A Level OCR Physics

Chapter 12 Electrical circuits

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
spec reference</th></tr>
<tr><td>1(a)</td><td>Level 3 (5–6 marks) Clear explanation of method with correct diagram, clear instructions on how to control temperature and light intensity and clear analysis.
There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.
Level 2 (3–4 marks) Some explanation of method with diagram and either some analysis or some control methods explained.
There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.
Level 1 (1–2 marks) Limited explanation and diagram or limited analysis.
The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.
0 marks No response or no response worthy of credit.</td><td>Indicative scientific points may include:
Method:
• Solar cell in series with ammeter and variable resistor
• Voltmeter in parallel with variable resistor (or solar cell)
• Change the resistance of the circuit using the variable resistance and record a series of voltage and current readings.
Control light intensity
• Use of lamp with shielding round solar cell (black card).
• keep the lamp at a constant distance

Control of temperature
• Turn light on for short periods when taking reading and leave to cool
• Place a clear container with water between the solar cell and light source.
Analysis:
• Plot a graph of voltage against current
• The y intercept is the e.m.f
• the gradient is the internal resistance.</td><td>6 max</td><td>4.3.2
1.1.1
4.3.2
AO3 × 3
AO2 × 3</td></tr>
<tr><td>(b)</td><td>Any sensible suggestion
The emf depends on the light intensity/temperature so they can only quote a value for average conditions</td><td></td><td>1</td><td>4.3.2
AO3</td></tr>
<tr><td>(c)</td><td>recognising ε = 8.2 V</td><td></td><td>1</td><td>4.3.2</td></tr>
</table>

Question	Answers	Extra information	Mark	AO spec reference
	Use of $\varepsilon = V + Ir$ 8.2 = 5.5 + (0.1 × r) 2.7 = 0.1r r = 27 Ω		1	AO2
(d)(i)	Series: ε = 2.5 V + 2.5 V = 5.0 V r = 4 Ω + 4 Ω = 8 Ω	1 mark for both correct	1	4.3.1 AO2
(ii)	Parallel: ε = 2.5 V $r = (1/4 + 1/4)^{-1}$ = 2 Ω		1	4.3.1 AO2
2(a)	The sum of the p.d. is equal to the sum of the emfs in a closed loop.		1	4.3.1 AO1
(b)	$V = IR$ V = 0.15 × 40 = 6 V		1	4.2.3 AO1
(c)	p.d. = 9 – (6 + 2) = 1 V $V = IR$ $I = V/R$ = 1 / 2.5 = 0.4 A	ECF	1 1	4.3.1 4.2.3 AO2
(d)	Current through A = 0.4 – 0.15 = 0.25 A p.d. across A = 6 – (10 × 0.25) = 6 – 2.5 = 3.5 V R = 3.5/0.25 = 14 Ω		1 1 1	4.3.1 AO2
(e)	$R = V/I$ = 2/0.4 = 5 Ω		1 1	4.3.1 AO2
3(a)	1 litre = 1000 cm^3 191 litres per hour = 53 $cm^3\ s^{-1}$		1 1	3.2.4 AO2

Question	Answers	Extra information	Mark	AO spec reference
	mass per second = ρV = 1000 × 53×10^{-6} = 0.053 kg s^{-1}			
(b)	$P = \Delta W/\Delta t$ or $gpe = mgh$ p = 0.053 × 9.81 × 0.3 = 0.16 W		1 1	3.3.2 AO2
(c)	$P = VI$ I = 1.2/5 = 0.24 A		1	4.2.5 AO1
(d)	Use of $\varepsilon = I(R + r)$ $\varepsilon = iR + Ir = V + Ir$ 6 = 5 + (0.24 × r) 1 = 0.24r r = 4.2 Ω OR Calc resistance of pump $R = V/I$ = 5/0.24 = 20.8 Ω $\varepsilon = I(R + r)$ 6 = 0.24 (20.8 + r) 6 = 5 + 0.24r		1 1 1	4.3.2 AO2
4(a)	$P = VI$ A I = 0.7/3.5 = 0.2 A B I = 1.95/6.5 = 0.3 A C I = 0.3 / 1.5 = 0.2 A	**2** marks max for all three correct.	1 1	4.2.5 AO1
(b)	I = 0.2 A + 0.3 A + 0.2 A = 0.7 A		1	4.1.1 AO2
(c)	p.d. across R_1 = 9.0 – 6.5 = 2.5 V $R_1 = V/I$ = 2.5/0.7 = 3.6 Ω	allow ecf from answer to 4(b)	1 1	4.3.1 4.2.3 AO2

