2009 Technological Studies

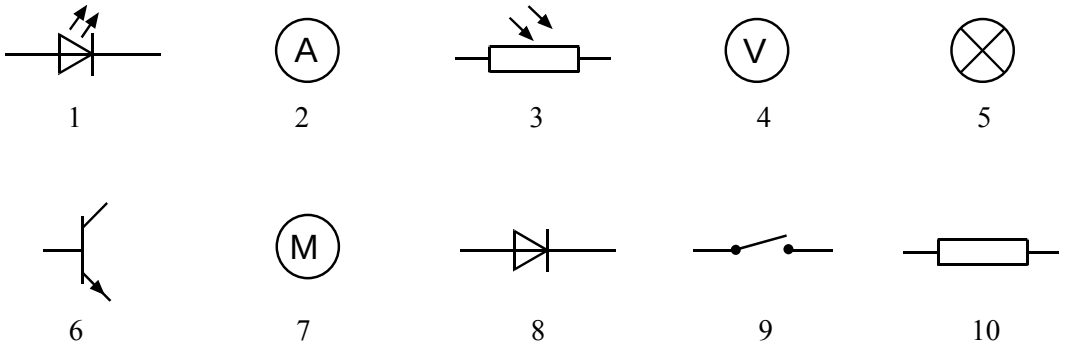
Standard Grade – General

Finalised Marking Instructions

Mark Allocation

Marks	
KU	**RNA**

1 (*a*) The following electronic symbols have been numbered 1 to 10.



1 2 3 4 5

6 7 8 9 10

Complete the table below by inserting the symbol number for each item. The first one has been completed for you.

Item	Symbol Number
Resistor	10
Lamp	**5**
LED	**1**
Motor	**7**
Transistor	**6**
Switch	**9**
LDR	**3**

6
5
4
3
2
1
0

System diagrams can be used to solve electronic problems.

(*b*) Draw the **Universal System Diagram**.

OR

3
2
1
0

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2. A hand held games console is shown.

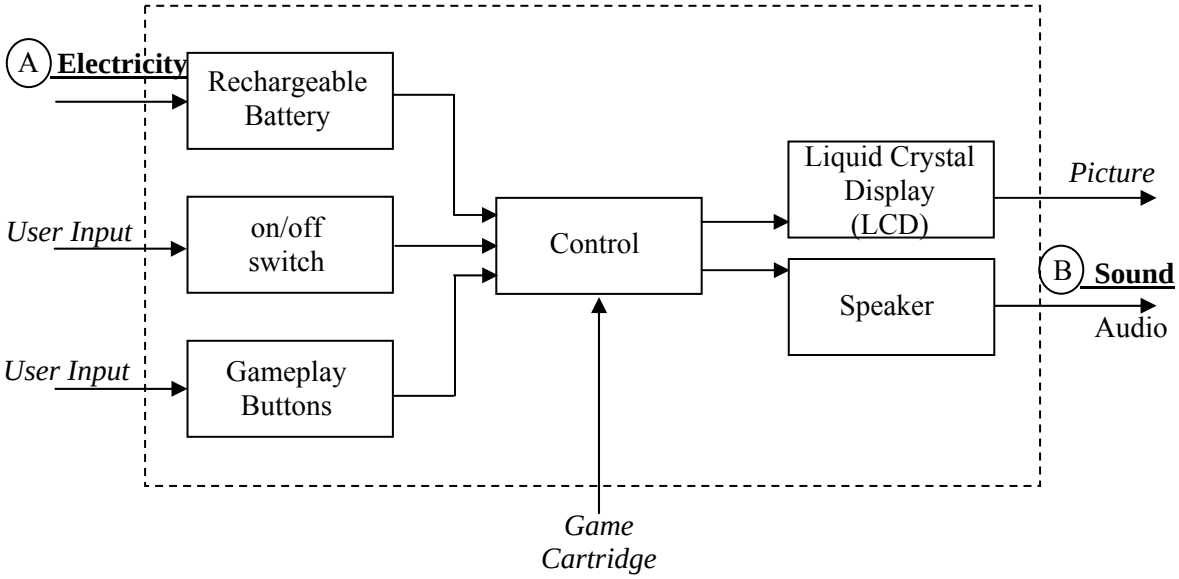
A simplified diagram of the main parts of the games console is shown below.

