



National 5
coursework
assessment task



National 5 Engineering Science Assignment Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by Qualifications Scotland appointed markers when marking external course assessments.

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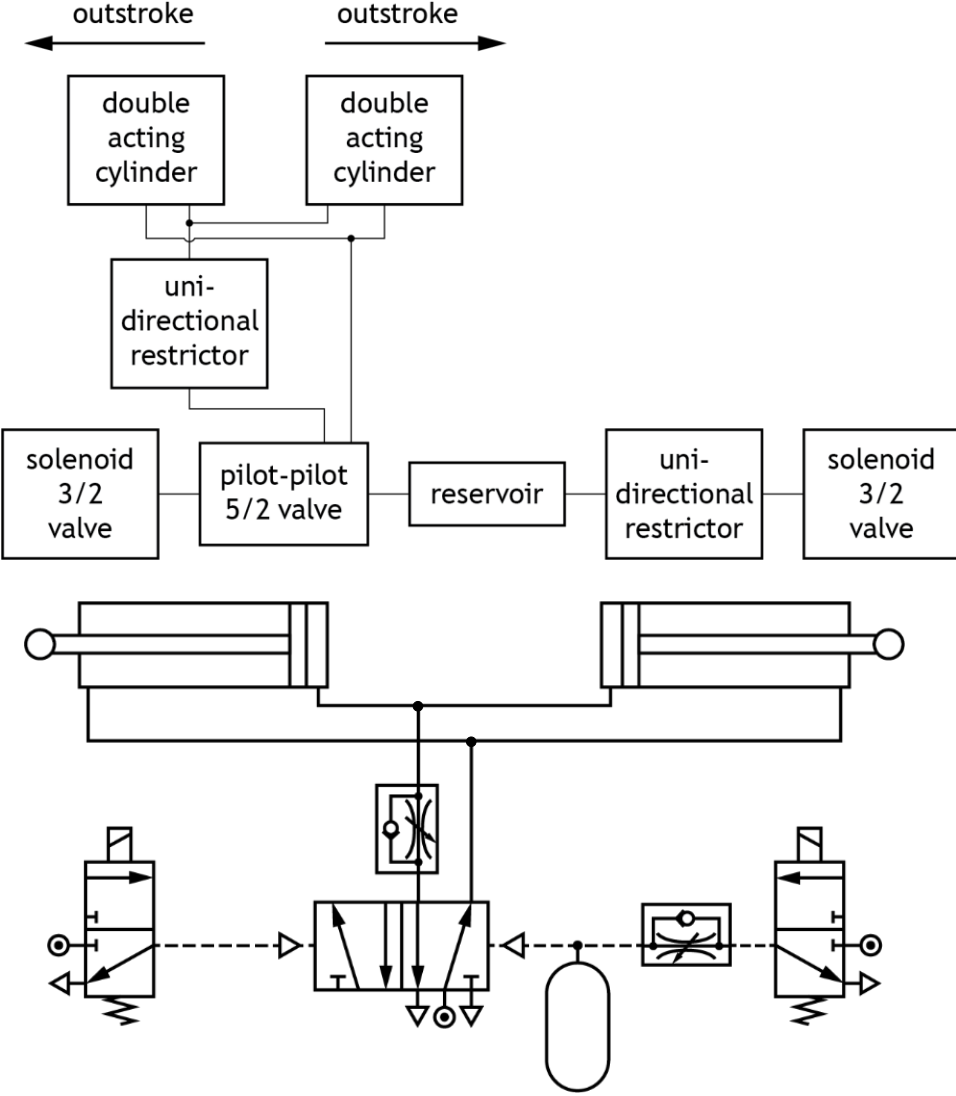


