1. (a) resistors in series add to 20 Ω and current is 0.60 A

accept potential divider stated or formula **B1**

so p.d. across XY is 0.60 × 12 (= 7.2 V)

gives (12 /20) × 12 V (= 7.2)V **B1**

(b) (i) the resistance of the LDR decreases **M1**

(so total resistance in circuit decreases) and current increases **A1**

(ii) resistance of LDR and 12 Ω (in parallel)/across **XY** decreases **B1**

so has smaller share of supply p.d. (and p.d. across XY falls)

alternative *I increases so p.d. across 8.0 Ω increases; so p.d. across **XY** falls* **B1**

[6]

2. (a) (i) I = V/R = 8.0/200

I = 0.040 (A) **C1** **A1**

(ii) V = 24 – 8 = 16 (V) **B1**

(iii) R = 16/0.04 giving

R = 400 (Ω)

accept *ratio of p.d.s to ratio of Rs*

ecf *from **(i)** & **(ii)** ie **(a)(ii)/(a)(i)*** **C1** **A1**

(iv) $P = VI = I^2R = V^2/R$

P = 0.640 (W)

ecf *from **(i)** & **(ii)***

accept *640 mW* **C1** **A1**

(b) (i) the thermistor has heated up/ its temperature has increased
so its resistance has dropped
so the ratio of the voltages across the potential divider changes/AW

accept *so the current increases*
accept *so IR of fixed resistor increases*

B1
M1
A1

(ii) voltages are equal so resistances are equal

B1

(c) (i) straight line through origin labelled R
passing through 0.06,12

allow *correct lines with no labels*

B1
B1

(ii) upward curve below straight line through origin labelled T
passing through 0.06,12

B1
B1

[15]

3. Any <u>four</u> from: B1 × 4

1. (As temperature increases) the resistance of the thermistor / **T** decreases
2. The <u>total</u> resistance decreases (Possible ecf)
3. The current increases (in the circuit) (Possible ecf)
4. The (voltmeter) reading increases / voltage across **R** increases (Possible ecf)
5. The voltage across the thermistor / **T** decreases (Possible ecf)
6. Correct use of the potential divider equation / comment on the 'sharing' of voltage / correct use of $V = IR$

[4]

4. (a) E = I(R + r)

B1

(b) (i) 1 0.80 Ω

B1

2 6.4 V

B1

(ii) (sum of) e.m.f.s = sum /total of p.d.s/sum of voltages (in a loop)

B1

(iii) 6.4 = 0.80I
I = 8.0 A

can be 2 ecf *from* ***(b)(i)****, eg 21.6/0.8*
= 27 A (1 ecf) or 21.8/0.68 = 31.8 A (2 ecf)

C1
A1

(c) (i) Q = It = 2.5 × 6 × 60 × 60

= 54000 (C)

allow *1 mark if forgets one or two 60's giving 900 C or 15 C*

C1
A1

(ii) energy = QE = 54000 × 14
= 756000 (J)

allow *(use of 12 V gives) 648000 J for 1 mark*

C1
A1

(iii) energy loss = I2Rt = VIt = 2 × 2.5 × 6.0 × 60 × 60 = 108000 J
percentage = (108000/756000) × 100 = 14%

accept *$Q\Delta V$ = 54000 × 2.0 = 108000 J*
accept *$Q\Delta V/QE$ = 2.0/14.0 = 14%*
not *756000/54000 = 14%*

C1
A1

[12]

5. (a) resistance = p.d./current

accept *voltage instead of p.d.; ratio of voltage to current; voltage per (unit) current*
not *R = V/I or p.d. = current x resistance or p.d. per amp or answer in units or voltage over current*

B1

(b) (i) 6 V

B1

(ii) R = V/I = 6/0.25
= 24 (Ω)

ecf (b)(i) *240 V gives 960 Ω*
award *0.024 Ω 1 mark only (POT error)*

C1
A1

(c) (i) 6 V supply with potential divider 'input' across it and lamp across p.d. 'output'
ammeter in series with lamp
voltmeter across lamp

accept *0 – 6 V variable supply with lamp across it*
not *variable R in series with supply*
circuit with no battery present can only score voltmeter mark

B1
B1
B1

(ii) non-zero intercept
line indicating increasing value of R with current

curve must reach y-axis
***accept** straight line or upward curve*

B1
B1

(iii) resistivity/resistance of filament wire increases with temperature
the temperature of the lamp increases with current/voltage increase
more frequent electron-ion/atom collisions/AW
increased ion vibrations

***accept** any two of the four statements*
***accept** AW, e.g the lamp heats up because of the current*

B1
B1

(d) (i) lamps do not light

***ignore** reasons unless too contrary*

B1

remaining lamps are lit with qualification

qualification could be more dimly or sensible explanation

B1

(ii) using resistors in parallel formula to obtain a value of R per unit
R per unit = 19.4 Ω or R total = 774 Ω
I = 6/19.4 or 240/774 = 0.31 A

eg takes R of bulb = 10 Ω giving R per unit = 9.1 Ω gains first mark only
ecf (b)(i)(ii)
***accept** R of resistors = 4000 Ω; current in chain = 0.06 A; total current = 0.06 + 0.25 = 0.31 A*
0.3 A is SF error so gains 2 marks only
*apply **SF error only once** in paper*

C1
C1
A1

[16]

6. (Sum of) e.m.f.s = sum /total of p.d.s/sum of voltages (in a loop) B1
energy is conserved B1

[2]

7. (a) (Semiconductor) diode B1

(b) The diode symbol circled (No ecf allowed) B1

(c) $R = \dfrac{V}{I}$ C1

At 0.20 V, R = infinite / very large A1

At 0.70 V, $R = (\dfrac{0.70}{0.020} =)35\,(\Omega)$ (Allow answers in the range: {31.82 to 38.89}) A1

(d) p.d across diode = 0.75 (V) / $(R_t = \dfrac{4.5}{0.060} =)\,75\,(\Omega)$ C1

p.d across resistor = 4.5 − 0.75 = 3.75 (V) / $(R_d = \dfrac{0.75}{0.060} =)12.5(\Omega)$ C1

$R = (\dfrac{3.75}{0.060} = 62.5 \approx)63(\Omega)$ / $R = (75 - 12.5 = 62.5\approx)\ 63\ (\Omega)$ A1

(Use of 0.70 V across the diode gives R = 63.3Ω - This can score 2/3)

(e) Straight line through the origin M1
Line of correct gradient (with line passing through 0.63 V, 0.01 A)
[Possible ecf] A1

[10]