

# Commentary on candidate evidence

Assessors awarded the candidate evidence the following marks for each question of the question paper.

## Candidate 1

The candidate was awarded a total of **42 marks** as follows.

### Question 1

The candidate was awarded **2 marks** because the air type symbols for exhaust and pilot are correctly named.

### Question 2

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- the answer value is correct from the given working, but the unit is incorrect (**0 marks**).

### Question 3(a)

The candidate was awarded **1 mark** because the arrangement of components is correctly named.

### Question 3(b)

The candidate was awarded **2 marks** because the correct symbol for a voltmeter is drawn, and the symbol is correctly placed parallel to the battery.

### Question 3(c)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 4(a)

The candidate was awarded **0 marks** because:

- the substitution is incorrect (**0 marks**)
- the answer value of 585 N is incorrect from the given working (**0 marks**).

## Question 4(b)

The candidate was awarded **0 marks** because 'Lengths/ Measurements' is too vague.

## Question 5

The candidate was awarded **2 marks** because the Boolean equation correctly shows the expression A OR B, and the expression NOT B.

## Question 6(a)

The candidate was awarded **1 mark** because 'stretches' correctly infers that the metal's length would increase.

## Question 6(b)

The candidate was awarded **0 marks** because 'It gets flatned' is too vague and does not indicate that the metal's length would decrease.

## Question 7(a)

The candidate was awarded **0 marks** because:

- error 1 incorrectly indicates the output should be a further system component (**0 marks**)
- error 2 incorrectly identifies a second input that does not exist in this system (**0 marks**).

## Question 7(b)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 8(a)(i)

The candidate was awarded **0 marks** because the response was too vague. The response does not refer to a circuit design for one of the labelled components on the robot that would involve tasks specific to an electronic engineer (ie the cameras or sensors). The candidate's response should have focused on a specific task such as designing, testing, calculating or writing code.

### Question 8(a)(ii)

The candidate was awarded **0 marks** because the response was too vague. The response did not refer to the labelled component on the robot that would involve tasks specific to an electrical engineer (the motorised wheels). The candidate's response should have focused on a specific task such as selecting, testing or calculating.

### Question 8(b)

The candidate was awarded **1 mark** because the response gives two causes of a social impact of using the robot to deliver shopping. Both parts of the response ('gets to its destination quicker' and 'won't get stuck in traffic') are valid points. However, an explain command word requires a cause and a related effect, linked appropriately with phrases such as 'because', 'therefore', 'so that' or 'resulting in'.

### Question 8(c)

The candidate was awarded **1 mark** because the response is correct.

### Question 8(d)

The candidate was awarded **2 marks** using the alternative method because:

- the velocity ratio is correctly calculated (**1 mark**)
- the 32:8 ratio is not used (**0 marks**)
- there is no correct transposition to change the subject to gear C (**0 marks**)
- 8 teeth is the correct answer from given working (**1 mark**).

### Question 8(e)(i)

The candidate was awarded **0 marks** because 'it wont break' is too vague.

### Question 8(e)(ii)

The candidate was awarded **1 mark** because 'you wont have to lubricate it' infers a reduced need for maintenance on the gear drive.

### Question 9(a)

The candidate was awarded **0 marks** because neither response correctly describes an appropriate task undertaken by a structural engineer. Appropriate tasks would include calculating, testing, and selecting.

### Question 9(b)

The candidate was awarded **3 marks** because the response was correct.

### Question 9(c)

The candidate was awarded **1 mark** because the response for  $F_2$  is incorrect and the response given for  $F_3$  is correct to one significant figure. The one significant figure response is allowable on the basis of the instructions given to candidates at the beginning of the question paper.

### Question 9(d)

The candidate was awarded **0 marks** because:

- the substitution is incorrect and incomplete (**0 marks**)
- transposition to change the subject to  $m$  is not shown (**0 marks**)
- the answer is incorrect from the given working (**0 marks**).

### Question 9(e)

The candidate was awarded **1 mark** because:

- there is no substitution into the formula (**0 marks**)
- transposition to change the subject to  $E_{in}$  is not shown (**0 marks**)

- the answer is correct from the given working **(1 mark)**.

