

Cambridge National

Engineering

R113/01: Systems Control in Engineering: Electronic principles, written

Level 1/2 Cambridge National Certificate/Award

Mark Scheme for January 2022

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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.

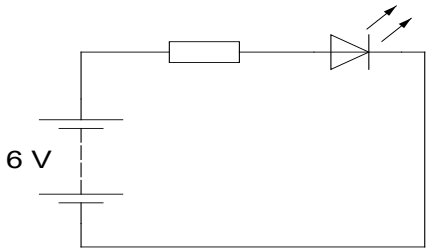
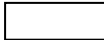
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1. Annotations

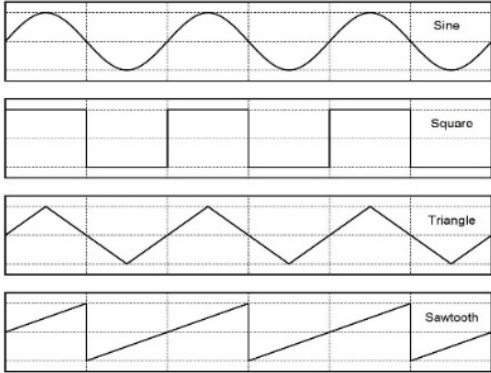
Annotation	Meaning
BP	Blank page
VG	Vague
	Tick
SEEN	Noted but no credit given
REP	Repeat
K	Knowledge
EG	Example/Reference
DEV	Development
BOD	Benefit of doubt
	Unclear
L3	Level 3
L2	Level 2
L1	Level 1

Question	Answer	Mark	Guidance
		3	

Question			Answer	Mark	Guidance
1	(a)	(i)	Portable Sustainable Continuous		Award one mark for each correct response.
1	(a)	(ii)	Drawbacks: <ul style="list-style-type: none"> • Difficult to generate enough electricity as compared to generation by fossil fuels. • Reliability of supply when you are dependent on the sun shining, the wind blowing, biomass, geothermal, tides or hydro systems. • Sustainable energy is more expensive relative to other forms of production. 	1	Award one mark for correct response.
1	(a)	(iii)	Examples of combined power sources are: <ul style="list-style-type: none"> • 230 V AC Mains and Battery • 230 V AC Mains and Solar • Battery and Solar 	2	Award one mark for each power source.
1	(b)		$V = IR$ $= 3.3 \times 70$ $= 231 \text{ V}$	4	Award one mark for $V = IR$. Award one mark for 3.3×70 . Award one mark for 231. Award one mark for V. Award four marks for correct answer with no workings and accept 231 V or 231.
Total				10	

Question		Answer	Mark	Guidance
2	(a)		1	Award one mark for correct shape i.e.  and position of resistor.
2	(b)	Potential difference = $6 - 2 = 4 \text{ V}$	2	Award one mark for workings. Award one mark for 4V or 4. Award two marks for correct answer with no workings and accept 4 V or 4.
2	(c)	The resistor is used to: <ul style="list-style-type: none"> • limit the current through the LED • protect the LED 	2	Award one mark for 'limit the current' and one mark for 'protection'
2	(d)	A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it.	2	Award one mark for 'emits light' and one mark for 'when current flows through it'.
2	(e)	$R = V / I$ $= 4 / (20 \times 10^{-3})$ $= 200 \Omega$	3	Award one mark for $R = V / I$ Award one mark for workings. Award one mark for 200Ω or 200. Award three marks for correct answer with no workings and accept 200Ω or 200.
Total			10	

Question		Answer	Mark	Guidance												
3	(a)	<table border="1"> <thead> <tr> <th>Techniques</th> <th>Tick</th> </tr> </thead> <tbody> <tr> <td>Portable appliance testing</td> <td>✓</td> </tr> <tr> <td>Power supply unit</td> <td></td> </tr> <tr> <td>Truth tables</td> <td></td> </tr> <tr> <td>Use of residual current device</td> <td>✓</td> </tr> <tr> <td>Visual inspection of equipment</td> <td>✓</td> </tr> </tbody> </table>	Techniques	Tick	Portable appliance testing	✓	Power supply unit		Truth tables		Use of residual current device	✓	Visual inspection of equipment	✓	3	Award one mark for each correct tick.
Techniques	Tick															
Portable appliance testing	✓															
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3	(b)	<p>Half split method:</p> <ul style="list-style-type: none"> • Check that the electronic circuit is switched off. • Choose half of the circuit. • In this half, check that the connections are all good. • Test each component in this half – if they pass the test, the fault must be in the other half of the circuit. • Continue halving your search group until you find the fault. 	3	Award one mark for each correct point made up to a maximum of three marks.												
3	(c)	<p>Benefits will include:</p> <ul style="list-style-type: none"> • The circuit does not need to be physically constructed. • The simulation can be saved. • There is no need to stock components or test equipment • The process is less expensive • Modifications can be made quickly and more easily with simulated components • Easier to detect faults. • Range of input signals available. 	2	<p>Award one mark for each valid benefit up to a maximum of two marks.</p> <p>Accept other correct responses.</p>												

