Level 2 Physics: Electricity – Circuits - Answers

Question	Evidence	Achievement	Merit	Excellence
2020(1) (a)	$\frac{1}{R}=\frac{1}{6}+\frac{1}{6}$ so $R=3$, or $R=\frac{6\times 6}{6+6}=3$	Show question.		
(b)	$R_T=3+\left(\frac{1}{10}+\frac{1}{10}\right)^{-1}=8\,\Omega$ $I=\frac{28}{8}=3.5\text{ A}$	Finds total *R* (8). OR 28 / (any calculated *R* – not 3).	3.5 A	
(c)	When the foot heater stops working, this increases the total resistance ofthe circuit. This reduces the total current in the circuit. This reduces the current ineach hand unit.	Total resistance increases Current through hand unit decrease.	Correct answer with reasoning. Must be clear that it's the current in the hand unit being referred to.	

(d)	$P = IV = \frac{V^2}{R}$ $120 = \frac{28^2}{R}$ so $R_{total} = 6.533\ \Omega$ $R_{total} = 6.533\ \Omega = 3 + \left(\frac{1}{10} + \frac{1}{10} + \frac{1}{R}\right)^{-1} \Rightarrow R = 12\ \Omega$ OR $I = \frac{P}{V} = \frac{120}{28} = 4.29\ A$ Voltage across hand units $= 3 \times 4.29 = 12.9\ V$ Voltage across foot units $= 28 - 12.9 = 15.1\ V$ $R_{foot\ combo} = \frac{V}{I} = \frac{15.1}{4.29} = 3.52\ \Omega$ So $\left(\frac{1}{10} + \frac{1}{10} + \frac{1}{R}\right)^{-1} = 3.52$ And $R = 12\ \Omega$	I = 4.29A	$R_{foot\ combo} = 3.52\ \Omega$ Or Finds $R_{total} = 6.533\ \Omega$	$12.0\ \Omega$ OR States a correct formula from which R could be calculated, e.g.: $6.533 = 3 + \left(\frac{1}{10} + \frac{1}{10} + \frac{1}{R}\right)^{-1}$ OR equivalent.
2019(1) (a)	$I = \frac{V}{R} = \frac{4}{5} = 0.8\ A$	Show question.		
(b)	$P = \frac{E}{t}$ so $E = 0.8 \times 11 \times 120 = 1056$ Joules	Correct power =8.8W Finds E by using t = 2 (17.6 J). OR any **power** multiplied by 120	Correct answer.	

(c)	$\left(\frac{1}{6+5.6}+\frac{1}{3.2}\right)^{-1}=2.51\,\Omega$	Finds 11.6. OR has 1/3.2 **Not** 6 + 5.6 + 3.2	Correct answer.	
(d)	Power determines brightness. By adding the extra lamp to Circuit 2, the total resistance of the circuit has decreased. This means the current in the circuit has increased, as the circuit voltage has remained the same. *P* = *IV*, so because the current has increased, so has the power of Circuit 2, meaning that Circuit 2 is brighter.	One correct statement. **Not** just circuit 2 is brighter.	Two correct statements.	Comprehensive answer that must state circuit 2 is brighter or equivalent. Specific example ok e.g. assigning a number for R to the bulbs and calculating power.
2018(3) (a)	$R_T = 7.00+\left(\frac{1}{4.80}+\frac{1}{7.00}\right)^{-1}=9.85\ \Omega$	9.84746 Ω Rounding NOT important.		
(b)	Current: $I=\frac{V}{R}=\frac{12}{9.85}=1.22\ A$ $V_{bulb1}=IR=1.22\times 7.00=8.53\text{ V}$ $V_{bulb2}=V_{supply}-V_{bulb1}$ $V_{bulb2}=12-8.53=3.47\text{ V}$ Accept use of 10 Ω	Correct current. OR Correct bulb 1 OR bulb 2 voltage.	Both voltages correct.	

