Higher
Coursework
Assessment Task

Higher Engineering Science
Assignment
Marking instructions

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General marking principles

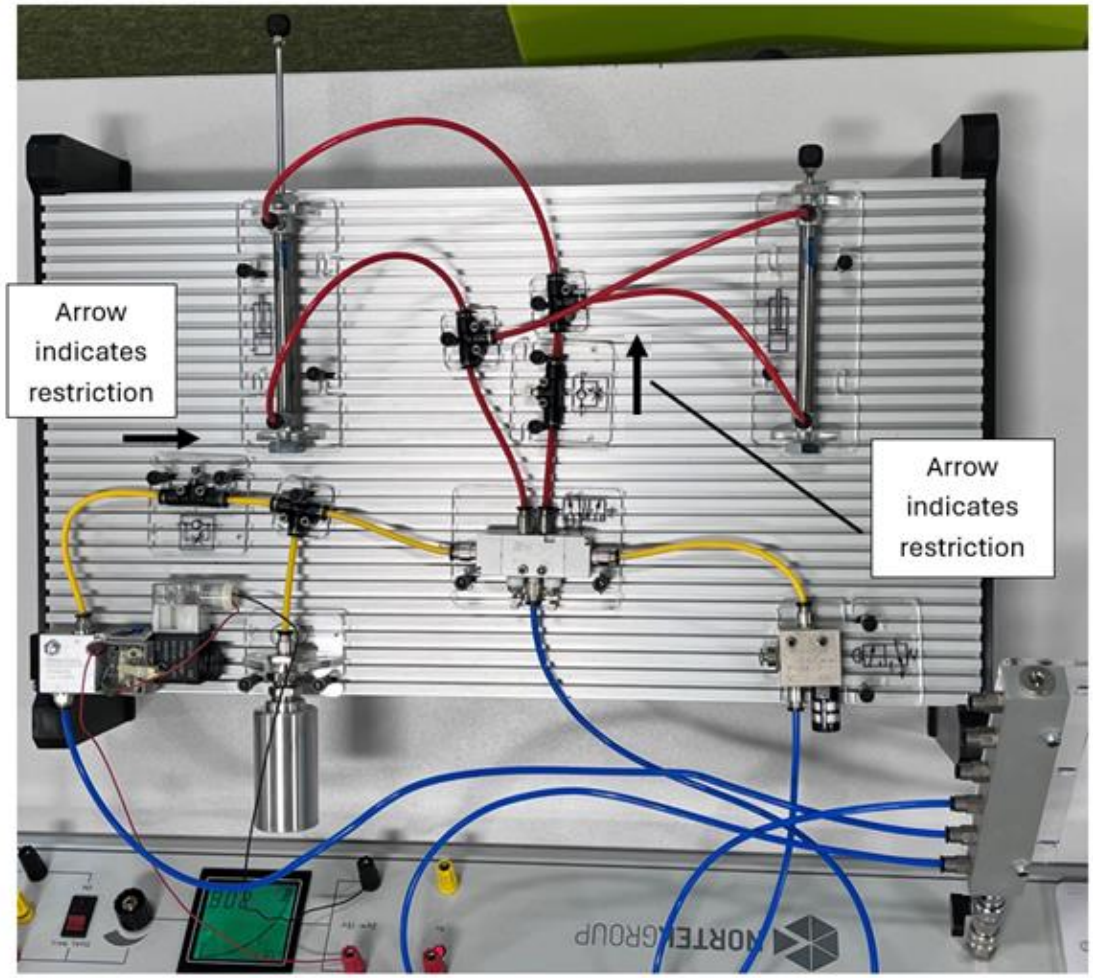
This information is provided to help you understand the general principles that must be applied when marking candidate responses in this assignment. These principles must be read in conjunction with the detailed/specific marking instructions, which identify the key features required in candidate responses.

