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 SQA appointed markers when marking external course assessments.

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.

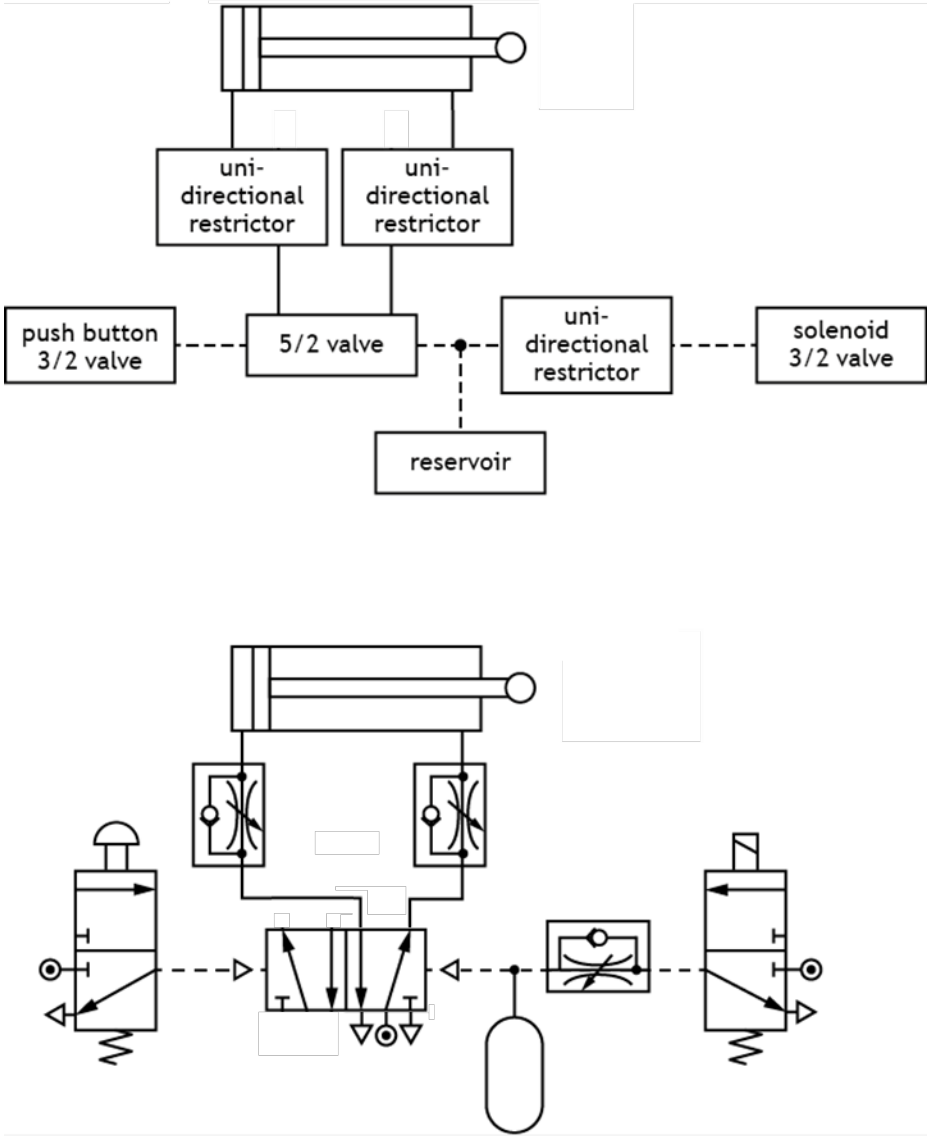
a Marks for each candidate response must always be assigned in line with general marking principles and the specific marking instructions for this assessment.