### Question 10(a)

The candidate was awarded **0 marks** because:

- the light level decreasing is not described **(0 marks)**
- the LDR resistance increasing is not described **(0 marks)**
- the increase of  $V_{in}$  is not described **(0 marks)**
- the transistor switching on is not described ('sends a signal' is too vague) **(0 marks)**
- the solenoid switching on is not described ('switch the machine on' is too vague) **(0 marks)**.

### Question 10(b)

The candidate was awarded **0 marks** because:

- the substitution is incorrect **(0 marks)**
- transposition to change the subject to  $V_1$  is not shown **(0 marks)**
- voltage calculated is incorrectly rounded **(0 marks)**
- voltage from previous step does not have 1.8 V added to give  $V_s$  **(0 marks)**.

### Question 10(c)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 10(d)

The candidate was awarded **0 marks** because the response was too vague. The response does not refer to tasks specific to a mechanical engineer in the context of the labelled component parts of the motorised conveyor belt (the gearbox or drive wheel). The candidate's response should have focused on a specific task such as designing, testing, calculating or simulating.

### Question 11(a)

The candidate was awarded **0 marks** because no response is given.

## Question 11(b)

The candidate was awarded **1 mark** because:

- the substitution is incorrect **(0 marks)**
- transposition to change the subject to F is not shown **(0 marks)**
- the answer is correct from the given working **(1 mark)**.

## Question 11(c)

The candidate was awarded **0 marks** because the response is incorrect. The system boundary encompasses the 'set horizontal level' input and the 'actual level' output, but these should both be outside of the system boundary.

## Question 11(d)

The candidate was awarded **0 marks** because:

- the response does not describe the control unit comparing both the input and output camera levels **(0 marks)**
- the response does not describe the motor switching on when at the incorrect level, or when an error is detected between the input and output camera levels **(0 marks)**
- the response does not describe the level sensor detecting the actual level, nor does it describe the level sensor feeding back to the control unit **(0 marks)**
- the response does not describe the motor being switched off when the camera is at the correct level, or when no error is detected between the input and output camera levels **(0 marks)**.

## Question 11(e)

The candidate was awarded **3 marks** because the response is correct.

## Question 12(a)

The candidate was awarded **4 marks** because:

- 'pin 1 on?' decision is incorrectly asked as 'pin 2 on?' **(0 marks)**
- 'pin 2 on?' decision is in the incorrect position **(0 marks)**

- 'pin 4 on' is in the incorrect position and asked as a decision **(0 marks)**
- the loop after 'pin 4 on' returns to start with an arrow, awarded as a follow through error **(1 mark)**
- 'pin 5 on' and 'pin 5 off' are in the correct position following the 'no' decision **(1 mark)**
- 0.5 s and 0.4 s delays with units are correct **(1 mark)**
- the 'repeat sequence 20 times' decision does not have a question mark, therefore is not asking a question to make a decision **(0 marks)**
- the 'no' decision route with arrow does not return to before 'pin 5 on' **(0 marks)**
- the 'yes' decision route with arrow does not return back to the start of the flowchart **(0 marks)**
- the 'is pin 4 on?' decision is being asked as a question; therefore all symbols are correct **(1 mark)**.

### Question 12(b)

The candidate was awarded **0 marks** because the responses are incorrect.

### Question 12(c)

The candidate was awarded **2 marks** because the response is correct.

### Question 12(d)

The candidate was awarded **0 marks** because the response refers to environmental impact instead of economic impact.

### Question 13(a)

The candidate was awarded **1 mark** because the response infers a reduction in the use of fossil fuels for a cause. The second mark cannot be awarded as there is no related effect of this reduction.

### Question 13(b)

The candidate was awarded **2 marks** because the value calculated is correct, but the full 3 marks were not awarded due to the unit being incorrect.

### Question 13(c)

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- the answer is correct from the given working as a final answer, but the unit is incorrect (**0 marks**)
- $R_t$  has not been calculated by adding  $51\text{ k}\Omega$  (**0 marks**).

