ENGINEERING PROGRAMMABLE SYSTEMS

INCLUDED ON THE
KS4 PERFORMANCE TABLES

Candidate Style Answers

OCR Level 1/Level 2

Cambridge National in

Engineering Programmable Systems

J824

For first teaching in 2022 | Version 1

Unit R047 Principles of electronic and programmable systems

ocr.org.uk/cambridgenationals

Cambridge Nationals

OCR
Oxford Cambridge and RSA

Contents

About this resource

We have produced this resource using the sample question paper and mark scheme Cambridge National in Engineering Programmable Systems J824.

The aim of the resource is to show you how marks or levels could be given and why. Our senior assessors have provided possible candidate responses and then applied the sample mark scheme, adding commentary.

Please note this resource does not constitute an indication of grade boundaries or endorsed answers. In a live series the mark a response gets depends on the process of standardisation, which considers the big picture of the year's scripts. The levels or marks we show in our resource is an estimation of what could be awarded. How levels and marks correspond to grade boundaries is then determined during the Awarding process. This process happens after the marking of scripts and depends on a number of factors including candidate performance across the board.

You can read more about this process in our guide.

Question 1

1 Which of these is the unit of measurement for frequency?

(a) Amp ☐

(b) Farad ☐

(c) Hertz ☐

(d) Watt ☐

[1]

Exemplar 1

1 mark

(a) Amp ☐

(b) Farad ☐

(c) Hertz ☑

(d) Watt ☐

[1]

Hertz is chosen as the correct option.

Some candidates may incorrectly link 'f' in frequency and 'F' in Farad together and select option (b).

It would be expected that most candidates could identify the link between current and amps and power and watts.

As per 1.1.1 of the specification, students should have an understanding of electronic circuit parameters and be able to define their SI units/SI derived units correctly.

Question 2

2 Which of these is best described as the flow of electrons around a circuit?

(a) Capacitance ☐

(b) Current ☐

(c) Resistance ☐

(d) Voltage ☐

[1]

Exemplar 1

1 mark

(a) Capacitance ☐

(b) Current ✓

(c) Resistance ☐

(d) Voltage ☐

[1]

Current is chosen as the correct option.

Some candidates may incorrectly link voltage to the flow of electrons around a circuit.

As per 1.2.1 of the specification, students should have an understanding of what electron flow is within a circuit.

Question 3

3 How many ohms is 1.5 megaohms (MΩ)?

(a) 1 500 Ω ☐

(b) 15 000 Ω ☐

(c) 150 000 Ω ☐

(d) 1 500 000 Ω ☐

[1]

Exemplar 1

1 mark

(a) 1 500 Ω ☐

(b) 15 000 Ω ☐

(c) 150 000 Ω ☐

(d) 1 500 000 Ω ✓

[1]

1 500 000Ω is selected as the correct response.

Candidates may be confused by the conversion between units with some using guess work to identify a response.

Some candidates may get confused between the conversion of KΩ and MΩ and select option (a).

As per 1.1.2 of the specification, students should be able to convert between multiples and submultiples.

Question 4

4 Which of these is the correct formula for calculating the power in a circuit?

(a) P = I / V ☐

(b) P = I V ☐

(c) P = I^2 V ☐

(d) P = V / I ☐

[1]

Exemplar 1

1 mark

(a) P = I / V ☐

(b) P = I V ✓

(c) P = I^2 V ☐

(d) P = V / I ☐

[1]

The correct response of P=IV is given.

As all distractors contain some form of P, I and V, some candidates may misread the options.

Some candidates may divide I and V instead of multiplying them together.

P=I^2V may also get confused with P= I^2R.

As per 1.2.3 of the specification, students should be aware of the relationship between power, current and voltage. They should also be able to rearrange the formula, but this does not include this use of P= I^2R.

Question 5

5 Which of these best describes the purpose of an output block in a system?

(a) Changes an electronic signal into a physical signal. ☐

(b) Changes a signal from the physical environment into an electronic signal. ☐

(c) Increases the size of an electronic signal. ☐

(d) Processes an electronic signal, such as by latching it on for a period of time. ☐

[1]

Exemplar 1

1 mark

(a) Changes an electronic signal into a physical signal. ☑

(b) Changes a signal from the physical environment into an electronic signal. ☐

(c) Increases the size of an electronic signal. ☐

(d) Processes an electronic signal, such as by latching it on for a period of time. ☐

[1]

The candidate correctly identifies that the purpose of an output block in a system is to change an electronic signal into a physical signal.

Some candidates may incorrectly select option (d) due to seeing the word 'on' and linking this to outputs.

Options (a) and (b) could also be seen by some candidates as being very similar, with some getting the responses the wrong way around.

As per 2.1 of the specification, students should know the difference between input, process, and output blocks.