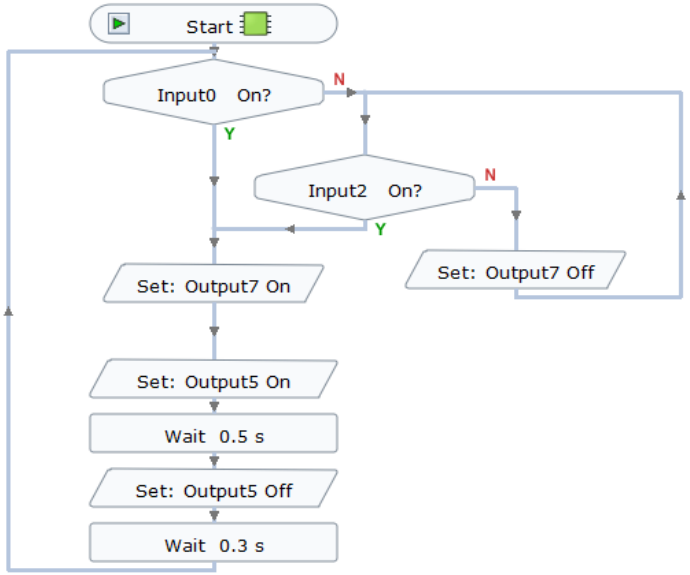
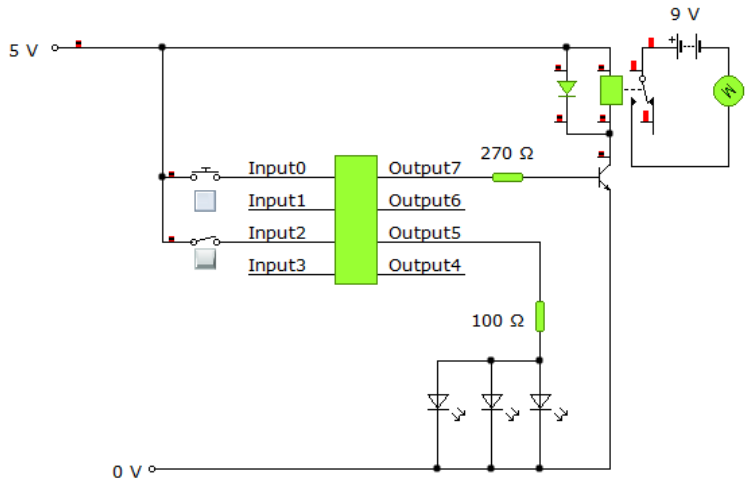
b Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

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		Diaphragm This actuator would act as a contactless sensor as the train passes, providing a longer lifespan for the sensor. Or Solenoid This actuator can be combined with a microswitch which senses model trains passing. Or Roller trip This actuator will detect trains in one direction of travel.	2	• Appropriate actuator selected: Any electrical, mechanical or pneumatic actuator. **(1 mark)** • An appropriate justification for selected actuator in context. **(1 mark)** Do not accept a manual actuator. Apply FTE for justification.

Task			Expected answer(s)	Max mark	Additional guidance
1	b			5	• Double-acting cylinder to 5/2 valve both pipes (with direction of outstroke indicated correctly if required). **(1 mark)** • 2 x uni-directional restrictor used to slow instroke & outstroke of cylinder. **(1 mark)** • 2 x 3/2 value to cause outstroke and instroke piped to 5/2 valve. **(1 mark)** • Push button for outstroking **and** selected actuator, from task 1a, for instroking. **(1 mark)** • Reservoir after instroking 3/2 valve (with optional uni-directional restrictor). **(1 mark)** Block diagram, circuit diagram (or a hybrid) or constructed/simulated. Components identified or implied by name or use of components (symbols). Connections between components and valves must be shown. Ignore line types. Port to port piping is not required. Ignore orientation of uni-directional restrictor symbols. Allow FTE for selected actuator (if no response for task 1a, accept any from given table).

Task			Expected answer(s)	Max mark	Additional guidance
2	a		 	5	**Flowchart** • All stages with correct symbols (to the software) and connections. **(1 mark)** • All correct pin numbers, pin states, decisions and time delays (to the software). **(1 mark)** **Electronic circuit** • All correct components selected. **(1 mark)** • Correct wiring, microcontroller pin connections, component orientations and values. **(1 mark)** **Integration** • Of flowchart and electronic circuit. **(1 mark)** Note: Allow use of alternative-sized microcontrollers.

Task			Expected answer(s)	Max mark	Additional guidance

2	b		`main:`
			`label0:`
			`  if Input0 = 1 then label1`
			`label2:`
			`  if Input2 = 1 then label1`
			`  low 7`
			`  goto label2`
			`label1:`
			`  high 7`
			`  high 5`
			`  pause 500`
			`  low 5`
			`  pause 300`
			`  goto label0`
			`  goto label1`
				1	• Code to fully match the flowchart, including pin numbers, in task 2**(a). (1 mark)**
					
					Accept manually written/automatically generated.
					
					Any high-level language acceptable.

