DC Circuits MS

M1. (a) (i) (total) resistance = (20 + 60) (Ω) **(1)**

($V = IR$ gives) $I = \frac{6.0}{80}$ = 0 075 A **(1)**

(ii) with S closed, (effective) resistance = 20 (Ω) **(1)**

$I = \frac{6.0}{20}$ =0.3 A **(1)**

max 3

(b) use of same current as in part (i) **(1)**
voltmeter reading = 0.075 × 60 = 4.5 V **(1)**

[or use potentiometer equation 6 × $\frac{60}{80}$ = 4.5 V]
(allow C.E. for value of I from (a)(i)

2

[5]

M2. (a) (i) 5 V **(1)**

(ii) R_T = 36 (Ω)
(use of $V = IR$ gives) 15 = I × 36 and I = 0.42 A **(1)**

3

(b) (i) equivalent resistance of the two lamps $\frac{1}{R} = \frac{1}{12} + \frac{1}{12} = \frac{1}{6}$ **(1)**

R_T = 6 + 12 = 18 (Ω) and 15 = I × 18 **(1)** (to give I = 0.83 A)

(ii) current divides equally between lamps (to give I = 0.42 A)
(or equivalent statement) **(1)**

3

(c) same brightness **(1)**
(because) same current **(1)**

2

[8]

M3. (a) (i) *(use of V = IR)*

I = (12-8) / 60 ✓ = 0.067 Or 0.066(A) ✓

2

(ii) *(use of V = IR)*

R = 8/0.067 = 120 (Ω) ✓

1

(iii) *(use of $Q = It$)*

$Q = 0.067 \times 120 = 8.0$ ✓ C ✓

2

(b) reading will increase ✓

resistance (of thermistor) decreases (as temperature increases) ✓

current in circuit increase (so pd across R_1 increases) OR correct potential divider argument ✓

3

[8]

M4. (a) (use of $P = VI$)

$I = 36/12 = 3.0$ A ✓

$I = 2.0/4.5 = 0.44$ A ✓

2

(b) (i) pd = 24 − 12 = 12 V ✓

1

(ii) current = 3.0 + 0.44 = 3.44 A ✓

1

(iii) $R_1 = 12/3.44 = 3.5\ \Omega$ ✓

1

(iv) pd = 12 − 4.5 − 7.5 V ✓

1

(v) $R_2 = 7.5/0.44 = 17\ \Omega$ ✓

1

(c) (i) (circuit) resistance increases ✓

current is lower (reducing voltmeter reading) ✓

or correct potential divider argument

2

(ii) pd across Y **or** current through Y increases ✓

hence power/rate of energy dissipation greater **or** temperature of lamp increases ✓

2

[11]

M5. (a) (i) (use of $R = V/I$)

$R = 10/2.0 = 5.0\ \Omega$ ✓

1

(ii) $\frac{1}{R} = \frac{1}{3} + \frac{1}{3+3} = \frac{3}{6}$ ✓

$R = 2\ (\Omega)$ ✓

$R_{total} = 2 + 3$ ✓ ($= 5\ \Omega$)

3

(b) (i) voltage across Y = 10.0 – 2.0 × 3.0 = 4.0 V ✓

current in Y = 4.0/3.0 = 1.3 A ✓

2

(ii) current through W = 0.67 A ✓

voltage = 0.67 × 3 = 2.0 V ✓

(**or** 4.0/2 = 2.0 V ✓)

2

[8]

M6. (a) (i) voltage = 0.01 × 540 = 5.4 V **(1)**

1

(ii) voltage = 15 – 5.4 = 9.6 V **(1)**

1

(iii) (use of resistance = voltage/current)

resistance = 9.6/0.01 **(1)** = 960 Ω **(1)**

or $R_T = 15/0.01 = 1500\ \Omega$ **(1)**

R = 150 – 590 = 960 Ω **(1)**

or potential divider ratio **(1)(1)**

2

(iv) (use of $1/R = 1/R_1 + 1/R_2$)

$1/960 = 1/200 + 1/R_2$ **(1)**

$1/R_2 = 1/960 - 1/1200$

$R_2 = 4800\ \Omega$ **(1)**

2

(b) (voltage of supply constant)

(circuit resistance decreases)

(supply) current increases or potential divider argument **(1)**

hence pd across 540 Ω resistor increases **(1)**

hence pd across 1200 Ω decreases **(1)**

or resistance in parallel combination decreases **(1)**

pd across parallel resistors decreases **(1)**

pd across 1200 Ω decreases **(1)**

3

[9]

M7. (a) (i) **working** circuit including power supply and thermistor (correct symbol) **(1)**

voltmeter and ammeter or ohm meter **(1)**

2

(ii) **The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.**

The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria.

High Level (Good to excellent): 5 or 6 marks

The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question.
The candidate states that the thermistor is connected in a suitable circuit with voltmeter and ammeter or ohmmeter.
The candidate gives details of how the thermistor is heated in a beaker of water **or** a water bath and a thermometer is used to measure the temperature at small regular intervals.
The candidate states that the resistance is found at various temperatures either directly with an ohmmeter or by dividing voltage by current. The candidate may mention that the water must be stirred to ensure that the thermistor is at the temperature measured by the thermometer.
The candidate may give some indication of the range of temperatures to be used.
The candidate may refer to repetition of whole experiment.
The candidate may plot a graph of resistance against temperature.
The candidate may use a digital thermometer.