Question 6

6 Which of these components is used as an interface device in a circuit?

(a) Buzzer ☐

(b) Diode ☐

(c) Relay ☐

(d) Thermistor ☐

[1]

Exemplar 1

1 mark

(a) Buzzer ☐

(b) Diode ☐

(c) Relay ☑

(d) Thermistor ☐

[1]

The candidate correctly chooses relay as the component used as an interface device in a circuit.

Some candidates may use a process of elimination when responding to this question. They should be aware that a buzzer is an output device and a thermistor is an input device.

Some candidates will be aware that diodes are passive protection devices, leaving relay as the solution.

As per 2.2.4 of the specification, students should be aware of interface devices and their uses.

Question 7

7 A system with feedback is called a:

(a) Closed process system ☐

(b) Closed loop system ☐

(c) Open loop system ☐

(d) Open process system ☐

[1]

Exemplar 1

1 mark

(a) Closed process system ☐

(b) Closed loop system ✓

(c) Open loop system ☐

(d) Open process system ☐

[1]

The candidate correctly identifies a closed loop system as a system that includes feedback.

Some candidates may get confused between a process system and loop system as shown in options (a) and (b).

Some candidates may get confused between open and closed loop systems, leading to them incorrectly thinking that open loop systems contain feedback.

As per 2.1 of the specification, students should be aware of the difference between open and closed loop systems.

Question 8

8 Which of these best describes what a logic probe is used for?

(a) To check the signal state of a digital circuit. ☐

(b) To measure the value of an analogue signal. ☐

(c) To produce analogue signal waveforms. ☐

(d) To produce digital signal waveforms. ☐

[1]

Exemplar 1

1 mark

(a) To check the signal state of a digital circuit. ☑

(b) To measure the value of an analogue signal. ☐

(c) To produce analogue signal waveforms. ☐

(d) To produce digital signal waveforms. ☐

[1]

The response correctly identifies that logic probes are used for checking the signal state of a digital circuit.

Some candidates will understand that logic links to digital signals but may get confused between producing waveforms and checking signal states.

As per 3.2 of the specification, students should be aware of the uses of a range of testing equipment. Ideally these would be used physically when testing their circuits in R048 or through practical circuit activities.

Question 9

9 What component does this circuit symbol represent?

(a) Push-to-break switch ☐

(b) Push-to-make switch ☐

(c) Reed switch ☐

(d) Single pole single throw (SPST) switch ☐

[1]

Exemplar 1

1 mark

(a) Push-to-break switch ☐

(b) Push-to-make switch ☐

(c) Reed switch ☐

(d) Single pole single throw (SPST) switch ☑

[1]

The candidate correctly selects option (d), identifying the circuit symbol as a single pole single throw switch.

Candidates should know about various switch types and their circuit symbols. They should be able to look at a switch symbol and gain some understanding of how it will operate from its path of movement. E.g., a push-to-make switch symbol looks like it will make contact with the two poles when the top of the switch is pressed. This should allow candidates to eliminate some distractors when attempting this style of question.

Question 10

10 You are developing a system that boosts an audio signal to a speaker.

What type of process device would be the most appropriate for this application?

(a) Amplifier ☐

(b) Analogue to digital converter ☐

(c) Latch ☐

(d) Pulse generator ☐

[1]

Exemplar 1

1 mark

(a) Amplifier ☑

(b) Analogue to digital converter ☐

(c) Latch ☐

(d) Pulse generator ☐

[1]

The candidate correctly identifies option (a) as a process device that will boost the audio signal to a speaker.

As the question is made up of two lines, some candidates may not read both the top and bottom line and therefore misunderstand what the question is asking.

Most candidates will link the phrase 'boosting an audio signal' with the function of an amplifier. Some may incorrectly select option (d), thinking that this connects with signal amplification.

Question 11 (a) (i)

11 You are developing a child's night light system.

The system must automatically produce a low level of lighting when it is nighttime.
The light must be off during the day.

(a) (i) Identify **one** suitable input component for use in this system.

.....

[1]

Exemplar 1 — 1 mark

Light Dependent Resistor (LDR)

[1]

The candidate correctly identifies an input that could be used in a night light system.

As stated in the mark scheme, this question is looking for input components that will automatically detect changes in light level.

In this scenario, most candidates will select an LDR as a suitable input component, with some selecting components such as photodiodes.

A small number of candidates may incorrectly select input components such as switches which are not light sensitive.

Exemplar 2 — 0 marks

Light Sensor

[1]

The candidate gives the response of 'light sensor' as a suitable input component.

As per the mark scheme, the candidate fails to name a specific component and therefore receives no marks for this response.

To improve the score gained for this question, candidates should identify a specific component such as an LDR or photodiode.

Some candidates may have built simple sensor circuits as part of their preparation for this unit.

Question 11 (a) (ii)

(ii) Explain **one** reason why this component is suitable.

.....

.....

.....

..... **[2]**

Exemplar 1 2 marks

An LDR would be suitable because it changes its resistance depending on light. This means that it will see when it is dark and allow a change in current.

