

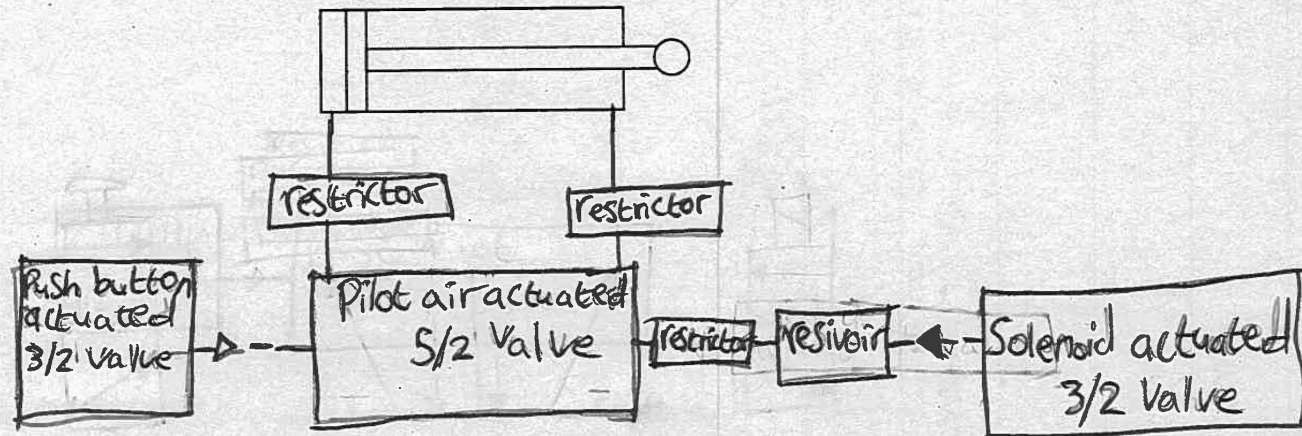
# Candidate 1 evidence

## Worksheet 1a

<b>Actuator</b>	Solenoid
<b>Justification</b>	Can create a microcontrolled circuit for the actuator that senses when a train passes using said microcontroller. This would be best because it would be easier due to there just being a microcontroller code, therefore much simpler to activate.

(2 marks)

Worksheet 1b

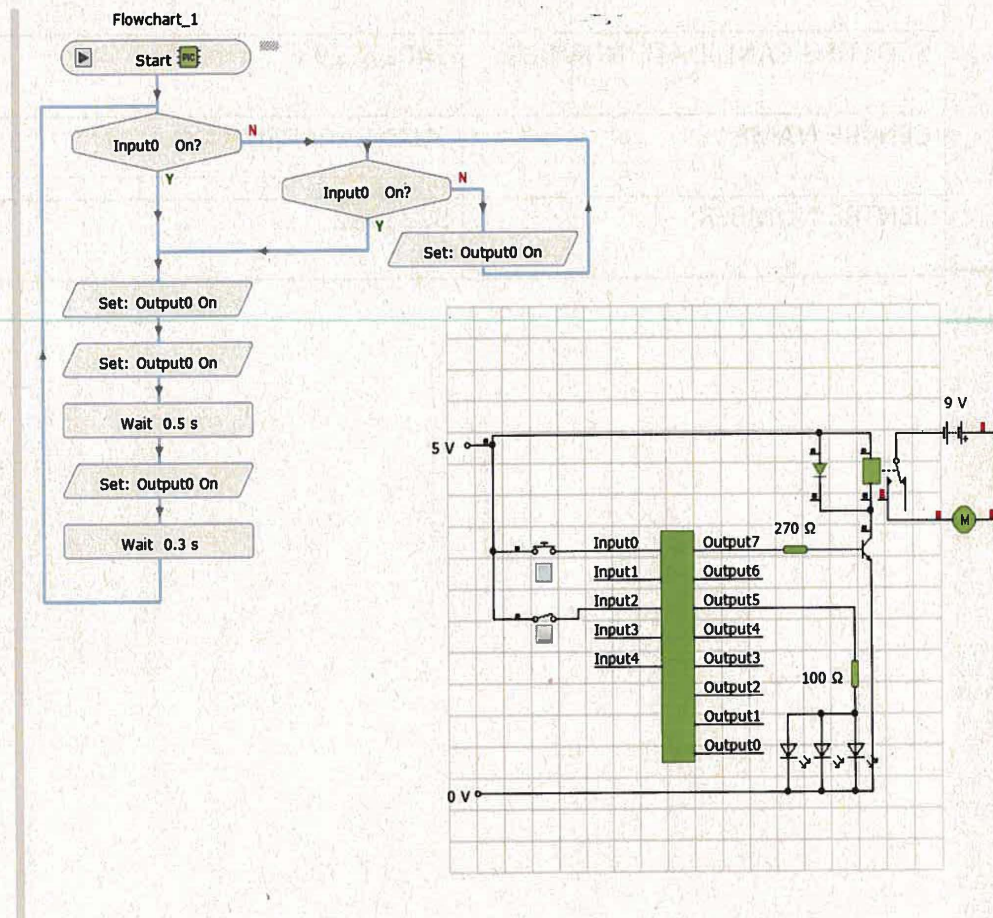


(5 marks)

# ASSIGNMENT

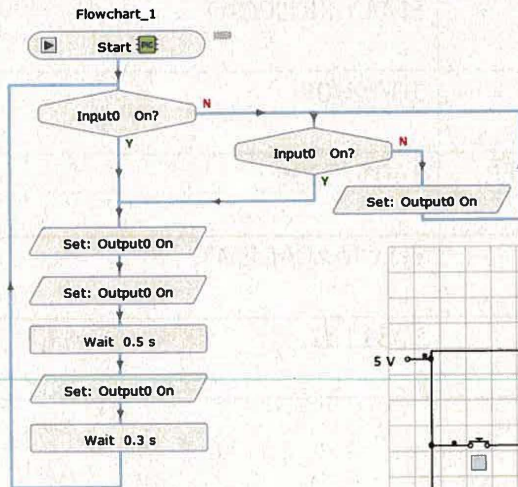
## TASK 2

### PART A:



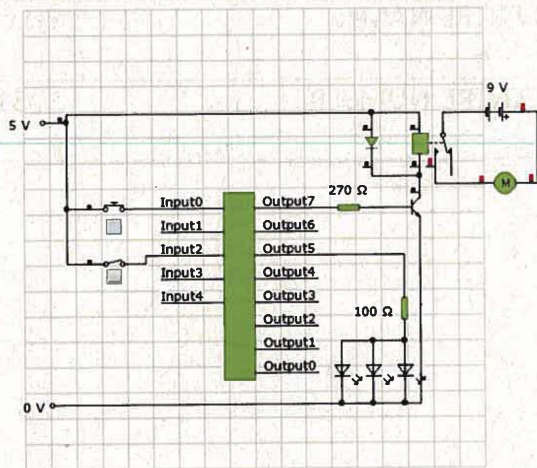
## TASK 2

### PART B:



```

BASIC Viewer
Flowchart_1
1
2 main:
3 label0:
4   if Input0 is On then label1
5 label2:
6   if Input0 is On then label1
7   Switch on 0
8   goto label2
9 label1:
10  Switch on 0
11  Switch on 0
12  pause 500
13  Switch on 0
14  pause 300
15  goto label0
16  goto label1
17
  
```



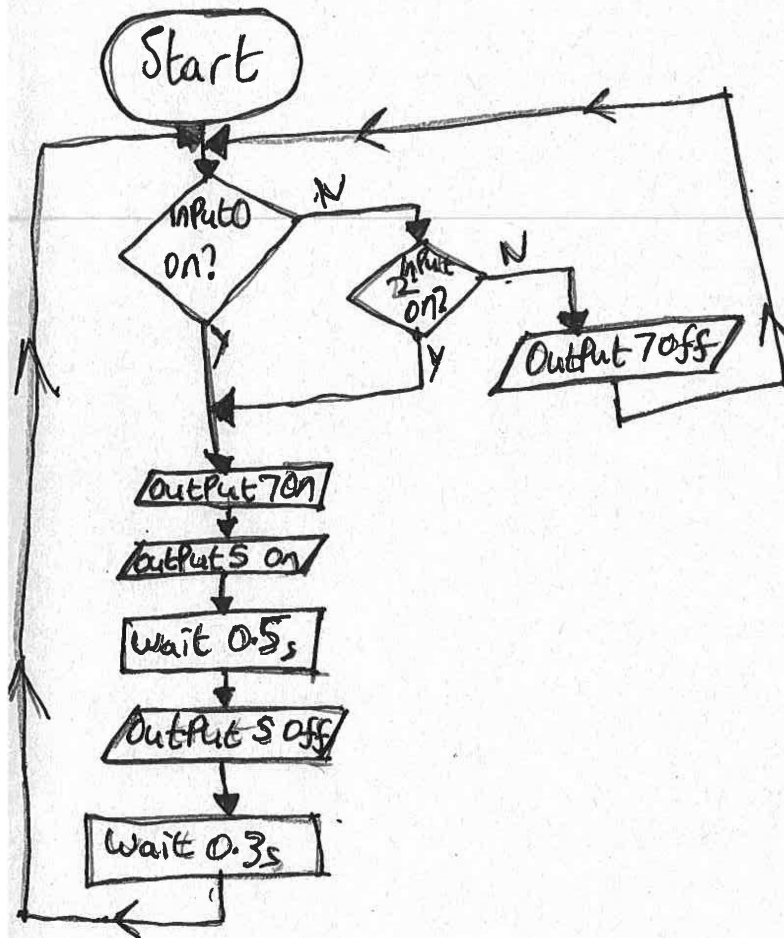
## Worksheet 2c

Planned test	Expected result	Initial test result	Planned amendment to circuit/flowchart	Retest result
<b>Test 1</b> Turn on the test switch (input 2) for around 20 seconds and then turn it off.	The motor starts to turn and the LEDs flash.  When the test switch is turned off, the LEDs turn off and the motor slows to a stop.	When the test switch is turned on ... <del>Nothing happens</del> <del>happened</del> Transistor + Diode exploded, LEDs flashed on + off When the test switch is turned off ... <del>Nothing happens</del> <del>happened</del> LEDs turn off	<del>LED's flash on + off</del> <del>Motor spins</del> Diode slipped around	When the test switch is turned on ... LED's flash on + off Motor spins  When the test switch is turned off ... LED's turn off Motor slows to a stop
Planned test	Expected result	Initial test result	Planned amendment to circuit/flowchart	Retest result
<b>Test 2</b> Press and hold the movement sensor (input 0) for around 20 seconds and then release it.	The motor starts to turn and the LEDs flash.  When the movement sensor is released, the LEDs turn off and the motor slows to a stop.	When the movement sensor is pressed ... Nothing happens.  When the movement sensor is released ... Nothing happens.	Flowchart amendment (see on other sheet)	When the movement sensor is pressed ... LED's flash on + off Motor spins  When the movement sensor is released ... LED's turn off Motor slows to a stop