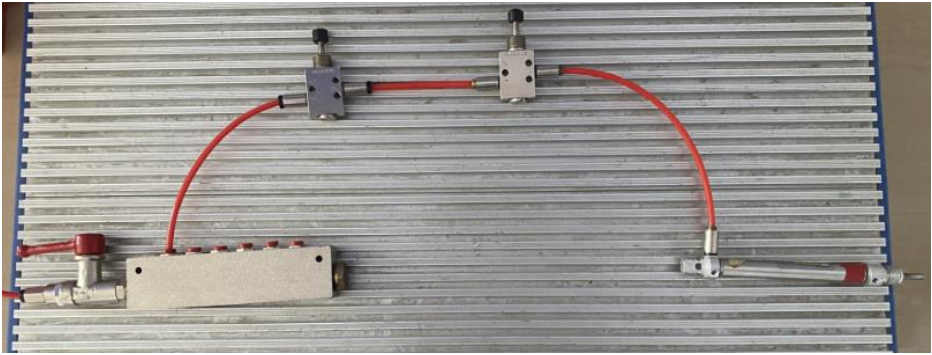
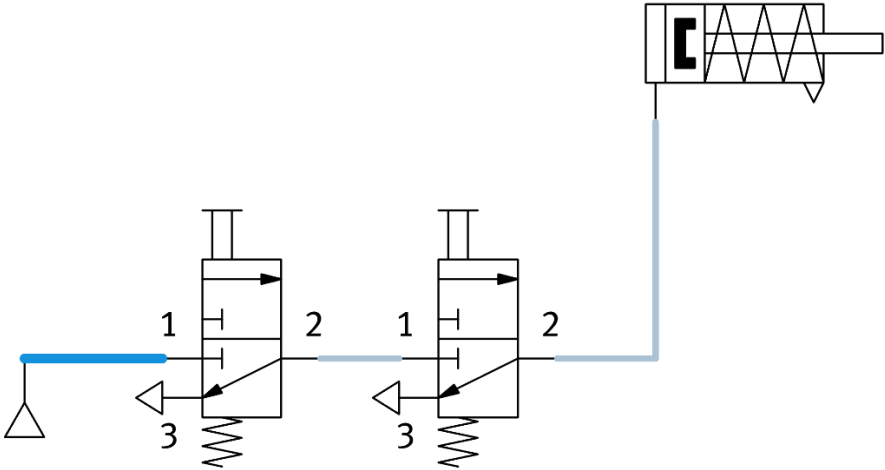
General marking principles

This information is provided to help you understand the general principles that must be applied when marking candidate responses in this assignment. These principles must be read in conjunction with the detailed/specific marking instructions, which identify the key features required in candidate responses.

- a Marks for each candidate response must always be assigned in line with these general marking principles and the specific marking instructions for this assessment.
- b Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.
- c If a specific candidate response is not covered by either the general marking principles or detailed marking instructions, you must seek guidance from your team leader.

Detailed marking instructions

Task	Expected answer(s)	Max mark	Additional guidance
1 a		5	• 2x 3/2 valves piped to change state of 5/2 valve (1 mark) • Solenoid actuators on all 3/2 valves connected to 5/2 valve (1 mark) • pilot - pilot 5/2 valve piped to both double acting cylinder ports (1 mark) • adjustable time delay components correctly piped to 5/2 valve to change state for instroke (1 mark) • uni-directional restrictor(s) to slow the exhaust air from both pistons when instroking (1 mark) Accept block diagram, circuit diagram (or a hybrid) or constructed/simulated. Accept components identified by name or symbols. (eg UDR) Ignore uni-directional restrictor orientation. Connections between components and valves must be shown. Ignore line types and port to port piping. Accept restrictor/UDR when piped to 5/2 instroking exhaust port.

Task	Expected answer(s)	Max mark	Additional guidance
1 b	 	2	Simulation/construction evidence shown. • piping a 3/2 valve including main air directly to a second 3/2 valve in series (1 mark) • piping of second 3/2 valve to single-acting cylinder (1 mark) Accept the use of any 3/2 valve actuator.