[2]

This question is asking for one reason why the component selected in the previous part of the question is suitable. Candidates should firstly identify that the question is looking for a 2 mark response.

This response is awarded the full 2 marks.

Exemplar 2 1 mark

LDR will change its resistance when it is light and dark.

.....

.....

..... **[2]**

The response given correctly explains that an LDR will change its resistance when it is light and dark.

As the candidate does not explain the reason, they are limited to 1 mark for this response.

As per 2.2.1 of the specification, students should know the purpose and function of a range of switches and sensors.

Question 11 (b)

(b) Identify **two** output components that could be used to produce light in this system.

1 .....

2 .....

[2]

Exemplar 1 — 2 marks

1 *Light Emitting Diode (LED)*

2 *Signal Lamp*

[2]

When attempting this style of question, candidates should be able to identify that 1 mark is given for each correct response, numbered 1 and 2.

The first response correctly identifies an LED as an output component that could produce light.

It is expected that most candidates would give this response as their first response, as they should be familiar with this basic component. They correctly give a signal lamp for the second output component, to secure the full 2 marks for this question.

Exemplar 2 — 1 mark

1 *LED*

2 *Torch Light*

[2]

The response given correctly identifies an LED as a suitable output component and therefore is awarded 1 mark.

As per the mark scheme, abbreviations are accepted.

The candidate gives a product as the second response, instead of a component that would be found inside the product (e.g. a filament lamp). This is not given a mark.

As per 2.2.3 of the specification, students should know the purpose and function of a range of output devices.

Question 11 (c) (i)

(c) You are prototyping the night light system using a breadboard.

(i) Explain **two** reasons for using a breadboard to prototype this system.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

Exemplar 1

4 marks

1 *One reason to use a breadboard could be because you can check that your circuit works using real components. This means you can check that the components will actually work in the real circuit.*

2 *The night light circuit could be breadboarded as it does not have many components, so could be made quickly and easily to test it works.*

[4]

This response is awarded the full 4 marks.

Candidates should firstly identify that the question is looking for two 2 mark responses. It is therefore looking for candidates to explain each reason given.

In the first response, as per the mark scheme, the candidate gives the reason that it is possible to check that the circuit works using real components. They support this by explaining that it will allow a check that the circuit will function to achieve the second mark.

The second response also achieves 2 marks, linked to the fact that the circuit does not have many components and is therefore quick to make and easy to test that it functions.

As per 3.1 of the specification, students should be able to recall the purpose and characteristics of different prototyping methods.

Exemplar 2

2 marks

1 *A breadboard uses real components. This is good so that I can see if my circuit will work when I make it.*

2 *It will be good to prototype it using a breadboard.*

[4]

The response scores 2 marks for the first reason given only. The candidate states that the breadboard will use real components for 1 mark and supports this with an explanation as to why this is good for the second mark.

The second reason fails to score any marks, as the response is vague and does not link to a valid reason for using this prototyping method.

Where possible, students should have first-hand experience of using prototyping methods such as breadboarding or through virtual simulation.

Question 11 (c) (ii)

(ii) State **one** drawback of using a breadboard to prototype this system.

.....

..... **[1]**

Exemplar 1 — 1 mark

The legs of the components can fall out of the holes and stop it working.

[1]

The response correctly states that legs of components could fall out of the holes when breadboarding. This clearly links to one of the examples given in the mark scheme.

First-hand experience of using prototyping methods would help to identify some of the possible drawbacks when using a breadboard.

Exemplar 2 — 0 marks

It's not very good

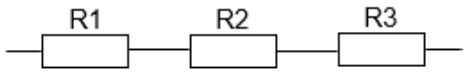
[1]

The candidate gives a vague response to this question, without stating a clear drawback of the prototyping method.

The response needs to be more specific to allow marks to be awarded for this question response.

Question 12 (a) (i)

12 A resistor arrangement is shown below.



(a) (i) Identify the type of resistor arrangement shown.

..... **[1]**

Exemplar 1 — 1 mark

Series ..... **[1]**

The response correctly identifies the resistor arrangement as series. This would be the only acceptable response for the question, as shown in the mark scheme.

As per 1.2.1 of the specification, students should be able to identify both series and parallel circuit arrangements.

Exemplar 2 — 0 marks

Resistors joined together ..... **[1]**

The candidate only identifies that the resistors are joined together but does not go as far as identifying the specific arrangement.

For this reason, the response gains no marks.

Question 12 (a) (ii)

(ii) The value of each of the resistors is:

R1 = 100 Ω
R2 = 1.2 kΩ
R3 = 4.7 kΩ

Calculate the total resistance of the resistor arrangement.

Give your answer in ohms and show all your working.

Total resistance = ... Ω

[3]

Exemplar continued on the next page

Exemplar 1

3 marks

(ii) The value of each of the resistors is:

R1 = 100 Ω
R2 = 1.2 kΩ
R3 = 4.7 kΩ

Calculate the total resistance of the resistor arrangement.