(6 marks)

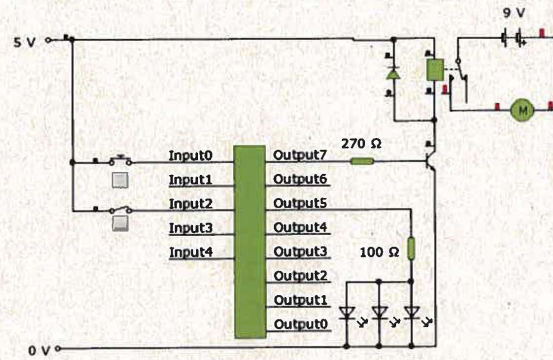
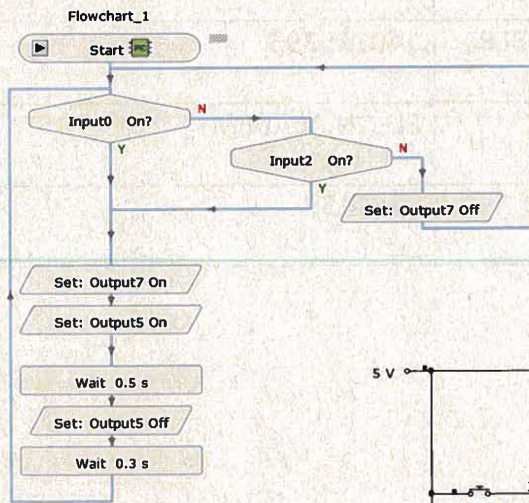
## Task 2

## Part C - Ammended Flowchart

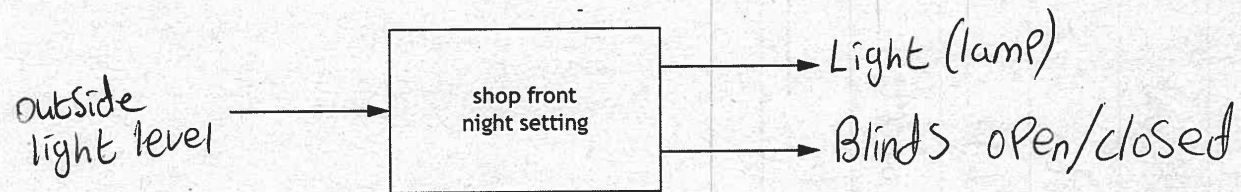


## TASK 2

### PART D:

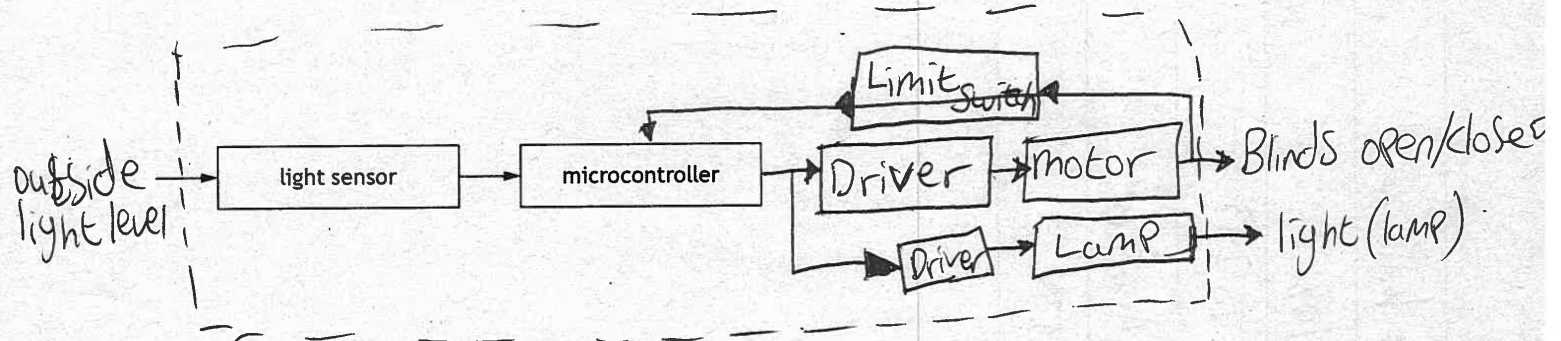


Worksheet 3a(i)



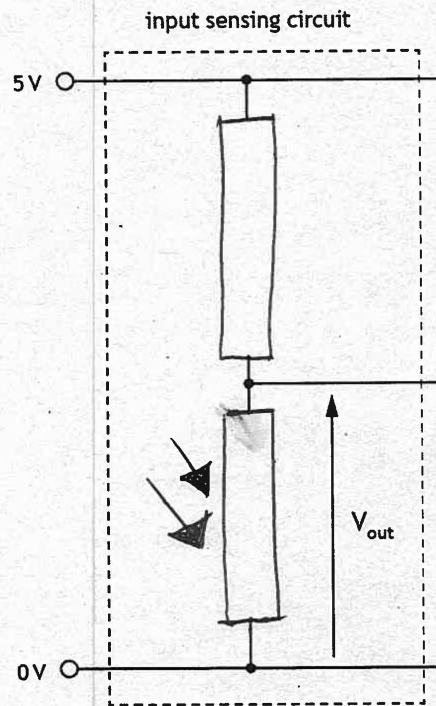
(2 marks)

Worksheet 3a(ii)



(6 marks)

Worksheet 3b



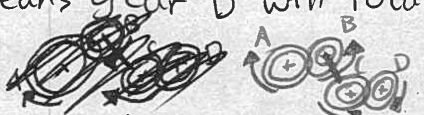
(3 marks)

## Worksheet 3c

Planned test	Expected result
<b>Test 1</b> Reduce the light level.	The lamp will turn on and the motor will fully close the blind
Planned test	Expected result
<b>Test 2</b> Increase the light level	The lamp will turn off and the motor will open the blind fully.

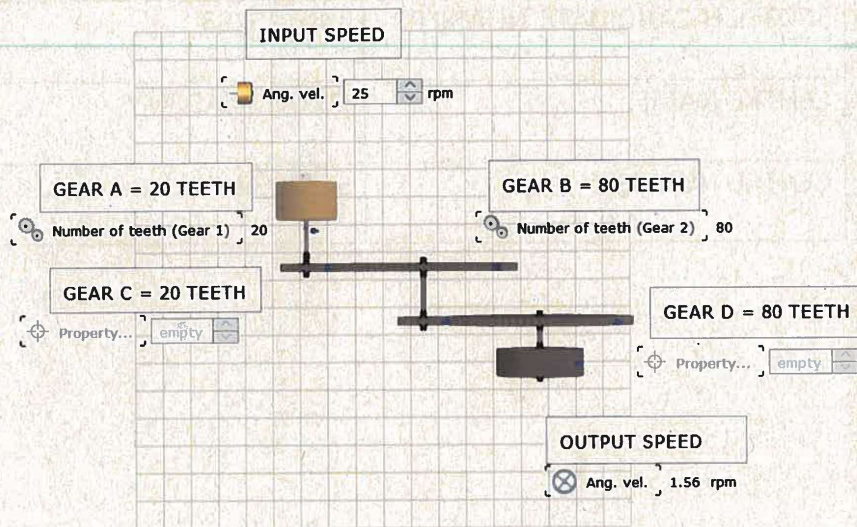
(3 marks)

