

Answers

Answer 1

7(a)	<p>For each task: One mark for correct state One mark for suitable reason</p> <ul style="list-style-type: none"> • Temperature: ready • Reason: waiting for the 10 seconds to be finished • Windspeed: running • Reason: it is currently recording the windspeed • Sending: blocked • Reason: it is waiting for the internet connection 	6
7(b)	<p>Any four from:</p> <ul style="list-style-type: none"> • Uses a timer // uses two timers • Each timer is continually checked to see if 10 seconds has passed • ...if it has, an interrupt is sent to the OS • ...OS checks interrupt status • ...and may pass control to the interrupt handling routine • (If 10 seconds has passed) then the ISR switches process state to running/ready • When finished it passes control back to OS • The timer is restarted 	4

Answer 2

9(a)

2

501	1	1	1	1	1	1	1	1	Door 1
502	0	0	0	0	0	0	0	0	Door 2
503	0	0	0	0	0	0	0	0	Door 3
504	1	1	1	1	1	1	1	1	Door 4
505	0	0	0	0	0	0	0	0	Door 5
506	0	0	0	0	0	0	0	0	Door 6
507	1	1	1	1	1	1	1	1	Door 7
508	0	0	0	0	0	0	0	0	Door 8

One mark for open doors correct
One mark for closed doors correct

9(b)(i)

4

Instruction			ACC	501
Label	Op code	Operand		
CHECK1:	LDD	500	&AA	
	AND	&80	&80	
	CMP	&00		
	JPE	DOOR1		
	LDM	&FF	&FF	
DOOR1:	STO	501		&FF
	WAIT			
	LDM	&00	&00	
	STO	501		&00
	WAIT			
	JMP	CHECK1		

Two marks for all values of ACC correct

Or

One mark for 3 values of ACC correct**Two** marks for both values of 501 correct

Or

One mark for one value of 501 correct

9(b)(ii)	<table border="1"> <thead> <tr> <th colspan="3">Instruction</th></tr> <tr> <th>Label</th><th>Op code</th><th>Operand</th></tr> </thead> <tbody> <tr> <td>CHECK2 :</td><td>LDD</td><td>500</td></tr> <tr> <td></td><td>AND</td><td>&40</td></tr> <tr> <td></td><td>CMP</td><td>&00</td></tr> <tr> <td></td><td>JPE</td><td>DOOR2</td></tr> <tr> <td></td><td>LDM</td><td>&FF</td></tr> <tr> <td>DOOR2 :</td><td>STO</td><td>502</td></tr> <tr> <td></td><td>WAIT</td><td></td></tr> <tr> <td></td><td>LDM</td><td>&00</td></tr> <tr> <td></td><td>STO</td><td>502</td></tr> <tr> <td></td><td>WAIT</td><td></td></tr> <tr> <td></td><td>JMP</td><td>CHECK2</td></tr> </tbody> </table> <p> One mark for correct LDM values One mark for correct AND value One mark for correct labels and jumps One mark for fully correct code </p>	Instruction			Label	Op code	Operand	CHECK2 :	LDD	500		AND	&40		CMP	&00		JPE	DOOR2		LDM	&FF	DOOR2 :	STO	502		WAIT			LDM	&00		STO	502		WAIT			JMP	CHECK2	4
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	STO	502																																							
	WAIT																																								
	JMP	CHECK2																																							
9(c)	<ul style="list-style-type: none"> • Either the value in 500 is always zero which means the light is off • Or it alternates between zero (light off) and 1 (light on) every second 	2																																							

Answer 3

7(a)	108 kilometres 10.25 litres Load unstable	3																											
7(b)	<p>One mark for 801 correct One mark for 802 correct One mark for 803 correct</p> <table><tr><td>801</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>802</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>803</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table>	801	0	1	1	1	1	0	0	0	802	1	0	0	0	1	1	0	1	803	1	0	0	1	0	0	0	0	3
801	0	1	1	1	1	0	0	0																					
802	1	0	0	0	1	1	0	1																					
803	1	0	0	1	0	0	0	0																					

