Question			Answer	Max mark	Additional guidance
12.	(a)	(i)	$(3 \times 1 \cdot 0 =)\ 3 \cdot 0$ V **(1)**	**1**	Accept: 3, 3·00, 3·000
		(ii)	$f = \frac{1}{T}$ **(1)** $f = \frac{1}{2}$ **(1)** $f = 0 \cdot 5$ Hz **(1)**	**3**	Accept: 0·50, 0·500
		(iii)	The LEDs will light when they are forward biased. **(1)** The change in polarity of voltage changes the biasing. **(1)**	**2**	**Independent marks** LEDs will only conduct in one direction (1) Identifying current/voltage has changed direction (1) Do not accept 'different direction' alone. One LED conducts during one half of the cycle the other LED conducts during the other half of the cycle.
	(b)		$V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V_S$ **(1)** $V_2 = \left(\frac{82}{68 + 82}\right) \times 3 \cdot 0$ **(1)** $V_2 = 1 \cdot 64$ (V) $V_{peak} = \sqrt{2} V_{rms}$ **(1)** $1 \cdot 64 = \sqrt{2} V_{rms}$ **(1)** $V_{rms} = 1 \cdot 2$ V **(1)**	**5**	**OR** consistent with (a)(i) Accept: 1, 1·16, 1·160 Alternative Methods: $V_{peak} = \sqrt{2} V_{rms}$ **(1)** $3 \cdot 0 = \sqrt{2} V_{rms}$ **(1)** $V_{rms} = 2 \cdot 12132034$ (V) $V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V_S$ **(1)** $V_2 = \left(\frac{82}{68 + 82}\right) \times 2 \cdot 12132034$ **(1)** $V_2 = 1 \cdot 2$ V **(1)**

Question			Answer	Max mark	Additional guidance
12.	(b)		continued		**OR** $V_{peak} = \sqrt{2}V_{rms}$ **(1)** $3 \cdot 0 = \sqrt{2}V_{rms}$ **(1)** $V_{rms} = 2 \cdot 12132034$ (V) $V = IR$ $2 \cdot 12132034 = I \times (68 + 82)$ $I = 0 \cdot 0141421356$ (A) $V = IR$ $V = 0 \cdot 0141421356 \times 82$ $V = 1 \cdot 2$ V $V = IR$ **twice** **(1)** Both substitutions into $V = IR$ **(1)** Final answer **(1)** **OR** $V = IR$ $3 \cdot 0 = I \times (68 + 82)$ $I = 0 \cdot 02$ (A) $V = IR$ $V = 0 \cdot 02 \times 82$ $V = 1 \cdot 64$ (V) $V_{peak} = \sqrt{2}V_{rms}$ **(1)** $1 \cdot 64 = \sqrt{2}V_{rms}$ **(1)** $V_{rms} = 1 \cdot 2$ V $V = IR$ **twice** **(1)** Both substitutions into $V = IR$ **(1)** Final answer **(1)**

Q12(a)(iii)

Maximum Mark: 2

RESPONSE 1

This is because the red LED is in forward bias, and can only allow current to flow from one direction (positive direction) whereas the green LED is in reverse bias and can only get a flow of current from the (negative) direction.

RESPONSE 2

The red LED is connected in forward bias but the green LED is in reverse bias. therefore the current needs to be travelling in different directions for each of them to operate

RESPONSE 3

LEDs are diodes and only conduct when forward biased. Since the LEDs are connected in opposite directions, they light up on opposite halves of the wave.

RESPONSE 4

Red light is electrons, green protons.

Q12(b)

Maximum Mark: 5

RESPONSE 1

Final answer (a)(i) 3V

$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{3}{\sqrt{2}} = 2.1V$

$V = IR \quad I = \frac{V}{R_t} = \frac{2.1}{150} = 0.014A$

$V = IR$
$= 0.014 \times 82$
$= 1.15V$

RESPONSE 2

$\frac{V_{peak}}{\sqrt{2}} = V_{rms}$

$\frac{1.64}{\sqrt{2}} = V_{rms}$

$V = 1.16V$

$V_1 = \left(\frac{R_1}{R_1+R_2}\right) V_S$

$V_1 = \left(\frac{82}{82+68}\right) 3$

$= 1.64V$

RESPONSE 3

$V_{peak} = 3V$

$3 = \sqrt{2} V_{rms}$ for whole circuit

$V_{rms} = 2.12V$

~~$V = IR$~~
~~2.12~~

$V_1 = \left(\frac{R_1}{R_1+R_2}\right) V_S$

$= \left(\frac{68}{68+82}\right) 2.12$

$= 0.96V$

RESPONSE 4

Peak $v = 3v$

r.m.s of supply $= \frac{3}{\sqrt{2}} = 2.12v$

$I = \frac{V}{R} = \frac{2.12}{150} = 0.014A$

$V = IR = 0.014 \times 82$

$V_{rms} = 1.15v$

2(b)

Q12(a)(ii)	**3**	
Response 1	**2**	An acceptable relationship is implied by correct substitution of data. The candidate has omitted a unit in the final answer, and so this mark is not awarded.
Response 2	**0**	Again, the candidate has not stated a selected relationship. An acceptable relationship cannot be implied by the candidate's incorrect substitution of data. The mark for the final answer cannot be accessed.
Response 3	**3**	The candidate has selected an appropriate relationship, substituted correctly and has given the correct final answer.
Q12(a)(iii)	**2**	
Response 1	**1**	The candidate's explanation acceptably covers one of the required elements of the answer (LEDs will light when they are forward biased), but not the other element (the change in polarity of voltage changes the biasing).
Response 2	**0**	The candidate's explanation does not satisfactorily cover either element of the answer.
Response 3	**1**	The candidate's explanation acceptably covers one of the required elements of the answer (LEDs will light when they are forward biased), but has not quite explained the other element (the change in polarity of voltage changes the biasing).
Response 4	**0**	The candidate's explanation does not satisfactorily cover either element of the answer.
Q12(b)	**5**	
Response 1	**4**	The candidate has used an alternative acceptable approach in answering the question. They have selected appropriate relationships, substituted correctly into each, but has not given an

Question /Response	Mark	Commentary
		acceptable final answer, possibly due to rounding at the intermediate stage. The mark for the final answer is not awarded.
Response 2	**5**	The candidate has selected appropriate relationships, substituted correctly into each, and given an acceptable final answer.
Response 3	**3**	By correct substitution of data, the candidate has implied an appropriate relationship ($V_{peak}=\sqrt{2}V_{RMS}$). The candidate has also stated an acceptable relationship for the second stage of the question, but has substituted data incorrectly. The mark for the final answer cannot be accessed.
Response 4	**4**	As in response 1, the candidate has used an alternative acceptable approach in answering the question. They have selected appropriate relationships, substituted correctly into each, but has not given an acceptable final answer, possibly due to rounding at the intermediate stage. The mark for the final answer is not awarded.