(c)	The voltage across each bulb is the same, however the current though bulb 2 is higher, due to having a lower resistance ($I = V/R$). Bulb 2 uses more power (2.51W vs 1.72 W) and is therefore brighter from $P = IV$. OR Power = V^2/R, the same voltage but different resistances will mean different power consumptions. Bulb 2: $P = \frac{3.47^2}{4.8} = 2.51\text{ W}$ Bulb 3: $P = \frac{3.47^2}{7.0} = 1.72\text{ W}$	One correct statement. E.g. the same voltage in parallel (could be implied make sure they are not referring to the circuit voltage). OR Bulb 2 is brighter. OR Bulb 2 has more current. Power = brightness	Two correct linked statements.	Complete argument.
(d)	Adding the ammeter short circuits bulb 1 (all current goes through the ammeter and none through bulb 1, 0 V across bulb 1), causing bulb 1 to go out. This causes the total resistance to drop (R_{total} = 2.85 Ω from 9.85 Ω), increasing the total current (I = V/R = 12/2.85 = 4.2 A) from 1.22 A. Voltage across bulbs 2 and 3 is now higher (12 V from 3.74 V). More current passes through bulbs 2 and 3, and a larger voltage is across bulbs 2 and 3, causing their respective brightnesses to increase.	Bulb 1 goes out. OR Bulbs 2 and 3 get brighter.	Bulb 1 goes out because no current through bulb 1. AND Bulbs 2 and 3 get brighter.	Merit + linked answer to Voltage OR Current for brightness of all 3 bulbs.
2017(2) (a)	$P = IV \rightarrow I = \frac{P}{V} = 1.33\text{ A (3SF)}$	Correct answer of 1.33 A		

(b)	As the resistance of the rheostat increases, a larger voltage drop is experienced across the rheostat. As both bulbs are in parallel, they both receive the same amount of voltage from: $V_{\text{bulbs}} = V_{\text{supply}} - V_{rheostat}$ the voltage across the bulbs decreases.	Voltage across bulb(s) decreases. OR Voltage across rheostat increases.	Voltage across BOTH bulbs decreases LINKED to V_{rheostat} increasing AND bulbs are in parallel.	
(c)	Total current is twice 1.33 A, as two bulbs in parallel: I_{total} = 2.67 A Voltage across rheostat is 12 – 9 = 3 V. So: $V = IR \rightarrow R = \frac{V}{I} = \frac{12-9}{2.667} = \frac{3}{2.667} = 1.125\ \Omega$ $R = 1.13\ \Omega\ (3\text{SF})$	THIS IS A SHOW QUESTION! 1 of: I_{total} = 2.67 A V_{rheostat} = 3.00 V	Correct answer 1.125 Ω with correct working showing I_{total} and V_{rheostat}.	

(d)	The addition of bulb 3 increases the total resistance. Total current goes down (I= V/R). Less current through the rheostat means less voltage is lost across the rheostat ($V = IR$). As bulb 1 and bulbs 2 & 3 are in parallel, they all receive the same voltage (Vsupply – Vrheostat), which was greater than before. So V_{bulb1} increases, $P = V^2/R$ As bulbs 2 and 3 are in series, they get only half of what bulb 1 receives. More voltage causes more power dissipation, causing bulb 1 to become brighter. Bulb 1 is more likely to blow, as it is now receiving more than its initial 9.00 V. ADDITIONAL NOT REQUIRED: $V_{rheostat} = IR = 2.13 \times 1.125 = 2.41 \text{ V} \rightarrow$ $V_{bulb} = V_{supply} - V_{rheostat} = 12 - 2.41 = 9.59 \text{ V}.$ As 9.59 > 9, bulb 1 has a greater likelihood of blowing. OR using unrounded answers: $V_{rheostat} = IR = 2.13333 \times 1.125 = 2.40 \text{ V} \rightarrow$ $V_{bulb} = V_{supply} - V_{rheostat} = 12 - 2.40 = 9.60 \text{ V}.$ As 9.60 > 9, bulb 1 has a greater likelihood of blowing, as it is receiving more than its stated 9.0 V (getting more energy per second than it should). $P = \frac{V^2}{R} = \frac{9.60^2}{6.75} = 13.7 \text{ W} > 12.0 \text{ W}$	Bulb 1 is brighter plus attempt at reasoning.	Correct answer with ideas not linked, or 1 omission / error. E.g.: Bulb 1 is brighter, as it receives more power, as V_{bulb1} increases. Therefore bulb 1 is more likely to blow.	Correct answer linked.

