

**Cambridge National**

**Engineering Programmable Systems**

**R047/01: Principles of electronic and programmable systems**

Level 1/2 Cambridge National Certificate/Award/Diploma

**Mark Scheme for June 2025**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## MARKING INSTRUCTIONS

### PREPARATION FOR MARKING RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training: OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

### MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.

#### 5. **Crossed-Out Responses**

Where a candidate has crossed out a response and provided a clear alternative then the crossed-out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed-out response where legible.

#### **Rubric Error Responses – Optional Questions**

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM Assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

**Multiple-Choice Question Responses**

When a multiple-choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

*When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

**Contradictory Responses**

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions (requiring only a list by way of a response, usually worth only one mark per response)**

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

**Short Answer Questions (requiring a more developed response, worth two or more marks)**

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space).

**Longer Answer Questions (requiring a developed response)**

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.

7. There is a NR (**No Response**) option. Award NR (No Response):

- if there is nothing written at all in the answer space
- OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
- OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

9. *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*

10. For answers marked by levels of response: Not applicable in F501

**To determine the level** – start at the highest level and work down until you reach the level that matches the answer

**To determine the mark within the level**, consider the following

| Descriptor                                            | Award mark                                                                                                |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| On the borderline of this level and the one below     | At bottom of level                                                                                        |
| Just enough achievement on balance for this level     | Above bottom and either below middle or at middle of level (depending on number of marks available)       |
| Meets the criteria but with some slight inconsistency | Above middle and either below top of level or at middle of level (depending on number of marks available) |
| Consistently meets the criteria for this level        | At top of level                                                                                           |

## 11. Annotations

| Annotation                                                                        | Meaning              |
|-----------------------------------------------------------------------------------|----------------------|
|  | Seen                 |
|  | Tick                 |
|  | Repetition           |
|  | Unclear              |
|  | Benefit of the doubt |
|  | Level 1              |
|  | Level 2              |
|  | Level 3              |
|  | Highlight            |

## Applying the annotations

Every page must have a stamp on it to indicate you have checked all the pages that are available. If a page is blank, use the 'seen' stamp.

Levels of response questions

- Do **not** use ticks, use the highlighter tool to indicate relevant sections. The number of highlighted sections does **not** equal the number of marks awarded.
- Always stamp the level number at the end of the question, e.g. L2

Do **not** use crosses.

| Question |  |  | Answer                                                                               | Mark | Guidance |
|----------|--|--|--------------------------------------------------------------------------------------|------|----------|
| 1        |  |  | <b>(b)</b> A sensor that has WiFi capability                                         | 1    |          |
| 2        |  |  | <b>(b)</b> Milli                                                                     | 1    |          |
| 3        |  |  | <b>(b)</b> Counter                                                                   | 1    |          |
| 4        |  |  | <b>(c)</b> NOT                                                                       | 1    |          |
| 5        |  |  | <b>(b)</b> Does not require knowledge of actual programming code                     | 1    |          |
| 6        |  |  | <b>(b)</b> A PCB production process where chemicals are used to remove excess copper | 1    |          |
| 7        |  |  | <b>(a)</b> Breadboarding                                                             | 1    |          |
| 8        |  |  | <b>(d)</b> Variable                                                                  | 1    |          |
| 9        |  |  | <b>(b)</b> $P = I \times V$                                                          | 1    |          |
| 10       |  |  | <b>(d)</b> Touchscreen                                                               | 1    |          |

| Question |     |     | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Mark | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11       | (a) | (i) | <p>Identifying input devices:<br/>Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• Push-to-make switch</li> <li>• Single pole single throw switch</li> <li>• Pressure sensor</li> <li>• Quantum Tunnelling Composite switch</li> </ul> <p>Up to <b>two</b> marks for stating the function of each e.g.:</p> <ul style="list-style-type: none"> <li>• Push-to-make switch – allows current to flow when the push button is pressed</li> <li>• Single Pole Single Throw switch – allows current to flow when the switch is in the ‘on’ position</li> <li>• Pressure sensor – allows current to flow when there is an applied pressing force</li> <li>• QTC switch – has a resistance that changes as the amount of force applied changes</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 4    | <p>1 mark for each suitable input device up to maximum of 2 marks.</p> <p>Accept abbreviations ‘PTM’, ‘SPST’ and ‘QTC’</p> <p><b>Do not accept Tilt switch, LDR, Thermistor or Infrared Sensor as these are not suitable for this application of being manually turned on by the user.</b></p> <p>A specific input device must be named.</p> <p><b>Do not accept toggle, button, switch, slide switch, motion sensor or pressure pad.</b></p> <p>Accept Push-to-break switch</p> <p>1 mark for stating how each input device functions to achieve the required outcome up to maximum of 2 marks.</p> <p>Mark for the function <b>only</b> to be awarded if the input device identified is appropriate.</p> <p>Accept comments linked to sending signals.</p> |





| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Mark | Guidance                                                                                                                                                                                                                                                                   |
|----------|-----|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11       | (b) |  | <p>Up to <b>four</b> marks for an evaluation e.g.:</p> <ul style="list-style-type: none"> <li>• LEDs can produce very bright light (1) so would be clearly seen by other walkers/road users (1)</li> <li>• LEDs only require a small amount of current (1) so are more energy efficient/require less battery power (1)</li> <li>• LEDs come in rugged casings (1) so are less likely to be damaged when used outside (1)</li> <li>• LEDs are small in size (1) allowing the case for the light to be compact (1)</li> <li>• LEDs are readily available in a range of colours (1)</li> <li>• LEDs need protecting with a suitable current limiting resistor (1) so additional components are required (1)</li> <li>• LED are polarised components (1) so must be connected the right way round in the circuit (1)</li> <li>• LEDs are low voltage components (1) so safe to use in a handheld / portable device (1)</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 4    | <p>1 mark for each reason up to a maximum of 2 marks.</p> <p>1 mark for evaluative point relating to each reason, up to maximum of 2 marks.</p> <p><b>Do not accept:</b><br/> Easy to replace<br/> Easy to use<br/> Safe<br/> Doesn't give off much light<br/> Cheaper</p> |

| Question |     |       | Answer                                                                                                                                     | Mark | Guidance                                                                                                                                                                                                                |
|----------|-----|-------|--------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12       | (a) | (i)   | The amount of energy transferred per unit time (per second)<br><br><b>Award credit for any other appropriate response.</b>                 | 1    | 1 mark for correct answer.<br><br>Accept comments linked to 'the rate at which energy is transferred by a circuit' or 'joules per second'.<br><br><b>Do not accept comments linked to electricity, voltage or power</b> |
| 12       | (a) | (ii)  | The energy transferred (per unit charge) between two points in a circuit<br><br><b>Award credit for any other appropriate response.</b>    | 1    | 1 mark for correct answer.<br><br>Accept comments linked to:<br>- 'the difference in electrical potential between two points in a circuit'<br>- 'the difference in voltage between two points'                          |
| 12       | (a) | (iii) | The number of waves that pass a set (fixed) point in unit time (per second)<br><br><b>Award credit for any other appropriate response.</b> | 1    | 1 mark for correct answer.<br><br>Accept comments linked to the number of waves generated per second<br><br><b>Do not accept comments linked to 'signals'</b>                                                           |
| 12       | (b) | (i)   | $R_{\text{tot}} = R_1 + R_2 + R_3$<br>$R_{\text{tot}} = 12 + 33 + 180$<br>$R_{\text{tot}} = 225 \Omega$                                    | 3    | 1 mark for correct formula for resistors in series.<br>1 mark for correct substitution of values into formula.<br>1 mark for correct value of $R_{\text{tot}}$                                                          |

| Question |     |      | Answer                                                                                         | Mark | Guidance                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-----|------|------------------------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12       | (b) | (ii) | $I = V / R$<br>$I = 5 / 225$<br>$I = 0.02 \text{ A}$ (answer to 2 d.p) (accept 0.02 recurring) | 4    | <p>1 mark for correct use of Ohm's law (<math>I = V / R</math>)<br/>           Accept (<math>V=IR</math>) or Ohm's law triangle</p> <p>1 mark for correct substitution of values into formula.<br/>           1 mark for correct answer.<br/>           1 mark for correct unit.</p> <p><b>Do not accept answer as a fraction</b></p> <p><b>Allow error carried forward from (b) (i).</b></p> |

