10	**The only correct answer is D (4 *v*)** A because this would be 16 times less than the actual value B is not correct because this would be 8 times less than the actual value C is not correct because this would half the actual value	1

4	**The only correct answer is C size of gap = wavelength of wave**	1
	***A** is not correct because size of gap is greater than the wavelength* ***B** is not correct because size of gap is greater than the wavelength* ***D** is not correct because size of gap is greater than the wavelength*	

5	The only correct answer is **C** A is not correct because attraction would not produce an interference pattern B is not correct because scattering would not produce an interference pattern D is not correct because refraction would not produce an interference pattern	1

1	**B is the correct answer** A is not correct the resistance of a metal increases with temperature C is not correct because resistance of a thermistor decreases with temperature and resistance of a metal increases with temperature D is not correct because resistance of a thermistor decreases with temperature	1

8	A - wavelength is unchanged B - speed is unchanged C - both wavelength and speed are unchanged **D - correct answer**	1

2	**The only correct answer is B 4W**	1
	***A** is not correct because only half the intensity is transmitted* ***C** is not correct because this is a quarter of the original intensity* ***D** is not correct because one polarising filter transmits half the intensity*	

1	**A is the correct answer as diffraction is the spreading of waves as they pass an object** B is not the correct answer as interference is not the spreading of waves C is not the correct answer as reflection is not the spreading of waves D is not the correct answer as refraction is not the spreading of waves	**(1)**

1	**B is the correct answer as it is a *V-I* graph for a filament lamp** A is not the correct answer as it is not a *V-I* graph for a diode C is not the correct answer as it is not a *V-I* graph for an ohmic conductor D is not the correct answer as it is not a *V-I* graph for a thermistor	**(1)**

Question Number	Answer	Mark
1	**The only correct answer is A diffraction**	1
	B *is not correct because polarisation is not the spreading of a wave* ***C*** *is not correct because reflection occurs at an interface between two media* ***D*** *is not correct because refraction is the change in direction of a wave when incident at an interface between two media*	

5	**D is the correct answer** A is not correct because both the resistance and lattice vibrations should increase. B is not correct because the resistance should increase. C is not correct because the lattice vibrations should increase.	1

2	**D is the correct answer** (Polarised waves have oscillations in one direction and perpendicular to the direction of wave travel) A is not the correct answer as the single plane of polarisation includes the direction of wave travel and is not perpendicular to it B is not the correct answer as polarised waves do not contain many plames C is not the correct answer as polarised waves do not contain many directions	**(1)**

2	**C is the correct answer** A is not the correct answer as the intensity does not vary as the filter is rotated B is not the correct answer as the intensity does not vary as the filter is rotated D is not the correct answer as one filter will allow some oscillations to pass	**(1)**

1	**The only correct answer is C (*v* represents the drift velocity of the charge carriers in the sample)** A is not the correct answer as *n* is the number of charge carriers per m^3 B is not the correct answer as *q* is the charge per charge carrier D is not the correct answer as *A* is the cross-sectional area	1

8	**The only correct answer is D (increased number of conduction electrons)** A is not correct because this factor on its own would not affect resistance B is not correct because this is not as significant a factor as D C is not correct because this is not as significant a factor as D	1

7	**The only correct answer is A** B is not correct because *I* and *V* are directly proportional C is not correct because *I* and *V* are directly proportional D is not correct because *I* and *V* are directly proportional	1

12(a)(i)	Angle of incidence measured from the diagram in the range 53° - 55° **(1)**		1

12(a)(ii)	Use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ **(1)** θ_2 = 32-33° (allow ecf from (a)(i)) **(1)**	Only penalise unit if not penalised in part ai Example of calculation $1 \times \sin 53° = 1.5 \times \sin\theta_2$ $\theta_2 = \sin^{-1}\left(\frac{1 \times \sin 53°}{1.5}\right) = 32°$	**2**

12(b)(i)	**Either** Unpolarised light has oscillations / vibrations in all / many planes **(1)** polarised light has oscillations / vibrations in one plane **(1)** which includes the direction of (wave) travel **(1)** **Or** Unpolarised light has oscillations / vibrations in all / many directions **(1)** Polarised light has oscillations / vibrations in one direction **(1)** which is perpendicular to the direction of (wave) travel **(1)** (MP3 dependent on MP2 being awarded)	(MP3 dependent on MP2 being awarded) (MP3 dependent on MP2 being awarded)	**3**

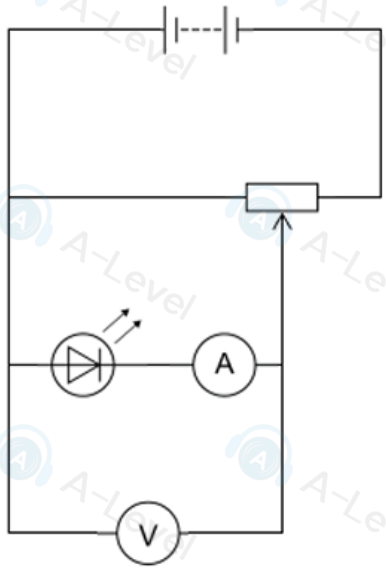
12(b)(ii)	Intensity of light varies **(1)** from a maximum to a minimum every 90 degree rotation **(1)** The maximum intensity occurs when the (plane of) the polarising filter is in the same direction as the (plane of) oscillation of the light **(1)** **Or** The minimum intensity occurs when the (plane of) the polarising filter is perpendicular to the (plane of) oscillation of the light	Allow amount of light / brightness for intensity	**3**