(*a*) Complete the diagram by adding:

(i) the missing input (A) ;

(ii) output (B) ;

(iii) the system boundary.



	1 0
	1 0
	1 0

(*b*) The system consists of six parts shown above.

These parts of the system are called **Sub Systems**

1 0	

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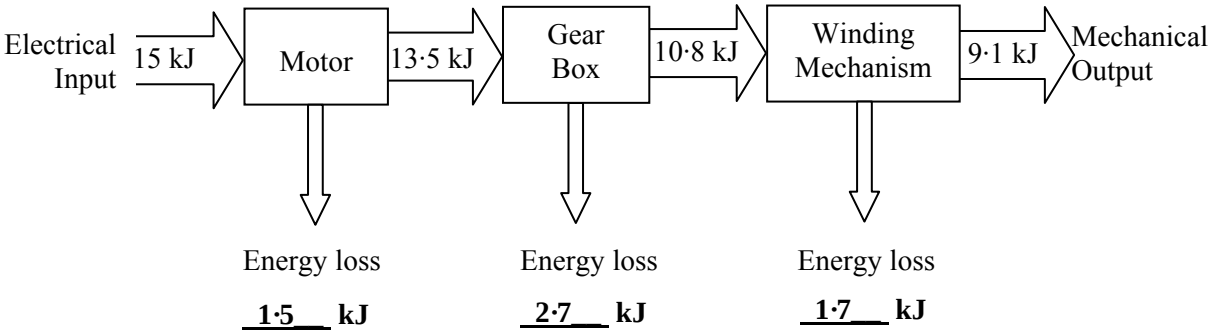
3. An electric motor is used to drive a ski tow.

(*a*) Complete the energy audit below.



3
2
1
0

(*b*) Calculate the **total** energy **loss** in the ski tow.

Total energy loss = **5·9** kJ **(FTE)**

1
0

(*c*) Complete the following sentence using the list of phrases given.

Input energy *Lost energy* *Output energy*

"Because the **Input energy** is always greater than the **Output energy**

the efficiency will always be less than 100%."

2
1
0

A local hydro electric power plant provides the energy for the ski tow. Hydro electricity is one example of renewable energy.

(*d*) State **three** other examples of **renewable** energy.

1 **Wind**

2 **Wave**

3 **Tidal, Solar, Geothermal, Biomass**

(NOT HYDRO)

3
2
1
0

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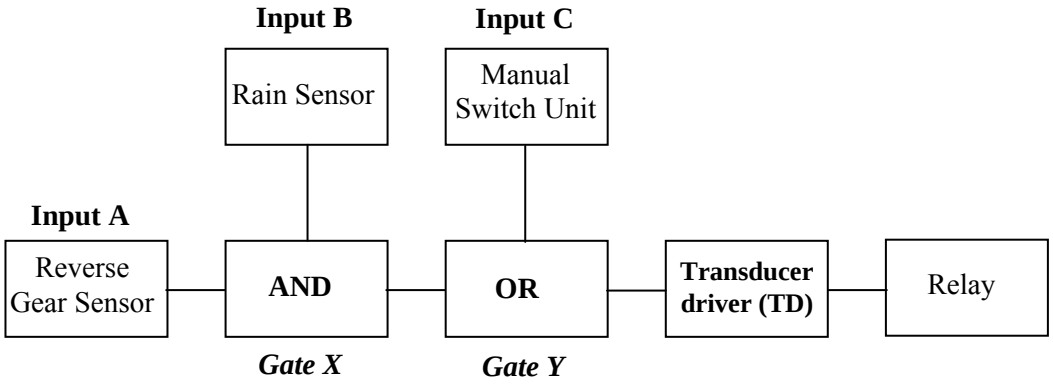
4. A car rear wiper is controlled using an electronic circuit.