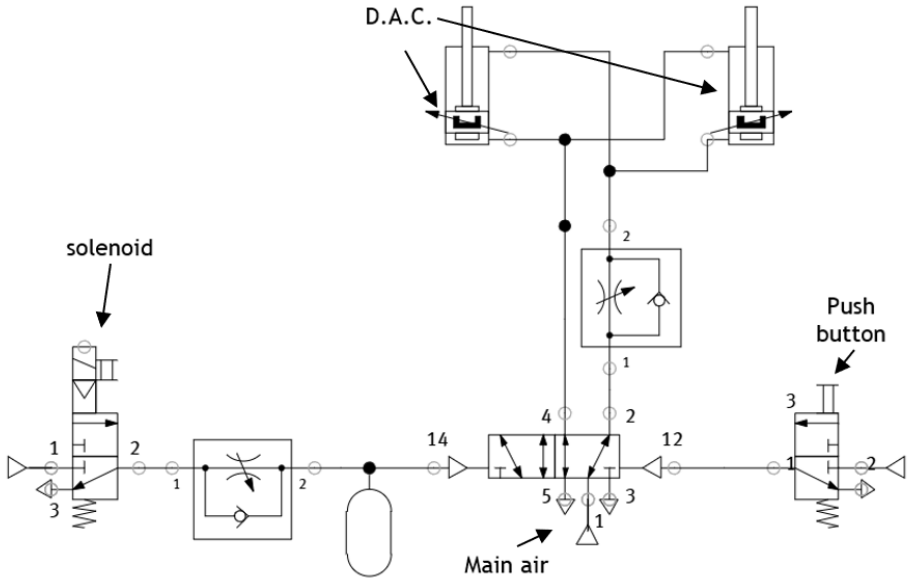
a Marks for each candidate response must always be assigned in line with these general marking principles and the specific marking instructions for this assessment.

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			4	Two 3/2 valves with correct actuators, correctly connected. Substituted actuators must be labelled. **(1 mark)** 5/2 valve with unidirectional restrictor B correctly orientated. **(1 mark)** **Maximum one mark for the above if any of the main air or exhaust connections are missing.** Unidirectional restrictor A correctly orientated, in correct order with reservoir, connected correctly to 5/2 valve. **(1 mark)** Two double-acting cylinders connected correctly. **(1 mark)**

Task			Expected answer(s)	Max mark	Additional guidance
1	a	(continued)			
					Diagram shown is an example of one available simulation software – other diagrams produced from other software may differ. If software uses different standards/symbols, these must be annotated for clarity.

<table>
<tr><th colspan="3">Task</th><th>Expected answer(s)</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>1</td><td>b</td><td></td><td>
<table>
<tr><th>Actual result</th><th>Amendments made</th></tr>
<tr><td>Cylinder X is in the instroke position.
Cylinder Y is in the outstroke position.</td><td>Swap pipe connections for cylinder Y.</td></tr>
<tr><td>Both cylinders start from instroke position and outstroke when actuated.</td><td>No amendment required.</td></tr>
<tr><td>The time delay for the cylinder outstroke changes each time.</td><td>No amendments required.</td></tr>
<tr><td>When outstroked, both double-acting cylinders instroke more slowly each time.</td><td>Re-connect UDR B to restrict exhaust air when instroking.</td></tr>
</table>
</td><td>6</td><td>Response should be descriptive.

Actual results and amendments from circuit given in 1a.