2016(1) (a)	$V = IR$ $V = 0.300 \times 10$ $V = 3.0$ V	Correct answer.		
(b)	$I = \frac{V}{R}$ $I = \frac{9}{80}$ $I = 0.113 \text{ A}$ Voltage across Speaker A = 12 – 3 = 9.0 V	Correct voltage across Speaker A 9.0 V. OR Incorrect current calculation due to incorrect voltage across Speaker A.	Correct current = 0.113 A	
(c)	Speaker B has a smaller resistance, because: more current is passing through Speaker B (300 mA – 113 mA =190 mA) R = $\frac{V}{I}$ and both have the same voltage.	Correct answer with one reason.	Correct answer with both correct reasons.	

(d)(i) (ii)	Current from car battery = $\frac{60}{12}$ = 5.0 A Current from the household lamp = $\frac{60}{240}$ = 0.25 A Both bulbs shine with the same brightness. Brightness depends on power, and both bulbs have the same power. OR Brightness depends on voltage and current, and product of voltage and current is same. OR Car bulb = 12 × 5 = 60 W Household lamp = 240 × 0.25 = 60 W	Correct current from the battery. OR Correct current through the household lamp. OR Both lamps have the same brightness.	Correct current through the car battery and the household lamp. Both lamps have the same brightness. OR Correct answer to part (ii).	Comprehensive answer.

2015(4) (a)	$P = VI$ $I = \frac{P}{V} = \frac{2.0}{6.0} = 0.33\text{ A}$	Correct answer.		
(b)	Voltage across resistor = 9.0 – 6.0 = 3.0 V Current through resistor = 2 × 0.33 = 0.66 A $V = IR$ $R = \frac{V}{I} = \frac{3.0}{0.66} = 4.5\ \Omega$	Correct voltage OR current.	Correct answer and working.	
(c)	The lamps are in parallel, so removing one lamp increases total resistance. The supply voltage is the same, so if the total resistance increases, total current will decrease.	Current decreases.	Correct answer and reason.	
(d)	Resistance of parallel lamps is: $R = \frac{R_1 \times R_2}{R_1 + R_2} = 2.0\ \Omega$ Total resistance = 6.0 Ω Total current is $I = \frac{V}{R} = \frac{9.0}{6.0} = 1.5\text{ A}$ Resistor voltage is $V = IR = 1.5 \times 4.0 = 6.0\text{ V}$	Correct total resistance.	Correct total resistance and current.	Correct answer and working.

2014(2) (a)	$R_{parallel} = \left(\frac{1}{6.8} + \frac{1}{3.5}\right)^{-1}$ $R_{parallel} = 2.31\,\Omega$ $R_T = 3.0 + 2.3 = 5.3\,\Omega$	Recognition that the 3 Ω resistor is in series with a parallel combination.	$R_{parallel} = \left(\frac{1}{6.8} + \frac{1}{3.5}\right)^{-1}$ $R_{parallel} = 2.3\,\Omega$ $R_T = 3.0 + 2.3 = 5.3\,\Omega$	
(b)	Voltage across battery $V = IR = 6.0 \times 5.3 = 31.8$ V Voltage across 3.5 Ω resistor = 31.86 – 18 = 13.8 V =14 V	Voltage across battery $V = IR$ = 6.0 × 5.3 = 31.8 V Or consistency from part (a).	Voltage across 3.5 Ω resistor = 31.8 – 18 = 14 V	
(c)	2sf. The final answer cannot be any more accurate than the least number of significant figures in the question.	2sf. The final answer cannot be any more accurate than the least number of sf in the question.		

(d)	(The energy per second is its power output.) Power depends on voltage and current. Since both resistors are on the same branch, they both have the same current through them. Since voltage is directly proportional to resistance, when current is the same ($V = IR$), the 4.6 Ω resistor would have a greater voltage across it. Hence the 4.6 Ω resistor would use greater energy per second.	(The energy per second is its power output.) Power depends on voltage and current.	Since both resistors are on the same branch, they both have the same current through them. OR Since voltage is directly proportional to resistance, when current is the same ($V = IR$), the 4.6 Ω resistor would have a greater voltage across it.	(The energy per second is its power output.) Power depends on voltage and current. Since both resistors are on the same branch, they both have the same current through them. Since voltage is directly proportional to resistance, when current is the same ($V = IR$), the 4.6 Ω resistor would have a greater voltage across it. Hence the 4.6 Ω resistor would use greater energy per second.