Give your answer in ohms and show all your working.

$R_{Total} = R_1 + R_2 + R_3$
$= 100 + 1200 + 4700$
$= 6000\,\Omega$

Total resistance = 6000 Ω

[3]

This response is awarded the full 3 marks. The question gives hints as to what should be expected from a full mark response. The question makes it clear that the response should be given in ohms and that all working should be shown.

Although some students may fail to read all lines of the question, within this response they have underlined key pieces of information and you should advise all students that this is something useful to do.

The response is laid out in a logical manner and correctly sets out the formula to gain the first mark.

On the second row they give the correct values for the resistors, including conversion into ohms for the second mark.

On the third row they give the response in ohms, which is repeated in the space provided to secure the third mark.

It is always good practice to show all stages of working which should be emphasised with students. Some students may only give the correct final response for total resistance without any working, which would also receive all 3 marks as shown in the mark scheme. If, however, students showed partial working with an incorrect final answer, they may still be able to secure some marks for the question.

Exemplar 2

1 mark

(ii) The value of each of the resistors is:

R1 = 100 Ω
R2 = 1.2 kΩ
R3 = 4.7 kΩ

Calculate the total resistance of the resistor arrangement.

Give your answer in ohms and show all your working.

$R_T = R_1 + R_2 + R_3$
$R_T = 100 + 1.2 + 4.7$
$R_T = 105.9$

Total resistance = ...105.9....Ω

[3]

This response is awarded 1 mark.

The response is laid out in a logical manner. The student identifies the correct formula/method to allow them to be awarded 1 mark.

They fail to convert resistor R2 and R3 from kilo ohms to ohms which therefore resulted in an incorrect response.

The response fails to convert correctly between units and achieve the correct final answer. This is a common error for some candidates.

As per 1.1.2 of the specification, students should be able to convert between multiples and submultiples.

Question 12 (a) (iii)

(iii) The current flowing through the resistor arrangement is 2 mA.

Using Ohm's Law calculate the potential difference across the arrangement.

Give your answer using the correct unit and show all your working.

.....Potential difference =……..……..Unit =……..

[4]

Exemplar continued on the next page

Exemplar 1

4 marks

(iii) The current flowing through the resistor arrangement is 2 mA.

Using Ohm's Law calculate the potential difference across the arrangement.

Give your answer using the correct unit and show all your working.

$V = I \times R$

mA → A ÷ 1000

2mA = 0.002A

$V = 0.002 \times 6000$

$= 12\ V$

..... Potential difference = 12 .....Unit = V .....

[4]

This response is awarded the full 4 marks.

The question gives hints as to what should be expected from a full mark response. The question makes it clear that the response should include the correct units and that all working should be shown.

Although some candidates may fail to read all lines of the question, within this response they have underlined key pieces of information and this is something that you should advise to all candidates.

The response shows that they have a good understanding of Ohm's Law, drawing out the Ohm's Law triangle, then using this to show the correct formula for calculating voltage to achieve the first mark.

They have clearly shown that they have a good understanding of unit conversions, by showing how to convert from milliamps to amps and then applying this to the current value of 2mA to achieve the second mark.

They have then entered the correct values into the equation, although error carried forward can be applied here from the previous question.

They have correctly taken to value and unit and added these in the spaces provided to secure the final two marks.

It is always good practice to show all stages of working which should be emphasised with students. Some students may only give the correct final response for potential difference without any working, which would also receive three of the four marks as shown in the mark scheme.

Exemplar 2

1 mark

(iii) The current flowing through the resistor arrangement is 2 mA.

Using Ohm's Law calculate the potential difference across the arrangement.

Give your answer using the correct unit and show all your working.

V = I x R

= 2 x 105.9

= 211.8 Watts

..... Potential difference = 211.8 ..... Unit = Watts

[4]

This response is awarded 1 mark.

The response is laid out in a logical manner. The candidate has made the correct link between potential difference and voltage to recall the correct formula. This allows them to be awarded 1 mark.

Although they have incorrectly calculated the total resistance, this is acceptable as the error is carried forwards.

They have failed to convert the current from milliamps to amps, and therefore no marks are awarded for this.

This has resulted in an incorrect answer and them showing some confusion between power and voltage when providing a unit.

As per 1.1.2 of the specification, students should be able to convert **between** multiples and be able to apply the correct units.

Question 12 (b)

(b) One application of resistors is to protect an LED from damage.

Identify **two** other applications where fixed or variable resistors can be used in electronic circuits.

1 .....

.....

2 .....

.....

[2]

Exemplar 1 — 2 marks

1 *You could use two resistors to create a potential divider circuit to give a smaller output voltage.*

2 *You could use a variable resistor in a light switch to change how bright the light is in a room.*

[2]

This response is awarded two marks.

