

Cambridge National

Engineering

Unit **R113**: Electronic principles

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

Mark Scheme for January 2017

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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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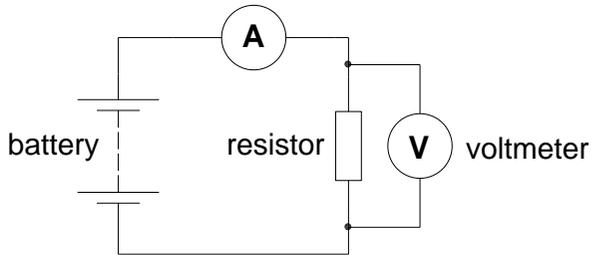
Question		Answer	Mark	Guidance
1	(a)	<p>Examples of power sources are:</p> <ul style="list-style-type: none"> • Battery • Mains • Solar • Generator • Power Adaptor • Power Pack/Bank • Combination of the above. 	2	<p>Award one mark for each correct response.</p> <p>Accept other correct responses.</p>
1	(b)	$I = V/R$ $= 9/6.8$ $= 1.32 \text{ A}$	2	<p>Award one mark for $I = V/R$ or $9/6.8$.</p> <p>Award one mark for an answer between 1.3A and 1.35A with or without the units.</p>
1	(c) (i)	$P = VI$ $= 12 \times 8$ $= 96 \text{ W}$	2	<p>Award one mark for $P = VI$ or 12×8.</p> <p>Award one mark for 96 W or 96.</p>
1	(d) (ii)	$W = Pt$ $= 500 \times 3$ $= 1500 \text{ Wh}$ $= 1.5 \text{ kWh}$ <p>OR</p> $W = Pt$ $= 500 \times 3 \times 60 \times 60$ $= 5400000 \text{ Ws} = 5400000 \text{ J} = 5400 \text{ kJ}$	2	<p>Award one mark for $W = Pt$ or 500×3.</p> <p>Award one mark 1500 Wh or 1.5 kWh with or without units.</p> <p>Award one mark for $W = Pt$ or $500 \times 3 \times 60 \times 60$</p> <p>Award one mark for 5400000 Ws or 5400000 J or 5400 kJ with or without units.</p>

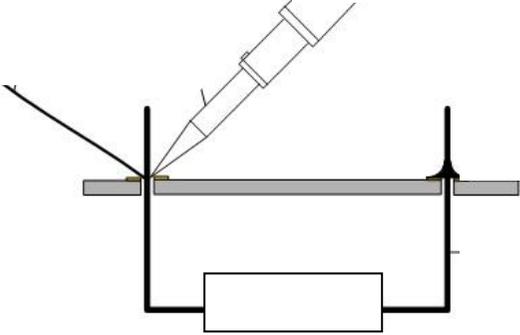
Question		Answer	Mark	Guidance
1	(e)	$24.2 = R_1 + 22$ Therefore $R_1 = 24.2 - 22$ $= 2.2 \Omega$	2	Award one mark for $24.2 = R_1 + 22$ or $R_1 = 24.2 - 22$. Award one mark for 2.2Ω or 2.2 .
Total			10	

Question		Answer	Mark	Guidance
2	(a)	A switch usually makes or breaks a circuit i.e. on or off; momentary switch is only on as long as your finger is on the switch. When the finger is removed from the switch the circuit is off. Examples <ul style="list-style-type: none"> • Doorbell - only rings while you are pressing the button • Burglar alarm test switch • Smoke alarm test switch • Push button on a video game controller • Buttons on a keyboard • Any keyboard switch 	2	Award one mark for the description and one mark for a correct example. Accept other correct examples.
2	(b)	Resistor Light dependent resistor / LDR Variable resistor Thermistor	4	Award one mark for each correct response.

Question			Answer	Mark	Guidance
2	(c)	(i)		1	Correct answer only.
		(ii)	<ul style="list-style-type: none"> • The fuse limits the current flow • The fuse will blow if the current exceeds the fuse rating with the benefit of avoiding electrocution and circuit damage • Relatively inexpensive • Readily available • Easily replaced • Available in different values 	2	Award one mark for each correct response. Accept other correct responses.
		(iii)	<ul style="list-style-type: none"> • Acts faster than a fuse • Can prevent electrocution • Can be reset • Gives a warning of potential faults by repeated tripping 	1	Accept other correct responses.
			Total	10	