2014(3) (a)	Lamp A would be dimmer.	Lamp A would be dimmer.		
(b)	Adding another lamp in parallel will mean effective resistance decreases. This means the circuit current will increase. Hence voltage across lamp A will increase. The voltage across lamps B, C, and D will decrease.	Effective resistance decreases. Voltage across B/C/D will decrease. V across A increases	Adding another lamp in parallel will mean effective resistance decreases. This means the circuit current will increase.	Adding another lamp in parallel will mean effective resistance decreases. This means the circuit current will increase. Hence voltage across lamp A will increase. The voltage across lamps B, C, and D will decrease.
(c)	$V = IR$ $V = 0.5 \times 6.0 = 3.0$ V	$V = IR$ $V = 0.5 \times 6.0 = 3.0$ V		
(d)	Voltage across each branch = 12 – 3 = 9.0 V. Current through bottom branch = V / R = 9.0 / 6.0 = 1.5 A Current through middle branch = 6.0 – 1.5 = 4.5 A Resistance of middle branch = V / I = 9.0 / 4.5 = 2.0 Ω Resistance of resistor = 2.0 Ω	Voltage across each branch = 12 – 3 = 9.0 V.	Current through bottom branch = V / R = 9.0 / 6.0 = 1.5 A Current through middle branch = 6.0 – 1.5 = 4.5 A	Resistance of middle branch = V / I = 9.0 / 4.5 = 2.0 Ω Resistance of resistor = 2.0 Ω

2013(2) (a)	$I = \frac{V}{R} = \frac{18}{6} = 3.0\text{ A}$	Accept 3A.		
(b)	*P* = *VI* and *V* = *IR* Doubling the voltage will also double the current. This will increase the power by 4. OR use $P = \frac{V^2}{R}$	Correct answer.	Correct answer AND explanation.	
(c)	$\text{current in } 12\,\Omega = 1.0\text{ A}$ $\text{current in } 3.0\,\Omega = 1.0 + 2.0 = 3.0\text{ A}$ $\text{voltage across } 3.0\,\Omega = I \times R = 3.0 \times 3.0 = 9.0\text{ V}$ $\text{power} = V \times I = 9.0 \times 3.0 = 27\text{ W}$	One correct equation and substitution.	Correct working except for one error.	Correct working and answer.
(d)	If the 12 Ω resistor is removed, the total resistance will increase. The total current will decrease ($I = \frac{V}{R}$). The current through the 3 Ω resistor will decrease. The voltage across the 3 Ω resistor will decrease. OR Total voltage = 21 V shared in ratio 1:2 So voltage across 3 Ω resistor is 7 V So voltage drops.	One correct statement.	Two correct statements.	Correct answer AND explanation.

Question	Achievement	Merit	Excellence
2012(1) (a)	When the voltage across the lamp is 12 V, the power output is 5 W.		
(b)	The 18 W lamp will be brighter as it has a greater power output. OR The brightness of a lamp depends on its power output.	The 18 W lamp will be brighter as it has a greater power output. AND The brightness of a lamp depends on its power output. OR both get 12V.	
(c)	$P = VI \rightarrow I_1 = 5 / 12 \rightarrow$ $I_1 = 0.42$ A OR $I_2 = 18 / 12 \rightarrow I_2 = 1.5$ A	$P = VI \rightarrow I_1 = 5 / 12 \rightarrow I_1 = 0.42$ A $I_2 = 18 / 12 \rightarrow I_2 = 1.5$ A $I_{total} = 1.92$ A	$P = VI \rightarrow I_1 = 5 / 12 \rightarrow I_1 = 0.42$ A $I_2 = 18 / 12 \rightarrow I_2 = 1.5$ A $I_{total} = 1.92$ A $R_{total} = 12 / 1.92 = 6.25\ \Omega$
(d)	$P = E / t$ Energy calculated using incorrect value for time.	$E = 18 \times 3 \times 60$ = 3240 J	