Question	Answers	Extra information	Mark	AO spec reference
(d)	p.d. across R_3 = 6.5 – 1.5 = 5.0 V $R_3 = V/I$ = 5.0/0.2 = 25 Ω		1 1	4.3.1 4.2.3 AO2
5(a)	In series: ε = 1.5 V + 1.5 V = 3.0 V r = 0.5 Ω + 0.5 Ω = 1.0 Ω		1 1	4.3.1 AO1
(b)	In parallel: ε = 1.5 V $r = (1/0.5 + 1/0.5)^{-1}$ = 0.25 Ω		1 1	4.3.1 AO1
(c)	2 cells in parallel with one cell in series		1	4.3.1 AO2
(d)	Use of $\varepsilon = V + Ir$ or r = ¾ = 0.75 Ω 3.0 = I (2.0 + 0.75) I = 1.1 A	ECF	1 1	4.3.2 AO2
(e)	$P = I^2R = 1.1^2 \times 2$ = 2.4 W	ECF	1	4.2.5 AO2
6(a)	Diagram showing 3 resistors connected in series		1	4.3.1 AO1
(b)	Total resistance = 33 Ω + 110 Ω + 67 Ω = 210 Ω		1	4.3.1 AO1
(c)	Diagram showing three resistors connected in parallel		1	4.3.1 AO1
(d)	Total resistance = 1/(1/110 + 1/67 + 1/33) R = 18 Ω		1 1	4.3.1 AO2

Question	Answers	Extra information	Mark	AO spec reference
(e)	Diagram showing two 33 Ω resistors in series and also in parallel with two other 33 Ω resistors in series		1	4.3.1 AO2
(f)	Accept any sensible suggestion: Smaller current through each resistor / less power transferred by each resistor / still resistance if 1 resistor breaks		1	4.3.1 AO3
7(a)	As temperature increases resistance of thermistor decreases pd across thermistor decreases or pd across fixed resistor R increases V_{OUT} increases which means it will switch something on when the temperature increases.		1 1	4.2.4 4.3.3 AO2
(b)	The resistance decreases non-linearly with temperature. This is because the number of charge carriers increase in the thermistor.		1 1	4.2.4 AO2
(c)	60 °C 280 Ω allow ±5 Ω 100 °C 190 Ω allow ±5 Ω	Both correct for mark	1	1.1.3 AO1
(d)	Variable resistor needed Range: R/5 = 280/4 R = 350 Ω R/5 = 190/4 R = 238 Ω	mark for either calculation of value	1 1	4.3.3 AO2
8(a)	LDR and resistor drawn in series correct symbols Some indication that V_{OUT} is across the fixed resistor		1 1	4.3.3 4.2.3 AO2
(b)	The resistance of the LDR decreases so current increases The pd across the fixed resistor increases since current increases $V = IR$/has a greater share of the total resistance so pd increases	This first mark maybe given even if V_{OUT} wrongly labelled in 8(a)	1 1	4.3.3 4.2.3 AO2

Question	Answers	Extra information	Mark	AO spec reference
(c)	Examples of calculation: 1 MΩ Dark V_{OUT} = (1M/2M) × 6 = 3 V Light V_{OUT} = (1×10^6 / (1×10^6 + 5400) × 6 = 6 V 10 kΩ: Dark V_{OUT} = (1×10^4 / (1×10^4 + 1×10^6) × 6 = 0.06 V Light V_{OUT} = (1×10^4 / (1×10^4 + 5400) × 6 = 4 V 1 kΩ: Dark V_{OUT} = (1×10^3 / (1×10^3 + 1×10^6) × 6 = 0.006 V Light V_{OUT} = (1×10^3 / (1×10^3 + 5400) × 6 = 0.9 V 10 kΩ has the greatest range	Examples of calculations max 3 1 mark for correct deduction with explanation	Max 4	4.3.3 AO2 × 2 AO3 × 2