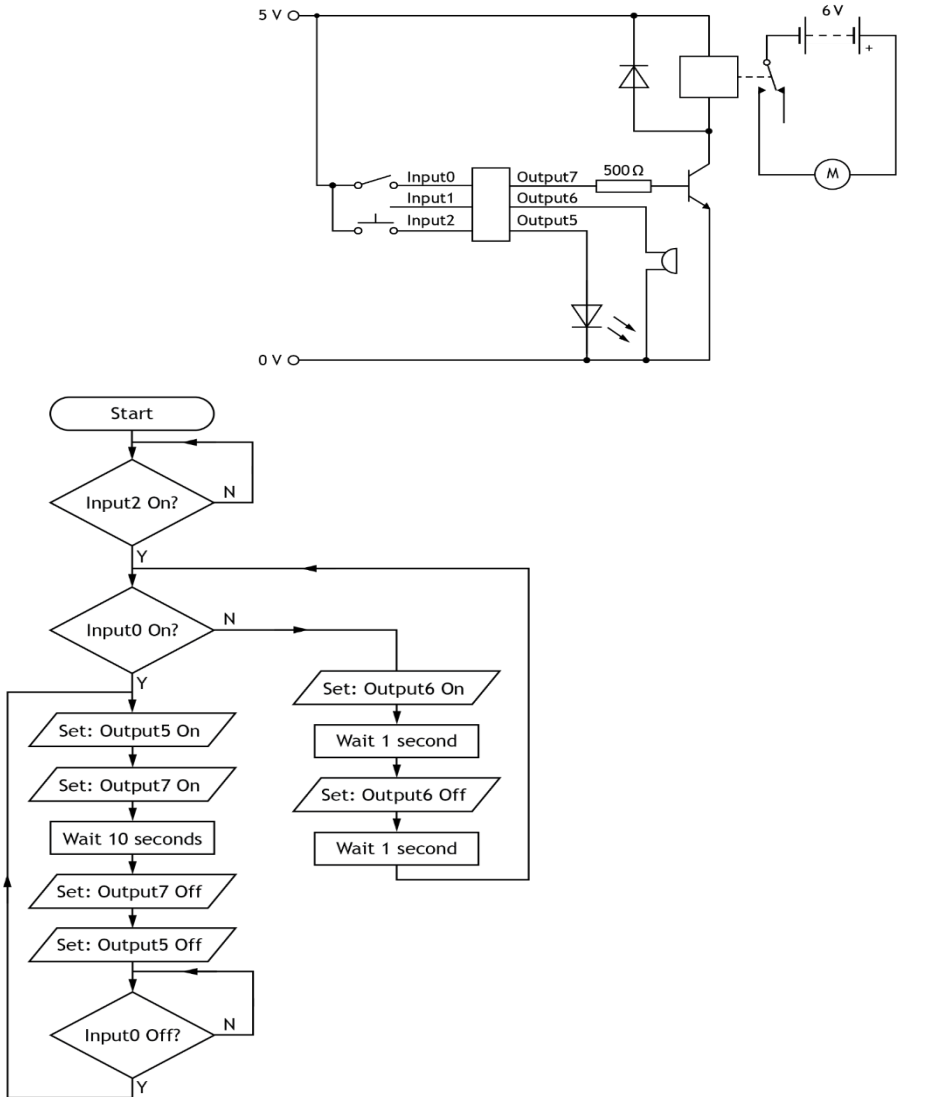
Task			Expected answer(s)			Max mark	Additional guidance
1	c		Planned test	Expected result	Test result	3	Apply FTE from Task 1b. If no evidence of simulation/construction for Task 1b then award 0 marks. - Test 1 result - piston does not outstroke (1 mark) - Test 2 result - piston does not outstroke (1 mark) - Test 3 result - piston outstrokes (1 mark)
			Test 1 Actuate valve 1 only	The piston should outstroke	The piston does not outstroke.		
			Test 2 Actuate valve 2 only	The piston should outstroke	The piston does not outstroke.		
			Test 3 Actuate valve 1 and valve 2 at the same time	The piston should outstroke	The piston outstrokes.		

Task			Expected answer(s)			Max mark	Additional guidance
1	d		Specification point	Met? Yes/No	Explanation	3	Apply FTE based on Task 1c test results. Explanation response with cause and related effect. - state that specification i was not met and identify valve 2 blocking the air flow, stopping the outstroke of the piston (1 mark) - state that specification ii was not met and identify valve 1 blocking the air flow, stopping the outstroke of the piston (1 mark) - state that specification iii was met and identify that actuating both valves allows air to flow, outstroking the piston (1 mark)
			i.	No	The air is blocked by valve 2... therefore the piston does not outstroke.		
			ii.	No	The air is blocked by valve 1... therefore the piston does not outstroke.		
			iii.	Yes	Air flows through both valve 1 and valve 2... therefore the piston outstrokes.		