### Question 13(d)(i)

The candidate was awarded **2 marks** because:

- the substitution is correct into an incorrectly transposed formula (**1 mark**)
- transposition to change the subject to  $I$  is incorrect (**0 marks**)
- the answer is correct from the given working (**1 mark**).

### Question 13(d)(ii)

The candidate was awarded **1 mark** because the response is correct.

### Question 13(e)

The candidate was awarded **0 marks** because both responses are too vague. To be awarded marks there must be a comparison made, for example if the response included 'easier to find any faults.'

### Question 14(a)(i)

The candidate was awarded **3 marks** because:

- valve 1 and valve 2 are correctly piped to the shuttle valve (**1 mark**)
- the shuttle valve is correctly piped to the left-hand actuator on the 5/2 valve (**1 mark**)
- valve 3 is correctly piped to the right-hand side of the 5/2 valve (**1 mark**).

### Question 14(a)(ii)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 14(b)

The candidate was awarded **1 mark** because:

- substitution is correct (**1 mark**)
- the answer value is correct to one significant figure from the given working, but the unit is incorrect (**0 marks**).

While  $\text{Nm}^{-2}$  (Pa) is given as the standard unit for pressure and stress in the data booklet, candidates should be prepared with the knowledge that most areas used in these calculations will be in the order of  $\text{mm}^2$ , and so final answers will normally reflect this. For a response to be awarded marks when expressed in  $\text{Nm}^{-2}$  or Pa, the value must be converted correctly.

## Question 14(c)

The candidate was awarded **2 marks** because the response is correct.

## Question 14(d)

The candidate was awarded **0 marks** because:

- the results in column D of the truth table are incorrect (**0 marks**)
- the results in column E of the truth table are incorrect (**0 marks**)
- there is no response for column Z (**0 marks**).

If there was a response in column Z that would have represented the correct logic output for a two-input OR gate with the inputs given by the candidate in columns D and E, then a follow through error could have been applied.

## Candidate 2

The candidate was awarded a total of **48 marks** as follows.

## Question 1

The candidate was awarded **2 marks** because the air type symbols for main and pilot are correctly named.

## Question 2

The candidate was awarded **1 mark** because:

- the substitution is incorrect (**0 marks**)
- the answer value is correct from the given working (**1 mark**).

## Question 3(a)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 3(b)

The candidate was awarded **0 marks** because there was no response.

## Question 3(c)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 4(a)

The candidate was awarded **1 mark** because:

- the substitution is incorrect (**0 marks**)
- the answer is correct from the given working (**1 mark**).

## Question 4(b)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 5

The candidate was awarded **1 mark** because the Boolean equation correctly shows the expression NOT B.

## Question 6(a)

The candidate was awarded **1 mark** because 'It stretches (gets longer)' correctly infers that the metal's length would increase.

### Question 6(b)

The candidate was awarded **1 mark** because 'It shortens (gets smaller)' correctly infers that the metal's length would decrease.

### Question 7(a)

The candidate was awarded **1 mark** because the response for error 1 is correct.

### Question 7(b)

The candidate was awarded **1 mark** because the response is correct.

### Question 8(a)(i)

The candidate was awarded **0 marks** because the response is too vague. The verb 'developed' is not specific and is repeated from the question stem. The candidate's response should have focused on more specific tasks such as designing, testing, calculating, or writing code.

### Question 8(a)(ii)

The candidate was awarded **0 marks** because the response is too vague. The verb 'developed' is not specific and is repeated from the question stem. The candidate's response should have focused on a specific task such as selecting, testing, or calculating.

### Question 8(b)

The candidate was awarded **1 mark** because the response 'so people won't be annoyed at it for making loud noises' is a valid effect. The cause 'it won't make a noise' is too vague, but the response would have been accepted if a comparison was made with standard delivery methods by referring to noise made by drivers or vehicles.

### Question 8(c)

The candidate was awarded **1 mark** because the response is correct.

