1)

Question			Expected Answers	Marks	Additional Guidance
	a		resistors in series add to 20 Ω and current is 0.60 A so p.d. across XY is 0.60 x 12 (= 7.2 V)	B1 B1	**accept** potential divider stated **or** formula gives (12 /20) x 12 V (= 7.2)V
	b	i	the resistance of the LDR decreases (so total resistance in circuit decreases) and current increases	M1 A1	
		ii	resistance of LDR and 12 Ω (in parallel)/across **XY** decreases so has smaller share of supply p.d. (and p.d. across XY falls)	B1 B1	**alternative** I increases so p.d. across 8.0 Ω increases; so p.d. across **XY** falls
			Total question 3	**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)	C1 A1	**accept** ratio of p.d.s to ratio of Rs **ecf** from **(i)** & **(ii)** ie **(a)(ii)/(a)(i)**
	(iv)	$P = VI = I^2R = V^2/R$ P = 0.640 (W)	C1 A1	**ecf** from **(i)** & **(ii)** **accept** 640 mW
(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	B1 M1 A1	 **accept** so the current increases **accept** so IR of fixed resistor increases
	(ii)	voltages are equal so resistances are equal	B1	
(c)	**(ii)**	straight line through origin labelled R passing through 0.06,12	B1 B1	**allow** correct lines with no labels
	(ii)	upward curve below straight line through origin labelled T passing through 0.06,12	B1 B1	
		Total question 3	**15**	

3)

a		resistance decreases with increase in light intensity	B1	**ora**
b	**i**	3.0 (V)	B1	**accept** 3 V, no SF error
	ii	$3.0 = I.1.2 \times 10^3$ giving $I = 2.5 \times 10^{-3}$ A $6.0 / 2.5\ 10^{-3} = R = 2400\ \Omega$ 2.4 kΩ	C1 C1 A1	**accept** 6 = (R/ R + 1.2 k).9 2R + 2.4 k = 3R or similar R = 2.4 k ;**give** 2 with POT error **accept** ratio of resistors 6/3 x 1.2 good candidates can do this by inspection with no working – full marks **allow** 2400 written on answer line rather than 2.4 if 2400 Ω within body of text
	iii	49 **or** 50 ($W\ m^{-2}$)	B1	**ecf (b)(ii)** if on R within graph range
c	**i**	2.2 (kΩ)	B1	**allow** any value from 2.1 to 2.2
	ii	large(r) changes in R at low light intensities relating change in R to change in V	B1 B1	**allow** greater sensitivity of LDR at low light **or** steeper gradient/AW **e.g.** bigger change in I so in V **or** use of $V = R/(R + 1200)\ V_s$ **or** bigger change in V ratio across Rs
d		V across 1.2 kΩ falls so V across LDR rises because ratio of Rs changes in favour of LDR/ potential divider argument **or** total V is constant	B1 B1 B1	**alternative** I increases because total R is less so V across LDR rises do **not** award B marks where there is CON e.g. V across 1.2 k rises so V across LDR rises
e		continuous record for very long time scale of observation can record very short time scale signals (at intervals) automatic recording/remote sensing data can be fed directly to computer (for analysis)	B1 B1	**allow** any two sensible suggestions which fall within the 4 categories listed for 2 marks
		Total question 4	**14**	

4)

(a)		R of thermistor decreases as temperature increases supply V is constant/ total R is smaller current increases as V = IR/AW	**B1** **B1** **B1**	**accept** more free e's as temperature rises using I = nAev current increases as v decrease very small/AW
(b)		R_{th} = 40 Ω at 240 °C (stated or used in calculation) total R in circuit = 240 Ω I = 6/240 = 0.025 A V = 200 x 0.025 = 5.0 V	**B1** **C1** **C1** **A1**	**apply ecf** if wrong value of R read from graph **allow** V = (200/240)6 so V = 5.0 V **accept** 5 V (no SF error)
(c)	**(i)**	correct symbol for LDR	**B1**	no circle required
	(ii)	R of LDR decreases/current in circuit increases so V increases across fixed/200 Ω resistor/AW	**M1** **A1**	 **accept** simple potential divider argument **accept** voltmeter reading increases
		Total	**10**	

5)

a	**i**	V is not proportional to I	**B1**	**accept** not a straight line; R is not constant
	ii	R (approximately) constant up to V = 0.5 V and I = 50 mA so R = 0.5/0.05 = 10 (Ω)	**B1** **B1**	**allow** graph is (almost) linear/straight (to V = 0.5 V) or constant gradient **allow** any correct calculation, e.g. 0.2/0.02
	iii	the resistivity/resistance of the (metal) filament increases with temperature the larger the current in the filament the hotter it becomes/AW	**B1** **B1**	larger current heats filament so resistance increases **or** electron-ion collisions increase/AW; **allow** atom for ion
b		Any potential divider argument or calculation *In the light* parallel combination less than or about 1 Ω/AW so V across lamp less than 0.5 V (so lamp out)/ small compared to V across 25 Ω	**B1** **B1** **B1**	**QWC** the arguments must be clear for full marks **allow** R_{lamp} = 10 to 25 Ω for any calculation **or** comparison of voltage across 25 Ω to 1 Ω **N.B.** answers given in terms of current are likely to score zero
		In the dark parallel combination about 25 Ω/AW so V across lamp approximately 6.0 V so lamp on	**B1** **B1**	
		Total	**10**	