Task			Expected answer(s)	Max mark	Additional guidance
2	a	i	 <pre> graph LR A[outside temperature] --> C[overdoor heater] B[user input] --> C C --> D[heat] C --> E[light] </pre>	2	• (outside) temperature input (1 mark) Accept low temperature as an input. Do not accept electricity/electrical (energy) as an input. • heat (energy) and light (energy) as individual outputs (1 mark) Input/outputs can be stated or inferred. Do not accept input or output components. Ignore additional boxes.

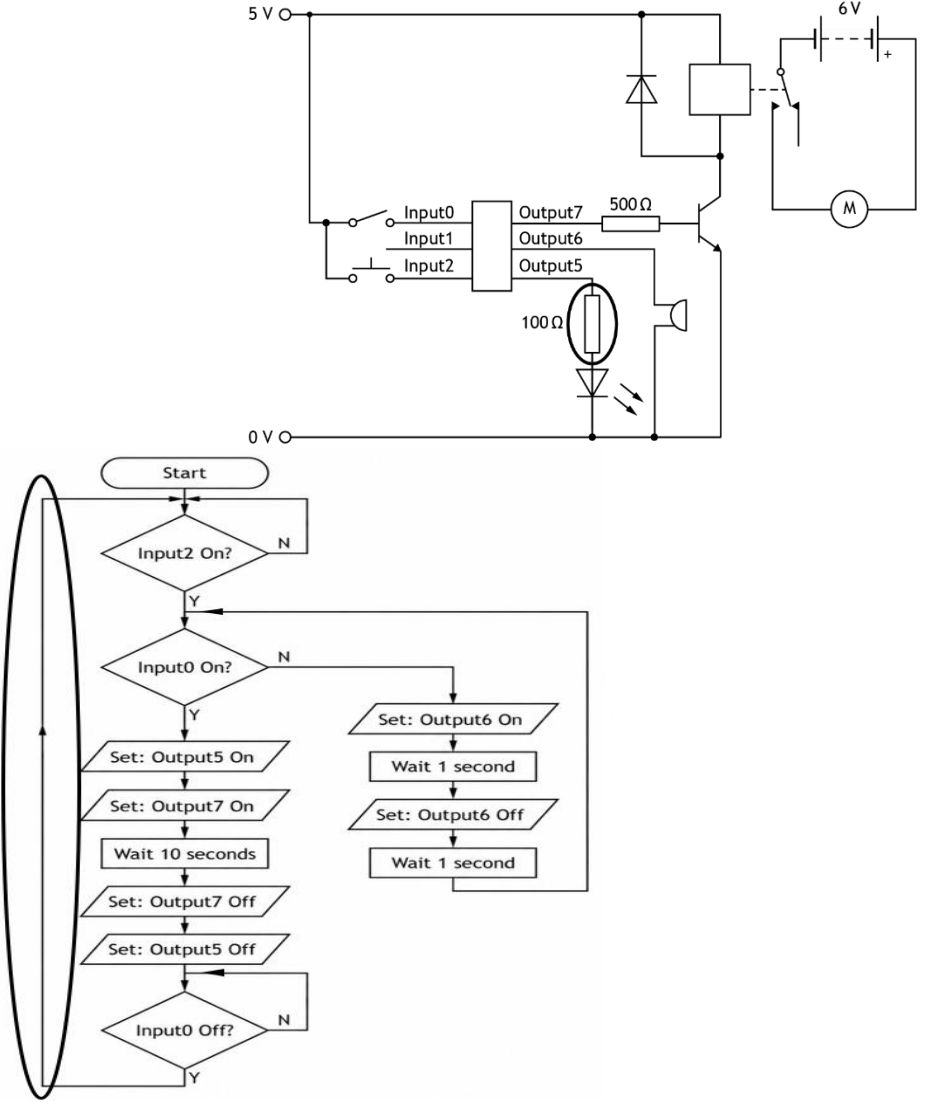
Task			Expected answer(s)	Max mark	Additional guidance
2	a	ii	<pre> graph LR OT[outside temperature] --> TS[temperature sensor] UI[user input] --> S[switch] S --> MC[micro-controller] MC --> D1[driver] MC --> D2[driver] D1 --> H[heater] H --> heat[heat] D2 --> L[lamp] L --> light[light] subgraph SystemBoundary [] TS MC D1 H end </pre>	6	Sub-systems (temperature sensor, driver, heater, lamp) must be in boxes to be awarded a mark. - input and outputs stated in Task 2a(i) for each device (1 mark) - temperature sensor as input sub-system, connected to the microcontroller (1 mark) - one driver per output, individually connected to the microcontroller (1 mark) - heater connected in output position (1 mark) (indicator) lamp connected in output position (1 mark) - system boundary around sub-systems only (1 mark) Apply FTE for input and outputs from Task 2a(i). Do not accept an action for sub-system (eg heater on). Ignore additional sub-systems.