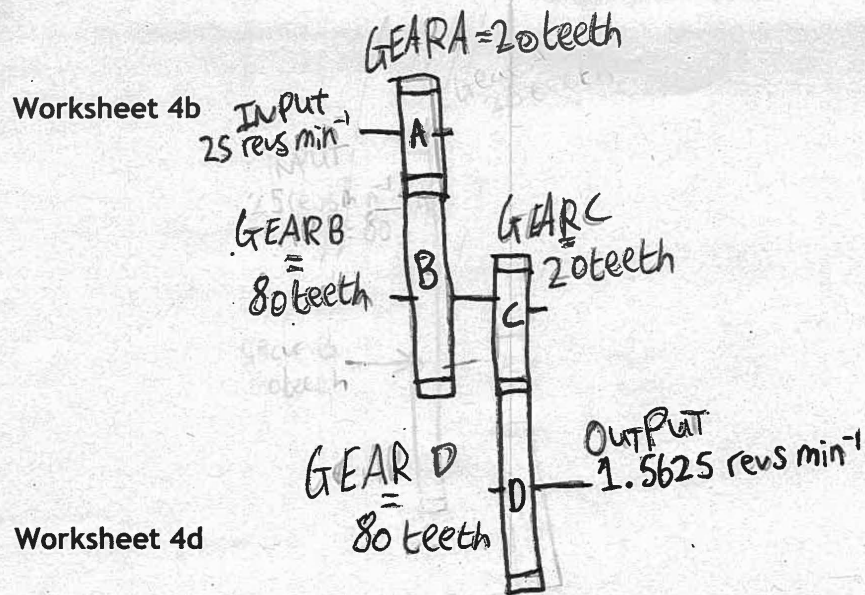
Worksheet 4a

Specification point	Met? Yes/No	Justification
i	Yes	The design is a compound gear train, which means it will fit into a compact space inside the rotating display stand.
ii	Yes	Gears B and C <del>act as idler gear</del> will rotate in the same way, which means gear D will rotate in the same direction as gear A. 
iii	NO	$MMR = \frac{\text{driven}}{\text{driver}} \times \frac{\text{driven}}{\text{driver}} = \frac{15}{60} \times \frac{16}{16} = \frac{1}{4} \times 1 = \frac{1}{4} = 1:4$ $VR: \frac{\text{input}}{\text{output}} = \frac{25}{100} = \frac{1}{4} = 1:4$ <p> <math>\frac{\text{input speed}}{\text{input size}} = \frac{\text{output speed}}{\text{output size}}</math>  <math>25 \times 60 = \frac{\text{output}}{15}</math>  <math>\text{output speed} = 1500/15 = 100 \text{ rev min}^{-1}</math> </p> <p> <math>\frac{\text{input speed}}{\text{input size}} = \frac{\text{output speed}}{\text{output size}}</math>  <math>100 \times 16 = \frac{\text{output}}{16}</math>  <math>\text{output speed} = 1600/16 = 100 \text{ rev min}^{-1}</math> </p> <p><i>This doesn't meet requirements because factors &lt; 6, 1, 1, 9</i></p>
		<p>this doesn't meet requirements because it increases the speed, it doesn't reduce it</p> <p style="text-align: right;">(3 marks)</p>

**TASK 4**

**PART C:**





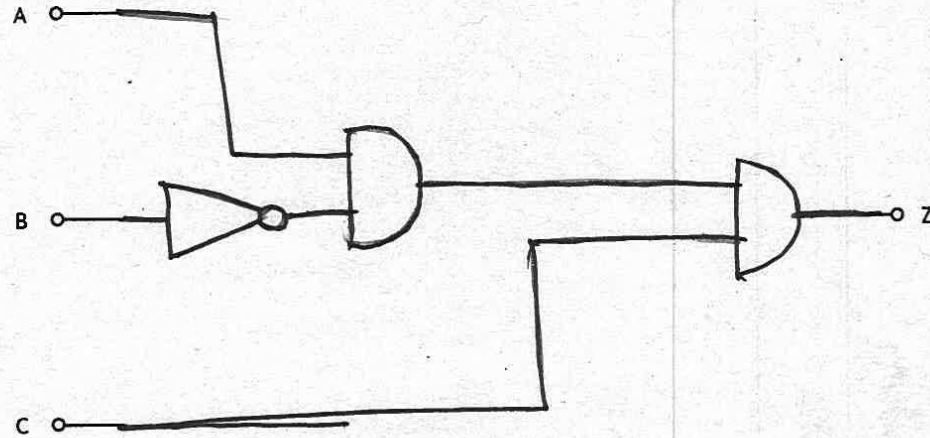
(2 marks)

Worksheet 4d

Planned test	Input speed	Output speed	Required Velocity Ratio	Actual Velocity Ratio
Measure the input speed and output speed of the gear system and calculate the actual velocity ratio.	25 revs min <sup>-1</sup>	1.56 rev min <sup>-1</sup>	Between 12:1 and 20:1	16.03:1

(2 marks)

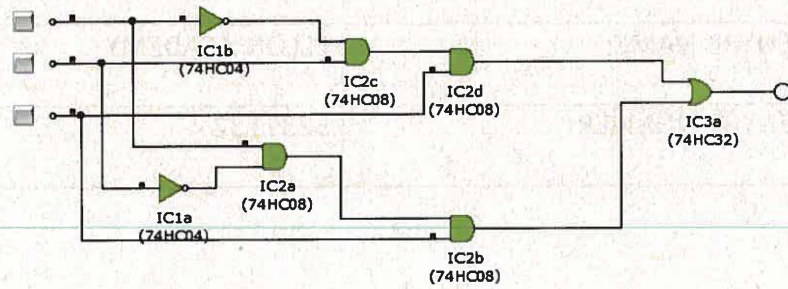
Worksheet 5a



(2 marks)

**TASK 5**

**PART B:**



## Worksheet 5c

Modification	add in another input with more logic gates
Justification	by adding another input, it decreases the probability of guessing what the code is. This therefore makes the toy safe harder to solve

(2 marks)

# Candidate 2 evidence

**Task 1A:**

1a Choose a suitable actuator from the table above, to sense when a train has passed.  
Complete worksheet 1a, justifying your choice.  
Present your evidence on A4 single-sided pages, with the task number clearly labelled. **(2 marks)**

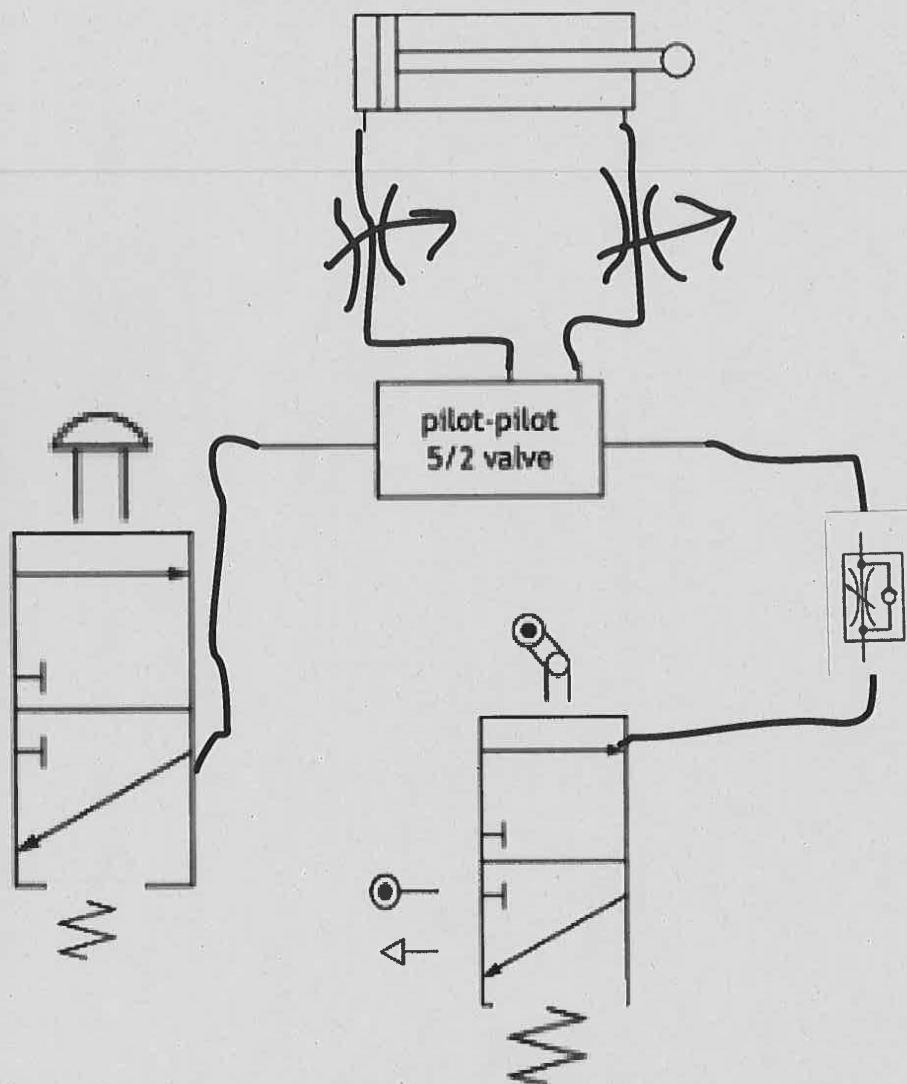
<b>Actuator</b>	Roller trim
<b>Justification</b>	Because it will detect when the train passes.

# Task 1B:

## Task 1 – model railway (continued)

1b Complete the design for the pneumatic circuit on worksheet 1b, to meet the specification, using your selected actuator from task 1a.

You must identify the name of each component, valve, and actuator, and indicate the direction of the piston ~~outstroke~~ outstroke. Show connections between all components and valves.

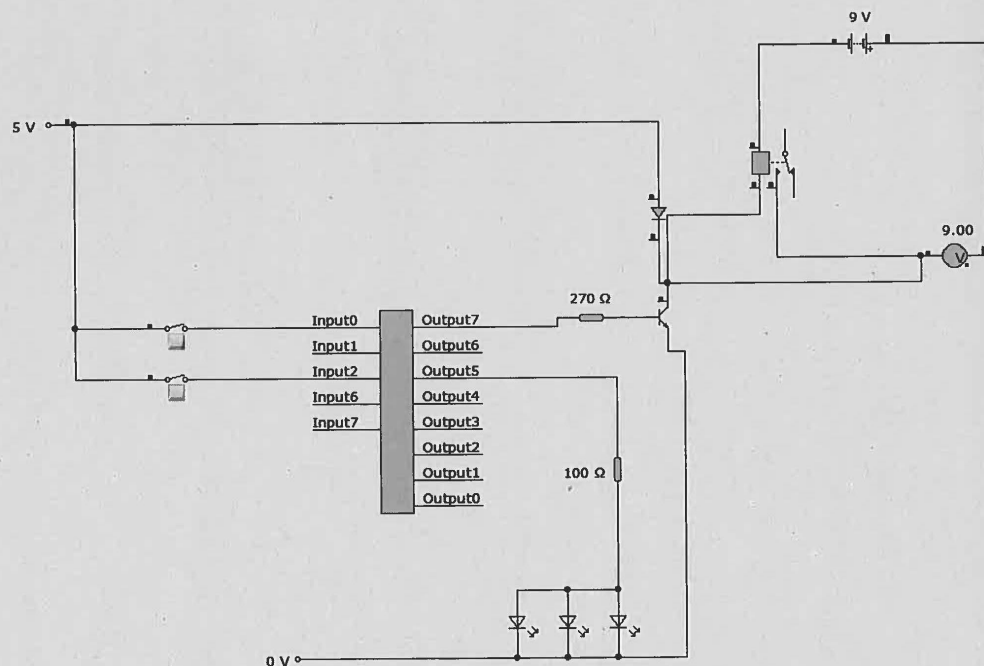


# Task 2a:

2a Simulate the flowchart sequence and electronic circuit integrated together, as shown on the following page. You can use a different sized microcontroller but the pin numbers must match the connections given.