## Question 8(d)

The candidate was awarded **1 mark** because:

- the values are correctly substituted into the correct formula (**1 mark**)
- the output speed is not calculated (**0 marks**)
- the output speed value is not substituted into the correct formula (**0 marks**)
- the final answer is incorrect and does not come from the given working (**0 marks**).

## Question 8(e)(i)

The candidate was awarded **1 mark** because the response is correct.

## Question 8(e)(ii)

The candidate was awarded **1 mark** because 'the lube on the gears will reduce any friction' infers less energy lost in the gear drive.

## Question 9(a)

The candidate was awarded **0 marks** because neither response correctly describes an appropriate task undertaken by a structural engineer. Appropriate tasks would include calculating, testing, and selecting.

## Question 9(b)

The candidate was awarded **2 marks** because:

- the substitution is incorrect (**0 marks**)
- transposition from given substitution is correct (**1 mark**)
- the answer from given working is correct with unit (**1 mark**).

## Question 9(c)

The candidate was awarded **0 marks** because both responses are incorrect.

## Question 9(d)

The candidate was awarded **3 marks** because the response is correct.

## Question 9(e)

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- transposition to change the subject to  $E_{in}$  is not shown (**0 marks**)
- the answer is incorrect from the given working (**0 marks**).

## Question 10(a)

The candidate was awarded **2 marks** because:

- the light level decreasing is not described (**0 marks**)
- the LDR resistance increasing is not described (**0 marks**)
- the increase of  $V_{in}$  is described (**1 mark**)
- the transistor switching on is not described ('if 0.7 and above' is too vague) (**0 marks**)
- the solenoid switching on is described (**1 mark**).

## Question 10(b)

The candidate was awarded **1 mark** because:

- the substitution is incorrect, 1.9 given instead of 19 (**0 marks**)

- transposition to change the subject to  $V_1$  is correct, implied through calculation **(1 mark)**
- the voltage calculated is incorrectly rounded to one significant figure, and given as final answer with correct unit, with follow through error applied from incorrect substitution **(0 marks)**
- Voltage from previous step does not have 1.8 V added to give  $V_s$  **(0 marks)**.

### Question 10(c)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 10(d)

The candidate was awarded **0 marks** because the response is too vague. The verb 'developed' is not specific and is repeated from the question stem. The candidate's response should have focused on a specific task such as designing, testing, calculating, or simulating.

### Question 11(a)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 11(b)

The candidate was awarded **0 marks** because there is no meaningful response.

### Question 11(c)

The candidate was awarded **1 mark** because the response is correct.

### Question 11(d)

The candidate was awarded **2 marks** because:

- the response describes the control unit comparing both the input and output camera levels **(1 mark)**
- the response does not describe the motor switching on when at the incorrect level, or when an error is detected between the input and output camera levels **(0 marks)**

- the response describes the level sensor feeding back to the control unit **(1 mark)**
- the response does not describe the motor being switched off when the camera is at the correct level, or when there is no error detected between the input and output camera levels **(0 marks)**.

### Question 11(e)

The candidate was awarded **2 marks** because:

- the diode symbol is incorrect **(0 marks)**
- the attempted diode symbol is connected in parallel with the relay **(1 mark)**
- the attempted diode symbol is drawn in the correct orientation **(1 mark)**.

### Question 12(a)

The candidate was awarded **5 marks** because:

- 'pin 1 on?' decision is incorrectly stated as 'pin 2 on?' **(0 marks)**
- the second decision 'pin 2 1?' should have been 'pin 2 = 1?' **(0 marks)**
- 'pin 4 on' is in the correct position **(1 mark)**
- the loop after 'pin 4 on' returns to start with an arrow **(1 mark)**
- 'pin 5 on' and 'pin 5 off' are in the correct position following the 'no' decision **(1 mark)**
- 0.5 s and 0.4 s delays with units are correct **(1 mark)**
- the 'repeat 20 times' decision does not have a question mark, therefore is not asking a question to make a decision **(0 marks)**
- there is no 'no' decision route with arrow to return to before 'pin 5 on' **(0 marks)**
- it is unclear if the decision route with arrow returning back to the start of the flowchart is intended to be a 'yes' decision as it is not labelled **(0 marks)**
- benefit of the doubt is given to the symbol for 'wait 0.4 s' as a rectangle can be seen and one of the sloping sides of the input/ output symbol is scored out therefore, all symbols are correct **(1 mark)**.

