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__ 1.08×10^4

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 6.8×10^{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 × 10^{28} × 1.1 × 10^{-7} × 1.6 × 10^{-19}

1 mark for correct substitutions into formula

C1

= 2.1 × 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 × 10^{-19} C1

n = 8.1 × 1020 A1

[6]

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

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

current = 2.5 × 10^{-2} (A) A0

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

$V = 3.0$ (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) $I = \dfrac{\Delta Q}{\Delta t}$ (Allow other subject, with or without Δ) C1

(charge =) 7800×0.23 C1
$1.794 \times 10^3 \approx 1.8 \times 10^3$ (C) (Ignore minus sign) A1
(1.8×10^6 (C) scores 2/3)

(c) (number =) $\dfrac{1.79 \times 10^3}{e}$ (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

(ρ = 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) $I = \dfrac{12}{8.0}$ C1

current = 1.5 (A) A1

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

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

power = 18 (W) A1

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

$\dfrac{1}{R} = 3 \times \dfrac{1}{8}$ 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)
(2.3×10^6 (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]