<table>
<tr><th colspan="3">Task</th><th>Expected answer(s)</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>2</td><td>c</td><td></td><td>
<table>
<tr><th>Test 1:
Initial test result</th><th>Planned amendment to circuit/flowchart</th><th>Re-test result</th></tr>
<tr><td>When the test switch is turned on…
LEDs flash and the motor did not turn.

When the test switch is turned off…
the LEDs turn off and the motor slows to a stop.</td><td>Rotate the diode 180^0.

No amendment.</td><td>When the test switch is pressed…
the motor turns on and the LEDs flash

When the test switch is turned off…
the LEDs turn off and the motor slows to a stop.</td></tr>
<tr><th>Test 2:
Initial test result</th><th>Planned amendment to circuit/flowchart</th><th>Re-test result</th></tr>
<tr><td>When the movement sensor is pressed…
the motor and LEDs do not turn on.

When the movement sensor is released…
the motor and LED remained off.</td><td>Alter loop back from output 7 off to the start of flowchart.

No amendment.</td><td>When the movement sensor is pressed…
the motor turns and LEDs flash.

When the movement sensor is released…
the motor and LEDs turn off.</td></tr>
</table>
</td><td>6</td><td>Mark Initial Test Result and Planned Amendment responses based on 2(a) evidence.

Mark Re-test result based on 2(d) evidence.

If no evidence for 2(a)/2(d), then mark as below.

• Description of LED(s) flashing and the motor did not turn. (1 mark)

• Description of changing the diode orientation. (1 mark)

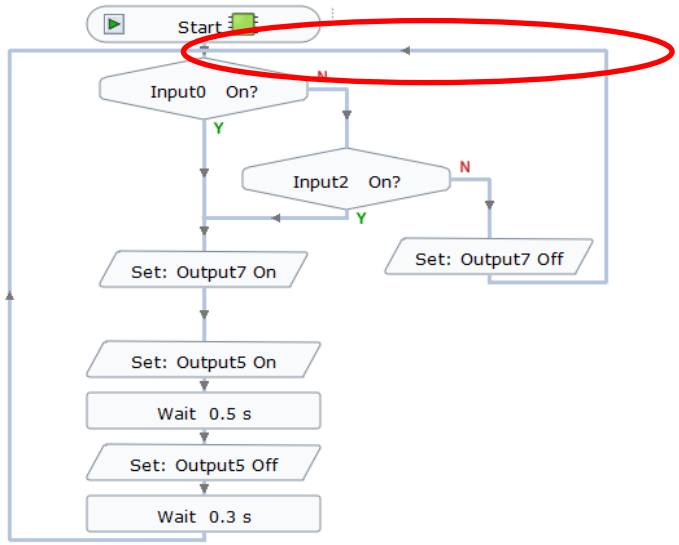
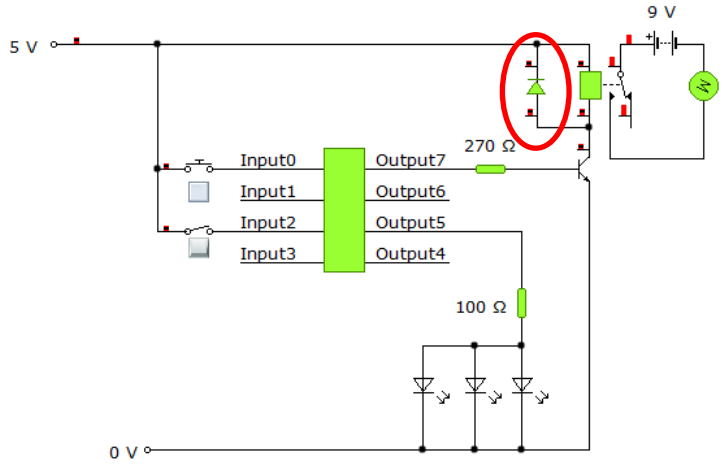
• Description of re-test result: motor starts to turn and the LED(s) flash. (1 mark)

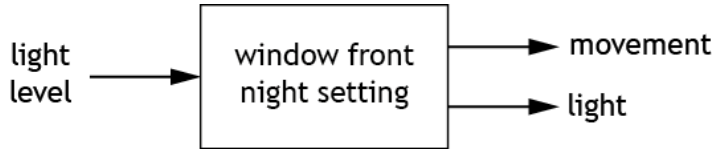
Apply FTE from Test 1 responses.