**Note:** for test purposes, the movement sensor is replaced with a push-to-make switch.

Present your evidence on A4 single-sided pages, with the task number clearly labelled. Screenshots or images must be clear and easy to read.



# Task 2b:

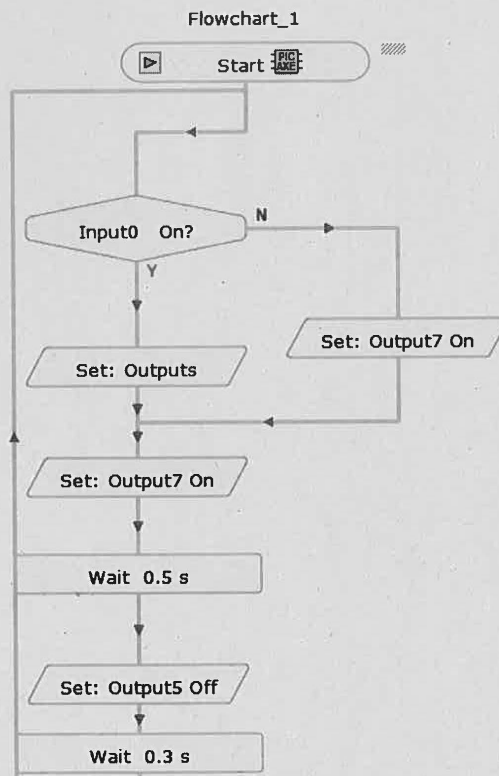
**2b** Produce high-level microcontroller code to fully match the flowchart from task 2a.

Present your evidence on A4 single-sided pages, with the task number clearly labelled. Screenshots or images must be clear and easy to read.

The microcontroller must meet the following specification:

- i Whenever the test switch (input 2) is activated, the motor will rotate, and the LEDs will flash on and off continuously.
- ii Whenever the movement sensor (input 0) detects a customer, the motor will rotate, and the LEDs will flash on and off continuously.
- iii When the movement sensor no longer detects a customer, the motor and the LEDs will switch off.

Errors were found in both the flowchart and electronic circuit during testing.



# Task2c:

2c Complete the testing table on worksheet 2c, by carrying out the planned tests and describing each initial test result.

Describe your planned amendments to the flowchart and/or circuit, so that it meets the specification and make the amendments.

Carry out each test again, describing the result of your retest, before moving onto the next test.

Present your evidence on A4 single-sided pages, with the task number clearly labelled.

(6 marks)

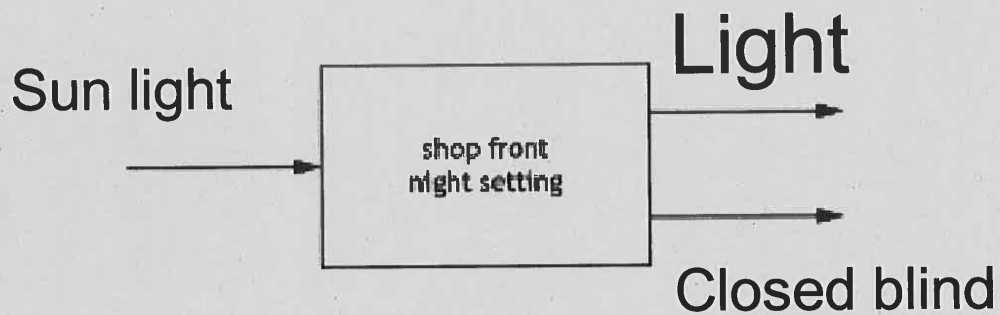
Planned test	Expected result	Initial test result	Planned amendment to circuit/flowchart	Retest result
<b>Test 1</b> Turn on the test switch (input 2) for around 20 seconds and then turn it off.	The motor starts to turn and the LEDs flash.  When the test switch is turned off, the LEDs turn off and the motor slows to a stop.	When the test switch is turned on ... <b>The transistor and diode blow up the LEDs flash and the motor turns</b>  When the test switch is turned off ... <b>The motor stops slowly and LEDs turn off</b>	<b>Flip the diode the other way around</b>	When the test switch is turned on ... <b>The motor starts to turn and the led flash</b> When the test switch is turned off ... <b>The LEDs turn off and the motor turns off slowly.</b>
<b>Test 2</b> Press and hold the movement sensor (input 0) for around 20 seconds and then release it.	The motor starts to turn and the LEDs flash.  When the movement sensor is released, the LEDs turn off and the motor slows to a stop.	When the movement sensor is pressed ... <b>The transistor and diode blow up the LEDs flash and the motor turns</b>  When the movement sensor is released ... <b>The motor stops slowly and LEDs turn off</b>	<b>Flip the diode the other way around</b>	When the movement sensor is pressed ... <b>The motor starts to turn and the led flash</b> When the movement sensor is released ... <b>The LEDs turn off and the motor turns off slowly.</b>

# Task 3a:

3a(i) Complete the system diagram on **worksheet 3a(i)** to meet the specification.

You must clearly show all external inputs and outputs.

Present your evidence on A4 single-sided pages, with the task number clearly labelled.



# Task3a:

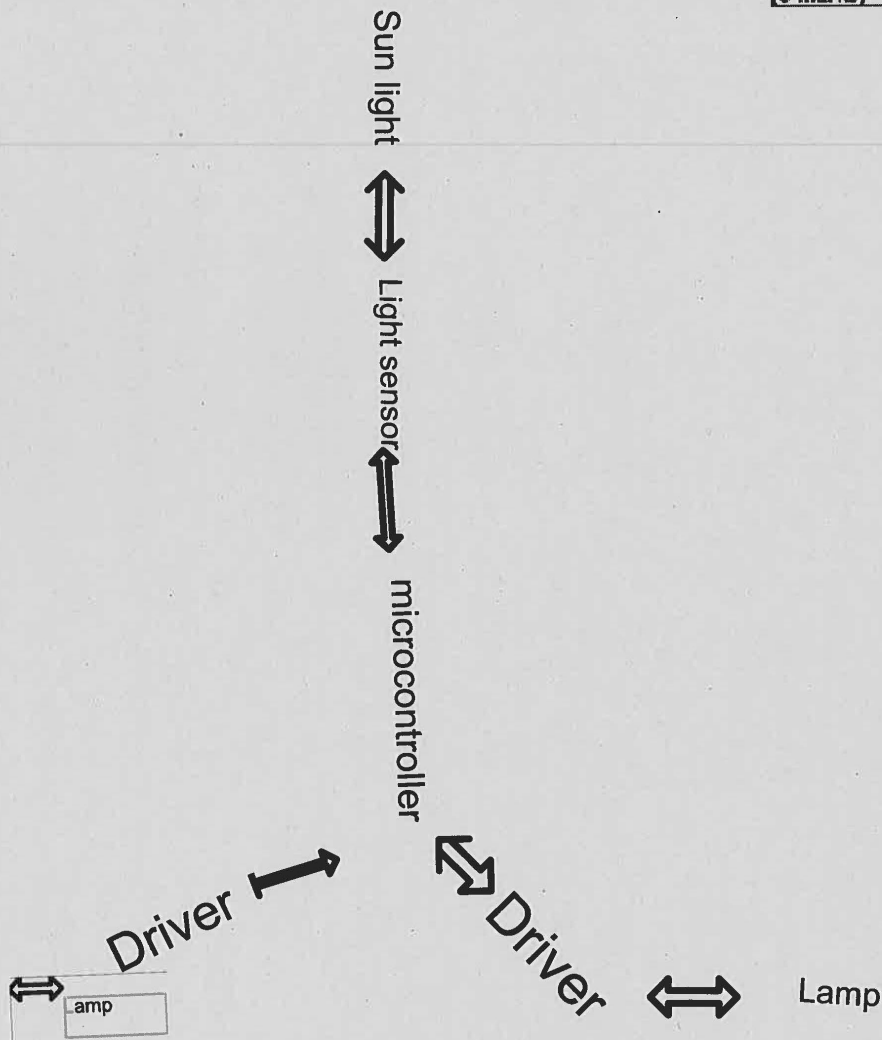
ii) Complete the sub-system diagram on worksheet 3a(ii) to meet the specification.

You must clearly show all external inputs and outputs, all sub-systems, the system boundary and the interactions between sub-systems.

Note: each output device requires a driver.

Present your evidence on A4 single-sided pages, with the task number clearly labelled.

**(6 marks)**

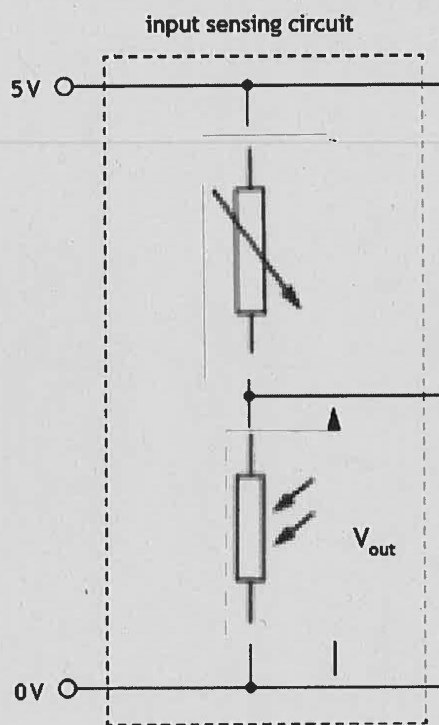


# Task 3b:

3b Complete the circuit diagram on worksheet 3b, by designing a suitable input sensing circuit that will produce a high signal ( $V_{out}$ ) when it is dark. Component values are not required.