| Question |     | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Mark | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13       | (a) | <p>Advantages:</p> <p>Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• Results in high quality circuits (1)</li> <li>• Suitable for SMT circuits/components (1)</li> <li>• Well suited to high volume/bulk production (1)</li> <li>• Is a relatively fast process (1)</li> <li>• Can be automated (1)</li> <li>• Small chance of defects (1)</li> <li>• Solder joints are consistent (1)</li> <li>• All joints are soldered at once (1)</li> <li>• Less human interaction / labour required (1)</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> <p>Disadvantages:</p> <p>Any <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• High initial cost of equipment (1)</li> <li>• High consumption of solder (1)</li> <li>• Can cause heat related damage to circuit/components (1)</li> <li>• Complex process to monitor/control (1)</li> <li>• Flux residue can lead to long-term damage (1)</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 4    | <p>1 mark for each advantage up to a maximum of 2 marks.</p> <p>1 mark for each disadvantage up to a maximum of 2 marks.</p> <p><b>Do not accept responses such as quick, cheap, easy, simple, reliable, inaccurate without supporting comment e.g. quicker than.....</b></p> <p>Due to wording in the specification, accept advantages / disadvantages of both 'flow' (THT) and 'reflow' (SMT).<br/>e.g only suitable for THT</p> <p><b>Do not accept comments linked to being dangerous, injuries, messy or easily removed</b></p> |

| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Mark | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|-----|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13       | (b) |  | <p>Points of discussion might cover areas such as:</p> <ul style="list-style-type: none"> <li>Automated picking/selection of components reduces time taken and increases speed and efficiency of overall assembly</li> <li>High level of accuracy, precision and repeatability of component placement as controlled by a computer/programming</li> <li>Can be reprogramed for assembling different circuits so increases flexibility of production</li> <li>Can work continuously and does not require breaks/downtime other than for maintenance</li> <li>Reduces number of workers required as is an automated process, so reduces labour costs and/or frees up workers to focus on other processes/projects</li> </ul> <p><b>Other relevant points should be credited.</b></p> | 6    | <p><b>Level 3 (high) 5-6 marks</b><br/>A thorough discussion. A good understanding with a range of reasons being clearly identified and developed. Consistently uses appropriate terminology.<br/><b>Answers might typically contain 3-4 relevant points being clearly identified and developed.</b></p> <p><b>Level 2 (mid) 3-4 marks</b><br/>An adequate discussion which shows some understanding, with some reasons identified and limited development. Uses some appropriate terminology.<br/><b>Answers might typically contain 2-3 relevant points being identified and limited development.</b></p> <p><b>Level 1 (low) 1-2 marks</b><br/>A basic discussion which shows limited/poor understanding. Some reasons identified but no development. Little or no use of appropriate terminology.<br/><b>Answers might typically contain 1-2 relevant points identified but no development.</b></p> <p><b>0 marks</b><br/>Response is not worthy of credit.</p> |

| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                        | Mark | Guidance                                                                                                                                                                                                                            |
|----------|-----|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14       | (a) |  | <pre> graph LR     Input[Input<br/>Tilt switch] --&gt; Process1[Process<br/>Microcontroller]     Process1 --&gt; Process2[Process<br/>Darlington driver]     Process2 --&gt; Output[Output<br/>Buzzer]     Output --&gt; Exit[...]           </pre>                                                                           | 2    | <p>1 mark for buzzer written in the output block.</p> <p>1 mark for microcontroller written in the process block.</p>                                                                                                               |
| 14       | (b) |  | <p>Up to <b>two</b> marks for a description of the purpose e.g.:</p> <ul style="list-style-type: none"> <li>To show the signals (1) and their direction of flow in the system (1)</li> </ul> <p><b>Award credit for any other appropriate response.</b></p>                                                                   | 2    | <p>1 mark for each relevant point up to a maximum of 2 marks.</p> <p>Accept comments linked to current flow</p> <p><b>Do not accept comments linked to ‘the order’ of inputs and outputs</b></p>                                    |
| 14       | (c) |  | <p>Up to <b>two</b> marks for an explanation of the function e.g.:</p> <ul style="list-style-type: none"> <li>Increases the output current/signal from the microcontroller (1) so that it is high enough for the buzzer to work/sound correctly (1)</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 2    | <p>1 mark for each relevant point up to a maximum of 2 marks.</p> <p>Accept comments linked to amplifying, boosting the current or higher gain</p> <p><b>Do not accept ‘sends signals to the buzzer’ or ‘powers the buzzer’</b></p> |