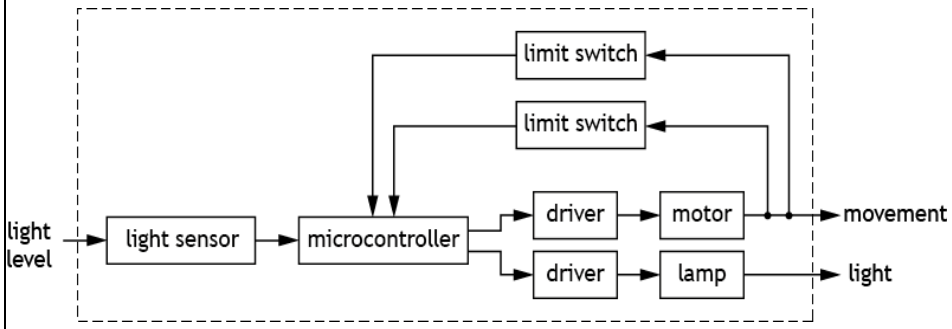
• Description of LED off and motor not turning. (1 mark)

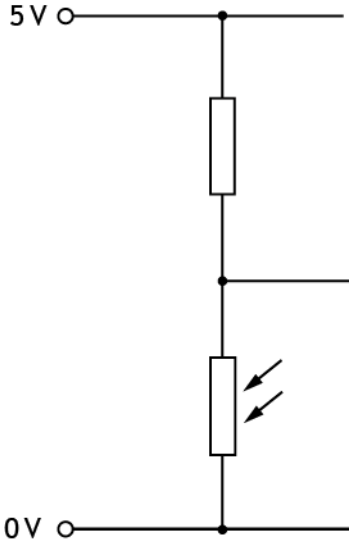
• Description of connection from output 7 off returning to start. (1 mark)

• Description of re-test result: motor starts and LED(s) flash and (when movement sensor released) LED(s) switch off and motor slows to a stop. (1 mark)</td></tr>
</table>

Task			Expected answer(s)	Max mark	Additional guidance
2	d		 	2	• Candidate's planned amendment 1 carried out: correction of protective diode orientation. **(1 mark)** • Candidate's planned amendment 2 carried out: Connection from output 7 off returning to start. **(1 mark)**

Task			Expected answer(s)	Max mark	Additional guidance
3	a	i		2	• Light/dark level input identified (implied). (**1 mark)** • Light **and** movement (implied) outputs identified. **(1 mark)** Accept light/daylight/darkness on its own as input. Do not accept light sensor. Do not accept components/devices. Ignore extra boxes or words.

Task			Expected answer(s)	Max mark	Additional guidance
3	a	ii		6	• System boundary around sub-systems only and boxes around each sub-system. **(1 mark)** • Motor in output position. **(1 mark)** • Lamp in output position. **(1 mark)** • One driver per output device individually connected to microcontroller. **(1 mark)** • 2 (limit) switches connected individually to the microcontroller. **(1 mark)** • Feedback loop(s) from after motor via (limit) switch(es) into microcontroller with both arrowheads. **(1 mark)** Accept 'motorised blind'. Do not accept 'light', 'bulb' or 'LED' instead of 'lamp'. Do not accept an action (eg 'lamp on'). Ignore extra sub-systems. If no arrows shown between sub-systems, assume left to right.

Task			Expected answer(s)	Max mark	Additional guidance
3	b			3	• Correct symbol for LDR. **(1 mark)** • Correct symbol for fixed/variable resistor. **(1 mark)** • Correct position of components connected to create a dark sensor. **(1 mark)** Values of components are not required. Do not accept simulation/construction evidence. Ignore additional circuitry.

<table>
<tr><th colspan="3">Task</th><th>Expected answer(s)</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>3</td><td>c</td><td></td><td>
<table>
<tr><th>Planned test</th><th>Expected result</th></tr>
<tr><td>Test 1

Reduce the light level.</td><td>

V_{out} will increase.</td></tr>
</table>
<table>
<tr><td>Test 2

Increase the light level.</td><td>

V_{out} will decrease.</td></tr>
</table>
</td><td>3</td><td>

V_{out} increases. (1 mark)
Test for rising light level. (1 mark)
Expected result from given test in terms of V_{out}. (1 mark)