First actual result – must refer to both cylinders. (1 mark)
First amendment – can be supported by amended circuit (1 mark)

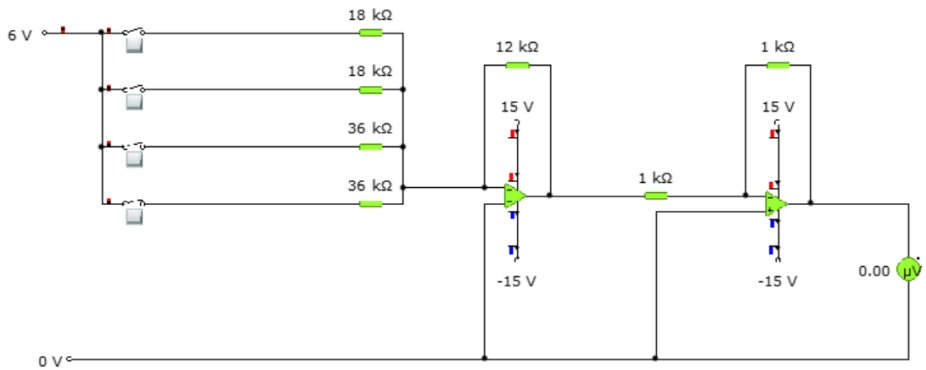
Second actual result. (1 mark)

Third actual result. (1 mark)

Fourth actual result. (1 mark)

Fourth amendment – to meet specification point 3 ‘slowly and smoothly’. (1 mark)</td></tr>
</table>

Task			Expected answer(s)	Max mark	Additional guidance
1	c		Specification point i: On initial connection to main air, one of the cylinders outstroked without the solenoid being energised. The piping was swapped on cylinder Y to allow both to outstroke simultaneously. Specification point ii: This operated as intended as during testing the time-delayed pilot signal was controllable therefore no amendments were required. Specification iii: Both cylinders instroked slowly but not smoothly. This was corrected by re-connecting unidirectional restrictor B in the exhaust line for both cylinders when instroking and in the correct orientation. On further testing, it was possible to instroke the two cylinders slowly and smoothly.	**3**	**1 mark** for each evaluative description for each specification point, referring to testing and any amendments made.

<table>
<tr><th colspan="3">Task</th><th>Expected answer(s)</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>1</td><td>d</td><td></td><td> 
</td><td>6</td><td>Four switches correctly connected. (1 mark)

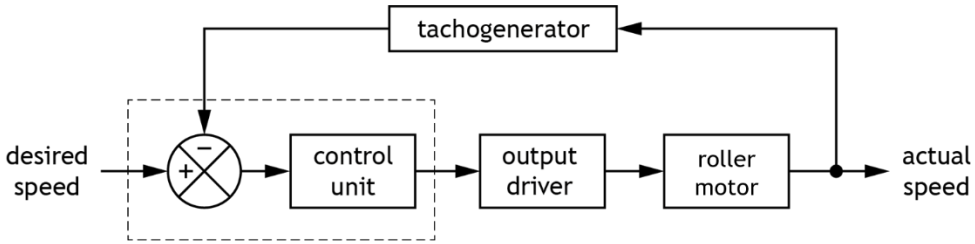
First op-amp in summing configuration.(1 mark)

Summing op-amp input resistors and feedback resistor values to give two pairs of different ratios, with one input pair double the other pair. (1 mark)

Second op-amp in inverting configuration. (1 mark)

Correct input and feedback resistor ratio for inverting amp to give correct output voltages based on summing op-amp design, with voltmeter to allow for testing. (1 mark)