| Question |     | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Mark | Guidance                                                                                                                                                                                                                                                                                                                                         |
|----------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14       | (d) | <p>Up to <b>four</b> marks for <b>two</b> advantages explained e.g.:</p> <ul style="list-style-type: none"> <li>• Reduces the size of the system/circuit (1) <ul style="list-style-type: none"> <li>○ As programming replaces physical hardware (1)</li> <li>○ So can allow for a smaller PCB (1)</li> </ul> </li> <li>• High speed of operation (1) <ul style="list-style-type: none"> <li>○ So the buzzer sounds as soon as the tilt is detected (1)</li> </ul> </li> <li>• Can be programmed many times (1) <ul style="list-style-type: none"> <li>○ So could be updated if the system requirements change (1)</li> </ul> </li> <li>• Relatively low cost (1) <ul style="list-style-type: none"> <li>○ As only a small microcontroller would be needed for this system (1)</li> </ul> </li> <li>• Provides greater flexibility (1) <ul style="list-style-type: none"> <li>○ As more inputs or outputs could be added to enhance the system further (1)</li> <li>○ As hardware can be repurposed / change its function (1)</li> </ul> </li> <li>• Increases functionality (1) <ul style="list-style-type: none"> <li>○ So allows the product to do more (1)</li> </ul> </li> <li>• Low power consumption (1) <ul style="list-style-type: none"> <li>○ So can extend battery life of the product (1)</li> </ul> </li> </ul> | 4    | <p>1 mark for each advantage given up to a maximum of 2 marks.</p> <p>1 mark for explaining each advantage given, up to maximum of 2 marks.</p> <p><b>Do not accept responses such as cheap, easy to use, more useful, practical, rugged and reliable</b></p> <p><b>Do not accept responses linked to angle detection of the tilt switch</b></p> |



| Question |  |  | Answer                                                                                                                                                                                                                                                                                              | Mark | Guidance |
|----------|--|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------|
|          |  |  | <ul style="list-style-type: none"> <li>Live diagnostics / simulation can be carried out on the system (1)               <ul style="list-style-type: none"> <li>To ensure the system functions as intended (1)</li> </ul> </li> </ul> <p><b>Award credit for any other appropriate response.</b></p> |      |          |

| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mark | Guidance                                                                                                                                                                      |
|----------|-----|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15       | (a) |  | <p>Any <b>one</b> from:</p> <ul style="list-style-type: none"> <li>To store (electrical) charge</li> <li>As part of a timer circuit (time delay)</li> <li>As part of an RC network</li> <li>Circuit protection (prevent damage to sensitive components)</li> <li>Noise filtering</li> <li>Smooth out voltage fluctuations</li> <li>Signal Coupling and Decoupling (allowing AC signals to pass while blocking DC, and vice versa)</li> <li>Secondary power supply</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 1    | <p>1 mark for correct answer.</p> <p><b>Do not accept comments linked to storing energy, power, electricity, voltage or current</b></p> <p><b>Do not accept 'battery'</b></p> |

| Question |     |     | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Mark | Guidance                                                                                                                                                                                                                                                                                                                                                               |
|----------|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15       | (b) |     | <p>Up to <b>two</b> marks for explaining the difference e.g.:</p> <ul style="list-style-type: none"> <li>• Polarised capacitors have a positive and negative leg/non-polarised capacitors do not (1) <ul style="list-style-type: none"> <li>○ So polarised capacitors must be connected the right way around in a circuit/non-polarised components can be connected any way around (1)</li> </ul> </li> </ul> <p><b>Award credit for any other appropriate response.</b></p>                                                                                                                                                                                                                  | 2    | 1 mark for each relevant point up to maximum of 2 marks.                                                                                                                                                                                                                                                                                                               |
| 15       | (c) | (i) | <p>Any <b>three</b> from:</p> <ul style="list-style-type: none"> <li>• Regenerative braking power in electric vehicles (Kinetic Energy Recovery System)</li> <li>• Powering electric buses/trains/trams</li> <li>• Lift power systems</li> <li>• Backup power supply</li> <li>• Powering electric locks</li> <li>• Uninterruptible power supplies</li> <li>• Forklifts and other material handling equipment in warehouses</li> <li>• Blade pitch control in wind turbines</li> <li>• Electrical grid stabilisation – store excess energy from solar / wind power</li> <li>• Fast charging of smartphones / cameras</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 3    | <p>1 mark for each relevant application up to maximum of 3 marks.</p> <p><b>Do not accept car batteries, taser, solar panels, electric vehicles, mobile phones, tablets, factories without supporting comment e.g used in an electric vehicle to.....</b></p> <p><b>Do not accept electric bus and electric train as two applications (one mark awarded – REP)</b></p> |