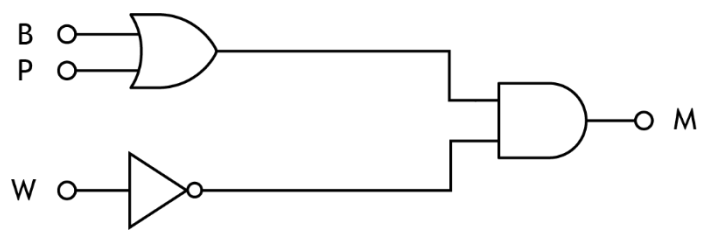
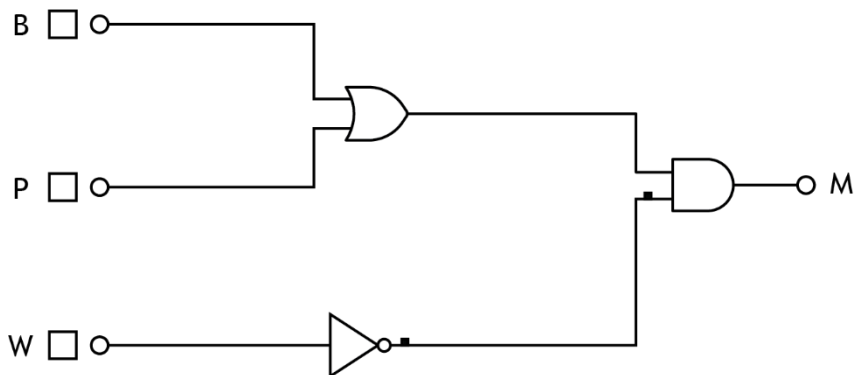
Task			Expected answer(s)			Max mark	Additional guidance
2	b		Specification point	Met? Yes/No	Justification	3	- state that specification i was met and refer to a thermistor being used (1 mark) - state that specification ii was not met and refer to V_{out} increasing when temperature increases or V_{out} decreasing when temperature decreases (1 mark) - state that specification iii was not met and refer to a (fixed) resistor not allowing for (manual) adjustment (1 mark) Do not accept amendments as justifications.
			i.	Yes	A thermistor has been used.		
			ii.	No	V_{out} increases when temperature increases. OR V_{out} decreases when temperature decreases.		
			iii.	No	A fixed resistor does not allow for V_{out} to be manually adjusted.		

Task	Expected answer(s)	Max mark	Additional guidance
3 a	 The circuit diagram shows a microcontroller with three inputs (Input0, Input1, Input2) and four outputs (Output5, Output6, Output7, and an unlabeled output). Input0 is connected to a switch. Input1 and Input2 are connected to a 5V supply through resistors. Output5 is connected to a 500Ω resistor and a green LED. Output6 is connected to a 5V supply through a 500Ω resistor and a red LED. Output7 is connected to a 5V supply through a 500Ω resistor and a blue LED. The unlabeled output is connected to a 6V battery through a switch and a motor (M). <pre> graph TD Start([Start]) --> Input2_On{Input2 On?} Input2_On -- N --> Input2_On Input2_On -- Y --> Input0_On{Input0 On?} Input0_On -- N --> Set_Output6_On[/Set: Output6 On/] Set_Output6_On --> Wait_1s_1[Wait 1 second] Wait_1s_1 --> Set_Output6_Off[/Set: Output6 Off/] Set_Output6_Off --> Wait_1s_2[Wait 1 second] Wait_1s_2 --> Input0_On Input0_On -- Y --> Set_Output5_On[/Set: Output5 On/] Set_Output5_On --> Set_Output7_On[/Set: Output7 On/] Set_Output7_On --> Wait_10s[Wait 10 seconds] Wait_10s --> Set_Output7_Off[/Set: Output7 Off/] Set_Output7_Off --> Set_Output5_Off[/Set: Output5 Off/] Set_Output5_Off --> Input0_Off{Input0 Off?} Input0_Off -- N --> Set_Output6_On Input0_Off -- Y --> Input2_On </pre>	5	Electronic circuit - all components selected and connections attempted (1 mark) - correct wiring, microcontroller pin numbers and connections, component orientations, and component values (1 mark) If pin numbers are not visible on microcontroller, refer to flowchart. Flowchart - correct symbols (to the software) with all connections as shown (1 mark) - all correct pin numbers (FTE from circuit), pin states, decisions, and time delays (1 mark) Accept use of any other microcontroller type. Integration - flowchart and electronic circuit (1 mark)