### Question 12(b)

The candidate was awarded **1 mark** because the first response is correct.

### Question 12(c)

The candidate was awarded **2 marks** because the response is correct. Although the final answer is given as '3630 mV', this is equal to the expected response of 3.6 V.

### Question 12(d)

The candidate was awarded **0 marks** because the response is too vague.

### Question 13(a)

The candidate was awarded **0 marks** because the response gives no valid cause or effect.

### Question 13(b)

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- transposition to change the subject to A is not shown (**0 marks**)
- the answer may be correct from the given working, but it is unclear that the candidate has multiplied due to no transposition being shown – the unit is also incorrect (**0 marks**).

### Question 13(c)

The candidate was awarded **1 mark** because:

- the substitution is incorrect (**0 marks**)
- the answer given is correct from the given working, but follow through error is not applied as the level of challenge in this operation is heavily simplified (**0 marks**)
- final  $R_t$  is calculated by adding 51 k $\Omega$  (**1 mark**).

### Question 13(d)(i)

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- transposition to change the subject to I is not shown (**0 marks**)

- the answer is correct from the given working but with the incorrect unit (**0 marks**).

### Question 13(d)(ii)

The candidate was awarded **1 mark** because the response is correct.

### Question 13(e)

The candidate was awarded **0 marks** because the responses are too vague as they are minimal generic descriptions that do not directly address the use of microcontrollers in this context.

### Question 14(a)(i)

The candidate was awarded **2 marks** because:

- valve 3 is correctly piped to the right-hand side of the 5/2 valve (**1 mark**)
- all airline types connected to the 5/2 valve are correct (**1 mark**).

### Question 14(a)(ii)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 14(b)

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- the answer value is correct to one significant figure from the given working, but the unit is incorrect (**0 marks**)

While  $\text{Nm}^{-2}$  (Pa) is given as the standard unit for pressure and stress in the data booklet, candidates should be prepared with the knowledge that most areas used in these calculations will be in the order of  $\text{mm}^2$ , and so final answers will normally reflect this. For a response to be awarded marks when expressed in  $\text{Nm}^{-2}$  or Pa, the value must be converted correctly.

### Question 14(c)

The candidate was awarded **2 marks** because the response is correct.

## Question 14(d)

The candidate was awarded **3 marks** because all three columns in the truth table are correct.

## Candidate 3

The candidate was awarded a total of **47 marks** as follows:

### Question 1

The candidate was awarded **0 marks** because none of the air type symbols are correctly named.

### Question 2

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- the answer value is correct from the given working, but the unit is incorrect (**0 marks**).

### Question 3(a)

The candidate was awarded **1 mark** because the arrangement of components is correctly named.

### Question 3(b)

The candidate was awarded **2 marks** because the correct symbol for a voltmeter is drawn, and the symbol has correctly been placed parallel to the battery.

### Question 3(c)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 4(a)

The candidate was awarded **2 marks** because the response is correct.

### Question 4(b)

The candidate was awarded **1 mark** because the response is correct. Although the candidate states 'moments' instead of forces, moments do not exist without forces acting at a distance from a given point on the beam, therefore forces are implied.

### Question 5

The candidate was awarded **2 marks** because the Boolean equation correctly shows the expression A OR B, and the expression AND C.

### Question 6(a)

The candidate was awarded **0 marks** because 'Its being pulled on' is too vague to infer that the metal's length will increase.

### Question 6(b)

The candidate was awarded **0 marks** because 'Its being pushed on' is too vague to infer that the metal's length will increase.

### Question 7(a)

The candidate was awarded **1 mark** because the response for error 1 is correct.

### Question 7(b)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 8(a)(i)

The candidate was awarded **0 marks** because the verb 'making' does not reflect a task that would have been carried out by the electronic engineer. The candidate's response should have focused on more specific tasks such as designing, testing, calculating or writing code.