**Note:** you must not construct or use simulation software to complete this part of the task.

Present your evidence on A4 single-sided pages, with the task number clearly labelled.



# Task 3c:

3c Using the input sensor circuit you designed in task 3b, complete the test plan on worksheet 3c by describing:

- ♦ the expected result from the planned test given in terms of *You*
- ♦ a second planned test and the expected result in terms of *You*

Present your evidence on A4 single-sided pages, with the task number clearly labelled.

Planned test	Expected result
<b>Test 1</b> Reduce the light level.	<b>Output 1: light turns on and blinds close</b>
Planned test	Expected result
<b>Test 2</b> Increase light level	<b>Output 2: light turns off and opens blind</b>

# Task4a :

4a Evaluate the initial gear train design against the specification and complete the table on worksheet 4a. You should:

- ✦ state if each specification point is met
- ✦ justify your decision

Present your evidence on A4 single-sided pages, with the task number clearly labelled.

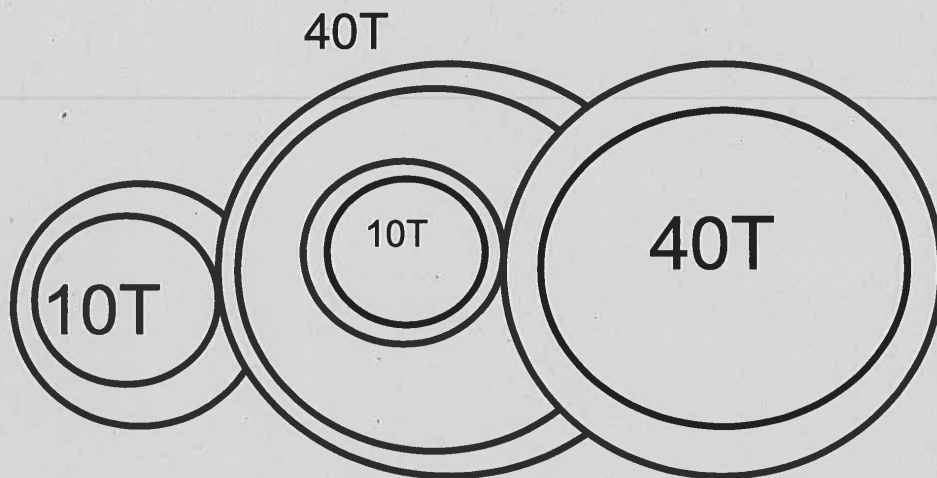
Specification point	Met? Yes/No	Justification
i	no	<b>Gear A is too big to fit in a tight space</b>
ii	yes	<b>Gear B and C act as an idler which makes gear D spin in the same direction as gear A</b>
iii	no	<b>The output speed is significantly greater than the input speed</b>

# Task4b:

4b Design a gear train on worksheet 4b, based on the gear sizes available to you. This needs to give a speed reduction of at least a factor of 12, but not greater than a factor of 20. Label the input gear and include all gear sizes.

**Note:** you must not construct or use simulation software to complete this part of the task.

Present your evidence on A4 single-sided pages, with the task number clearly labelled.



$$\text{Out/in} = 10/40 \times 10/40$$

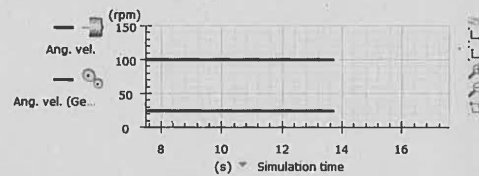
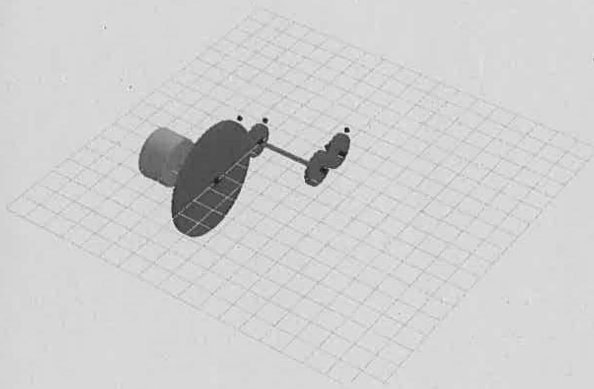
$$\text{Out/20} = 1/16$$

$$\text{Out} = 1.25 \text{ RPM}$$

# Task 4c:

- 4c Simulate or construct your design from task 4b. You must include an input component to allow for testing and label all gear sizes.

Present your evidence on A4 single-sided pages, with the task number clearly labelled. Screenshots or images must be clear and easy to read.



# Task 4d:

4d Complete the test result table on worksheet 4d by:

- ♦ entering the results from task 4c that you observed during simulation or after construction
- ♦ calculating the actual velocity ratio, using your recorded values for the input and output speeds

Present your evidence on A4 single-sided pages, with the task number clearly labelled.

Planned test	Input speed	Output speed	Required Velocity Ratio	Actual Velocity Ratio
Measure the input speed and output speed of the gear system and calculate the actual velocity ratio.	20 RPM	1.25RPM	Between 12:1 and 20:1	16:1

$$VR = \text{in/out}$$

$$VR = 20/1.25 \text{ RPM}$$

$$VR = 16:1$$

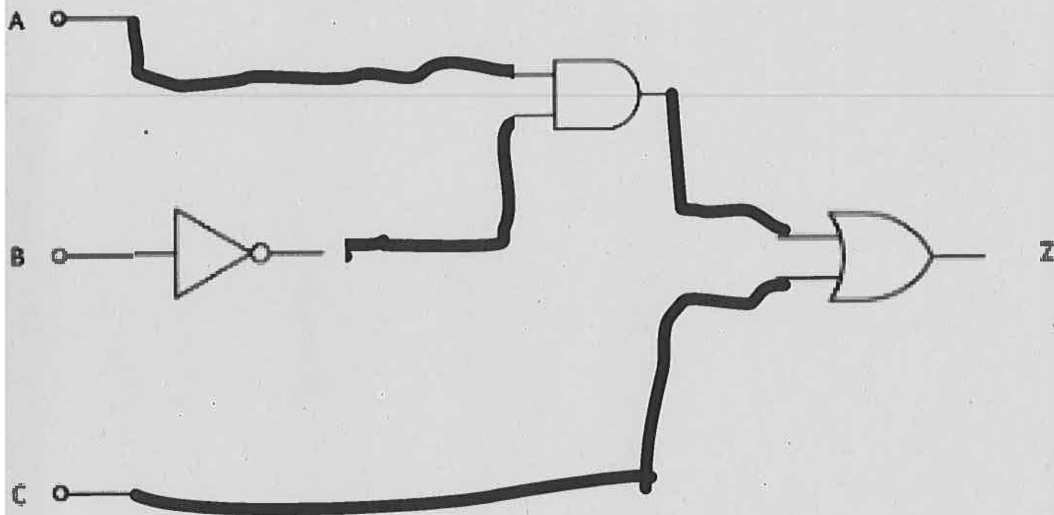
# Task 5a:

5a Complete the logic diagram on worksheet 5a to unlock the safe by sending a high (1) signal to output Z when:

input A is high (1) and input B is low (0) and input C is high (1)

Note: you must not construct or use simulation software to complete this part of the task.

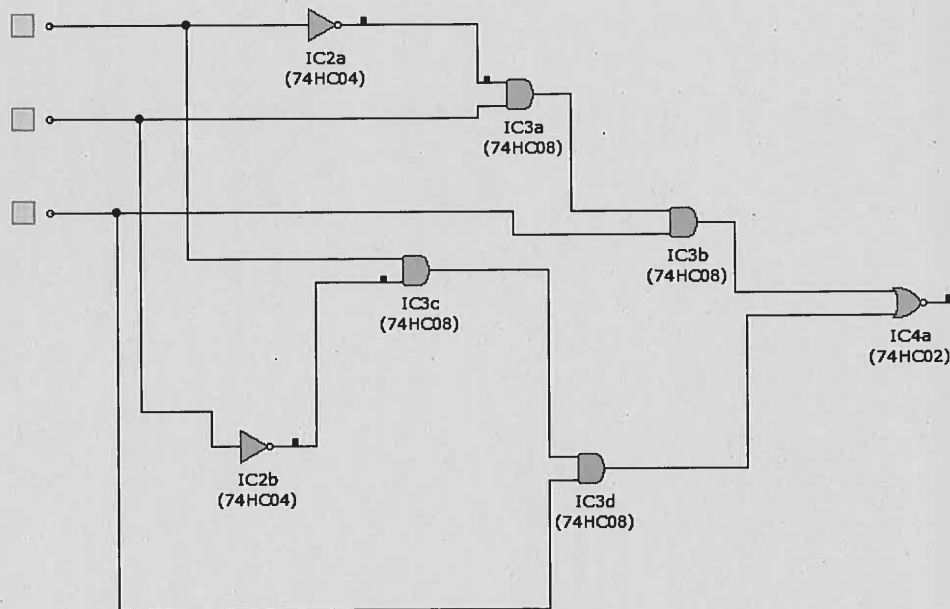
Present your evidence on A4 single-sided pages, with the task number clearly labelled.



# Task 5b:

5b Simulate or construct the logic diagram shown above. You must include suitable input and output devices to allow for potential testing. If constructed, you must clearly label the integrated circuit (IC) numbers.

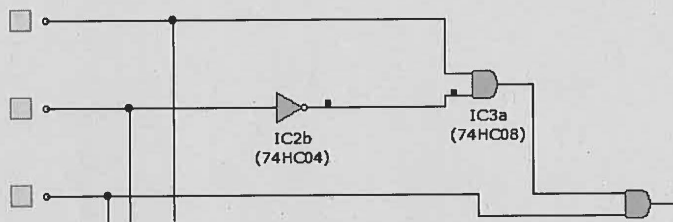
Present your evidence on A4 single-sided pages, with the task number clearly labelled. Screenshots or images must be clear and easy to read.