| Question |     |      | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Mark | Guidance                                                                                                                                                                                                            |
|----------|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15       | (c) | (ii) | <p>Up to <b>four</b> marks for <b>two</b> reasons explained e.g.:</p> <ul style="list-style-type: none"> <li>• Less electronic waste (1) <ul style="list-style-type: none"> <li>○ As use less hazardous materials / chemicals (1)</li> </ul> </li> <li>• Easier to recycle/re-use (1) <ul style="list-style-type: none"> <li>○ Due to simpler construction (1)</li> </ul> </li> <li>• Can be charged/recharged more times without degradation (last longer / lifespan) (1) <ul style="list-style-type: none"> <li>○ Reducing the amount of new units that need to be made/raw materials required (1)</li> </ul> </li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 4    | <p>1 mark for each reason given up to a maximum of 2 marks.</p> <p>1 mark for explaining each reason given, up to maximum of 2 marks.</p>                                                                           |
| 16       | (a) |      | <p>Any <b>three</b> from:</p> <ul style="list-style-type: none"> <li>• Ensure is properly grounded</li> <li>• Ensure power is off on the tested circuit before connecting to it</li> <li>• Do not exceed the maximum input voltage</li> <li>• Ensure the cover is in place</li> <li>• Do not use in a damp/wet environment</li> <li>• Check the logic probe for damage, cracks or exposed wires</li> <li>• Do not touch exposed wires while in use</li> <li>• Do not touch the sharp end of the probes</li> <li>• Disconnect from the circuit after use</li> </ul>                                                                                                                         | 3    | <p>1 mark for each correct answer up to maximum of 3 marks.</p> <p><b>Do not accept goggles, gloves, apron, comments linked to settings, trip hazards or making sure the circuit functions prior to testing</b></p> |

| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Mark | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|-----|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |     |  | <ul style="list-style-type: none"> <li>Ensure you read the instructions / manual prior to use</li> </ul> <p><b>Award credit for any other appropriate response.</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 16       | (b) |  | <p>Up to <b>five</b> marks for describing the steps e.g.:</p> <ul style="list-style-type: none"> <li>Ensure circuit is powered off/de-energised (1)</li> <li>Connect the signal generator to the circuit to be tested (1)</li> <li>Set the required signal/waveform parameters (1) such as the frequency/amplitude/periodic time (1)</li> <li>Turn on/set power supply to the correct levels (1)</li> <li>Observe how the tested circuit responds to the signal/waveform generated (1) e.g. by comparing the signal generated with the output signal from the circuit being tested (1)</li> <li>Modify the signal and check results as many times as needed (1)</li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 5    | <p>1 mark for each relevant descriptive point up to maximum of 5 marks.</p> <p><b>Note</b><br/>‘Connecting the signal generator to the circuit’ must come before ‘turning on’.</p> <p>Steps must be in a logical order:</p> <ul style="list-style-type: none"> <li>- Power on / connect to a power source</li> <li>- Configure wave type</li> <li>- Connect circuit – output of the generator to the input</li> <li>- Adjust the settings (waveform parameters)</li> <li>- Turn on the circuit</li> <li>- Observe / adjust</li> <li>- Remove probes and turn off the signal generator</li> </ul> <p><b>Do not accept vague responses such as plug it in, turn it on, set the right settings</b></p> |

| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Mark | Guidance                                                                                                                                                                                      |
|----------|-----|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16       | (c) |  | <p>Up to <b>two</b> marks for <b>one</b> characteristic explained e.g.:</p> <ul style="list-style-type: none"> <li>• Can be bent/twisted/folded (1) <ul style="list-style-type: none"> <li>○ So can fit into complex/unusual shaped casings (1)</li> <li>○ Without breaking / being damaged (1)</li> </ul> </li> <li>• Thinner than other PCB types (1) <ul style="list-style-type: none"> <li>○ So more lightweight (1)</li> </ul> </li> <li>• High resistance to temperature/vibration (1) <ul style="list-style-type: none"> <li>○ So less likely to break during use (1)</li> </ul> </li> </ul> <p><b>Award credit for any other appropriate response.</b></p> | 2    | <p>1 mark for any characteristic given.<br/>1 mark for explaining characteristic given.</p> <p><b>Do not accept comments linked to them using smaller components or being 'flexible'.</b></p> |

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