



Cambridge National

Engineering

Unit **R113**: Electronic principles

Level 1/2 Cambridge National Award/Certificate in Systems Control in Engineering

Mark Scheme for January 2018

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

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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations

Annotation	Meaning
	Blank page
	Vague
	Tick
	Noted but no credit given
	Repeat
	Knowledge
	Example/Reference
	Development
	Cross
	Benefit of doubt
	Unclear
	Level 3
	Level 2
	Level 1

Question			Answer	Mark	Guidance					
1	(a)		<table border="1"> <thead> <tr> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>Watt-hour (Wh) or kilowatt-hour (kWh) or joule (J)</td> </tr> <tr> <td>Volt (V)</td> </tr> <tr> <td>Hertz (Hz)</td> </tr> <tr> <td>Henry (H)</td> </tr> </tbody> </table>	Unit	Watt-hour (Wh) or kilowatt-hour (kWh) or joule (J)	Volt (V)	Hertz (Hz)	Henry (H)	4	<p>Award one mark for each correct unit.</p> <p>Accept correct unit abbreviations.</p>
Unit										
Watt-hour (Wh) or kilowatt-hour (kWh) or joule (J)										
Volt (V)										
Hertz (Hz)										
Henry (H)										
1	(b)	(i)	$R_1 = 2 \Omega$ and $R_2 = 3 \Omega$ $1/R = 1/R_1 + 1/R_2$ $1/R = 1/2 + 1/3$ $1/R = (2 + 3)/6$ $R = 6/5$ $R = 1.2 \Omega$	3	<p>Award one mark for: $1/R = 1/R_1 + 1/R_2$.</p> <p>Award one mark for workings.</p> <p>Award one mark for 1.2 or 1.2 Ω.</p> <p>Award three marks for correct answer 1.2 or 1.2 Ω. without working.</p>					
1	(b)	(ii)	$P = I^2R$ $I = V/R \quad 6 / 1.2 = 5 \text{ A}$ $P = 5^2 \times 1.2$ $P = 25 \times 1.2$ $P = 30 \text{ W}$	3	<p>Allow ecf from 1(b)(i) for R</p> <p>Award one mark for $P = I^2R$.</p> <p>Award one mark for workings.</p> <p>Award one mark for 30 or 30 W.</p> <p>Award three marks for correct answer 30 or 30 W without working.</p> <p>Accept other correct methods.</p>					
Total				10						

Question		Answer	Mark	Guidance
2	(a)	Differences between polarised capacitor (PC) and non-polarised capacitor (NPC): <ul style="list-style-type: none"> • PC must be connected into a circuit the correct way round • PC is usually larger than NPC • PC has a higher leakage current than NPC • PC has a lower frequency response than NPC 	2	Award two marks for one correct statement. Accept other correct responses.
2	(b) (i)	Polarised/electrolytic	1	Accept either correct response.
2	(b) (ii)	The shorter leg indicates the negative leg / cathode	1	
2	(c) (i)	The voltage rating on a capacitor is the maximum amount of voltage that a capacitor can safely be exposed to.	2	Award one mark for reference to 'maximum amount of voltage' and one mark for 'listed value'. Accept other correct responses
2	(c) (ii)	Tolerance is the maximum and minimum expected range in capacitance compared to its listed value.	2	Award one mark for reference to maximum and one mark for reference to minimum. Accept other correct responses
2	(d)	Maximum value = $100 + (20\% \text{ of } 100)$ = $100 + 20$ = $120 \mu\text{F}$. Minimum value = $100 - (20\% \text{ of } 100)$ = $100 - 20$ = $80 \mu\text{F}$.	2	Correct answer only with or without units.
Total			10	

Question			Answer	Mark	Guidance
3	(a)	(i)	Temperature sensor or Potentiometer	1	
3	(a)	(ii)	Heater	1	Correct answer only
3	(a)	(iii)	Comparator or X	1	
3	(a)	(iv)	Potentiometer	1	Correct answer only
3	(b)	(i)	X	1	Correct answer only
3	(b)	(ii)	Temperature sensor	1	Correct answer only
3	(b)	(iii)	Comparator	1	Correct answer only
3	(c)		<p>Reasons why the heater is not connected directly to the comparator:</p> <p>Because the current from the comparator is very low it would not turn the heater on. The heater is rated at 230 V 1000 W which gives a current of $I = P/V = 1000/230 = 4.4$ A. The relay is an electronically operated switch with voltage differences. The current flowing in the relay coil circuit causes the opening or closing of relay output contacts, switching the heater on or off.</p>	3	Three marks for explanation that includes three points. Allow two marks for single point fully explained
			Total	10	