2012(2) (a)	Since the lamps are connected in series, they will have the same current through them. OR Since the lamps are identical, they will have the same resistance.	**Any two of:** Since the lamps are connected in series, they will have the same current through them. OR Since the lamps are identical, they will have the same resistance, hence voltage across each one is the same. OR Since P=VI, each will have the same power output and hence the same brightness.	Since the lamps are connected in series, they will have the same current through them. AND Since the lamps are identical, they will have the same resistance, hence voltage across each one is the same. AND Since P=VI, each will have the same power output and hence the same brightness.
(b)	Resistance of each lamp = $\frac{12 \times 12}{5} = 28.8\Omega$	Resistance of each lamp = $\frac{12 \times 12}{5} = 28.8\ \Omega$ Effective resistance = $28.8 + (28.8^{-1} + 28.8^{-1})^{-1} = 43.2\ \Omega$	Resistance of each lamp = $\frac{12 \times 12}{5} = 28.8\ \Omega$ Effective resistance = $28.8 + (28.8^{-1} + 28.8^{-1})^{-1} = 43.2\ \Omega$ Circuit current = $I = \frac{V}{R} = \frac{12V}{43.2\ \Omega} = 0.28\ \text{A}$

(c)	Voltage across Lamp A $V = IR$ V = 0.28 × 28.8 V = 8.064 V Lamp A gets twice the current	Voltage across Lamp A = $V = IR \rightarrow$ V = 0.28 × 28.8 → V = 8.064 V Voltage across lamps in parallel = 12 – 8.064 = 3.94 V Lamp A gets twice the current because current splits / R the same	Voltage across Lamp A = $V = IR \rightarrow$ V = 0.28 × 28.8 → V = 8.064 V Voltage across lamps in parallel = 12 – 8.064 = 3.94 V Power output of Lamp A = $P = VI$ = 8.064 × 0.28 = 2.25 W Power output of parallel lamps = $P = VI$ = 3.94 × (3.94 / 28.8) = 0.54 W Hence lamp A has a greater power output and hence is brighter than Lamps B and C. Lamp A gets twice the current because / current splits / resistances the same and $P = I^2R$

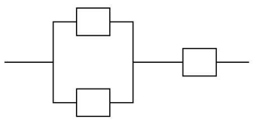
Question	Evidence	Achievement	Merit	Excellence
2011(3) (a)	When the bulb has 12 V across it, the power output is 5 W.	[1]Correct answer. (Must link power of 5W to 12V)		
(b)	$P = VI$ $I = \frac{P}{V}$ $I = \frac{5}{12} = 0.42\text{ A}$	[2]Correct answer.		
(f)	*R* = *V*/*I* = 3.5/0.7 = 5.0 Ω (Must be 5 – no other option). OR if tangent **drawn** then R=0.6	[2]Correct answer.		
(c)	As the current increases, resistance decreases.	[1]Correct answer.		
2010(2) (a)	$R_{\text{parallel}} = \left(\frac{1}{6} + \frac{1}{5}\right)^{-1} = 2.73$ $R_T = 3.0 + 2.73 = 5.73\ \Omega$ $= 5.7\ \Omega$	[2]Correct substitution. E.g. 1/6 + 1/5 OR Correct calculation of effective resistance in series = 6.0 Ω	[2]Correct except for one error. E.g. finds 2.73.	[2]Correct answer.