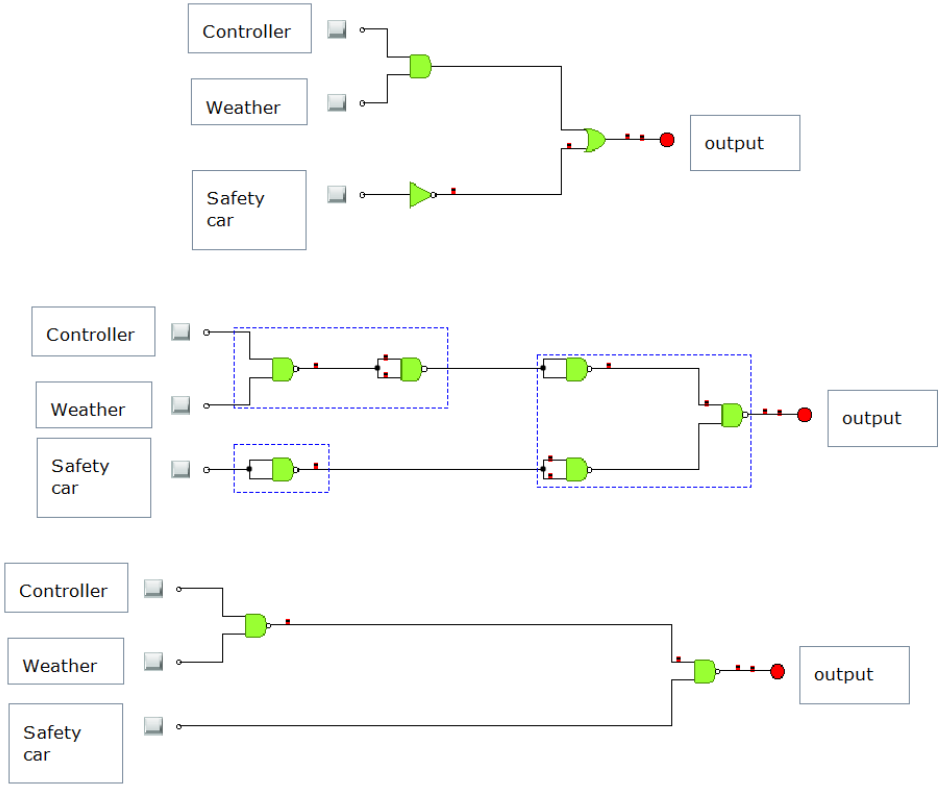
Appropriate V_{cc} values for both op-amps to achieve 12 V output. (1 mark)</td></tr>
<tr><td></td><td>e</td><td></td><td><table>
<tr><th>Planned test</th><th>Expected result</th></tr>
<tr><td>Close two switches to simulate sensing both front wheels only.</td><td>The output voltage will be + 4 V.</td></tr>
<tr><td>Close two switches to simulate sensing both rear wheels only.</td><td>The output voltage will be + 8 V.</td></tr>
<tr><td>Close four switches to simulate sensing all four wheels.</td><td>The output voltage will be + 12 V.</td></tr>
</table></td><td>3</td><td>1 mark awarded for each planned test and expected result (max 2 marks if only wheels referenced).</td></tr>
</table>

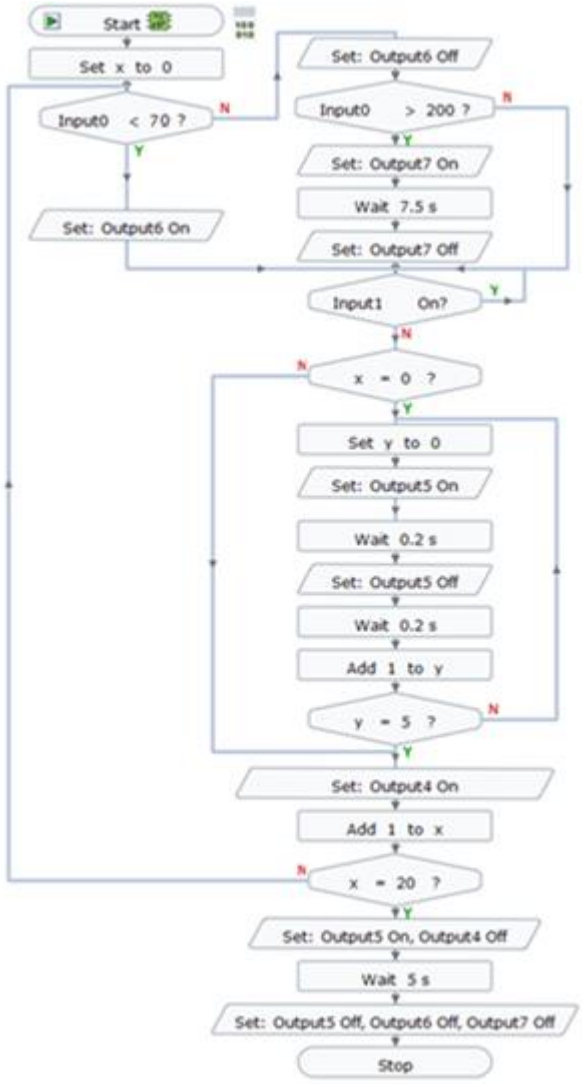
Task			Expected answer(s)	Max mark	Additional guidance
2				**6**	Error detector in negative configuration. **(1 mark)** Control unit. **(1 mark)** Accept ‘op-amp’ or ‘microcontroller’. Control boundary. **(1 mark)** Output driver. **(1 mark)** Accept ‘driver’. Roller motor. **(1 mark)** Accept ‘motor’ or ‘motorised roller’. Tachogenerator with correct interaction arrows. **(1 mark)**