7(c)(i)	Loading 0 and storing in 801 and 802 Loading 240 ...and storing in 803 LDM #0/B00000000/&(0)0 STO 801 STO 802 LDM #240/B11110000/&F0 STO 803	3
7(c)(ii)	&40 / #64 / B01000000 &20 / #32 / B00100000 TEMP CHECKLOAD	4

Answer 4

8(a)	44 kilometres 5.125 litres Low battery	3																											
8(b)	One mark for 601 correct One mark for 602 correct One mark for 603 correct <table><tr><td>601</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>602</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>603</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr></table>	601	0	1	0	1	0	0	0	0	602	0	0	1	1	1	0	1	0	603	0	0	0	0	1	0	1	0	3
601	0	1	0	1	0	0	0	0																					
602	0	0	1	1	1	0	1	0																					
603	0	0	0	0	1	0	1	0																					
8(c)(i)	1 mark per bullet point <ul style="list-style-type: none">Storing 0 in 601 and 602Loading the correct pattern for 603... Storing in 603 <div><div>LDM &00 /#0 / B00000000 STO 601 STO 602 LDM B00001111 /#15 /&0F STO 603</div><div>}</div></div>	3																											
8(c)(ii)	&02 / #2 / B00000010 &04 / #4 / B00000100 TEMP CHECKFLAGS	4																											

Answer 5

6(a)	1 mark per bullet point (max 3) <ul style="list-style-type: none"> ∞ To ensure that the system operates within the given criteria ∞ By enabling system output to affect subsequent system inputs ∞ Thus enabling the system to <u>automatically</u> adjust conditions ∞ Suitable example of feedback 	3
6(b)	1 mark per bullet point <ul style="list-style-type: none"> ∞ Sensors <u>continually</u> measure the temperature of the <u>water</u> in the swimming pool ∞ The (stream of) readings are sent to a processor and compared with 28 degrees ∞ If the reading is out of range (by a system set amount) then actuators turn the heater/cooler on or off as necessary ∞ Feedback ensures that the water temperature remains close to 28 degrees 	4
6(c)	1 mark for example of monitoring system, max 2 for explanation <ul style="list-style-type: none"> ∞ Suitable example identified ∞ Use of data captured ∞ No feedback as there is no output that could change the system environment <p>For example:</p> <ul style="list-style-type: none"> ∞ Monitoring the rainfall ∞ The amount of rainfall collected over a specific time is measured ∞ There is no output to change the level of rainfall or ∞ Security camera ∞ Sending pictures to control room ∞ No changes made to environment by system 	3

Answer 6

6	1 mark for identifying hardware, 1 mark for the purpose to max 2 hardware devices. <ul style="list-style-type: none"> ∞ Moisture sensor ... ∞ ... to <u>measure</u> the level of moisture in the <u>soil</u> ∞ Humidity sensor ... ∞ ...to <u>measure</u> the level of moisture in the <u>air</u> ∞ Pressure/Precipitation sensor ... ∞ ...to <u>measure</u> the amount of rainfall ∞ Actuator ... ∞ ...to turn the sprinklers on/off ∞ Analogue to Digital Converter/ADC ... ∞ ...to convert analogue signal <u>from a sensor</u> to a digital value that can be stored / recorded 	4
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Answer 7

5(a)	<p>1 mark per bullet point to max 2</p> <ul style="list-style-type: none"> Monitoring only gathers information but control systems also perform actions Output in a control system can affect the input There is no feedback in a monitoring system // a control system relies on feedback Example of monitoring applied to the weather station 	2
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Answer 8

7(a)	control system // monitoring and control system	1																								
7(b)	<p>1 mark for identifying hardware, 1 for purpose to max 4 for 2 hardware devices</p> <p>For example:</p> <ul style="list-style-type: none">∞ actuator/relay/switch (1) to turn a heater/fan on or off (1)∞ heater (1) to heat the museum (1)∞ fan (1) to cool the museum (1)∞ analogue to digital converter (1) to convert analogue signal <u>from sensor</u> to a digital value that can be stored/manipulated (1)∞ transmission hardware//cable (1) to transfer data/signals (1)∞ processor (1) to manage the temperature control (1)∞ Visible/audible warning device (1) to give warning to a human if temperature is at a dangerous level (1)	4																								
7(c)(i)	<p>1 mark per bullet</p> <ul style="list-style-type: none">∞ Temperature reading is 179∞ reading in room 5∞ has been processed	3																								
7(c)(ii)	<p>1 mark for each 8 bits</p> <div><table><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr></table><p>Byte 1</p></div> <div><table><tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table><p>Byte 2</p></div>	1	1	1	0	1	1	1	0	7	6	5	4	3	2	1	0	0	0	0	1	0	0	0	0	2
1	1	1	0	1	1	1	0																			
7	6	5	4	3	2	1	0																			
0	0	0	1	0	0	0	0																			