The rear wiper can be activated manually using a switch **or** automatically if the reverse gear is selected **and** rain is detected.

(*a*) Complete the block diagram by choosing the correct devices from the list below.

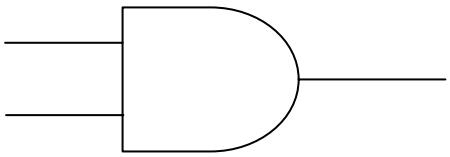
Pulse generator *AND gate* *OR gate* *Magnetic Switch*

Latch *Temperature sensor* *Transducer driver* *NOT gate*



	3 2 1 0

(*b*) (i) Sketch the logic symbol for ***Gate X***.

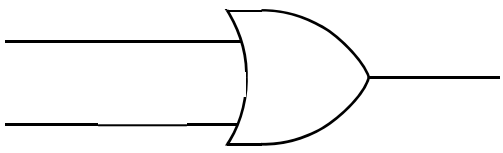


Allow FTE

1 KU for correct shape
1 KU 2 input + 1 output

2 1 0	

(ii) Sketch the logic symbol for ***Gate Y***.



Allow FTE

2 1 0	

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Marks	
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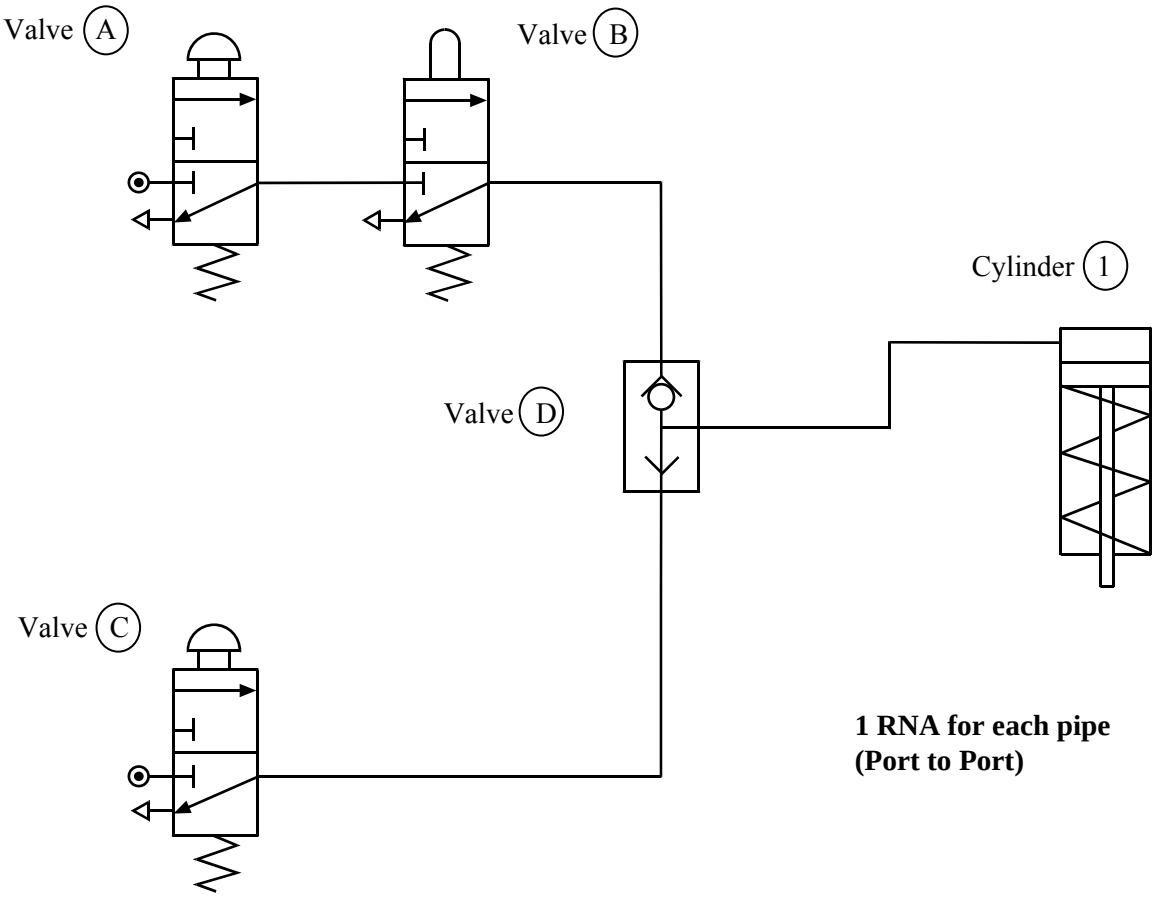
5. A control gate in a gas pipeline is operated by a pneumatic cylinder.

