Question Number	Answer	Mark
1(a)	Volt is a Joule coulomb $^{-1}$ or V = J C^{-1} or $V = W/Q$ (not rearranged) Amp is a Coulomb sec^{-1} or A = C s^{-1} or $I = Q/t$ (not rearranged) Show units/symbols cancelling and **equating to a watt**. This mark can only be given if <u>both</u> the other marks scored. Method must be clear, do not allow 'let t = 1'.	**(1)** **(1)** **(1)**
1(b)(i)	Use of energy = power × time Energy = 2.9 × 10^5 J <u>Example of calculation</u> E = 700 × 7 × 60 E = 294 000 J	**(1)** **(1)**
1(b)(ii)	QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence See internal resistance / r Current will be less Less energy/power is lost in internal resistance OR wasted energy/power is reduced OR reduced lost volts OR it is more efficient	 **(1)** **(1)** **(1)**
	Total for question	**8**

Question Number	Answer	Mark
2	Attempt to use $I = Q / t$	**1**
	use of e = 1.6 × 10 ^-19 1	**1**
	I = 2.8 × 10 ^6 A [C s^-1] 1	**1**
	[omit e gives answer 1.73 × 10 ^25 scores 1]	
	Example of answer	
	I = (2.6 × 10 ^26 × 1.6 × 10 ^-19 C) ÷ 15 s	
	I = 2.77 × 10 ^6 A	
	Total for question	**3**

Question Number	Answer	Mark
3	The answer must be clear and organised in a logical sequence • Different currents / current divides in parallel circuit(1) • • Same potential difference/voltage across each lamp (1) • • Use of $P = V^2 / R$ **OR** $P = VI$ if identified $I_A < I_B$ (1) • Leading to high resistance, smaller power (1) • • lamp B will be brighter/ lamp A dimmer (1) • • Each electron loses the same energy (1) • There are more electrons/sec in B (1) • Hence greater total energy loss /sec in B (1)	
		Max 5
	Total for question	**5**

Question Number	Answer		Mark
4(a)	Diode / LED (Any type of recognised diode scores the mark but if diode is included in a list of other components the mark cannot be gained.)	**(1)**	
4(b)	Infinite / infinity / ∞ **Or** Very high **Or** very large	**(1)**	**1**
4(c)	Use of $R=V/I$ Correct value of R for their current in range 0.40 A to 0.43 A (Any valid pair of values for first mark. Use of tangent or gradient scores no marks) Example of calculation R= 0.70 V / 0.41 A R= 1.7 Ω	**(1)** **(1)**	**2**
4(d)	**Any One from, e.g.** To protect components / circuits Rectification Restricts current / flow (of charge) to one direction AC to DC Produce DC supply Power indicator light Light source, e.g. Christmas tree light, torch Regulate voltage (Accept any reasonable practical use for diode or LED)	**(1)**	**1**
	Total for question		**5**

Question Number	Answer		Mark
5(a)	(sound waves travel as) longitudinal waves **Or** (Air molecules) vibrate parallel to direction of travel of wave (sound waves travel as) a series of compressions **and** rarefactions **Or** (sound waves travel as) areas of high and low pressure The idea that these vibrations create a pressure/force/stress/strain on the film **Or** The idea that these compressions/rarefactions create a pressure/force/stress/strain on the film This pressure/force/stress/strain generates a potential difference (accept idea that vibration/pressure/force/stress/strain causes redistribution of charge within crystal)	**(1)** **(1)** **(1)** **(1)**	**4**
5(b)	Thin film is flexible / lightweight The idea that there is not much energy in sound Large area gathers more sound (energy) **Or** Large area generates more power/current/pd	**(1)** **(1)** **(1)**	**3**
5(c)	Use of $P=E/t$ with any time, energy in J or kJ Conversion of kJ→J **and** correct time in s (36000 s) P =0.56 W (accept J s^{-1}) <u>Example of calculation</u> Power = 20000 J / 10 × 3600 s Power = 0.56 W	**(1)** **(1)** **(1)**	**3**
5(d)	**ONE** *Disadvantage* Expensive, Not washable Only works with (loud) noise Long time to charge a phone Low output power **ONE** *Advantage* Free source of energy Lower/zero running cost Portable Can be used when away from mains electricity [Credit should be given for any reasonable correct physics point but not for generalised comments such as 'good for the planet' 'environmentally friendly']	**(1)** **(1)**	**2**
	Total for question		**12**

Question Number	Answer		Mark
6	Indication that 500 W is 15% of incident radiation / Apply 15% efficiency to incident flux of 210 W m^{-2} (i.e. find useful input) Use of radiation flux is power per unit area Answer = 16 m^2 [2.38 m^2 is the answer without applying 15% → 1 mark] <u>Example of calculation</u> Input power = (500 × 100)/15 = 3300 W Area = input power/radiation flux = 3300 W / 210 W m^{-2} = 16 m^2 OR (15/100) x 210 W m^{-2} = 31.5 W m^{-2} Area = 500 W / 31.5 W m^{-2} = 16 m^2	(1) (1) (1)	**3**
	Total for question		**3**

Question Number	Answer		Mark
7(a)	Use of $W = QV$ Energy of electron = 1.6×10^{-14} (J) <u>Example of calculation</u> Energy = $1.6 \times 10^{-19} \times 100\,000$ J Energy of electron = 1.6×10^{-14} J	**(1)** **(1)**	**2**
7(b)	Use of energy = power × time Energy = 2.88×10^7 (J) <u>Example of calculation</u> Energy = 1000 × 8 × 3600 Energy = 2.88×10^7 J	**(1)** **(1)**	**2**
7(c)	**2** eV is very much smaller than Joule kW h is very much bigger than Joule in these units, answers more easily obtained from information available OR answers can be found without conversions	**(1)** **(1)** **(1)**	**Max 2**
	Total for question		**6**

Question Number	Answer	Mark
8(a)	Current (through a conductor) is (directly) proportional to the potential difference/voltage (across it) providing the temperature of conductor remains constant OR external conditions remain constant.	**1** **1**
(b)	**Ohmic conductor; fixed resitor** horizontal straight line **Filament lamp;** graph showing increasing resistance (straight line or curve) from a non zero resistance start (conditional on 2nd mark)	**1** **1** **1**
(c)	Filament lamps work at high temperatures OR as temp of lamp increases OR as lamp heats up. Resistance of conductor changes OR the ions vibrate more.	**1** **1**
	Total for question	**7**

Question Number	Answer	Mark
9(a)(i)	e.m.f./total resistance (accept $E/(R+r)$	**1**
(ii)	= D4*A4 or p.d. = current × load resistance OR (B4*A4)/(A4+C4) or p.d. = e.m.f. – (internal resistance x current) OR F4/D4 or p.d.=power/current	**1**
(iii)	9.2 (W) R and r in series	**1**
(b)	R and r in series Potential divider r constant so as R increases p.d. also increases **OR** $V = E - Ir$ E and r constant Identifies that the term Ir decreases **OR** $E = I(R+r)$ E and r constant As R increases I decreases	**1** **1** **1**
(c)(i)	(power) increases and then decreases Maximum power when load equals 0.8 Ω	**1** **1**
(ii)	Similar pattern of power increasing to a max and decreasing	**1**
	Maximum power when load resistance is 1.6 Ω	**1**
	Total for question	**10**

Question Number	Answer	Mark
10(a)	A coulomb is an Amp sec or As (1) Do not credit current × time	**1**
(b)	I_1 = 10 mA (1) I_2 = 5 mA (1) I_3 = 30 mA (1)	**3**
	Total for question	**4**