# Task5c :

5c Using worksheet 5c, describe a suitable modification to the logic circuit in task 5b that would make the code for the toy safe harder to solve and justify your reason.

Present your evidence on A4 single-sided pages, with the task number clearly labelled.



Modification	<b>Move the not gate from the A input to the B input</b>
Justification	<b>Previously the only time when the outputs was high was when ABC were high and when the AC were high and now. With the not gate moved the only correct combination is AC</b>

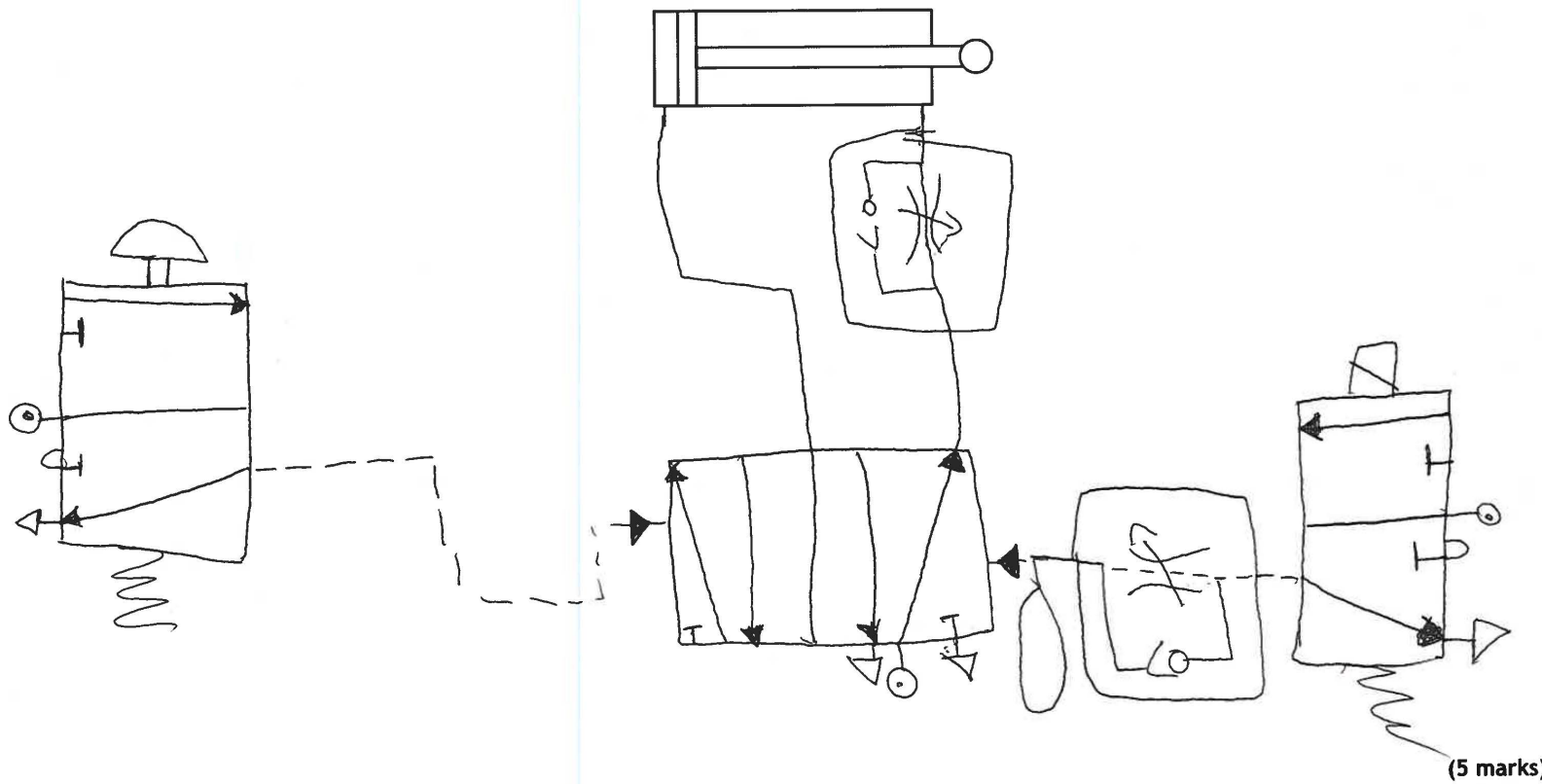
# Candidate 3 evidence

## Worksheet 1a

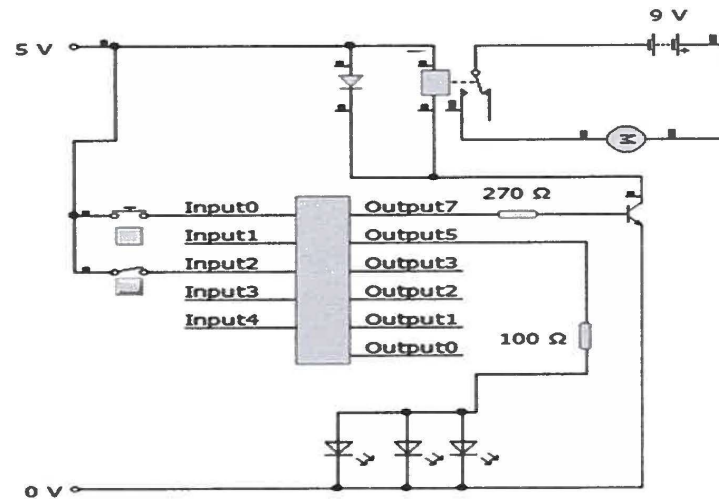
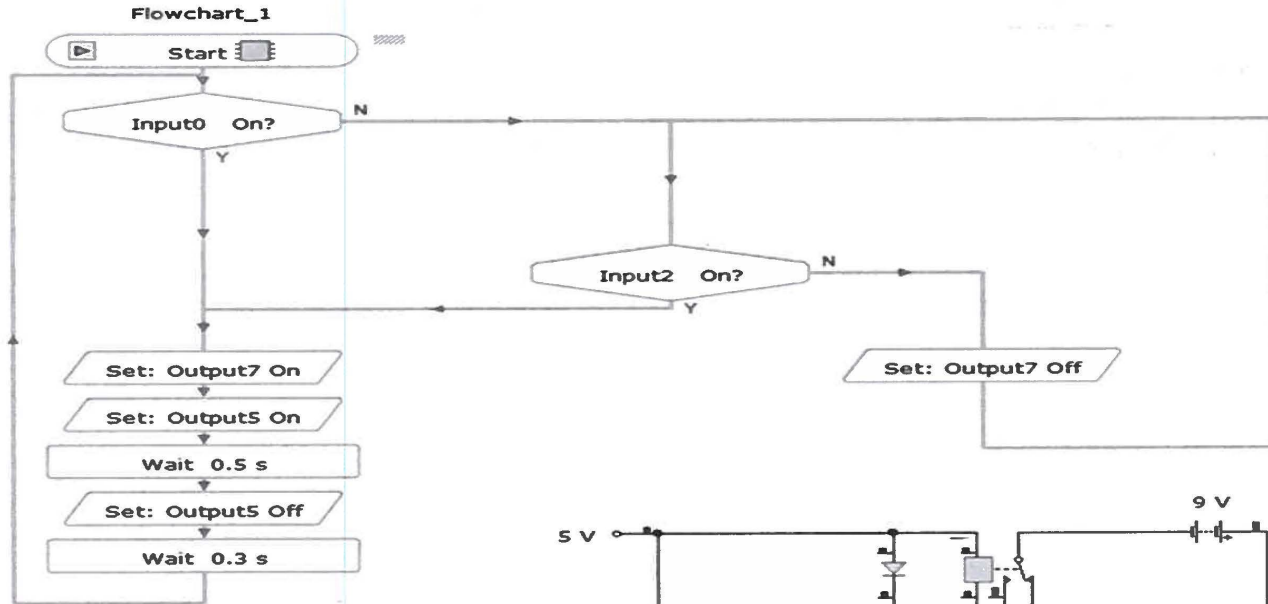
<b>Actuator</b>	electrical solenoid
<b>Justification</b>	This was my choice because there will be no person needed to switch any switches and there won't be any contact needed when switching between rails. It will be easier and more efficient for train companies.

(2 marks)

Worksheet 1b



# Task 2a



# Task 2b

BASIC Viewer

Flowchart\_1

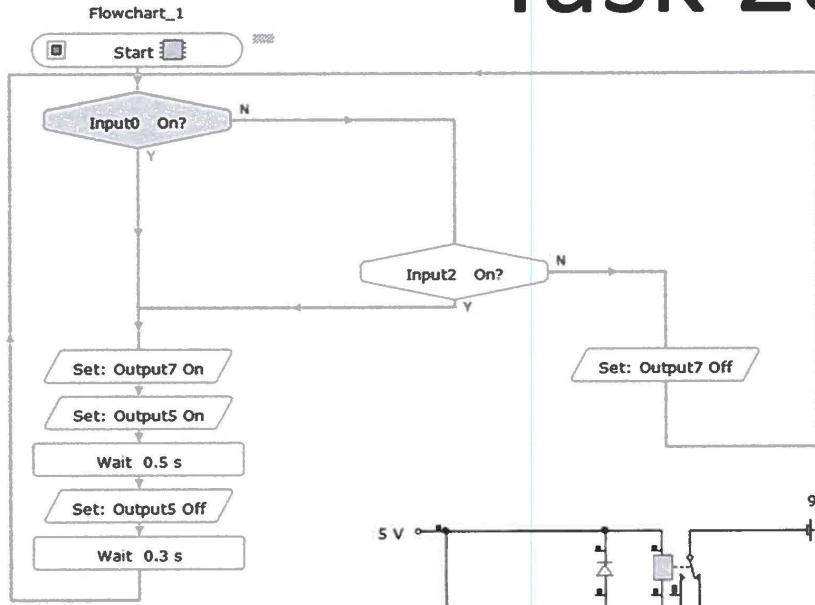
```
1
2 main:
3 label0:
4   if Input0 is On then label1
5 label2:
6   if Input2 is On then label1
7   Switch off 5
8   goto label2
9 label1:
10  Switch on 5
11  Switch on 4
12  pause 500
13  Switch off 4
14  pause 300
15  goto label0
16  goto label1
17
```

