [9]