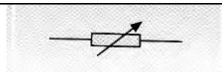
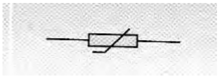
Question			Expected Answers	M	Additional Guidance
1					
	a	**i**	V J $^{-1}$ R V $^{-1}$ P J $^{-1}$ I C $^{-1}$.	B1 B1 B1	4 correct 3 marks; 2 correct 2 marks 1 correct 1 mark
	b	**i**	using $V_{out} = R_2/(R_1 + R_2)\ V_{in}$: **alt:** 2.4 = I x 560 V_{out} = 3.6 V so I = 4.3 mA 3.6 = R_2/(560 + R_2) 6 3.6 = I R_2 R_2 = 840 (Ω)	C1 C1 A1	 **accept** R_2 = (3.6/2.4) x 560 or .2.4 = 560/(560 + R_2) 6
		ii	I = 4.3 x 10^{-3} (A)	B1	**accept** 4.3 m(A) or 3/700 (A) **ecf (b)(i)** i.e. I = 6/(560 + R_2)
	c	**i**	20 ± 2 (^{o}C)	B1	
		ii	R_{Th} will fall/ resistance will fall giving greater share of supply V across fixed R/AW causing the voltage across (fixed) R/voltmeter reading to rise	B1 B1 B1	 **accept** explanation in terms of potential divider equation **or** current increases **or** current same in both resistors/resistors in series
		iii	ΔR is large for small ΔT at low temperatures/AW in terms of gradient so thermistor is better in circuit to control low temp, refrigerator	M2 A1	**accept** sensitivity greater at low temperature **or** vice versa **or** ΔR is small for small ΔT at high temperatures scores 1 out of 2
			Total question 3	**14**	

Question			Expected Answers	Marks	Additional Guidance
2					
	a		ρ = RA/l with terms defined	M1 A1	full word definition gains both marks **allow** *A is area* as adequate; no unit cubes
	b	**i**	**either** the cable consists of (38) strands in parallel; **or** the area of the cable is 38 times the area of a strand or vice versa; so the resistance of 1 strand is 38 times bigger, (i.e. 1.98 Ω km^{-1}) **or** the resistance is inversely proportional to the area	B1 B1	max 1 mark for 38 x 0.052 = 1.98 with no further explanation **allow** with **either** and **or** **allow only** with **or**
		ii	A = ρ l/R = 2.6 x 10^{-8} x 1000/2.0 = 1.3 x 10^{-5} (m^2)	C1 A1	**allow** 1 mark max. for R = 0.052 giving A = 5.0 x 10^{-4} (m^2) **give** 1 mark max. for 1.3 x 10^{-8} (m^2)
	c	**i**	P = VI = 400x 10^3 x 440 = 1.8 x 10^8 (W) or 180 M(W)	C1 A1	P = VI **not** adequate for first mark **expect** 176
		ii	2000/176 = 11.4 so 12 required	B1	**ecf(c)(i);** using 180 gives 11.1
		iii	P = I^2R = 440^2 x 0.052 = 1.0 x 10^4 W (km^{-1}) or 10 kW (km^{-1})	C1 C1 A1	**accept** power/cable = 2000/12 = 167 MW I = 167M/400k = 417 A P = 417^2 x 0.052 = 9.0(3) kW (km^{-1}) **N.B.** answer mark includes consistent unit
		iv	power lost per cable = 10 k x 100 x 12 = 12.0 MW fraction remaining = (2000 – 12)/2000 = 0.994 x 100 = 0.994 so 99.4% or power lost per strand = 10 k x100 = 1.0 MW fraction remaining = (176 – 1)/176 = 0.994 so 99.4%	C1 A1	**ecf(c)(ii)(iii)** **allow** second mark for 'correct' answer as fraction not percentage with BOD sign **allow** 1 mark max. if give correct % lost given rather than % remaining **allow** 1 mark max. for 100 x (2000 – 1)/2000 = 99.95%
			Total question 2	**14**	

Question			Expected Answers	Marks	Additional Guidance
3					
	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**	

Question			Answer	M	Guidance
4					
	a		 for R_1  for R_2	B1 B1	
	b	**i**	500 Ω	B1	**accept** ± 20 Ω
		ii	7.0 = I x 500; I 0.014 (A)	B1	**ecf b(i)**
		iii	5.0 = 0.014 x R or 12 = 0.014(500 + R) R = 360 Ω	M1 A1	**ecf b(i)(ii)** **allow** R = 500 x 5/7 = 360 Ω
		iv	(at 200°C) R_{th} = 250 Ω V across thermistor =12 x 250/(250 + 350) = 5.0 V **alt** 5.0 = 12 x R/(R + 350) **or** I = 7.0/350 = 0.02 A; V_h = 5.0 = 0.02 x R R = 250 Ω which occurs at 200°C	B1 B1	**allow** R_{th} = 250 ± 10 giving 4.8 to 5.1 V **expect** 350 or 360; **allow** 1 SF where answer is 5.0 **NOT** 250 x 0.02 = 5.0 V; 0.02 A must be justified **allow** 7.0 = 12 x 350/(350 + R)
	c		**switch on** 5.0 = 12 x 250/(250 + R) or 7.0 = 12 x R/(250 + R) giving R = 350 Ω which is 190°C **switch off** 7.0 = 12 x 250/(250 + R) or 5.0 = 12 x R/(250 + R) giving R = 180 Ω which is 210°C **or** Switch on, R2 / R1 = 7/5 giving R2 - 250 x 7/5 = 350 ohm Switch off, R2 / R1 = 5/7 giving R2 = 250 x 5/7 = 179 ohm	M1 A1 M1 A1	**accept** solution in 2 stages first calculating currents on I = 0.02 and R = 7/0.02 off I = 0.028 and R = 5/0.028 **allow** ± 5°C in reading from graph **N.B.** zero marks for correct temperatures quoted without some correct working/justification
			Total question 2	**12**	