### Question 8(a)(ii)

The candidate was awarded **0 marks** because the response is too vague. The response does not refer to the labelled component on the robot that would involve tasks specific to an electrical engineer (the motorised wheels). The candidate's response should have focused on a specific task such as selecting, testing or calculating.

### Question 8(b)

The candidate was awarded **1 mark** because 'making less foot traffic' is a valid effect coming from a vague cause of 'less people outside on streets', which does not attract the first mark.

### Question 8(c)

The candidate was awarded **0 marks** because the response is incorrect.

### Question 8(d)

The candidate was awarded **4 marks** because the response is correct.

### Question 8(e)(i)

The candidate was awarded **1 mark** because the response is correct.

### Question 8(e)(ii)

The candidate was awarded **1 mark** because 'it wont generate as much heat energy' infers less energy lost in the gear drive.

### Question 9(a)

The candidate was awarded **0 marks** because neither response correctly describes an appropriate task undertaken by a structural engineer. Appropriate tasks would include calculating, testing, and selecting.

### Question 9(b)

The candidate was awarded **1 mark** because:

- there is no substitution into the formula **(0 marks)**
- transposition is correct **(1 mark)**
- answer from given working is correct but no unit is given **(0 marks)**.

### Question 9(c)

The candidate was awarded **2 marks** because both responses are correct.

### Question 9(d)

The candidate was awarded **2 marks** because:

- the substitution is correct in the already transposed formula **(1 mark)**
- transposition to change the subject to  $m$  is correct **(1 mark)**
- the answer is correct from the given working but given to too many significant figures **(0 marks)**.

### Question 9(e)

The candidate was awarded **0 marks** because:

- the substitution is not for the correct formula **(0 marks)**
- transposition to change the subject to  $E_{in}$  is not shown **(0 marks)**
- there is no final answer from the given working **(0 marks)**.

### Question 10(a)

The candidate was awarded **1 mark** because:

- the light level decreasing is not described **(0 marks)**
- the LDR resistance increasing is incorrectly described ('Resistance increases on the other resistors') **(0 marks)**
- the increase of  $V_{in}$  is not described **(0 marks)**
- the transistor switching on is incorrectly described ('causing the transistor to turn off') **(0 marks)**
- 'solenoid to turn off' is correct for when the transistor is switched off, so a follow through error is applied **(1 mark)**.

## Question 10(b)

The candidate was awarded **2 marks** because:

- the substitution is correct with ‘?’ accepted as referring to  $V_1$  (**1 mark**)
- transposition to change the subject to  $V_1$  is not shown (**0 marks**)
- $V_1$  is calculated correctly from given working as final answer with correct unit, with follow through error applied (**1 mark**)
- voltage from previous step does not have 1.8 V added to give  $V_s$  (**0 marks**).

## Question 10(c)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 10(d)

The candidate was awarded **0 marks** because the response is too vague. The response does not refer to tasks specific to a mechanical engineer in the context of the labelled component parts of the motorised conveyor belt (the gearbox or drive wheel). The candidate’s response should have focused on a specific task such as designing, testing, calculating, or simulating.

## Question 11(a)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 11(b)

The candidate was awarded **0 marks** because:

- the substitution is incorrect (**0 marks**)
- transposition to change the subject to  $F$  is not shown (**0 marks**)
- the answer is correct from the given working, but is given to too many significant figures, and the unit is incorrect (**0 marks**).

## Question 11(c)

The candidate was awarded **0 marks** because there is no response.

## Question 11(d)

The candidate was awarded **1 mark** because:

- the response does not describe the control unit comparing both the input and output camera levels **(0 marks)**
- the response does not describe the motor switching on when at the incorrect level, or when an error is detected between the input and output camera levels – ‘Push the motor to the desired level’ is too vague **(0 marks)**
- the response does describe the level sensor feeding back to the control unit **(1 mark)**
- the response does not describe the motor being switched off when the camera is at the correct level, or when there is no error is detected between the input and output camera levels **(0 marks)**.