## Worksheet 2c

Planned test	Expected result	Initial test result	Planned amendment to circuit/flowchart	Retest result
<b>Test 1</b> Turn on the test switch (input 2) for around 20 seconds and then turn it off.	The motor starts to turn and the LEDs flash.  When the test switch is turned off, the LEDs turn off and the motor slows to a stop.	When the test switch is turned on ... The diode and the NPN transistor blow up. The motor stops and the LEDs turn on and then off.  When the test switch is turned off ... The motor stays stopped and the LEDs don't turn back on.	I will move the diode 180° so it is on its correct side because it was upside down.	When the test switch is turned on ... The LEDs turn on and off repeatedly and the motor turns.  When the test switch is turned off ... The LEDs stop and the motor slowly comes to an end.
Planned test	Expected result	Initial test result	Planned amendment to circuit/flowchart	Retest result
<b>Test 2</b> Press and hold the movement sensor (input 0) for around 20 seconds and then release it.	The motor starts to turn and the LEDs flash.  When the movement sensor is released, the LEDs turn off and the motor slows to a stop.	When the movement sensor is pressed ... nothing happens it doesn't turn on.  When the movement sensor is released ... Nothing happens it stays the way it was.	I made it an OR Programme by changing the input 7 off so it will go back to the start and re-ask the question is input '0' on?	When the movement sensor is pressed ... The motor starts and the LEDs go on and off.  When the movement sensor is released ... The motor slowly comes to a stop and the LEDs stop flashing.

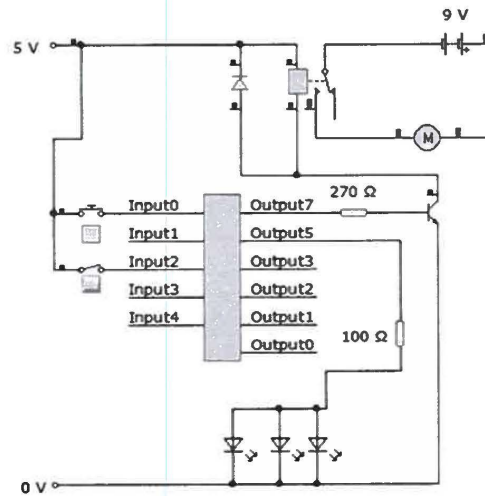
(6 marks)

# Task 2d

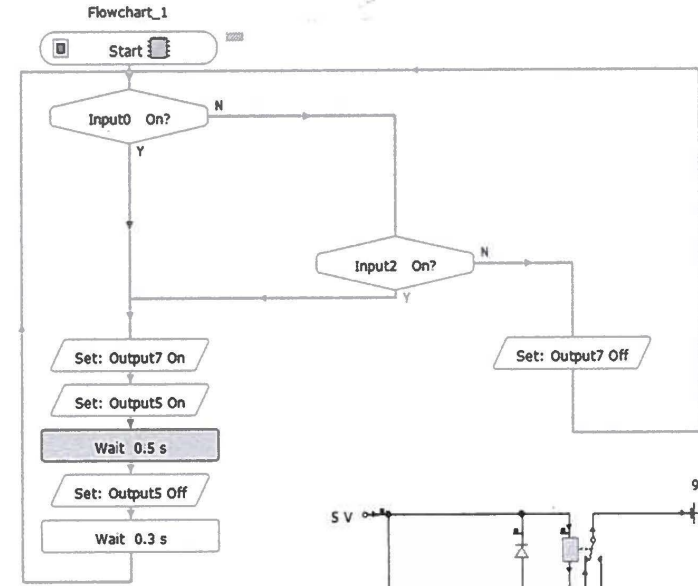


```

BASIC Viewer
Flowchart_1
1
2 main:
3 label10:
4   if Input0 is On then label1
5   if Input2 is On then label1
6   Switch off 5
7   goto label10
8 label1:
9   Switch on 5
10  Switch on 4
11  pause 500
12  Switch off 4
13  pause 300
14  goto label10
15  goto label1
16
    
```

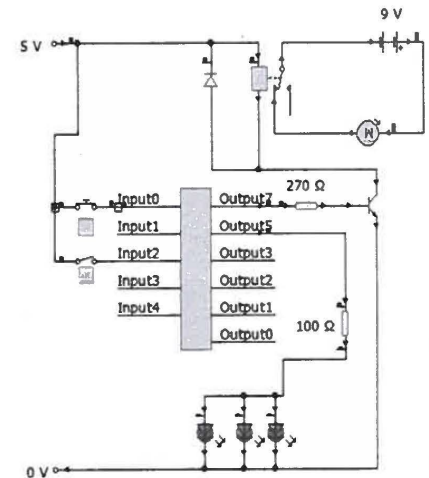


Off



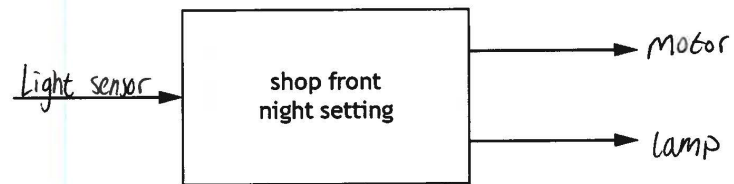
```

BASIC Viewer
Flowchart_1
1
2 main:
3 label10:
4   if Input0 is On then label1
5   if Input2 is On then label1
6   Switch off 5
7   goto label10
8 label1:
9   Switch on 5
10  Switch on 4
11  pause 500
12  Switch off 4
13  pause 300
14  goto label10
15  goto label1
16
    
```



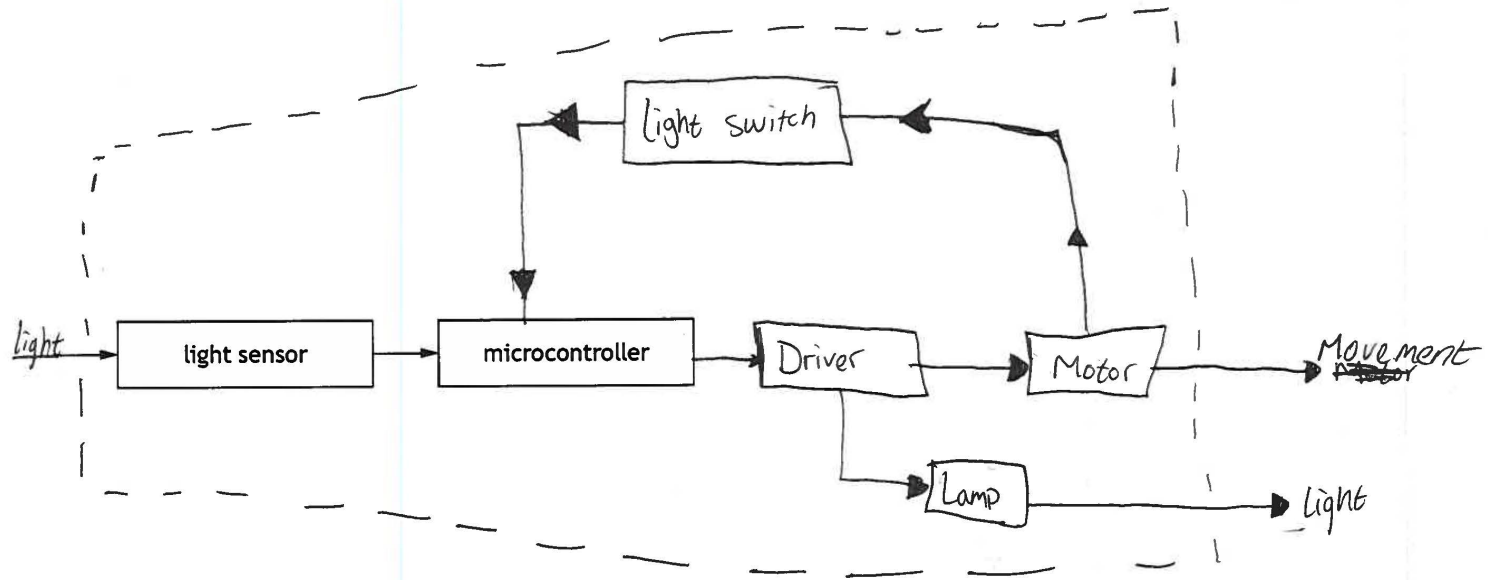
On

**Worksheet 3a(i)**



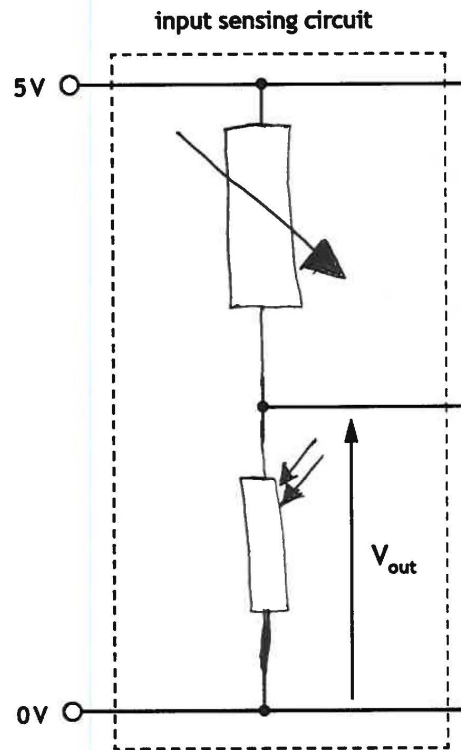
**(2 marks)**

Worksheet 3a(ii)