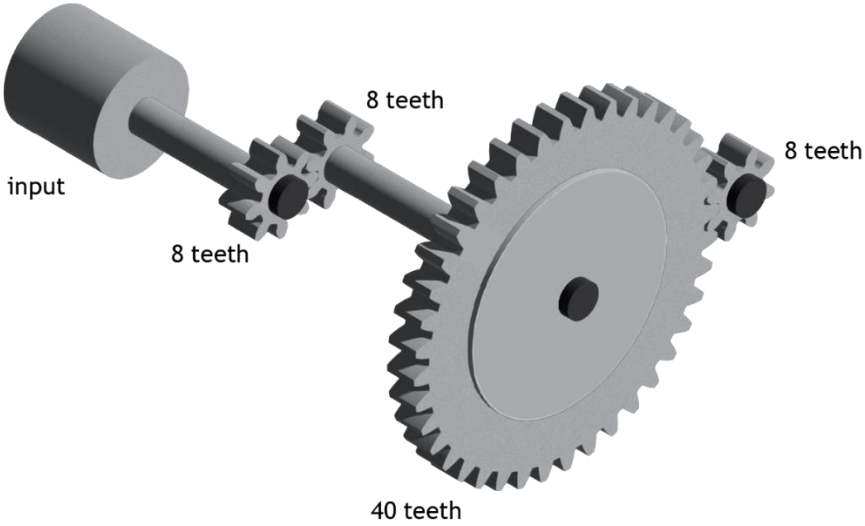
Task			Expected answer(s)	Max mark	Additional guidance
3	b		PBasic: main: label0: if Input2 is On then label1 goto label0 label1: if Input0 is On then label2 Switch on 6 pause 1000 Switch off 6 pause 1000 goto label1 label2: Switch on 5 Switch on 7 pause 10000 Switch off 7 Switch off 5 label3: if Input0 is Off then label2 goto label3 goto label2 C++ (Arduino): void loop() { if (digitalRead(IN_2) == HIGH) { if (digitalRead(IN_0) == HIGH) { digitalWrite(OUT_5, HIGH); digitalWrite(OUT_7, HIGH); delay(10000); digitalWrite(OUT_7, LOW); digitalWrite(OUT_5, LOW); if (digitalRead(IN_0) == LOW) { } else { } } } } digitalWrite(OUT_6, HIGH); delay(1000); digitalWrite(OUT_6, LOW); delay(1000); }	1	If no flowchart is shown in Task 3a, award 0 marks. code to fully match the flowchart, including pin numbers, in Task 3a (1 mark) Accept manually written or automatically generated. Any high-level language acceptable.

Task			Expected answer(s)					Max mark	Additional guidance
3	c		Planned test	Expected result	Initial test result	Planned amendment to circuit/ flowchart	Re-test result	4	Apply FTE from Task 3a. If no (or partial) evidence for Task 3a, then marks should be awarded for planned amendments and re-test results, up to a maximum of 2 marks, based on evidence from Task 3d. If no evidence of simulation for Task 3a and Task 3d, then award 0 marks. Test 2 - initial test result. The LED is destroyed and the motor turns on for 10 seconds before slowing down and stopping (1 mark) - description of amendment to circuit and appropriate re-test result (1 mark) Test 3 - initial test result. The system does not return to the start/the LED and motor turn on again for 10 seconds (1 mark) - description of amendment to flowchart and appropriate re-test result (1 mark)
			Test 1 Press the start switch.	The buzzer will sound for 1 second and then switch off for 1 second.	The buzzer sounded for 1 second and then switched off for 1 second.	No amendments required.	No retest required		
			Test 2 Press the luggage sensor switch.	The LED and motor turn on for 10 seconds before slowing down and stopping.	The LED is destroyed and the motor turns on for 10 seconds before slowing down and stopping.	Connect a (suitable protective) resistor in series with the LED.	The LED and the motor turn on for 10 seconds before slowing down and stopping.		
			Test 3 Release the luggage sensor switch.	The system should return to the start.	System does not return to the start/ the LED and motor turn on again for 10 seconds.	Move the input 0 off yes decision back to the start of the sequence.	The system returns to the start.		