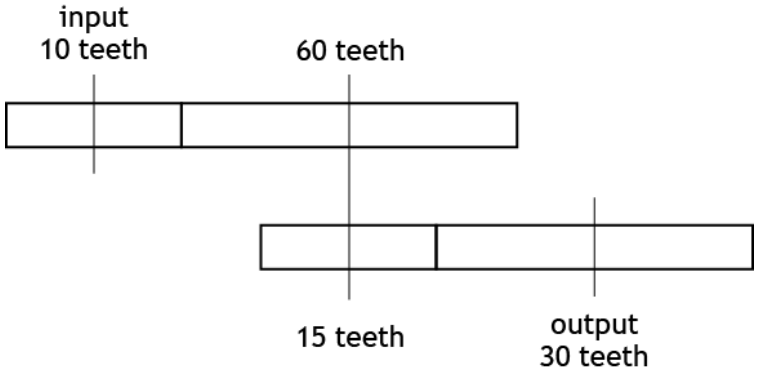
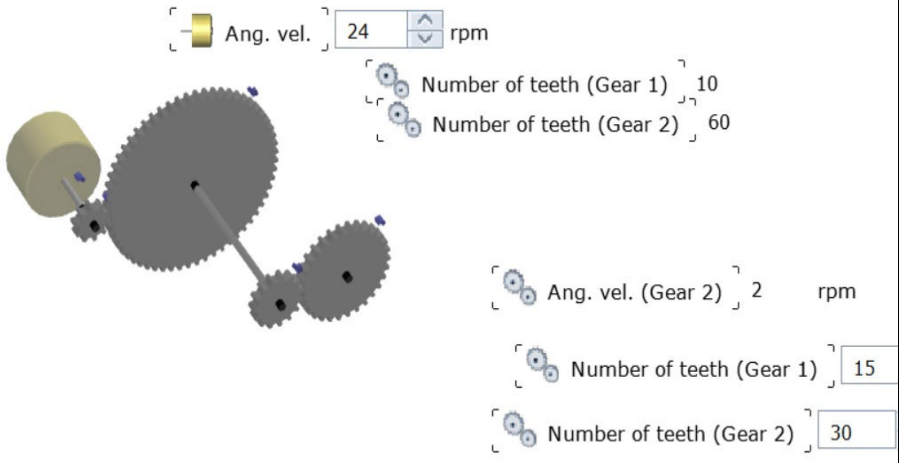
Apply FTE for expected result from Planned test 2.

If no planned test 2 given, then no mark can be awarded for its unless expected result statement includes a description of the planned test.
</td></tr>
</table>

<table>
<tr><th colspan="3">Task</th><th>Expected answer(s)</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr>
<td>4</td><td>a</td><td></td>
<td>
<table>
<tr><th>Specification point</th><th>Met? Yes/No</th><th>Justification</th></tr>
<tr><td>i.</td><td>Yes</td><td>As the gear system is a compound gear train.</td></tr>
<tr><td>ii.</td><td>Yes</td><td>The input gear and output gear both turn in same direction.</td></tr>
<tr><td>iii.</td><td>No</td><td>The speed of the output gear would be increased.</td></tr>
</table>
</td>
<td>3</td>
<td>

State that specification (i) was met (Y)/ not met (N) and description referring to compound gear train/number of gears/ size of gears. (1 mark)
State that specification (ii) was met (Y) and refers to direction of rotation/acting as an idler. (1 mark)
State that specification (iii) was not met (N) and refers to increase in output speed (from input drive). (1 mark)

Mark can be awarded for specification (iii) for calculation-based justification which must compare like for like (eg velocity ratio to velocity ratio, rather than velocity ratio to gear ratio).
</td>
</tr>
</table>

Task			Expected answer(s)	Max mark	Additional guidance
4	b			2	• Simple/compound gear train/worm & wheel **and** all gear sizes. **(1 mark)** • Correct speed reduction of at least a factor of 12 but no more than 20 **and** labelling input or implied (eg through inclusion of motor or calculations or output labelled). **(1 mark)** Do not accept chain or belt drive. Do not accept simulation/construction evidence.
	c			2	• Simulated or constructed of mechanism type shown in 4(b), with input identified. **(1 mark)** • All gear sizes shown and matching the design in 4(b) or evidence of velocity ratio (eg graph) that proves teeth numbers. **(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>4</td><td>d</td><td></td>
<td>
<table>
<tr><th>Input speed</th><th>Output speed</th><th>Required VR</th><th>Actual Velocity Ratio</th></tr>
<tr><td>24 revs min^{-1}
or
24 turns</td><td>2 revs min^{-1}
or
2 turns</td><td>Between 12:1 and 20:1</td><td>12:1</td></tr>
</table>
</td>
<td>2</td>
<td>
• Input and output speed/turns from given solution in 4(c). (1 mark)