(6 marks)

### Worksheet 3b



**(3 marks)**

## Worksheet 3c

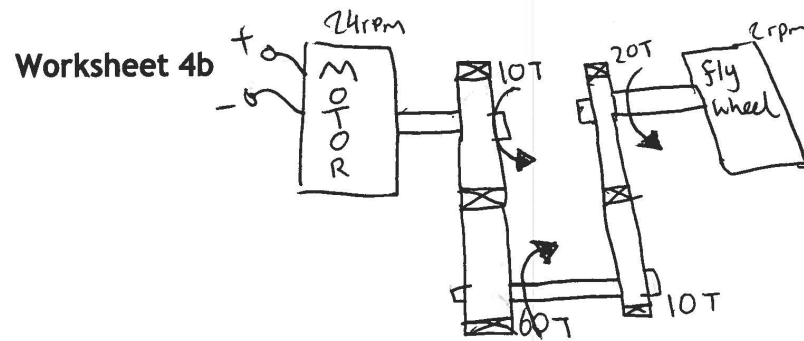
Planned test	Expected result
<b>Test 1</b> Reduce the light level.	The light dependent resistor will sense lower level of light, because of this the resistance will be increased helping it produce a high signal.
Planned test	Expected result
<b>Test 2</b> change the resistance of the variable resistor	This will allow the light dependent resistor (LDR) to be adjusted to allow it to sense a lighter or darker light level.

(3 marks)

## Worksheet 4a

Specification point	Met? Yes/No	Justification
i	NO	because they are all spaced out / the gaps in between them are too big, meaning it will not fit into compact space.
ii	Yes-	because gear 'A' spins clockwise - this will force gear 'B' to spin anticlockwise because 'B' and 'C' are connected together / joined together they will spin in the same way. because 'C' is going anticlockwise it will force 'D' to spin clockwise.
iii	NO.	because the gear chain starts with a big gear instead of a small gear because of this the gears will make it that the output speed will be bigger than 9.

(3 marks)



$$\begin{aligned}
 VR &= \frac{D_n}{D_r} \times \frac{D_n}{D_r} \\
 &= \frac{60}{10} \times \frac{20}{10} \\
 &= \frac{6 \times 2}{1 \times 1} \\
 &= \underline{\underline{12}}
 \end{aligned}$$

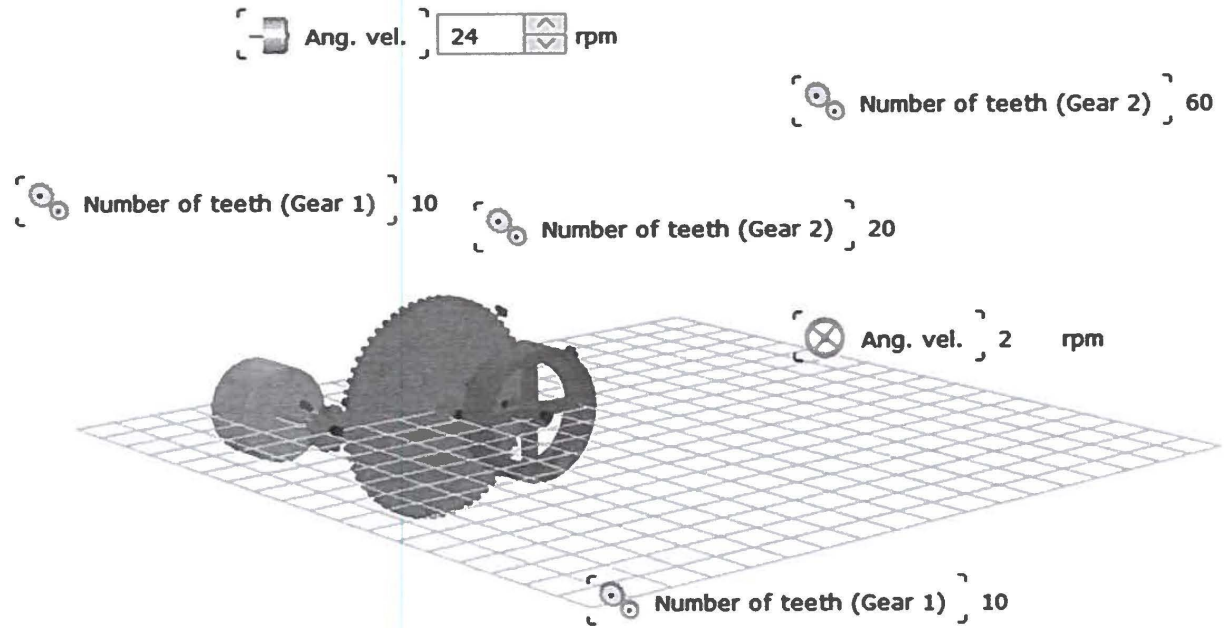
(2 marks)

**Worksheet 4d**

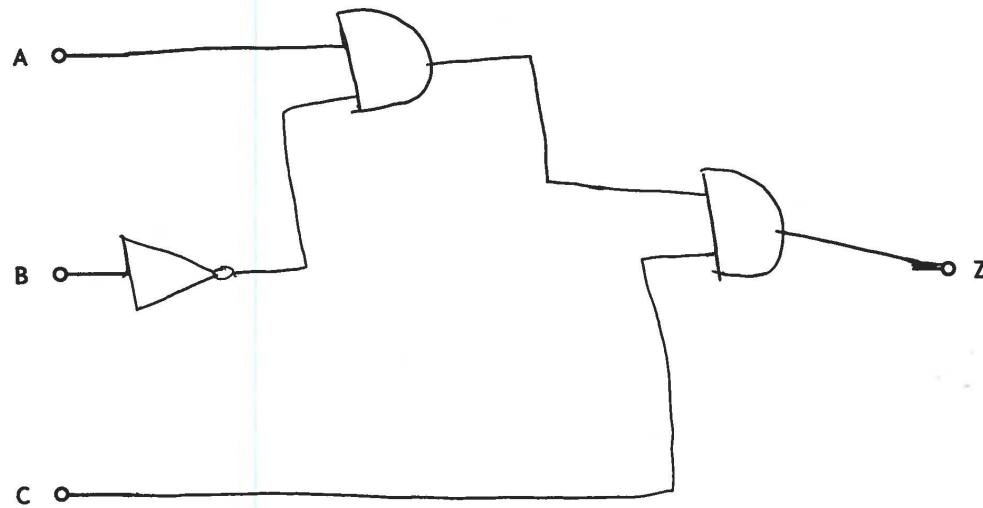
Planned test	Input speed	Output speed	Required Velocity Ratio	Actual Velocity Ratio
Measure the input speed and output speed of the gear system and calculate the actual velocity ratio.	24 rpm	2 rpm	Between 12:1 and 20:1	$  \begin{aligned}  &\frac{60 \times 20}{10 \times 10} \\  &= \frac{1200}{100} \\  &= \underline{\underline{12}}  \end{aligned}  $

(2 marks)

# Task 4c

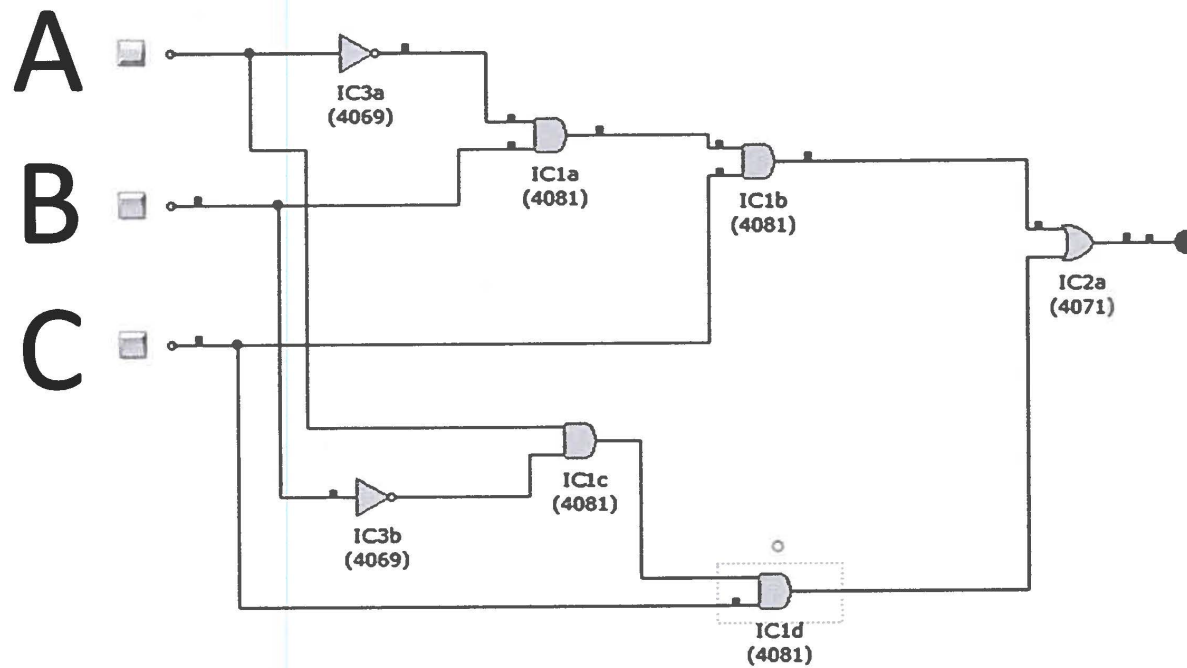


**Worksheet 5a**



**(2 marks)**

# Task 5b



## Worksheet 5c

<b>Modification</b>	I would make it have more input, e.g. A → B → C → D → E →
<b>Justification</b>	This will make it that the person will have to guess more numbers and a lot more number combinations. This will make it harder and challenging so no-one will break into your safe.

(2 marks)