Answer 9

6(a)	<p>2 marks for all 5 single lines correct, 1 mark for 4 lines correct otherwise zero</p> <p>Scenario</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Car speed display</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Aeroplane autopilot</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Rollercoaster</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Recording the rainfall at a weather station</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Robot loading a part onto a conveyer belt</div> </div> <p>System</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Control</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">Monitoring</div> </div>	2
6(b)	<p>1 mark for identifying hardware, 1 for purpose to max 6 for 3 hardware devices</p> <ul style="list-style-type: none"> temperature sensor/thermistor (1) measures current temperature (1) thermostat (1) measures current temperature automatically turns heater on/off (1) actuator/relay/switch (1) to turn a heater/fan on or off (1) heater (1) to heat the water in the tank(s) (1) fan (1) to cool the water in the tank(s) (1) analogue to digital converter (1) to convert analogue signal <u>from sensor</u> to a digital value that can be stored/manipulated (1) transmission hardware/cable (1) to transfer data/signals (1) processor (1) to manage the temperature control (1) Visible/audible warning device (1) to give warning <u>to a human</u> if temperature is at a dangerous level (1) 	6
6(c)(i)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> temperature reading in fish tank number 3 temperature is 11 has not been processed 	3
6(c)(ii)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> Byte 1: 10010000 Byte 2: 11111110 	2
6(d)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> LDD 6753 OR #B00010000 / #16 / #&10 STO 6753 	3

Answer 10

6(a)(i)	Control system	1
6(a)(ii)	Use of actuators means that the system is controlling	1

Answer 11

6(c)(v)	AND #B0000001000000000 // AND #0200 // AND #512 Op code Operand	2
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Answer 12

6(a)(i)	Monitoring system	1
6(a)(ii)	There is no element of 'control' in the system // the system does not alter conditions in the building if sensors triggered	1
6(a)(iii)	Any two sensors from: Sound / acoustic Pressure Infra-red / motion /proximity Temperature / Thermal Light Smoke Tilt	Max 2

Answer 13

6(a)(i)	Control system	1
6(a)(ii)	System is controlling devices // turns heaters on and off // use of actuators maintain the environment // makes use of feedback	1
6(b)	Computer/microprocessor ... to process the sensor readings Analogue to digital convertor ... <u>Sensor</u> produces analogue signal but processor requires digital data Digital to analogue convertor ... <u>Processor</u> produces digital signal but actuator may require analogue sign Actuator ... May be required to turn heater on or off 1 mark for device, 1 mark for justification, max 2 devices	4

6(c)(i)	One mark per column excluding LOWTEMP	4																																																																																
	<table><tr><th>LOWTEMP</th><th>LOWREG</th><th>COUNTER</th><th>ACC</th><th>IX</th></tr><tr><td>15</td><td>B00000000</td><td>1</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td>0</td></tr><tr><td></td><td></td><td></td><td>17</td><td></td></tr><tr><td></td><td></td><td></td><td>1</td><td></td></tr><tr><td></td><td></td><td></td><td>2</td><td></td></tr><tr><td></td><td></td><td>2</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td>1</td></tr><tr><td></td><td></td><td></td><td>14</td><td></td></tr><tr><td></td><td></td><td></td><td>B00000000</td><td></td></tr><tr><td></td><td>B00000010</td><td></td><td>B00000010</td><td></td></tr><tr><td></td><td></td><td></td><td>2</td><td></td></tr><tr><td></td><td></td><td></td><td>4</td><td></td></tr><tr><td></td><td></td><td>4</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td>2</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table>	LOWTEMP	LOWREG	COUNTER	ACC	IX	15	B00000000	1							0				17					1					2				2							1				14					B00000000			B00000010		B00000010					2					4				4							2						
LOWTEMP	LOWREG	COUNTER	ACC	IX																																																																														
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6(c)(ii)	<ul style="list-style-type: none">∞ COUNTER has an initial value of 1∞ Test for final value is before COUNTER updated∞ COUNTER is doubled in value each time around loop∞ six sensors values/bits to check∞ COUNTER is doubled in value 6 times // 2⁵∞ Values of COUNTER at test will therefore be 1 – 2 – 4 – 8 – 16 – 32 <p style="text-align: right;">1 mark for valid point, max 2</p>	2																																																																																
6(c)(iii)	<ul style="list-style-type: none">∞ Load the contents of LOWREG into ACC∞ Check bit position in LOWREG∞ For each of the least significant 6 bits∞ Use AND operation / mask to isolate a bit∞ Jump to code corresponding to bit being looked at∞ if value of bit is 1∞ Send signal to appropriate actuator to turn on the heater <p style="text-align: right;">1 mark for valid point, max 3</p>	3																																																																																

