Question			Answer	Max mark	Additional guidance
11.	(a)		The number of joules/energy gained by/supplied to 1 coulomb (of charge passing through the cell).	**1**	Accept unit charge for 1 coulomb.
	(b)		$\text{gradient} = \dfrac{\left(290\times10^{-3} - 470\times10^{-3}\right)}{\left(105\times10^{-6} - 55\times10^{-6}\right)}$ **(1)** $\text{gradient} = -3600$ **(1)** $(\text{gradient} = -\text{r})$ $r = 3600\ \Omega$ **(1)**	**3**	Accept: 4000 Gradient = r is wrong physics, award 0 marks. subs into gradient formula **(1)** calculating gradient **(1)** Alternative method: $E = V + Ir$ (1) $670\times10^{-3} = 400\times10^{-3} + 75\times10^{-6}r$ (1) $r = 3600\ \Omega$ (1)
	(c)		The electrons do not gain enough energy to move into/towards the conduction band of the p-type.	**1**	Electrons in conduction band (of the n-type) do not gain enough energy to move into/towards the p-type.

Q11(a) **Maximum Mark: 1**

RESPONSE 1

The pushing force of a given cell, i.e. the force that drives the current round the circuit.

RESPONSE 2

Energy per volt

(Energy given to 1 unit volt)

RESPONSE 3

the maximum theoretical Voltage of a circuit.

RESPONSE 4

The energy given to each coulomb of charge passing through the supply

Q11(b)

Maximum Mark: 3

RESPONSE 1

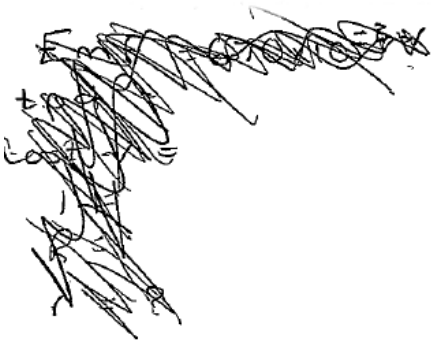
internal resistance = m

$m = \frac{\Delta y}{\Delta x}$ resistance can't be negative

$= \frac{110}{50}$ $\Rightarrow$ internal resistance $= 3.6\,\Omega$

$= -3.6$

RESPONSE 2



$m = (-r)$

$m = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{670 \times 10^{-3} - 600 \times 10^{-3}}{0 - 20}$

$= \frac{0.07}{-20}$

$= -3.5 \times 10^{-3}$

Internal resistance $= 3.5 \times 10^{-3}\,\Omega$

RESPONSE 3

$E = V + Ir$

$E = 670 \times 10^{-3}\,V$

$r = \frac{E - V}{I}$

$r = \frac{670 \times 10^{-3} - 200 \times 10^{-3}}{130 \times 10^{-6}}$

$r = 3615\,\Omega$

Q11(c) **Maximum Mark: 1**

RESPONSE 1

In photocell the battery is not of a high enough voltage to give the electrons in the n-type material enough energy to jump from the valence to the conduction band ~~as~~ which, in turn, prevents any transition from the conduction to valence bands in the p-type semiconductor ∴ preventing the emission of photons. The band gap is bigger in the blue LED than in the red as blue light requires a higher frequency of photon and ∴ bigger energy gap. The battery does not provide enough energy for electrons to jump the gap in this LED.

RESPONSE 2

Electrons in the conduction band are not supplied with sufficient energy to cross the gradient from the n-type to p-type material and hence cannot fall into the valence band of the p-type semiconductor

RESPONSE 3

Electrons in conduction band c/o not have enough energy to move cecross clepleion layer to p-type

Q12(a)(ii) **Maximum Mark: 3**

RESPONSE 1

Period 4
Timebase 0·5

$2 = 1/f$
$f = 0.5$

RESPONSE 2

$$\text{frequency} = \frac{1}{0.5 \times 2.5} = 0.8\,\text{Hz}$$

RESPONSE 3

$$f = \frac{1}{T} \qquad f = \frac{1}{4 \times 0.5}$$

$$f = \frac{1}{2} \qquad f = 0.5\ \text{Hz}$$

Q11(a)	1	
Response 1	**0**	The candidate's statement is incorrect.
Response 2	**0**	The candidate's statement is incorrect.
Response 3	**0**	The candidate's statement is incorrect.
Response 4	**1**	The candidate's statement is correct.

Question /Response	Mark	Commentary
Q11(b)	**3**	
Response 1	**0**	The candidate's initial statement 'internal resistance = m' is incorrect.
Response 2	**2**	The candidate has substituted acceptable values into the gradient relationship (the omission of the '× 10^{-6}' from the values on the denominator could be consistent with a correct unit in the final answer). The calculated value of the gradient is acceptable, but the unit in the final answer is not consistent with the substitutions made, and so the mark for the final answer is not awarded (*Physics: general marking principles*, issue 5a).
Response 3	**3**	The candidate has used an acceptable alternative method to determine the internal resistance. Data selected from the graph is correct and the final answer acceptable.
Q11(c)	**1**	
Response 1	**0**	The candidate's explanation is not sufficiently clear.
Response 2	**1**	The candidate's suggestion is acceptable.
Response 3	**1**	Again, the candidate's suggestion is acceptable, being similar to the second alternative acceptable answer given in the marking instructions.