Question Number	Answer		Mark
1(a)	Operable circuit with bulb and power supply variable to 12 V (ignore meters) Ammeter correctly positioned Voltmeter correctly positioned (voltmeter may be across ammeter as well, or whole circuit – but not across any additional resistive components such as a variable resistor)	**(1)** **(1)** **(1)**	**3**
1(b)(i)	The gradient of this graph is the rate of change of current with p.d. Resistance is the ratio of pd/current **Or** It is calculated using a value of pd ÷ the corresponding value of current **Or** it isn't a straight line so the gradient is not *R* (credit *R* not constant, so value at 6 V isn't applicable to other voltages)	**(1)** **(1)**	**2**
1(b)(ii)	Use of $R = V/I$ $R = 4.76\ \Omega$ Example of calculation $R = 6.00\ V / 1.26\ A$ $R = 4.76\ \Omega$	**(1)** **(1)**	**2**
***1(c)**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** The resistance increases (Because) the temperature increases (accept heats up) Increasing the amplitude of the oscillation of the lattice ions Leading to more (frequent) collisions of electrons with lattice ions Allow converse marks for an explanation explicitly based on decreasing potential difference	 **(1)** **(1)** **(1)** **(1)**	**4**
	Total for question		**11**

Question Number	Answer	Mark
2(a)	Resistance (of a fluid) to flow **(1)**	**1**
2(b)(i)	Rate of flow is inversely proportional to the viscosity **Or** rate of flow decreases with increasing viscosity (and vice versa) **(1)** The time to empty the cup is proportional to the viscosity **Or** the time to empty the cup is inversely proportional to the flow rate **Or** the time to empty the cup decreases as viscosity decreases **Or** the time to empty the cup decreases as the flow rate increases **(1)** (Accept converse explanation in terms of time increasing for MP2)	**2**
2(b)(ii)	The temperature was greater on the first day **Or** the temperature was lower (on the second day) **Or** the paint/room was colder (on the second day) **Or** the time is greater when the temperature is lower **Or** the time is lower when the temperature is greater **(1)**	**1**
2(c)	Error 1 **(1)** Correct outcome from error 1 **(1)** Error 2 **(1)** Correct outcome from error 2 **(1)** (Do not credit descriptions of changing temperature) Examples of answer Reaction time Measured time greater than actual time Initial paint level in cup could be higher/lower than the level Time would be greater /less Hole/opening becomes blocked Time to drain would be greater Paint left in cup after pouring **Or** paint spilt Reduces time to drain	**4**
	Total for Question	**8**

Question Number	Answer	Mark
3(a)	Resistivity is a constant for the material / metal OR resistivity depends on / is a property of the material / metal Resistance depends on (resistivity and) length / area /dimensions OR $R = \rho l / A$ with terms defined (do not credit rearranged equation)	**(1)** **(1)**
3(b)	Correct substitution into the $R = \rho l / A$ formula $R = 0.0085\ \Omega$ [ue applies. Common error is to rearrange eqn and confuse R and ρ gives answer 3.4×10^{-14} scores zero] <u>Example of calculation</u> $R = (1.7 \times 10^{-8}\ \Omega\ m \times 0.5\ m) / 1 \times 10^{-6}\ m^2$ $R = 0.0085\ \Omega$	**(1)** **(1)**
12	**Total for question**	**4**

Question Number	Answer	Mark
4(a)	Use of $V=IR$ V = 3.0 V	**1** **1**
(b)	pd across 30 Ω resistor = 6.0 V ecf their answer (a) I_2 = 6.0/30 = 0.20 A	**1** **1**
(c)	I_1 = 0.60 – 0.20 = 0.40 A R = 15 Ω full ecf their answer for I_2 and their V across 30 Ω	**1** **1**
	Total for question	**6**

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**