## Question 11(e)

The candidate was awarded **0 marks** because:

- the diode symbol is incorrect **(0 marks)**
- the attempted diode symbol is not connected in parallel with the relay **(0 marks)**
- the attempted diode symbol is drawn in the incorrect orientation **(0 marks)**.

The candidate has made two attempts at this response, neither on the provided diagram. The response that has not been scored out is the only one that can be assessed.

## Question 12(a)

The candidate was awarded **3 marks** because:

- ‘Input 1’ decision does not have a question mark, therefore is not asking a question to make a decision **(0 marks)**
- ‘Input 2’ decision does not have a question mark, therefore is not asking a question to make a decision **(0 marks)**
- ‘pin 4 on’ is in the correct position **(1 mark)**
- the loop after ‘pin 4 on’ returns to start with an arrow **(1 mark)**

- 'pin 5 on' and 'pin 5 off' are in the correct position following the 'no' decision  
(1 mark)
- 0.5 s and 0.4 s delays are in the correct positions but have no units (0 marks)
- 'loop 20 times' does not have a question mark, therefore, is not asking a question to make a decision (0 marks)
- there is no 'no' decision route with arrow to return to before 'pin 5 on' (0 marks)
- it is unclear if the decision route with arrow returning back to the start of the flowchart is intended to be a 'yes' decision as it is not labelled (0 marks)
- 'loop 20 times' is in a process symbol rather than a decisions symbol therefore, not all symbols are correct (0 marks).

### Question 12(b)

The candidate was awarded **1 mark** because the first response is correct.

### Question 12(c)

The candidate was awarded **1 mark** because:

- the substitution is incorrect (0 marks)
- the answer is correct from the given working (1 mark).

### Question 12(d)

The candidate was awarded **1 mark** because the response indicates a financial impact of using an electric toothbrush. Note that this response is barely a description, and responses with more depth should be encouraged.

### Question 13(a)

The candidate was awarded **1 mark** because 'less greenhouse gases' is accepted as a valid effect.

### Question 13(b)

The candidate was awarded **3 marks** because the response is correct to four significant figures, which is allowable on the basis of the instructions given to candidates at the beginning of the question paper.

## Question 13(c)

The candidate was awarded **1 mark** because:

- the substitution is incorrect as subject  $1/R_p$  is not shown **(0 marks)**
- it is unclear what the value of  $R_p$  is in this response **(0 marks)**
- $R_t$  is calculated by adding 51 k $\Omega$  **(1 mark)**.

## Question 13(d)(i)

The candidate was awarded **1 mark** because:

- there is no evidence of substitution **(0 marks)**
- transposition to change the subject to  $I$  is correct **(1 mark)**
- the answer is correct from the given working but there is no unit **(0 marks)**.

## Question 13(d)(ii)

The candidate was awarded **0 marks** because there is no response.

## Question 13(e)

The candidate was awarded **0 marks** because the responses are too vague (minimal generic descriptions that do not directly address the use of microcontrollers in this context).

## Question 14(a)(i)

The candidate was awarded **3 marks** because:

- valve 1 and valve 2 are correctly piped to the shuttle valve **(1 mark)**
- the shuttle valve is correctly piped to the left-hand actuator on the 5/2 valve **(1 mark)**
- valve 3 is correctly piped to the right-hand side of the 5/2 valve **(1 mark)**.

## Question 14(a)(ii)

The candidate was awarded **0 marks** because the response is incorrect.

## Question 14(b)

The candidate was awarded **1 mark** because:

- the substitution is correct (**1 mark**)
- the answer value is correct from the given working, but no unit is given (**0 marks**).

While  $\text{Nm}^{-2}$  (Pa) is given as the standard unit for pressure and stress in the data booklet, candidates should be prepared with the knowledge that most areas used in these calculations will be in the order of  $\text{mm}^2$ , and so final answers will normally reflect this. For a response to be awarded marks when expressed in  $\text{Nm}^{-2}$  or Pa, the value must be converted correctly.

## Question 14(c)

The candidate was awarded **2 marks** because the response is correct.

## Question 14(d)

The candidate was awarded **3 marks** because all three columns in the truth table are correct.