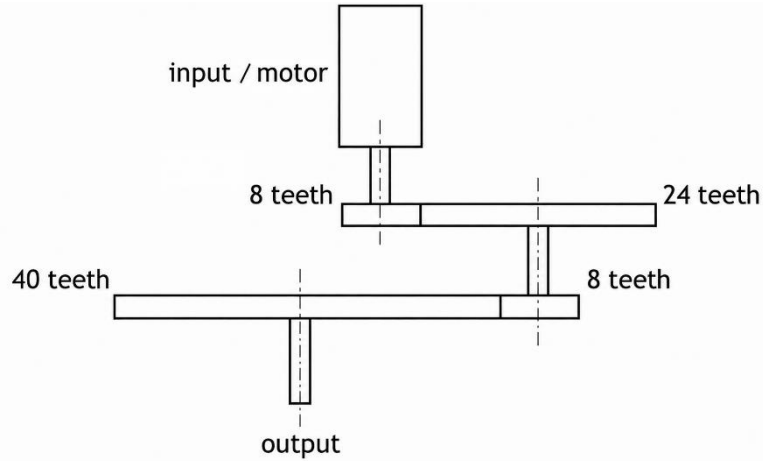
Task	Expected answer(s)	Max mark	Additional guidance
3 d	 The circuit diagram shows a 5V supply connected to three inputs (Input0, Input1, Input2) of a PLC. The PLC has three outputs: Output5, Output6, and Output7. Output5 is connected to a 100Ω resistor and an LED. Output6 is connected to a 500Ω resistor and a relay coil. Output7 is connected to a 500Ω resistor and a relay coil. The relay is a double-throw switch controlled by a 6V battery. The relay's common terminal is connected to a 6V supply, and its normally open terminal is connected to a motor (M). The normally closed terminal is connected to a 0V supply. The flowchart starts with a 'Start' oval, leading to a decision diamond 'Input2 On?'. If 'Y' (Yes), it proceeds to a decision diamond 'Input0 On?'. If 'Y', it sets Output5 On, then Output7 On, waits 10 seconds, sets Output7 Off, sets Output5 Off, and then checks 'Input0 Off?'. If 'Y', it loops back to the 'Input2 On?' decision. If 'N' (No) at 'Input0 On?', it sets Output6 On, waits 1 second, sets Output6 Off, and waits 1 second before looping back to the 'Input2 On?' decision. If 'N' at 'Input2 On?', it loops back to the 'Start' oval.	2	Markers should take account of simulation evidence from Task 3a and testing evidence from Task 3c. Apply FTE. - proposed circuit amendment carried out/ inclusion of appropriate value resistor (1 mark) - proposed flowchart amendment carried out/ loop back to start (1 mark)

Task			Expected answer(s)	Max mark	Additional guidance
4	a		 <pre> graph LR B((B)) --- OR1[OR] P((P)) --- OR1 OR1 --- AND1[AND] W((W)) --- NOT1[NOT] NOT1 --- AND1 AND1 --- M((M)) </pre>	3	If simulated/constructed award 0 marks. - OR gate with inputs B and P connected (1 mark) - NOT gate with input W connected (1 mark) - AND gate with inputs from OR and NOT gates and connected to M (1 mark)
	b		 <pre> graph LR B[]((B)) --- OR1[OR] P[]((P)) --- OR1 OR1 --- AND1[AND] W[]((W)) --- NOT1[NOT] NOT1 --- AND1 AND1 --- M((M)) </pre>	1	Apply FTE from Task 4a. If no evidence for Task 4a, award 0 marks. all three gates wired correctly with suitable labelled inputs to allow for testing (1 mark) If constructed using ICs, components must be clearly labelled.