(b)	$I = \frac{V}{R} = \frac{12}{5.73} = 2.09\ \text{A} = 2.1\ \text{A}$	[2]Correct answer. OR Consequential from 2(a).		
(c)	$V_{3\Omega} = 2.09 \times 3.0 = 6.27\ \text{V}$ $V_{5\Omega} = 12 - 6.27 = 5.73\ \text{V}$ $I = \frac{5.73}{5} = 1.15A$ OR $I_{5.0\Omega} = \frac{6}{11} \times 2.09 = 1.15\ \text{A}$	[2]Correct answer to voltage across 3 Ω resistor: **6.27**	[2]Correct answer to voltage across 5 Ω resistor: **5.73**	[2]Correct answer. **I = 1.15**
(d)	The brightness of a lamp depends on its power output. Power depends on the current through and the voltage across the lamp. ($P = VI$ or $P = I^2R$) The 3 Ω lamp will be the brightest because its power output is the greatest. (P = 6.28 x 2.09 = 13.12 W). The current through the branch with the4.0 Ω resistor is only (2.09 – 1.14) = 0.95 A. Hence the power output of that lamps will be $0.95^2 \times 4.00 = 3.61$ W	[1]Recognition that brightness of a lamp depends on its **power** output. OR **Power** depends on the current through and the voltage across a component. OR Shows the calculation for **power** for any one lamp in the circuit.	[1]Recognition that brightness of a lamp depends on its power output. AND Power depends on the current through and the voltage across a component. OR Shows the calculation for power for any one lamp in the circuit.	[1]Recognition that brightness of a lamp depends on its power output. AND Power depends on the current through and the voltage across a component. AND Shows the calculation for power for the two lamps in the circuit.
2009(2) (a)	$I = \frac{V}{R} = \frac{12}{12} = 1.0\ \text{A}$	[2]Correct answer.		

(b)	$R_P = 4\ \Omega$ $R_{Tot} = 10\ \Omega$ $I = \frac{V}{R} = \frac{12}{10} = 1.2\ \text{A}$ current through 12 Ω is $\frac{1}{3} \times 1.2 = 0.4\ \text{A}$ $V = IR = 0.4 \times 12 = 4.8\ \text{V}$ or $V = \frac{4}{10} \times 12 = 4.8\ \text{V}$	[2]One correct step. E.g. 10 ohms or 4 from parallel.	[2]Correct answer except for one error. E.g. 1.2 A	[2]Correct answer.
(c)	If the resistance increases, the total resistance increases and the total current decreases. This means the voltage across the two series resistors decreases.	[1]One correct idea. Must answer question correctly.	[1]Two correct ideas.	[1]Correct answer and explanation.
2008(2) (a)	12 J	**Two grades here** [2]Correct number. [2]Correct unit.		
(b)	**This is a "show" question**: $4.5 + \left(\frac{1}{3.4} + \frac{1}{5.2}\right)^{-1}$ = 4.5 + 2.06 = 6.56 Ω	[2]States $\frac{1}{R} = \frac{1}{3.4} + \frac{1}{5.2}$	[2]Correct working.	
(c)	$I = \frac{V}{R} = \frac{12}{6.56} = 1.83A$	[2]Correct answer.		
(d)	Effective resistance of 3.4 Ω and 5.2 Ω		[2]Calculates voltage correctly. 3.8 V	

	= 2.06 and V=IR=1.83 × 2.06 = 3.8 V **OR** Voltage across 4.5 Ω resistor is: *V* = *IR* = 8.235 V Voltage across the 3.4 Ω resistor is 12 – 8.235 = 3.8 V			
(e)	The voltage across the 5.2 Ω resistor will also be 3.8 V, as it is in parallel with the 3.4 Ω resistor.	[1]Mentions that the voltage is 3.8 V.	[1]Achievement, plus states that this is because it is in **parallel** with the 3.4 Ω resistor.	
(f)	The circuit current depends on the supply voltage and the effective resistance. The supply voltage does not change. Current is inversely proportional to resistance. The diode is in the reverse bias and hence no current flows through the 5.2 Ω resistor. The effective resistance of the circuit increases to 7.9 Ω. This means the circuit current will decrease.	[1]Mentions that current will decrease. OR Resistance increases.	[1]Achievement, plus states that the current decreases **because** the resistance increases	[1]Merit, plus gives reason why the resistance increases (removing another path), **or** states that the supply voltage does not change. **Or** R increases to 7.9