The gate must operate when **both** valves (A) **and** (B) are actuated **or** when valve (C) is pressed.

(*a*) Complete the piping of the pneumatic circuit below.



1 RNA for each pipe (Port to Port)

	4
	3
	2
	1
	0

Mark Allocation

Marks	
KU	**RNA**

(*b*) State the **full name** of the following pneumatic components.

3
2
1
0

(i) Valve (B) **3/2/plunger/spring return** **1 KU per aspect**

1
0

(ii) Valve (D) **shuttle (valve)**

1
0

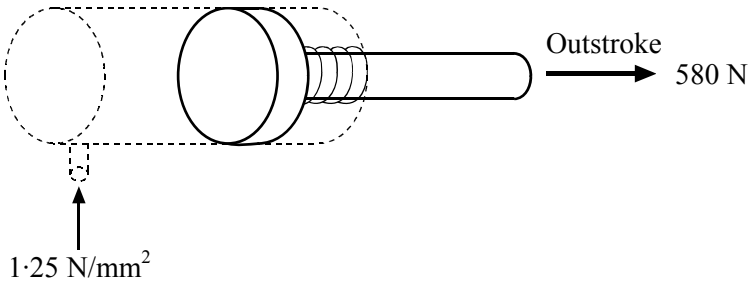
(iii) Cylinder (1) **single acting**

(*c*) State **one** advantage of using compressed air as an energy source.

1
0

Clean/safe/dependable

(*d*) Calculate the piston area if air is supplied at 1·25 N/mm^2 and the outstroking force of the piston rod is 580 N.
(Ignore the force of the spring.)



$P = \frac{F}{A}$

$A = \frac{F}{P}$

$= \frac{580}{1 \cdot 25}$ **1 RNA for correct substitution** **2**

1

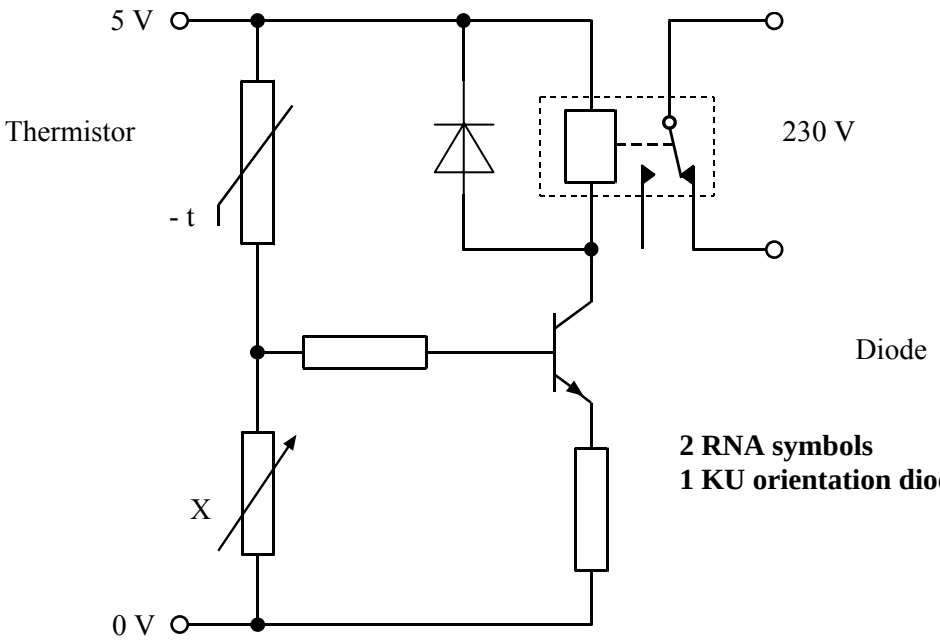
$= 464 \text{ mm}^2$ **1 RNA for correct answer from given working** **0**