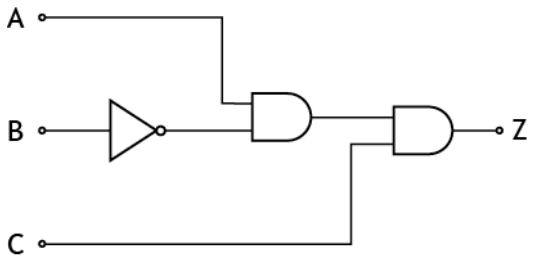
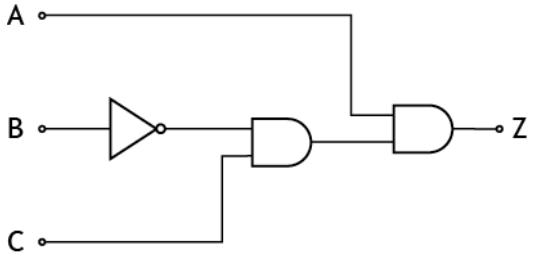
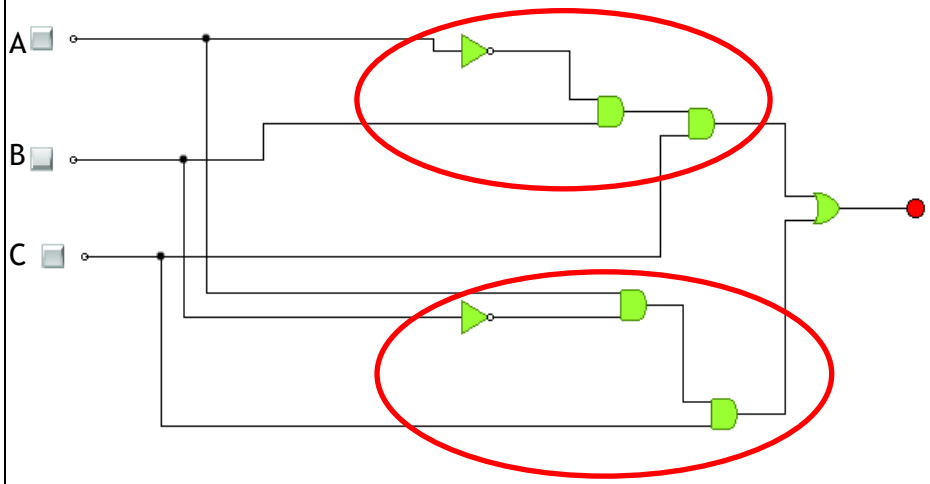
• Correct velocity ratio for input and output speeds given in table (expressed as ratio, number or fraction). (1 mark)

Units not required.

If no sizes/speed indicated in task 4(c) then use values from 4(b) to determine VR.

No evidence of VR (through teeth numbers, graph or velocities) or teeth numbers indicated on either 4(b) or 4(c) then award 0 marks.

No evidence of simulation/construction in 4(c). (1 mark maximum for velocity ratio, if correct)
</td>
</tr>
</table>

Task			Expected answer(s)	Max mark	Additional guidance
5	a		 OR 	2	• NOT gate connected to B. **(1 mark)** • AND gate(s) connected to inputs A, B & C **and** output Z. **(1 mark)** Accept alternative correct circuit including three input AND gate. Do not accept simulation/construction evidence.
	b			2	Maximum 1 mark if OR gate not included. • Mark for $\overline{A}$.B.C **(1 mark)** • Mark for A.$\overline{B}$.C **(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><td>Modification</td><td>Increase the number of inputs to the circuit.

OR

Remove the lower part of circuit to only allow one combination of A/B/C.</td></tr>
<tr><td>Justification</td><td>Increase the number of possible combinations for the toy safe code.

OR

Increases the chance of getting the code incorrect.</td></tr>
</table>
</td><td>2</td><td>
• Appropriate suggested modification to the logic circuit. (1 mark)

• Appropriate justification of suggested modification to the logic circuit. (1 mark)

Do not accept ‘to make it harder to solve’ on its own as justification.

Do not accept ‘replace OR gate with AND gate’. (input combination impossible)

The modification must be to the logic circuit rather than alternative solutions.

Apply FTE for justification.
</td></tr>
</table>

[END OF MARKING INSTRUCTIONS]