Question		Answer	Mark	Guidance
3	(d)	 <p>The answer section contains four separate plots on a grid, each with a label on the right:</p> <ul style="list-style-type: none"> Sine: A smooth, periodic wave oscillating between the top and bottom horizontal grid lines. Square: A square wave alternating between the top and bottom horizontal grid lines. Triangle: A periodic wave that increases linearly from the bottom to the top horizontal grid line and then decreases linearly back to the bottom. Sawtooth: A periodic wave that increases linearly from the bottom to the top horizontal grid line and then drops sharply back to the bottom. 	2	Award one mark for correct x axis and award one mark for correct y axis.
Total			10	

4	(a)*	<p>Level 3 (5–6 marks)</p> <ul style="list-style-type: none"> Detailed discussion showing a thorough understanding of the benefits of surface mounted components. Information is presented clearly and accurately, with correct use of appropriate technical language and engineering terminology. Accurate use of spelling, punctuation and grammar. <p>Level 2 (3–4 marks)</p> <ul style="list-style-type: none"> Adequate discussion showing some understanding of the benefits of surface mounted components. Information is presented clearly and with some accuracy. Appropriate technical language and engineering terminology is used on some occasions. Occasional errors in spelling, punctuation and grammar. <p>Level 1 (1–2 mark)</p> <ul style="list-style-type: none"> Basic discussion showing limited understanding of the benefits of surface mounted components. Information presented is basic and may be ambiguous or badly presented. There will be little or no use of technical language and engineering terminology. Errors of spelling, punctuation and grammar may be intrusive. <p>Level 0 (0 marks)</p> <ul style="list-style-type: none"> A response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at end of response. 	<p>Benefits can include:</p> <p>Smaller components are used. Fewer holes need to be drilled. Number of components per unit area is higher. Components can be placed on both sides of the circuit board. Small errors in component placement are corrected automatically. Lower initial cost and time of setting up for mass production. Simpler and faster automated assembly. Many SMT parts cost less than equivalent through-hole parts. Better mechanical performance under shock and vibration conditions. Lower resistance and inductance at the connection. Fewer unwanted RF signal effects and better and more predictable high-frequency performance.</p> <p>6</p> <p>Markers are reminded to use 'K' for knowledge and 'DEV' for development.</p>
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4	(b)		Manufacturing processes are: <ul style="list-style-type: none"> • Flow solder wave process • Pick and place robot • Manual component placement 	3	Award one mark for each correct response.
4	(c)		Any one item of test equipment from: <ul style="list-style-type: none"> • Power supply unit • Multimeter • Voltmeter • Ammeter • Ohmmeter • Continuity tester • Logic probe • Signal generator • Oscilloscope 	1	Award one mark for a correct response. Accept virtual or physical responses.
			Total	10	

Question		Answer	Mark	Guidance
5	(a)	Quantum tunnelling composite (QTC) Shape memory alloy (SMA) Thermochromic Shape memory plastics Piezoelectric materials Photochromic materials	2	Award one mark for each correct response.
5	(b)		4	Award one mark for correct connection 1. Award one mark for correct connection 4. Award one mark for correct connection 8. Award one mark for correct connection 2 and 6.
5	(c)	Pin 3 – Output	1	Award one mark for correct response.
5	(d)	regular square external An astable circuit will produce a regular signal in the form of a square wave, without the need for an external trigger.	3	Award one mark for each correct response.
Total			10	

Question			Answer	Mark	Guidance
6	(a)	(i)	Temperature sensor Smoke sensor	2	Award one mark for each correct response.
6	(a)	(ii)	Loudspeaker	1	Award one mark for correct response.
6	(a)	(iii)	Comparator	1	Award one mark for correct response.
6	(a)	(iv)	Temperature sensor	1	Award one mark for correct response.
6	(b)		The voltage rating on a capacitor is the maximum amount of voltage that a capacitor can safely be exposed to and can store.	2	Award one mark for 'maximum amount of voltage' and one mark for 'safely be exposed to and can store'.
6	(c)		Maximum = $120 + 10\%$ of 120 = $120 + 12$ = $132 \mu\text{F}$ Minimum = $120 - 10\%$ of 120 = $120 - 12$ = $108 \mu\text{F}$	3	Award one mark for workings for BOTH maximum and minimum. Award one mark for $132 \mu\text{F}$ or 132. Award one mark for $108 \mu\text{F}$ or 108. Award three marks for correct answers with no working and accept correct numerical answers with or without units.
Total				10	

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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