

1. (a) resistors in series add to  $20\ \Omega$  and current is  $0.60\ \text{A}$   
*accept potential divider stated or formula* B1
- so p.d. across XY is  $0.60 \times 12 (= 7.2\ \text{V})$   
*gives  $(12/20) \times 12\ \text{V} (= 7.2\ \text{V})$*  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  $12\ \Omega$  (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  $8.0\ \Omega$  increases; so p.d. across XY falls* B1
- [6]**
2. (a) (i)  $I = V/R = 8.0/200$   
 $I = 0.040\ (\text{A})$  C1  
A1
- (ii)  $V = 24 - 8 = 16\ (\text{V})$  B1
- (iii)  $R = 16/0.04$  giving  
 $R = 400\ (\Omega)$   
*accept ratio of p.d.s to ratio of Rs*  
*ecf from (i) & (ii) ie (a)(ii)/(a)(i)* C1  
A1
- (iv)  $P = VI = I^2R = V^2/R$   
 $P = 0.640\ (\text{W})$   
*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 four from: B1 × 4

1. (As temperature increases) the resistance of the thermistor / **T** decreases
2. The total 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)  $6.4 = 0.80I$   
 $I = 8.0 \text{ A}$
- can be 2 ecf from (b)(i), eg  $21.6/0.8$   
 $= 27 \text{ A}$  (1 ecf) or  $21.8/0.68 = 31.8 \text{ A}$  (2 ecf)*
- C1  
A1

- (c) (i)  $Q = It = 2.5 \times 6 \times 60 \times 60$

$$= 54000 \text{ (C)}$$

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

C1  
A1

(ii) energy =  $QE = 54000 \times 14$   
 $= 756000 \text{ (J)}$

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

C1  
A1

(iii) energy loss =  $I^2Rt = VI t = 2 \times 2.5 \times 6.0 \times 60 \times 60 = 108000 \text{ J}$   
 percentage =  $(108000/756000) \times 100 = 14\%$

*accept  $Q\Delta V = 54000 \times 2.0 = 108000 \text{ J}$*

*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  $\times$  resistance or p.d. per amp or  
 answer in units or voltage over current*

B1

(b) (i) 6 V

B1

(ii)  $R = V/I = 6/0.25$   
 $= 24 \text{ (}\Omega\text{)}$

*ecf (b)(i) 240 V gives 960  $\Omega$*

*award 0.024  $\Omega$  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 =  $19.4 \Omega$  or R total =  $774 \Omega$   
I =  $6/19.4$  or  $240/774 = 0.31 \text{ A}$   
*eg takes R of bulb =  $10 \Omega$  giving R per unit =  $9.1 \Omega$  gains first mark only*  
**ecf (b)(i)(ii)**  
**accept** R of resistors =  $4000 \Omega$ ; current in chain =  $0.06 \text{ A}$ ; total current =  $0.06 + 0.25 = 0.31 \text{ A}$   
*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)  
energy is conserved
- B1**  
**B1**
- [2]**
7. (a) (Semiconductor) diode
- B1**
- (b) The diode symbol circled (No ecf allowed)
- B1**

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

At 0.20 V, R = infinite / very large A1

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

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

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

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

(Use of 0.70 V across the diode gives  $R = 63.3\Omega$  - 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]