Candidates should firstly identify that the question is looking for two 1 mark responses. It is therefore looking for candidates to just state two applications.

The response correctly identifies that two resistors could be used to create a potential divider. This clearly links to the example given in the mark scheme.

For the second point, they give a specific use for a variable resistor within a light switch. The mark scheme does not directly list this response but allows for other valid responses to gain the credit.

Exemplar 2 — 1 mark

1 *Protect a transistor from damage*

.....

2 *To stop a motor being damaged*

.....

[2]

This response is awarded 1 mark. This candidate gives a response linked to a resistor stopping a transistor from being damaged.

The second response receives no marks because it does not give a correct application for a resistor.

As per 2.2.5 of the specification, students should have an understanding of both fixed and variable resistors, including their uses.

Question 13 (a)

13 **(a)** Describe **two** differences between analogue and digital signals.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

Exemplar 1

4 marks

1 *Digital signals are either 1 or 0. Analogue signals can be any value like an LDR.*

.....

.....

2 *Digital signals are a square wave. An analogue wave continues to change like an S.*

.....

.....

.....

[4]

This response is awarded the full 4 marks.

The candidate correctly identifies that digital signals are either 1 or 0 and that analogue signals can be an infinite number.

2 marks are given for this response as they describe the difference between the two signals, giving specific information about each form.

A further 2 marks are gained through describing both wave forms in a similar style to the first response.

As per 1.2.1 of the specification, students should be able to identify analogue and digital signals, plus their advantages and disadvantages.

Exemplar 2

2 marks

1 *A digital wave is either on or off (1 or 0)*

2 *Analogue waves continue to change*

[4]

This response is awarded 2 marks.

The response given describes that digital wave forms are either on or off (1 or 0). This links with the mark scheme where 1 mark is awarded for stating that they are either 1 or 0.

Candidates commonly assume that because they have stated that digital signals are 1 or 0, they do not have to provide a response about analogue signal. This common misconception can be applied to other areas within the subject where candidates should describe both areas.

For the second response, they correctly identify that analogue waves continue to change. This links to the mark scheme related to an analogue wave being continuous.

Question 13 (b) (i)

(b) (i) Describe the function of a logic OR gate.

.....

.....

.....

..... **[2]**

Exemplar 1 — 2 marks

The output is high when both of the inputs are high. The output is also high when one of the inputs is high and the other is low. The output is low when both inputs are low.

..... **[2]**

This response is awarded the full 2 marks.

This question is looking for candidates to describe the various input and output combinations of the OR gate.

The response correctly describes all input and output combinations to show that they know how an OR gate functions.

They describe the scenarios when the output is high for 1 mark and then support this with scenarios when the output is low for the second mark, as reflected in the mark scheme.

Exemplar 2 — 1 mark

When both inputs are 1 or 1 input is 1, the output is 1.

.....

.....

..... **[2]**

The response correctly identifies that when both or one of the inputs is 1, the output is 1. This allows 1 mark to be awarded for this response.

Candidates commonly assume that because they have stated when the output signal is 1, they do not have to provide a response as to when the output signal will be 0.

This common misconception can be applied to other areas within the subject where candidates should describe all valid combinations.

Question 13 (b) (ii)

(ii) Complete the truth table below for a logic NAND gate.

Input A	Input B	Output
0	0	
0	1	
1	0	
1	1	

[2]

Exemplar 1

2 marks

Input A	Input B	Output
0	0	*1*
0	1	*1*
1	0	*1*
1	1	*0*

[2]

The response correctly gives the output combinations of a NAND gate.

As per the mark scheme, both marks have been awarded due to all outputs being correct.

As per 2.2.2 of the specification, students should be able to recall the function and truth tables for a range of different logic gates (as listed in the specification).

Exemplar 2

1 mark

Input A	Input B	Output
0	0	*1*
0	1	*1*
1	0	*1*
1	1	*2*

[2]

The response correctly identifies that the output on a NAND gate will be 1 when both or one of the inputs is 0. As per the mark scheme, they identify three of the outputs correctly and therefore are awarded 1 mark.

As in this case with the 4th row, some candidates may numerically add the inputs instead of listing a correct logic level based on the type of logic gate.

Candidates should be made aware that all outputs should be either 1 or 0.

Question 13 (c)

(c) A central heating system is one application of a logic AND function.

Identify **two** other applications of a logic AND function.

1 .....

.....

2 .....

.....

[2]

Exemplar 1 — 2 marks

1 *Safety system on a machine in centre*

.....

2 *A function on a computer keyboard where two buttons need to be pressed for a certain thing to happen on screen*

.....

[2]

This response is awarded the full 2 marks.

Candidates should firstly identify that the question is looking for two 1 mark responses. It is therefore looking for students to just identify two applications.

The response correctly identifies that a safety system on a machine may use an AND function. This is also given in the mark scheme.

For the second response, they correctly identify a further use, although not listed in the mark scheme directly. As the mark scheme allows credit for any other valid responses, the second mark has been awarded.