Intermediate Level (Modest to adequate): 3 or 4 marks

The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate.

The candidate states that the thermistor is connected in a suitable circuit with voltmeter and ammeter or ohmmeter.
The candidate gives details of how the thermistor is heated in a beaker of water and a thermometer is used to measure the temperature.
The candidate states that the resistance is found at various temperatures either directly with an ohmmeter or by dividing voltage by current.

Low Level (Poor to limited): 1 or 2 marks

The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary.
The form and style of writing may be only partly appropriate.

The candidate changes temperature at least once and measures V and I or R.

The explanation expected in a competent answer should include a coherent selection of the following points concerning the physical principles involved and their consequences in this case.

Max 6

(b) (i) pd = 6.0 – 1.6 = 4.4 (V) **(1)**

1

(ii) current = 4.4/1200 = 3.7×10^{-3} (A) **(1)** (not 3.6)

1

(iii) resistance = $1.6/3.7 \times 10^{-3}$ = 440 **or** 430 (Ω) **(1)**

2 sfs **(1)**

2

(c) less current now flows **or terminal pd/voltage** lower **(1)**
(or voltage across cell/external circuit is lower)

(hence) pd/voltage across resistor will decrease **(1)**

2

[14]

M8. (a) (use of $1/R_{total} = 1/R_1 + 1/R_2$)

$1/R_{total} = 1/400 + 1/400 = 2/400$

$R_{total} = 200\ \Omega$ **(1)** (working does not need to be shown)

hence total resistance = 25 + 200 = 225Ω **(1)**

2

(b) (i) (use of $P = V^2/R$)

$1 = V^2/400$ **(1)**

$V^2 = 400$ (working does not need to be shown)

$V = 20$V **(1)**

(ii) (use of $I = V/R$)

$I = 20/400 = 0.05$A **(1)** (working does not need to be shown)

hence current = 2 × 0.05 = 0.10A **(1)**

(iii) (use of $V = IR$)

pd across 25Ω resistor = 25 × 0.10 = 2.5V **(1)**
(working does not need to be shown)

hence maximum applied pd = 20 + 2.5 = 22.5V **(1)**

6

[8]

M9. (a) (i) R (= V^2/P) = $12^2/45$ **(1)**

$R = 3.2\Omega$ **(1)**

(ii) (resistive strips are in parallel)

$1/R_T = 1/R_1 + 1/R_2 \ldots = 5/R$ **(1)**

R_T (= 5 × 3.2) = 16Ω **(1)**

4

(b) (using $R = \rho l/A$ and $A = wt$)

thickness = $\rho l/wR$ **(1)**

$= 3 \times 10^{-5} \times 0.80/2.5 \times 10^{-3} \times 16$ **(1)**

= 0.60 mm **(1)**

3

(c) I (= P/V) = 45/12 = 3.75 A **(1)**

t (Q/I) = 1.44 × 10^{-5}/3.75 = 3.84 × 10^{4}s **(1)**

3.84 × 10^{4}/60 × 60 = 10.7 hr **(1)**

3

[10]

M10. (a) (i) no of bulbs = $\left(\frac{230}{5}\right)$ = 46 **(1)**

(ii) (use of $P = VI$ gives) $I = \left(\frac{0.4}{5}\right)$ = 0.080 A **(1)**

(iii) resistance of each bulb = $\frac{230}{0.080 \times 46}$ = 63 Ω (62.5 Ω)

(allow C.E. for number of bulbs and value of I)

[or $R \left(= \frac{V}{I}\right) = \frac{5}{0.08}$ = 62.5 Ω

or $\left(P = \frac{V^2}{R} \text{ gives}\right) R = \frac{25}{0.40}$ = 62.5 Ω]

5

(iv) energy consumed by the set = 0.4 × 46 × (2 × 60 × 60) **(1)**
= 132 kJ **(1)**
(allow C.E. for number of bulbs from (i))

(b) (i) no of bulbs = 56, gives total resistance = 62.5 × 56 (Ω) (= 3500) **(1)**

$I = \frac{230}{3500}$ = 0.066 A **(1)** (0.0657 A)

(use of 63 Ω gives 0.065 A)

(allow C.E. for no. of bulbs in (a) (i) and R in (a) (iii))

(ii) bulbs would shine less bright **(1)**

3

[8]

M11. (a) (i) three resistors in series **(1)**

(ii) $R = 3.0 + 4.0 + 6.0 = 13\ \Omega$ **(1)**

(iii) three resistors in parallel **(1)**

(iv) $\frac{1}{R} = \frac{1}{3} + \frac{1}{4} + \frac{1}{6} = \frac{9}{12}$ **(1)**

$R = 1.3\ \Omega$ **(1)**

5

(b) (i) two resistors in parallel give $\frac{1}{R'} = \frac{1}{3} + \frac{1}{6}$ and $R' = 2.0\ (\Omega)$ **(1)**

total resistance = (2 + 4) = 6.0 Ω **(1)**

4

(ii) divide the emf in the ratio of 2 : 4 **(1)**
to give 4.0 V **(1)**
[or any suitable method]

[9]