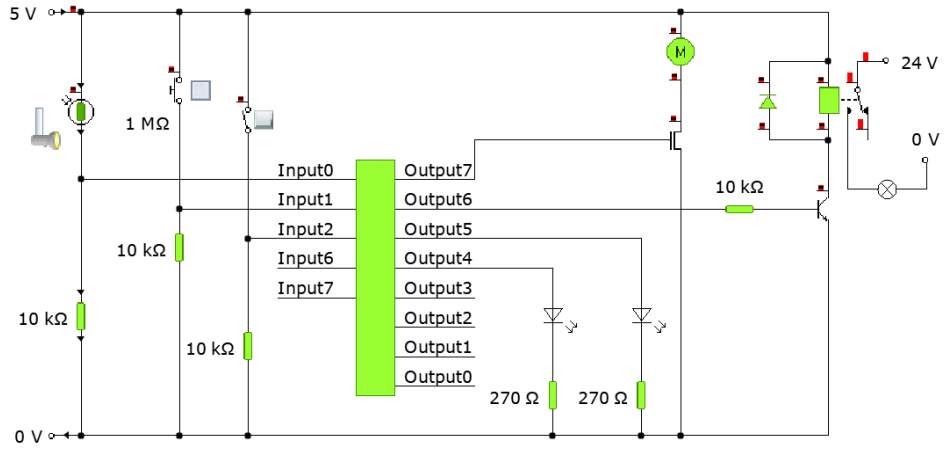
Task			Expected answer(s)	Max mark	Additional guidance
3	a		Specification i - strength: Material A, B and C are strong enough to meet the specification while material D is not. Specification ii – elasticity: Materials B, C and D are elastic enough to meet the specification while material A is not. Specification iii – energy absorption: Materials A, B and C all have relatively high energy absorption while material D does not. Specification iv – weight: Materials A, C and D are lightweight and therefore meet the specification while material B is heavyweight and does not.	**4**	**1 mark** awarded for each evaluative comment comparing all four materials against the specification point. Accept comparison of numerical values.
	b		Material C is the most appropriate choice of material, as it meets all of the specification points. It is strong enough, elastic enough, has high energy absorption properties and is lightweight.	**1**	Stating material C with appropriate justification with reference to at least three specification points. **(1 mark)**

Task			Expected answer(s)	Max mark	Additional guidance

4			*PBASIC*
			
			symbol mark = b1
			symbol space = b2
			symbol brake = B.***5***
			
			let mark = 10
			let space = ***40***
			
			label:
			if pin0 = 0 then label
			
			main:
			high brake
			pause mark
			low brake
			pause space
			goto ***label***
			
			Arduino C++
			
			int brake = ***5***
			int pin0 = 0
			
			void setup(){
			pinMode(brake,OUTPUT);
			pinMode(pin0,INPUT);
			}
			
			void loop()
			{
			if(digitalRead(pin0)==LOW){
			digitalWrite(brake,LOW;}
			else
			
			{
			digitalWrite(brake,HIGH);
			delay(10);
			digitalWrite(brake,LOW);
			delay(**40**);
			}
			}
				3	Correct pin 5 set up for brake. **(1 mark)**
					
					Appropriate mark:space ratio of 1:4. **(1 mark)**
					
					Correct loop to retest pin 0. **(1 mark)**
					
					Maximum 2 marks if additional amendments would prevent code from operating.
					