Exemplar 2 — 1 mark

1 *Heating at home*

.....

2 *House alarm*

.....

[2]

The response gives two applications of an AND function within the home.

As with the first response, candidates may reword the example that has been given in the question, thinking that this is a different application. Due to it being the same system, this has gained no marks.

They then correctly give a house alarm as a second application. This links closely to the 'burglar alarm' example given in the mark scheme, and therefore the response would receive credit.

The question therefore secures 1 mark in total.

As per 2.2 of the specification, students should be able to recall typical applications or process devices such as logic gates.

Question 14 (a) (i)

14 **(a)** You are testing a single strand wire in a circuit to make sure that it is still capable of conducting electricity.

(i) Identify **two** pieces of test equipment that you could use to do this.

1 .....

2 .....

[2]

Exemplar 1 — 2 marks

1 *Multimeter*

2 *Continuity Tester*

[2]

The response correctly identifies a multimeter and a continuity tester as two methods of testing the capability of a single strand wire to conduct electricity.

As these are both valid methods of testing the wire and are also given in the mark scheme, the response is awarded the full 2 marks.

As per 3.2 of the specification, students should be aware of the main characteristics, purpose and use of test equipment.

Exemplar 2 — 1 mark

1 *Multimeter*

2 *Voltmeter*

[2]

The response correctly identifies a multimeter as a method of testing the capability of a single strand wire to conduct electricity. This method is also listed in the mark scheme.

The second response does not gain a mark. Although the mark scheme does allow for other appropriate and valid responses, this would not be seen as a suitable method for testing a single strand wire.

Where possible, it would be beneficial for students to gain first-hand experience of testing and problem-solving circuits using virtual and/or physical test equipment.

Question 14 (a) (ii)

(ii) Describe how you would use **one** of the pieces of test equipment named in **(i)** to do this.

..... **[5]**

Exemplar 1 — 5 marks

Get the multimeter and connect the two wires which are red and black to the multimeter in the right places.

You then need to turn the knob to the continuity setting.

You then need to place one probe at one end of the wire and the other probe at the other end.

If the wire is good, it will beep at you.

..... **[5]**

This response is awarded the full 5 marks.

Candidates should firstly identify that the question is worth 5 marks and therefore should be breaking this down into at least five stages. Some candidates may use the area around the question to plan out the five stages in the correct sequence before they attempt a valid response.

As per the mark scheme, the response has correctly identified at least five stages.

The first mark is given for reference to the two probes being connected to the multimeter.

They gain the second mark for talking about changing of the settings and then gain 2 further marks for reference to the contact positions of the two probes (this is broken down in the mark scheme).

The final mark is given for indicating that a beep will be heard if the wire is capable of conducting electricity.

Exemplar 2

3 marks

Put the red and black probes at each end of the wire and listen for a beep to tell you the wire is ok.

[5]

The response gains 2 marks for describing the connecting of the two probe positions.

A third mark is given for noting that a beep should be heard if the wire is ok.

As many multimeters in Centres will have the probe terminals already connected (from prior use), some candidates fail to mention this in a response.

This response has also failed to comment on selection of the correct test range or setting on the multimeter.

Exemplar 3

1 mark

You would hear it beep if the wire is ok and if it doesn't beep it is not ok.

[5]

The response shows that the candidate has some understanding of how to carry out a continuity test, but unfortunately, they fail to describe valid steps in the correct sequence.

The response gains one mark for mentioning the fact that a beep is heard if the wire is complete and can conduct electricity.

Where possible, it would be beneficial for candidates to gain first-hand experience of testing and problem-solving circuits using virtual and/or physical test equipment, as well as experience of setting the meter itself.

Question 14 (b)

(b) Multi-strand wire can be used to connect batteries to circuit boards.

Explain why multi-strand wire is suitable for this.

.....

.....

.....

.....

.....

.....

[3]

Exemplar 1 — 3 marks

Multi-strand wire is made up of lots of smaller wires. This makes it more flexible than one single wire. As the wire has lots of small wires in it, it will not break as easily when it is moved around or bent. This will make sure that the product works every time you use it.

.....

.....

[3]

This response is awarded the full 3 marks.

The response shows that the candidate understands what multi-strand wire is and gains the first mark from mentioning that it is flexible (as listed in the mark scheme).

For the second mark, they explain the wire not breaking easily when moved.

They expand this point further by explaining why this would help in an end product to gain the third and final mark.

This also links to the responses in the mark scheme which make reference to power loss and maintenance.

Exemplar 2

1 mark

The wire is made up of lots of smaller wires. This will make it easier to move around.

[3]

The candidate refers to the fact that it is easier to move around and therefore links to the use of 'flexible' within the mark scheme.

As they only identify one valid point for this response, they are awarded 1 mark. This may be due to a lack of knowledge of this topic area.