***15(a)**	Current increases as p.d. increases (1) Causing temperature of filament/lamp to increase **Or** causing filament/lamp to get hotter (1) There is an increase in ion/atom vibrations (1) Greater rate of collisions between electrons and ions/atoms/lattice (causes an increase in resistance) (1) The rate of increase of current with p.d. decreases (1)	**5**
15(b)	Uses graph to find I at 4.2 V (500 – 520(m)A) (1) Uses sum of p.d. = sum of e.m.f. (Accept use of $\varepsilon = V + Ir$) (1) r = 3.5/3.6 Ω (1) **OR** Uses graph to find I at 4.2 V (500 – 520(m)A) (1) Uses $R = V/I$ twice with V = 6.0V and V = 4.2V (1) r = 3.5/3.6 Ω (1) Example of Calculation $6\ \text{V} = 4.2\ \text{V} + (0.51\ \text{A} \times r)$ $r = 3.5\ \Omega$	**3**
	Total for question 15	**8**

Question Number	Answer		Mark
14(a)	10°C corresponds to 2.0 Ω	(1)	
	Use of ratio of resistances	(1)	
	Use of corresponding ratio of p.d.s	(1)	
	To a p.d. of 0.7(06) V	(1)	
	If temperature goes below this level then resistance of thermistor increases	(1)	
	So p.d. to heater (switch) increases and so heater switch does perform as required	(1)	
	Example of calculation $\frac{V}{6.0} = \frac{2.0}{15 + 2.0}$ $V = 0.706$ V		
	Or		
	10°C corresponds to 2.0 Ω	(1)	
	Use of $I = V/R$ for whole circuit	(1)	
	Use of $V = IR$ for thermistor	(1)	
	To a p.d. of 0.7(06) V	(1)	
	If temperature goes below this level then resistance of thermistor increases	(1)	
	So p.d. to heater (switch) increases and so heater switch does perform as required	(1)	6
	Example of calculation $I = 6.0$ V / (2 + 15) Ω = 0.353 A $V = 0.353$ A × 2.0 Ω = 0.706 V		
14(b)	Increase in temperature results in more electrons released **Or** Increase in temperature results in more electrons moving into conduction band	(1)	
	So resistance decreases (dependent on MP1)	(1)	2
	[allow converse argument]		
	Total for question 14		**8**

15(a)	Mention of diffraction (of radiowaves) When the wavelength is of comparable size to the hill **Or** wavelength is greater than the height of the hill Use of $v = f\lambda$ with $3\times10^{8}\ \text{m s}^{-1}$ $\lambda = 433$ m Example of calculation $3\times10^{8}\ \text{ms}^{-1} = 693\times10^{3}\ \text{s}^{-1}\lambda$ λ=433 m	(1) (1) (1) (1)	**4**
15(b)	Use of Radiation flux = power per unit area Use of Energy = Power × time Energy = 7.5×10^{-7} J Example of calculation $E = 8.3\times10^{-9}\ \text{Wm}^{-2}\times0.025\ \text{m}^{2}\times3600\ \text{s}$ E= 7.5×10^{-7} J	(1) (1) (1)	**3**
***15(c)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) UV frequency is greater (than radio frequency) Reference to photon (Photon) energy is proportional to frequency (Electromagnetic waves with) a higher frequency/energy cause more ionisation **Or** UV is more ionising (MP3 dependent on MP2)	(1) (1) (1) (1)	**4**
	Total for question 15		**11**

Question Number	Answer	Mark

14(a)	LED, power supply and ammeter, in series (allow diode for LED)	**(1)**	
	Method to vary the potential difference across the LED	**(1)**	
	LED connected in forward bias **and** voltmeter connected in parallel with LED	**(1)**	**3**
	<u>Example circuit</u>  		

14(b)	Current = 37 (mA) read from graph (allow range 36 to 38 mA)	**(1)**	
	Use of $P = VI$	**(1)**	
	Power of LED = 0.0814 W (allow range 0.079 to 0.084 W)	**(1)**	**3**
	<u>Example calculation</u> $P = 2.2\ \text{V} \times 37 \times 10^{-3}\ \text{A} = 0.0814\ \text{W}$		

14(c)	Between 0 V and 1.6 V the resistance of the LED was (almost) infinite	**(1)**	
	(As p.d. increased) above 1.6 V, the resistance of the LED decreased	**(1)**	**2**
	Max 1 mark for statement that resistance is initially (almost) infinite and then decreases		
	Total for question 14		**8**

17(a)	Each point on a <u>wavefront</u> is (treated as) a source of (secondary) <u>wavelets</u>	**(1)**	
	these further wave (let)s interfere / superpose (and the resulting waves predict the shape)	**(1)**	**2**

***17(b)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. IC points / IC mark / Max linkage mark / Max final mark 6 / 4 / 2 / 6 5 / 3 / 2 / 5 4 / 3 / 1 / 4 3 / 2 / 1 / 3 2 / 2 / 0 / 2 1 / 1 / 0 / 1 0 / 0 / 0 / 0 The following table shows how the marks should be awarded for structure and lines of reasoning. Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout — Number of marks awarded for structure of answer and sustained line of reasoning: 2 Answer is partially structured with some linkages and lines of reasoning — 1 Answer has no linkages between points and is unstructured — 0 **Indicative content** IC1 Waves (from each gap) interfere / superpose IC2 At position A there is no path / phase difference IC3 So, there is constructive interference (leading to large amplitude oscillations) IC4 At position B, the phase difference varies with wavelength IC5 If there is an odd number of half wavelengths path difference, there is destructive interference leading to small oscillations **Or** If the waves are in antiphase there is destructive interference leading to small oscillations IC6 And if there is a whole number of wavelengths path difference there is constructive interference leading to large oscillations **Or** If the waves are in phase there is constructive interference leading to large oscillations	**6**
	Total for question 17	**8**