**1.** (a) (i) $E = (Pt =)\ 36 \times 3600$

*__allow__ $I = 3$ A and $E = VIt$, etc.*

**C1**

$= 1.3 \times 10^5$ (J)

*__accept__ 129600 (J)*

**A1**

(ii) $Q = E/V = 1.3 \times 10^5/12$ **or** $Q = It = 3 \times 3600$

*__ecf__ (a)(i)*

**C1**

$= 1.1 \times 10^4$

*__accept__ $1.08 \times 10^4$*

**A1**

unit: C

*__allow__ A s __not__ $J\ V^{-1}$*

**B1**

(iii) $Q/e = 1.1 \times 10^4/1.6 \times 10^{-19}$

***ecf (a)(ii)***

**C1**

$= 6.9 \times 10^{22}$

*__accept__ 6.75 or $6.8 \times 10^{22}$ using 10800*

**A1**

(b) (i) *no mark for quoting formula*

the average displacement/distance travelled of the electrons along the wire per second;

*__allow__ in one second*

**B1**

(over time/on average) they move slowly in one direction through the metal/Cu lattice (when there is a p.d. across the wire);

**B1**

(because) they collide constantly/in a short distance with the lattice/AW

***max 2 marks** from 3 marking points*

**B1**

(ii) select I = nAev (= 3.0 A)

*1 mark for correct formula* **C1**

$v = 3.0/8.0 \times 10^{28} \times 1.1 \times 10^{-7} \times 1.6 \times 10^{-19}$

*1 mark for correct substitutions into formula* **C1**

$= 2.1 \times 10^{-3}$ (m $s^{-1}$)

*1 mark for correct answer to 2 or more SF* **A1**

**[12]**

**2.** (a) (i) Electrons in a metal B1

(ii) Ion in an electrolyte B1

(b) **1.** $I = Q/t$ / $I = 650/5$ C1

$I = 130$ (A) A1

**2.** $n = I/e = 130/1.6 \times 10^{-19}$ C1

$n = 8.1 \times 1020$ A1

**[6]**

**3.** (a) $R = R_1 + R_2$ / $R = 200 + 120$ / $R = 320$ C1

current = $\frac{8.0}{320}$ C1

current = $2.5 \times 10^{-2}$ (A) A0

(b) $V = 25 \times 10^{-3} \times 120$ / $V = \frac{120}{120 + 200} \times 8.0$

$V = 3.0$ (V) (Possible ecf) B1

(c) p.d. across the 360 (Ω) resistor = p.d. across the 120 (Ω) resistor /
There is no current between **A** and **B** / in the voltmeter B1
(Allow '*A & B have same voltage*' - BOD)

The p.d. calculated across 360 Ω resistor is shown to be 3.0 V /
The ratio of the resistances of the resistors is shown to be the same. B1

**[5]**

**4.** (a) Into the page B1

(b) $I = \frac{\Delta Q}{\Delta t}$ (Allow other subject, with or without Δ) C1 (charge =) $7800 \times 0.23$ C1

$1.794 \times 10^3 \approx 1.8 \times 10^3$ (C) (Ignore minus sign) A1

($1.8 \times 10^6$ (C) scores 2/3)

(c) (number =) $\frac{1.79 \times 10^3}{e}$ (Possible ecf) C1

(number =) $1.12 \times 10^{22} \approx 1.1 \times 10^{22}$ A1

**[6]**

**5.** (a) $Q = It$ (Allow any subject) C1

$Q = 0.040 \times 5.0 \times 60 \times 60$ \ $Q = 0.040 \times 1.8 \times 10^4$

charge = 720 A1

($40 \times 5 = 200$ or $0.040 \times 5 = 0.02$ or $40 \times 1.8 \times 10^4 = 7.2 \times 10^5$ scores 1/2)

coulomb \ C \ As B1

(b) It is less because the average current is less \ area (under graph) is less \ current 'drops' after 3 hours. B1

**[4]**

**6.** (a) Ammeter in series B1

Voltmeter in parallel (across the ends of the wire) B1

| | | |
|---|---|---|
| (b) $\rho = \frac{RA}{L}$ | (Allow any subject) | M1 |
| $R$ = resistance, $L$ = length and $A$ = (cross-sectional) area | | A1 |
| ($\rho$ = resistivity is given in the question) | | |
| Any **four** from: | | |
| Measure the length of the wire using a ruler | | B1 |
| Measure the diameter of the wire | | B1 |
| using a micrometer \ vernier (calliper) | | B1 |
| Calculate the (cross-sectional) area using A = πr2 \ A = πd2/4 | | B1 |
| Calculate the resistance (of the wire) using $R = \frac{V}{I}$ | | B1 |
| Repeat experiment for different lengths \ current \ voltage \ diameter (to get an average) | | B1 |
| Plot a graph of R against L. The gradient = ρ/A. | | B1 |
| (Or Plot V against I. The gradient is ρL/A) | | |
| Structure and organisation. | | B1 |
| Spelling and grammar. | | B1 |

**[10]**

**QWC**

The answer must involve physics, which attempts to answer the question.

**Structure and organisation**

Award this mark if the whole answer is well structured.

**Spelling and Grammar mark**

More than two spelling mistakes or more than two grammatical errors means the SPAG mark is lost.

**7.** Coulomb / C B1

**[1]**

**8.** (a) Parallel B1

(b) (i) $I = \frac{12}{8.0}$ C1

current = 1.5 (A) A1

(ii) $P = \frac{V^2}{R}$ / $P = IV$ $P = I^2 R$ C1

$P = \frac{12^2}{8}$ / $P = 1.5 \times 12$ $P\ 1.5^2 \times 8.0$ (Possible ecf) C1

power = 18 (W) A1

(iii) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + (\frac{1}{R_3})$ / $\frac{1}{R} = \frac{1}{8} + \frac{1}{8} + \frac{1}{8}$ C1

$\frac{1}{R} = 3 \times \frac{1}{8}$ C1

resistance = 2.67 ≈ 2.7 (Ω) (Allow answer expressed as 8/3) A1
(0.375 or 3/8 scores 2/3)

(iv) energy = 0.018 × 12 × 3 C1
energy = 0.648 ≈ 0.65 (kW h) (Possible ecf) A1
(0.22 (kW h) scores 1/2)
(648 (kW h) scores 1/2)
($2.3 \times 10^6$ (J) scores 1/2)

(c) It will be brighter B1
The current is larger / correct reference to: $P \propto 1 / R$ B1

**[13]**

**9.** The sum of the currents entering a point / junction is equal to the sum of the currents leaving (the same point) Or 'Algebraic sum of currents at a point = 0' B2
(–1 for the omission of 'sum' and -1 for omission of 'point'/ 'junction')
(Do not allow $I_1 + I_2 = I_3 + I_4$ unless fully explained)

**[2]**