(g)	$I_{new} = \frac{V_s}{R_T}$ $R_T = 4.5 + 3.4$ $R_T = 7.9\ \Omega$ $I_{new} = \frac{12.0}{7.9} = 1.52\ \text{A}$ $V_{3.4} = IR = 1.52 \times 3.4 = 5.168\ \text{V}$ $E = VIt = 5.168 \times 1.52 \times 60$ $E = 471\ \text{J}$ OR Could also use $P = I^2 R = 1.52^2 \times 3.4$	[2]Calculated new current (1.52 A)	[2]Calculated voltage across the 3.4 Ω resistor correctly, but did not convert minute to seconds for calculating energy and gets P = 5.168 × 1.52 = **7.8**	[2]Correct answer. **471 J**
2007(2) (a)	$R = \frac{V}{I} = \frac{4.5}{25 \times 10^{-3}} = 180\ \Omega$	[2]Correct except for unit conversion.	[2]Correct answer.	
(b)	$V = 12.0 - 4.5 = 7.5\ \text{V}$	[2]Correct working.		
(c)	$I_t = \frac{V}{R} = \frac{7.5}{214} = 0.035\ \text{A}$ current through $R = 0.035 - 0.025$ $= 0.010\ \text{A}$ $R = \frac{V}{I} = \frac{4.5}{0.01} = 450\ \Omega$ **Or** Circuit $R = \frac{12}{0.035} = 342.4$ R of parallel branch $= 342.4 - 214 = 128.4$ And $\frac{1}{R} = \frac{1}{128.4} - \frac{1}{180}$ gives $R = 450$	[2]Calculates total current. 0.035	[2]Calculates current through R. 0.035 -0.025=0.01 [2] Correct method but makes a computational error [2] Calculates $R_t = 342.4$	[2]All working correct. Needs 4.5/0.01=450 or equivalent Or Evidence of solving R in parallel combination

(d)	Total resistance increases. (to 664) Total current decreases. (was 0.03 now 0.018) Current through 214 Ω resistor decreases. Voltage across 214 Ω resistor decreases (*V*= *IR*). (was 7.5 now 3.85)	[1]Voltage decreases (across 214) Voltage increases across **R (**450 Ω) Total *R* increases Current decreases	[1]Two ideas Voltage decreases because current decreases	[1]Full and clear explanation clearly linking ideas. (Can have maths but needs written explanation)
(e)	Both resistors are in series, therefore carry same current. 450 Ω resistor has higher resistance therefore higher voltage. ($V = IR$) Therefore, higher power output, (P=VI), therefore more heat output in the same time $P = I^2R$ so same current means bigger resistor (450/R) gives more power and more heat.	[1]450 Ω/**R** resistor produces more heat. Current through both 214 and *R* the same Biggest *V* gives biggest power 214 produces less Now a series circuit links power to heat	[1]Two linked ideas i.e. same current- higher *V* (gives more heat) same current so higher *R* (gives more heat) *R* as larger	[1]Full and clear explanation clearly linking ideas. Should mention that heat relates to power or (energy and volts) could be explicitly stated or by stating P=IV or $P = I^2R$
(f)		[2]Correct answer.		
2006(2) (a)	$V = \frac{E}{q}$ $E = V q = 1.5$ J (Can be answered from definition, so does not need to show working.)	[2]Correct. 1.5		

(b)	$I = \frac{V}{R}$ $I = \frac{1.5}{5}$ *I* = 0.3 A	[2]Correct		
(c)	• Resistance is the slowing down of electrons as they flow through a conductor when the ends of the conductor are connected to a supply of electrical energy • a measure of how much a component opposes the flow of electrons through itself • ratio of V/I	[1]A correct concept. Slowing electron/ current flow Opposing electron/ current flow **ratio** of V/I $\Omega = {}^{V}/_{Cs^{-1}}$		
(d)	$I = \frac{Q}{t}$ $Q = It$ Q = 0.3 × 3 × 60 (**consequential** on 1(b)) Q = 54 C	[2]Calculated without converting minutes to seconds 0.3 x 3 = 0.9 0.3 x 60	[2]Correct answer with working. Q = 0.3 × 3 × 60 Q = 54	
(e)	1.5 × 3 = 4.5 V	[2]Correct answer.		
(f)	*R* = 14 + $(4.00^{-1} + 4.00^{-1})^{-1}$ = 16.0 Ω	[2]Adds resistors in parallel • $(4.00^{-1} + 4.00^{-1})^{-1}$ • 2.00 • 14 + 0.5 = 14.5	[2]Correct calculation. 14.0+2.00=16.0	
	s.f. = 3	[1]3 significant figures		