Question		Answer	Mark	Guidance																									
3	(a)	<ul style="list-style-type: none"> Moisture sensor Pressure switch Touch Screen 	3	Award one mark for each correct tick ✓ up to three marks.																									
3	(b)	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">NAND gate output</td> <td style="width: 50%; border: none;">XOR gate output</td> </tr> <tr> <td style="border: none;">1</td> <td style="border: none;">0</td> </tr> <tr> <td style="border: none;">1</td> <td style="border: none;">1</td> </tr> <tr> <td style="border: none;">1</td> <td style="border: none;">1</td> </tr> <tr> <td style="border: none;">0</td> <td style="border: none;">0</td> </tr> </table>	NAND gate output	XOR gate output	1	0	1	1	1	1	0	0	2	Award one mark for each correct column.															
NAND gate output	XOR gate output																												
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3	(c) (i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> </tr> </tbody> </table>	A	B	C	D	E	0	0	1	1	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0	1	2	Award one mark for correct columns C and D . Award one mark for correct column E
A	B	C	D	E																									
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1	0	0	1	1																									
1	1	0	0	1																									
	(ii)	OR gate	1																										
	(d)	<ul style="list-style-type: none"> QTC is a composite material that varies its electrical resistance according to the pressure being applied to it Without any pressure the composite is an insulator i.e. switch open With pressure the composite becomes a conductor so a current can flow i.e. switch closed. 	1 1	Accept other correct responses.																									
Total			10																										

Question		Answer	Mark	Guidance
4	(a)	Test equipment : Voltmeter Ohm-meter Multi-meter Oscilloscope Sweep generator Logic probe Ammeter Continuity tester Power supply unit Signal generator Wattmeter	3	Award one mark for each correct response. Accept other correct responses.
4	(b)	 <p>The diagram shows a series circuit containing a battery, an ammeter (A), and a resistor. A voltmeter (V) is connected in parallel across the resistor. Labels 'battery', 'resistor', and 'voltmeter' are placed near their respective components.</p>	4	Award one mark for each item correctly connected.
4	(c)	A voltage regulator generates a fixed output voltage, 1 mark. of a preset magnitude, 1 mark. that remains constant regardless of changes to its input voltage or load conditions, 1 mark.	3	Award one mark for reference to generates a fixed output voltage. Award one mark for reference to preset magnitude. Award one mark for reference to remains constant regardless of changes to its input voltage or load conditions.
Total			10	

Question	Answer	Mark	Guidance
5 (a)	 <ul style="list-style-type: none"> • Fit resistor tight against the PCB and bend the legs to prevent movement. • Make sure that the soldering tip is clean and tinned. • Hold the soldering iron like a pen, near the base of the handle. Touch the tip of the soldering iron onto the joint to be soldered. • Apply a small amount of solder onto the joint. • Remove the solder from the joint. • Remove the soldering iron from the joint. • Do not disturb the joint. • Check that the resistor is firmly in position and that the solder is shiny and looks like a volcano shape. 	6	<p>Diagram</p> <p>Award one mark for a correctly positioned resistor.</p> <p>Award one mark for joints being of the correct shape and position.</p> <p>Award up to four marks for any four stages in the correct sequence.</p>

Question		Answer	Mark	Guidance
5	(b)		4	<p>Award one mark for each of the following:</p> <ul style="list-style-type: none"> a 6 V battery for the supply a 10 K variable resistor connected to the inverting terminal of the operational amplifier (op amp) a 5 K variable resistor connected to the non-inverting terminal of the op amp a light emitting diode (LED) with a 470 R protective resistor as an output device.
Total			10	

Question		Answer	Mark	Guidance
6	(a)		4	<p>Award one mark for each correct label i.e. feedback path, input, output and process.</p>

Question	Guidance	Mark	Answer
<p>6 (b)*</p>	<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 photodiodes and phototransistors 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 photodiodes and phototransistors in electronic circuits. • 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>6</p>	<p>Discussion points.</p> <p>A photodiode is a transducer that takes light energy and converts it into electrical energy. Examples of photodiode applications.</p> <p>Camera Light meters, automatic shutter control, auto-focus and flash control.</p> <p>Medical CAT scanners - X ray detection, particle blood analyser and pulse meter.</p> <p>Safety Equipment Smoke detectors, flame monitors, security inspection equipment - airport X ray and intruder alert - security system.</p> <p>Automotive Headlight dimmer, twilight detectors and climate control - sunlight detector.</p> <p>Communications Fibre optic links, optical communications and optical remote control.</p> <p>Industry Bar code scanners, light pens, brightness controls, encoders, position sensors, surveying instruments and toner in photocopiers.</p>

Question	Guidance	Mark	Answer
	<p>Level 1 (1–2 mark)</p> <ul style="list-style-type: none"> • Basic discussion showing limited understanding of the function and applications of photodiodes and phototransistors 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 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>Discussion points.</p> <p>A Phototransistor is an electronic switching and current amplification component which relies on exposure to light to operate. When light falls on the junction, reverse current flows which is proportional to the luminance.</p> <p>Examples of phototransistor applications. Coin counters, position sensors – joysticks, remote controllers - toys, appliances, audio/visual equipment and games - laser tag.</p> <p>Medical Provide electrical isolation between patient and equipment and monitor intravenous injection rates.</p> <p>Accept other correct responses.</p>
	Total	10	

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