Question			Expected Answers	M	Additional Guidance
1					
	a	**i**	12/2.0 = 6.0 (Ω)	B1	**allow** 6; do not apply the SF penalty (N.B. applied only once per paper) for any answer where the second SF is 0
		ii	attempt to <u>use</u> resistors in parallel formula 1/R = 8/6 R = 0.75 (Ω)	C1 C1 A1	no mark for just quoting formula **ecf (a)(i)** **allow** ¾ (Ω)
		iii	$P = V^2/R = 12^2/0.75$ **or** $8VI = 8 \times 12 \times 2$ **or** $I^2R = 16^2 \times 0.75$ = 192 W	C1 A1	**ecf (a)(ii)**
	b		ρ = RA/l $= 6.0 \times 0.24 \times 2.0 \times 10^{-6}/0.9$ $= 3.2 \times 10^{-6}$ Ω m	C1 C1 A1 B1	correct rearrangement of formula **ecf (a)(i);** substitution into a correct formula 2/3 marks for one or more POT errors **accept** 3.2 Ω μm; 4×10^{-7} scores 2/3
	c	**i**	(As V is the same) then R must be the same to give <u>same P</u>	B1	**accept** alternative wording producing same argument, e.g. same I, same V so same R
		ii	0.75/8 = 0.094 (Ω)	B1	**ecf (a)(ii)**/8; **accept** 3/32 but NOT 0.09
		iii	for parallel circuit with break in one wire rest still work **or** series strips very wide (if use material of same resistivity as such low resistance/ giving poor visibility))	B1	any sensible statement
	d	**i**	14 V	B1	
		ii	**e**.g. V = 12 V; I = 20 substitution into E = V + Ir, e.g. 14 = 12 + 20 r r = 0.1 Ω	C1 C1 A1	**or** any suitable pair of readings from graph **ecf(d)(i); accept** r = gradient; = (14 – 10)/40 or similar ; = 0.1 Ω
			Total question 2	**17**	

Question			Expected Answers	M	Additional Guidance
2					
	a		energy per unit area per unit time	B1	**accept** power per unit area; **allow** second for unit time
	b		Small changes in R for high light intensities/daylight conditions Large changes in R for low light intensities/dim light/night time conditions to change circuit state need a significant change in R to be useful/reliable	B1 B1 B1	**accept** low R by day, high R by night for 1 mark **NOT** comparison e.g. R by day smaller than R at night **max 2 marks** from 3 marking points
	c	**i** **ii** **iii**	2.5 (kΩ) 5.0 = I x 2.5 kΩ giving I = 2.0 x 10^{-3} A 4.0 = 2.0 x 10^{-3} x R **or** potential divider argument giving R = 2.0 x 10^{3} Ω	A1 C1 A1 M1 A0	**allow** 2.4 to 2.6 **ecf (c)(i)** **accept** 2.0 mA **ecf (c)(ii) or ecf (c)(i)** **accept** 2.0 kΩ
	d		R (of LDR) = 1(.0 kΩ) potential divider of 1.0 kΩ and 2.0 kΩ giving 3.0 V across LDR	B1 C1 A1	 **accept** I = 3.0 (mA) so V = 3.0 (mA) x 1.0 (kΩ) = 3.0 V
	e		light shining on the LDR will cause it to switch the illumination off causing an ON/OFF oscillation/AW	B1 B1	two suitable qualifying statements for the 2 marks
			Total question 3	**12**	

Question			Expected Answers	M	Additional Guidance
3					
	a	**i**	When connected/using/AW to the 230 V supply the power/energy per second from supply/output/dissipated/AW is 25 W	B1 B1	**accept** when working normally/AW **not** 230 V (going) through/into lamp/AW **accept** transferred from electrical (into other) form(s) is 25 W
		ii	$25 = 230^2/R$ R = 2100 Ω **or** 2.1 kΩ	C1 A1	**accept** I = 25/230 = 0.11 A R = 230/0.11 = 2100 Ω (2116 Ω)
		iii	Using the equation in the form P = VI, for larger P need larger I so 60 W	M1 A1	accept $P = V^2/R$, for larger P need smaller R so larger I; do **not** allow any argument using 880 Ω unless this value is calculated here
		iv1	1/R = 1/2100 + 1/880 R = 620 Ω	C1 A1	substitution into formula for Rs in parallel **ecf (a)(ii)**
		iv2	I = 230/620 I = 0.37 (A)	C1 A1	**ecf (a)(iv)1** using 1/R gives 143 kA accept total P = 85 W so I = 85/230 ;= 0.37 (A)
	b		the resistivity/resistance (of a metal) increases with temperature **or** R is greater when hot(ter) at 6V/low I little heating effect **or** at 230 V/high I large heating effect	B1 A1	**ora** less when colder **QWC mark**: explanation linked to observations
	c	**i**	(a unit of) energy equal to 3.6 MJ **or** 1 kW for 1 h/AW	B1	**eg** 1000 W for 3600 s or similar
		ii	0.06 x 8 = 0.48 (kWh) or 60 x 8 = 480 (Wh) 0.48 x 21 = 10(.1) p	C1 A1	no marks for using s instead of h POT error e.g. 100 or 10000 p
			Total question 2	**15**	