(g)	Total current = $I = \frac{V}{R}$ $I = \frac{4.5}{16}$ I = 0.281 A Voltage across radio $V = IR$ $V = 0.281 \times 14.0$ V_{radio} = 3.94 V Voltage across lamp = 4.5 – 3.94 = 0.56 V (**consequential** on 1(e),1(f))	[2]Calculated total current of 0.281	[2]Voltage across radio $V = 0.281 \times 14.0 = 3.94$	[2]Working and answer correct. V_{lamp} = 4.5 – 3.94 = 0.56 $V_{lamp} = 4 \times .14 = 0.56$ Voltage across parallel resistance $V_{parallel} = .281 \times 2 = 0.56$ $\frac{4.5}{16} \times 2 = 0.56$
2005(2) (a)	$I = \frac{V}{R}$ $= 6.0/1.2$	[2]Correct substitution.		
(b)	$P = V \times I$ $= 6.0 \times 5.0$ $= 30$ W	[2]Correct answer. 1 Correct unit.		
(c)	When the switch is closed, the current quickly increases, the lamp filament quickly heats up, the resistance increases, so the current will decrease to a steady value. (Must discuss the headlamp only.)	[1]Current increases. Reaches a steady value. Bulb heats up. Resistance increases. Current decreases.	[1]Correctly links TWO ideas. (Changing current qualified.)	[1]Correctly links THREE connected ideas in a clear explanation.

(d)	The headlamp draws 5.0 A. The tail lamps are in parallel so must draw 1 A. Therefore, their combined resistance is: $R = \frac{V}{I}$ $= \frac{6.0}{1}$ $= 6.0\ \Omega$ Each tail lamp is therefore 3.0 Ω. **ALTERNATIVELY** $I = 6.0$ A $V = 6.0$ V $R = \frac{V}{I} = \frac{6}{6} = 1.0\ \Omega$ For parallel resistors : $\frac{1}{R_1} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_{\text{headlamp}}} + \frac{1}{R_{\text{taillamps}}}$ $\Rightarrow \frac{1}{1.0} = \frac{1}{1.2} + \frac{1}{R_{\text{TLS}}}$ $\Rightarrow \frac{1}{R_{\text{TLS}}} = \frac{1}{1.0} - \frac{1}{1.2} = \frac{1.2 - 1.0}{1.2} = \frac{0.2}{1.2}$ $\Rightarrow R_{\text{TLS}} = \frac{1.2}{0.2} = 6.0$ Each tail lamp is therefore 3.0 Ω.	[2]Resistance of each tail light is ½ total resistance of the branch Calculation of correct current (1A) 3 V across each tail light 3 (unjustified) Calculation of total resistance as 1.0 Ω. Current ratio 5:1	[2]TWO correct calculations. Calculation of total *R* in the tail light branch as 6.0 Ω. Correct use of V/I to find Resistance of Tail light Correct substitution in parallel resistors formula. Resistance of Tail light 1:5 1.2 : 6	[2]Correct answer. $^6/_2 = 3\ \Omega$

Level 2 Physics: **AS 91173** replaced **AS 90257.**

The Mess that is NCEA Assessment Schedules….

In 90257, from **2004 to 2011**, there was an Evidence column with the correct answer and Achieved, Merit and Excellence columns explaining the required level of performance to get that grade. Each part of the question (row in the Assessment Schedule) contributed a single grade in either Criteria 1 (Explain stuff) or Criteria 2 (Solve stuff). From 2003 to 2008, the NCEA shaded columns that were not relevant to that question (Sorry haven't had time to do 2004 yet).

In 91173, from **2012 onwards**, the answers/required level of performance are now within the Achieved, Merit and Excellence columns. Each part of a question contributes to the overall Grade Score Marking of the question and there are no longer separate criteria. There is no shading anymore. At least their equation editor has stopped displaying random characters over the units.

And in **2013 - 2015**, with 91173, we are back to an Evidence column with the correct answer and Achieved, Merit and Excellence columns explaining the required level of performance to get that part. Each part of a question contributes to the overall Grade Score Marking of the question.

And now in **2014 - 2017**, we have the Evidence column back……