As per 2.2.7 of the specification, students should understand different wire types and their characteristics.

Question 15 (a)

15 **(a)** State **three** characteristics of surface mount technology (SMT).

1 .....

.....

2 .....

.....

3 .....

.....

[3]

Exemplar 1 — 3 marks

1 *You don't have to drill holes in the PCB*

.....

2 *You can put components on both sides of the PCB*

.....

3 *The components are smaller so the PCB can be smaller*

.....

[3]

This response is awarded the full 3 marks. Candidates should firstly identify that the question requires three points.

The candidate shows that they understand the surface mount process and give three valid responses that link closely with those listed in the mark scheme.

Exemplar 2 — 1 mark

1 *It puts them on the surface and not in holes.*

.....

2 *You don't have to solder them.*

.....

3 *It is very slow.*

.....

[3]

This candidate attempts to state three valid points for characteristics of surface mount technology (SMT).

The response receives 1 mark for the first point only. They explain that you place the components on the surface instead of in holes, which links closely to the point given in the mark scheme.

The second and third points show a lack of understanding of the process itself.

Students would benefit from seeing first-hand/video clips of commercial circuit production techniques to make sure they have a broad understanding of all processes used.

Question 15 (b)

(b) Describe how a pick and place machine is used to assemble a circuit.

.....

.....

.....

.....

.....

..... **[3]**

Exemplar 1 — 3 marks

A pick and place machine picks up components from lots of different reels. Each reel has lots of the same component. It then has been programmed to know where to put the component on the PCB. It makes sure that each component is in the correct place. It has an eye that looks to see if it has put it in the correct place.

..... **[3]**

This response is awarded the full 3 marks. The question is looking for candidates to describe the stages of computer-controlled pick and place machines.

In this response the first mark is given for reference to the pick and place machine picking up the components from different reels.

The second mark is given for describing the machine being programmed to place components in certain locations.

The final mark is awarded for describing the checks that occur as the components are fitted. Although this is not listed in the mark scheme, credit is awarded for other valid responses.

Exemplar 2 — 1 mark

It picks up stuff and puts it in the good place on the PCB.

.....

.....

.....

.....

..... **[3]**

The response given shows only a basic understanding of what a pick and place machine does.

The lack of detail limits the mark given, but as the candidate has made reference to the machine picking up components and placing them in correct locations it is awarded 1 mark.

Question 15 (c)

(c) Describe the steps to fit and solder components to a PCB using the through-hole construction method.

.....

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.....

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.....

.....

..... **[4]**

Exemplar 1 — 4 marks

If you are fitting a resistor, you need to bend the legs so that they will fit in the holes. You can then put the resistor into the holes in the PCB. You could check you have put it in right against your real-world view. You need to get the soldering iron and tin the end of it by adding some solder. You then put the end of the iron on the pad and leg of the resistor and add a small amount of solder to make a cone shape. If you are happy with it, you can then cut off the legs with some cutters. **[4]**

This response is awarded the full 4 marks. Candidates should firstly read the question carefully and identify that the question is looking for a description of the 'steps'.

Although the response does not directly cover the four steps given in the mark scheme, credit is awarded for other valid responses.

Exemplar 2

2 marks

You heat up the circle and add some solder to make a cone.

You then let it cool down and cut off the sticks.

[4]

This response is awarded 2 marks. The response given has limited use of key terminology, but it is clear that the candidate has some understanding of the process.

The first mark is given for reference to heating up the PCB pad (no mention of component leg), and then adding solder to make a cone shape. This is limited to 1 mark due to the lack of appropriate terminology.

The second mark awarded links closely to the mark scheme with reference to allowing the solder to cool before cutting off the component leg.

The overall score is limited as the candidate only makes reference to the soldering stage.

This can be a common error, where candidates fail to read the question fully or assume that the component is fitted in a previous process.

This question links to Unit R048, where students will gain first-hand experience of fitting and soldering components.

Question 16 (a)

16 A company designs and manufactures home security systems using non-programmable circuitry.

The company is considering changing to microcontroller-based systems.

(a) Discuss the advantages and disadvantages to the company of changing from non-programmable circuitry to microcontroller-based systems.

.....

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.....

.....

.....

.....

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.....

.....

.....

..... **[6]**

Exemplar continued on the next page

Exemplar 1

Level 3

An advantage of moving from non-programmable circuitry to microcontroller-based systems is that it will need less components. This means that the PCB will be smaller when it is made and will fit in the home security system easier.

Another advantage is that you can programme it as many times as you want and change the programme. This means that they can do updates on the circuits if they find that something doesn't work as they want it to.

A disadvantage is that the microcontroller costs more to make. This means that they will have to put up the price to the end user to still make a profit.

Another disadvantage is that if a company was changing over, they would need to spend time and money changing the machines and training the staff. This would all cost them lots of money. **[6]**

This response is awarded Level 3. Candidates should firstly identify that this is a 6 mark response and a 'discuss' style of question.