					Note: due to the nature of programming, there may be other methods of coding that will provide the same functionality.
					
					Note: ignore syntax errors.

Task			Expected answer(s)	Max mark	Additional guidance
5	a			3	**1 mark** total for initial logic circuit. **2 marks** total awarded for NAND equivalent circuit. **3 marks** total awarded for simpified NAND equivalent circuit (accept correctly scored through gates).

Task			Expected answer(s)	Max mark	Additional guidance
5	b			**5**	Correct flowchart. **(2 marks)** Maximum two errors. **(1 mark)**

Task			Expected answer(s)	Max mark	Additional guidance
5	**b**	**(continued)**			
					Correct input components and connections to microcontroller. **(1 mark)** Correct output connections for motor and both LEDs. **(1 mark)** Correct output components and connections from output pin 6. **(1 mark)**

<table>
<tr><th colspan="3">Task</th><th>Expected answer(s)</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>5</td><td>c</td><td></td><td>
<table>
<tr><th>Specification</th><th>Amendments</th></tr>
<tr><td>Specification ii:
If the reading from the light sensor is under 70 at the start of a new lap, track lighting turns on (and turns off again if the reading rises to 70 or more.</td><td>Reassign input 0 to an analogue input.</td></tr>
<tr><td>Specification iv:
When the race starts, a red LED flashes five times before turning off, and a green LED turns on.</td><td>Move the ‘No’ loop from the ‘Y = 5?’ decision to directly underneath ‘Y = 0’ .</td></tr>
<tr><td>Specification v:
The race controller’s start switch is checked once each lap, and if it is open the green LED turns off and the red LED turns on until this switch is closed again to resume racing.</td><td>Switch the ‘Yes’ and ‘No’ branches for ‘input 1 ON?’ decision box

and

add an output box from the ‘No’ branch to turn the green LED off and the red LED on.</td></tr>
<tr><td>Specification vi:
As the leading car completes a lap, a lap counter switch is pressed to count up to twenty laps.</td><td>Add a correctly connected decision box anywhere between ‘Output 4 = ON’ and ‘X = 20’ to check if ‘input 2 ON?’</td></tr>
</table>
</td><td>4</td><td>Note: amendment descriptions can be supported by amended circuit.

1st amendment. (1 mark)

2nd amendment. (1 mark)

3rd amendment must include both parts. (1 mark)

4th amendment. (1 mark)</td></tr>
</table>

Task			Expected answer(s)	Max mark	Additional guidance
5	d		The microcontroller system and flowchart program has only been tested against four of the seven specification points therefore the overall effectiveness of the amended solution cannot be determined. Examples of improvement include: The circuit and code do not provide a way to retract the blinds if the light level drops, meaning the blinds will remain in place. The circuit and code could be modified to allow the blinds to open and close. A sensor system could be used to count laps rather than a human race controller constantly closing switches. There is only one check for accidents or obstructions on the road each lap. Continual checks could be built in to improve safety. Only red and green LEDs are used to control the movement of cars. The use of additonal coloured LED could be used to gradually slow down cars. The lap counter could be changed to a push to make switch and the race controller switch could be changed to a SPST to make it easier to manage the control of the race.	**2**	Evaluative comment. **(1 mark)** Detailed description of possible improvement. **(1 mark)** Any other valid description of an improvement can be awarded.

[END OF MARKING INSTRUCTIONS]