Question		Answer	Mark	Guidance
4	(a)	SPDT – single pole double throw. DPDT – double pole double throw DPST – double pole single throw. SPST - single pole single throw	4	Award one mark for each correct response.
4	(b)*	<p>Level 3 (5–6 marks)</p> <ul style="list-style-type: none"> Detailed discussion showing a thorough understanding of the function and applications of a momentary action switch and a latching switch in electronic circuits. 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 function and applications of a momentary action switch and a latching switch in electronic circuits. Information is presented clearly 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 marks)</p> <ul style="list-style-type: none"> Basic discussion showing limited understanding of the function and applications of a momentary action switch and a latching switch in electronic circuits. 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 in 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. 	6	<p>Momentary switches are switches that don't save their state when you press the button.</p> <p>When you press the button the circuit is on.</p> <p>When you release the button the circuit is off.</p> <p>Discussion of applications could include:</p> <ul style="list-style-type: none"> keys on a keyboard doorbells anti-theft alarms laser pointers lifts microcontroller boards. <p>A Latching Switch is a switch that once triggered on stays on until the power that goes into it is removed or disabled. Unlike other switches, which operate only when pressed, latches remain on even after the button which triggers it is turned on. A latch, essentially, "latches on" and does not turn off until the power is completely removed from it. Pressing the button which triggers a latch has no effect to turn it off.</p>

Question			Answer	Mark	Guidance
					Many devices operate with latches, so they have widespread application within circuits. Think of the major applications of alarms, which function with latches. Once alarms are triggered, they remain on indefinitely, until the whole system is disabled. This is the case for most alarms, including burglar alarms and fire alarms.
			Total	10	

Question		Answer	Mark	Guidance
5	(a)	<p>Items of test equipment are:</p> <ul style="list-style-type: none"> • Power Supply Unit • Logic Probe • Signal Generator • Multimeter 	4	Award one mark for each correct item of test equipment up to a maximum of four marks.
5	(b)	<p>Up to six marks for a detailed description which could include:</p> <p>Selection of the correct mode on a multimeter e.g.:</p> <ul style="list-style-type: none"> • Turn the dial to Continuity Test mode / lowest setting of Ohms Ω possible. / Use the beep continuity tester. • Check the correct mode has been selected e.g. with the test probes separated, the multimeter display may show OL and Ω. When the probes touch notice the very low Ω reading. <p>Correct positioning / ordering of test leads e.g.:</p> <ul style="list-style-type: none"> • First insert the black test lead into the COM jack • Then insert the red lead into the V Ω jack . <p>Connection of test leads to component e.g.:</p> <ul style="list-style-type: none"> • With the circuit de-energized, • Connect the test leads across the component being tested. The positioning of the test leads doesn't matter. <p>Output of test e.g.:</p> <ul style="list-style-type: none"> • The digital multimeter will emit a sound if a continuity path is detected / if the circuit is open, the switch is in the OFF position and the digital multimeter will not emit sound. <p>Finishing the test e.g.:</p> <ul style="list-style-type: none"> • When testing is finished the test leads should be removed in reverse order. • Turn the multimeter OFF to preserve battery life. 	6	Accept other suitable points made.
Total			10	

Question		Answer	Mark	Guidance
6	(a)	Benefit stated of pick and place robots e.g.: <ul style="list-style-type: none"> • The production costs are reduced • More efficient/accurate/reliable/consistent • More work carried out in a shorter time • Quality and reliability are improved. • Takes up less floor space. • Very little waste made. • Can work 24/7 with low maintenance costs. • Workers are safer because they do not come into direct contact with materials or machines. • Multiple applications can be performed by one robot. 	6	Award one mark for each correct benefit up to a maximum of six. Accept other valid responses.
6	(b)	$I = P/V$ $= 2000/230$ $= 8.7 \text{ A}$	2	Award one mark for $I = P/V$ or 2000/230. Award one mark for 8.7 A or 8.7 or 8.7 with any unit. Award two marks for correct answer without workings.
6	(c)	$\text{Energy (W)} = Pt$ $= 4 \times 10$ $= 40 \text{ kWh}$	2	Award one mark for $W = Pt$ or 4×10 . Award one mark for 40 kWh or 40 or 40 with any unit. two marks for correct answer without workings. Award two marks for correct answer without workings.
Total			10	

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