Answer 14

6(a)	<p>One mark for suitable sensor, one mark for justification Max one sensor, max two marks</p> <p>humidity ... to ensure that the plants have the right level of moisture in the air</p> <p>pressure / proximity ... to detect whether the windows are open or closed condone 'check'</p> <p>moisture ... to ensure the water levels in the soil are correct</p> <p>light ... to ensure the light levels in the greenhouse are correct for plant growth ... to ensure the windows are closed when night falls</p> <p>Accept pH sensor for one mark only</p> <p>Accept CO₂ sensor for one mark only, accept gas or O₂ for one mark only</p> <p>Justification needs to answer the question why? Not just describe the sensor</p> <p>Accept suitable actions resulting from sensor readings as justification</p>	2
6(b)	<p>Three from:</p> <ul style="list-style-type: none"> ∞ Actions taken by system // or by example: e.g. adjust heater / turn on sprinkler / open windows ∞ May affect the readings taken by the sensors // or by example ∞ Which in turn may cause a change in the actions taken by the system // or by example ∞ This is a continuous process... 	3
6(c)(i)	<p>One from:</p> <ul style="list-style-type: none"> ∞ Lowest allowable temperature ∞ Highest allowable temperature ∞ Sampling time interval 	1

6(c)(ii)	<p>If answer to c(i) is highest allowable or lowest allowable temperature:</p> <p>∞ The sensor reading is compared to a stored parameter (1)</p> <p>∞ Depending upon result of comparison an action may or may not be carried out (1)</p> <p>If answer to c(i) is sampling time interval:</p> <p>∞ The higher the sampling rate... (1)</p> <p>∞ ...The better / more efficient is the control system (1)</p>	2
6(d)(i)	20	1
6(d)(ii)	<pre>LDD 4002 // load the contents of the 16 bit location containing the value for Sensor 5 into the Accumulator LSR #8 // move the bits in the Accumulator so that the Accumulator stores the value of Sensor 5 as unsigned 16-bit binary integer</pre> <p>1 mark for 4002</p> <p>1 mark for LSR</p> <p>1 mark for #8</p>	3

Answer 15

6 (a) (i)	Monitoring system	1
(ii)	<p>This is not a 'feedback' system //</p> <p>There is no 'control' taking place/use of actuators //</p> <p>No output other than from alarm</p>	1
(b)	<p>Examples:</p> <p>Pressure ...</p> <p>If intruder steps on sensor</p> <p>Infra-red ...</p> <p>If beam cut by intruder</p> <p>Motion / ultrasonic...</p> <p>Detects any movement in an area</p> <p>Contact / magnetic ...</p> <p>If door / window opened</p>	<p>1 – sensor</p> <p>1 – justification</p> <p>Maximum 2 sensors</p> <p>Max 4</p>

(c) (i)	temperature reading in location 5 has been processed	1 1
(ii)	0100 0000 1111 1011 1 mark per byte	2
(d) (i)	AND #B00010000 // AND #&10 // AND #16 1 mark for AND, 1 mark for address mode, 1 mark for mask, 1 mark for indication of numbering system	1 + 1 + 1 + 1
(ii)	OR #B00000001 // OR #&01 // OR #1 1 mark for OR, 1 mark for mask	1 +1