Task			Expected answer(s)				Max mark	Additional guidance
4	c						1	Apply for FTE from circuit in Task 4b. • column M (1 mark) If no simulation/construction in Task 4b, no mark awarded. If suitable inputs not shown in Task 4b, no mark awarded.
			B	P	W	M		
			0	0	0	0		
			0	0	1	0		
			0	1	0	1		
			0	1	1	0		
			1	0	0	1		
			1	0	1	0		
			1	1	0	1		
			1	1	1	0		

Task			Expected answer(s)	Max mark	Additional guidance
5	a			2	- compound gear train simulated or constructed, with input to allow for testing (1 mark) - all gear teeth sizes shown to match given gear train (1 mark) Accept handwritten gear numbers.

Task		Expected answer(s)				Max mark	Additional guidance						
5	b		<table><tr><th>Planned test 1</th><th>Input direction</th><th>Output direction</th></tr><tr><td>Observe and record the direction of the input and output gears.</td><td>anti-clockwise</td><td>anti-clockwise</td></tr></table>		Planned test 1	Input direction	Output direction	Observe and record the direction of the input and output gears.	anti-clockwise	anti-clockwise		3	Apply FTE from Task 5a. No evidence of simulation/construction in Task 5a, only 1 mark can be awarded for calculated velocity ratio. Planned test 1 - input and output gears turn in same direction (1 mark) Planned test 2 - input speed, and output speed correct to the gear sizes evidenced in Task 5a (1 mark) - actual velocity ratio from input and output speeds (1 mark) Accept velocity ratio given as a fraction or decimal value. Units not required.
		Planned test 1	Input direction	Output direction									
		Observe and record the direction of the input and output gears.	anti-clockwise	anti-clockwise									
			<table><tr><th>Planned test 2</th><th>Input speed/turns</th><th>Output speed/turns</th><th>Actual velocity ratio</th></tr><tr><td>Measure the input speed (or number of turns) and output speed (or number of turns) of the gear system and calculate the actual velocity ratio.</td><td>25 revs min⁻¹</td><td>125 revs min⁻¹</td><td>1:5</td></tr></table>		Planned test 2	Input speed/turns	Output speed/turns	Actual velocity ratio	Measure the input speed (or number of turns) and output speed (or number of turns) of the gear system and calculate the actual velocity ratio.	25 revs min ⁻¹	125 revs min ⁻¹		
Planned test 2	Input speed/turns	Output speed/turns	Actual velocity ratio										
Measure the input speed (or number of turns) and output speed (or number of turns) of the gear system and calculate the actual velocity ratio.	25 revs min ⁻¹	125 revs min ⁻¹	1:5										

Task			Expected answer(s)	Max mark	Additional guidance									
5	c		<table><tr><th>Specification point</th><th>Met? Yes/No</th><th>Justification</th></tr><tr><td>i.</td><td>Yes</td><td>Both (input and output) gears turn in the same direction.</td></tr><tr><td>ii.</td><td>No</td><td>The speed of the output gear was increased rather than decreased. OR Velocity ratio is 1:5, so not between 7:1 and 12:1.</td></tr></table>	Specification point	Met? Yes/No	Justification	i.	Yes	Both (input and output) gears turn in the same direction.	ii.	No	The speed of the output gear was increased rather than decreased. OR Velocity ratio is 1:5, so not between 7:1 and 12:1.	2	Apply FTE from Task 5b. - state that specification i. was met and refer to direction of rotation of the input and output gears (1 mark) - state that specification ii. was not met and compare increase in output speed/velocity ratio with specification (1 mark) Justification must refer to speeds or velocity ratio given in Task 5b.
Specification point	Met? Yes/No	Justification												
i.	Yes	Both (input and output) gears turn in the same direction.												
ii.	No	The speed of the output gear was increased rather than decreased. OR Velocity ratio is 1:5, so not between 7:1 and 12:1.												
	d			2	If simulated/constructed award 0 marks. - compound gear train (1 mark) - input labelled, and correct gear teeth numbers to give a speed reduction of 15-25 inclusive (1 mark) Accept calculation as evidence of sizes.									

[END OF MARKING INSTRUCTIONS]