They should plan this style of question beforehand using the space provided, to make sure that they can identify valid advantages and disadvantages, and support this with justification and relevant examples.

This response gives a good balance between advantages and disadvantages, giving two for each side of the discussion.

The response is well structured, and it is clear where the next point starts.

Each point is valid and supported by reasoning as to why this would be an advantage or disadvantage.

Overall, the response shows a thorough discussion, with consistent use of terminology and so is awarded Level 3.

To make sure candidates are able to gain full marks in this style of question, the 'discuss the advantages and disadvantages' opening line could be applied to other topics within the specification.

Exemplar 2

Level 2

If a company is changing over from non-programmable circuitry to microcontroller-based systems, it can have many advantages and disadvantages.

An advantage would be that microcontrollers can be simulated on screen before they are used in the security system. This means that they can test that the system works on the computer before they use it in the real security system.

A disadvantage would be that the company will have to train their staff on how to use the simulation software. This is bad because it will take up time and cost them money to get people in to show them what to do.

[6]

The response secures Level 2 and provides an adequate discussion, showing some understanding of one advantage and disadvantage to changing to microcontroller-based systems.

The advantage and disadvantage given are fully justified.

As shown in this response, some candidates feel that they need to give an introduction to the piece of work. This introductory sentence has no value to the marks that can be awarded and leaves candidates using up valuable space and time or feeling that they have completed the response as all lines have been used.

You should advise students to avoid doing this, and instead start the discussion immediately with the first advantage or disadvantage.

Exemplar 3

Level 1

A good thing about using microcontrollers in a security system is that they will control the security system through being small. It is also good as it is small, they can make them faster and use smaller circuits.

A bad thing is that the company will have to change things.

[6]

This response shows some understanding of the impact of change on a company manufacturing electronic products and is therefore awarded Level 1.

The candidate identifies one advantage which shows some limited development and one disadvantage, but with no further development.

The advantage given shows some appropriate terminology in places, but the disadvantage is very vague and shows a lack of understanding as to what would have to change.

Question 16 (b) (i)

(b) The company could use a block-based editor to program their new systems.

(i) State **two** features of block-based programming editors.

1 .....

.....

2 .....

.....

[2]

Exemplar 1 — 2 marks

1 *Block-based programming means that you can see it on screen and understand it better.*

2 *Block-based programming is easy for you to learn how to do it.*

[2]

This response is awarded 2 marks. Candidates should firstly identify that the question is a 'state' style question and therefore should give two valid points.

The first mark is given as per the mark scheme, where the candidate refers to the fact that it is a visual programming method.

The second mark is again linked to the mark scheme, where they identify block-based programming as being easy to learn.

Exemplar 2 — 1 mark

1 *You can drag blocks into place and connect them together and see what it does*

2 *It is made of blocks*

[2]

This response is awarded 1 mark. The response shows that the candidate has some understanding of what block-based programming is.

They refer to the fact that you connect the blocks together and 'see' what it does.

This links closely with the point given in the mark scheme and is therefore worthy of 1 mark.

They state that block-based programming is made of blocks, but this is not worthy of a mark as they have simply repeated this from the question and do not clearly give a feature.

As per 2.3.2 of the specification, students should have an understanding of programming languages and systems and their main features. Where possible, first-hand use of these languages would also be beneficial.

Question 16 (b) (ii)

(ii) State **two** drawbacks of using block-based editors to program microcontroller systems.

1 .....

.....

2 .....

.....

[2]

Exemplar 1 — 2 marks

1 *You can only do what the blocks say, so can't make up your own code.*

.....

2 *It might be slower than being able to create your own codes as you have to use their blocks.*

.....

[2]

This response is awarded the full 2 marks. Candidates should firstly identify that the question is a 'state' style question and therefore should make sure that they give two valid points.

The first mark awarded is linked to 'not being flexible' from the mark scheme, where the candidate refers to the fact that you can't make up your own code.

For the second mark, they refer to this programming method being slower as the blocks limit what you can do. Although this is not directly linked to the mark scheme, this is given as a valid response.

Exemplar 2 — 1 mark

1 *You might have lots of blocks, so it might be hard to work out where the programme has gone wrong*

2 *It could take some a long time to understand how to use it*

.....

[2]

This response is awarded 1 mark. The response shows that the candidate has some understanding of the drawbacks of using block-based editors for programme microcontrollers.

The first mark is awarded as the candidate states that you might have lots of blocks, but also makes reference to the fact that it can be hard to work out where the programme has gone wrong. This links in closely to where the mark scheme identifies programmes being more complex than they need to be.

For the second point they state that block-based editors may take more time to understand. This is clearly incorrect and gains zero marks.

As per 2.3.2 of the specification, students should be able to recall the advantages and disadvantages of each type of programming language (as listed in the specification). Where possible, first-hand use of these languages would also be beneficial, to help identify advantages and disadvantages.

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