Mark Allocation

Marks	
KU	**RNA**

6. A microwave oven is fitted with a safety circuit that will automatically switch off if the outside surface gets too warm.

The incomplete safety circuit is shown below.



2 RNA symbols
1 KU orientation diode

KU	RNA	
	2	
1	**1**	(*a*) Draw the symbols for the two components named above to complete the safety circuit.
0	**0**	
		(*b*) State the name of component **X**.
1		
0		**Variable resistor**
	2	(*c*) Determine, with reference to the Data Booklet, the temperature **range** of a **type 1** thermistor.
	1	
	0	**-75°C** to **125°C**
		(*d*) State the saturation voltage of a transistor.
1		
0		V_{be} **0·7**

Mark Allocation

Marks	
KU	**RNA**

(*e*) (i) Calculate the current flowing through the relay if the coil has a resistance of 400 Ω and a voltage drop of 4 V.

$V = IR$

$I = \frac{V}{R}$

$= \frac{4}{400}$ **1 RNA for substitution** — **2**

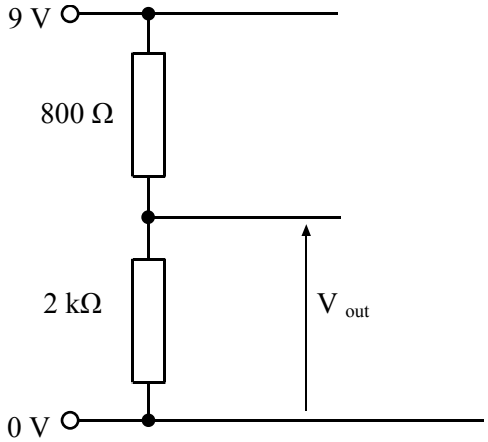
$= 0{\cdot}01$ A **1 RNA for correct answer from working** — **1 0**

(ii) Calculate the power used by the relay coil.

	$P = I^2R$	**OR**	$P = \frac{V^2}{R}$	**OR**	$P = VI$				
Allow FTE	$= 0{\cdot}01^2 \times 400$	**- 1 RNA**	$= \frac{4^2}{400}$		$= 4 \times 0{\cdot}01$			**2**	
	$= 0{\cdot}04$ W	**- 1 RNA**	$= 0{\cdot}04$ W		$= 0{\cdot}04$ W			**1**	
	Answer from given working							**0**	

Resistors are used in many electronic circuits.

(*f*) (i) Calculate the voltage V_{out} in the circuit shown below.



$V_{out} = \frac{R_2}{R_t} \times V_S$

$V_{out} = \frac{2000}{2800} \times 9$ **1 RNA**

$V_{out} = 6{\cdot}43$V **1 RNA**

1 RNA for substitution — **2**

1 RNA for correct answer from working — **1 0**

(ii) State the name of the series resistor arrangement shown above.

Voltage divider/Potential divider — **1 0**

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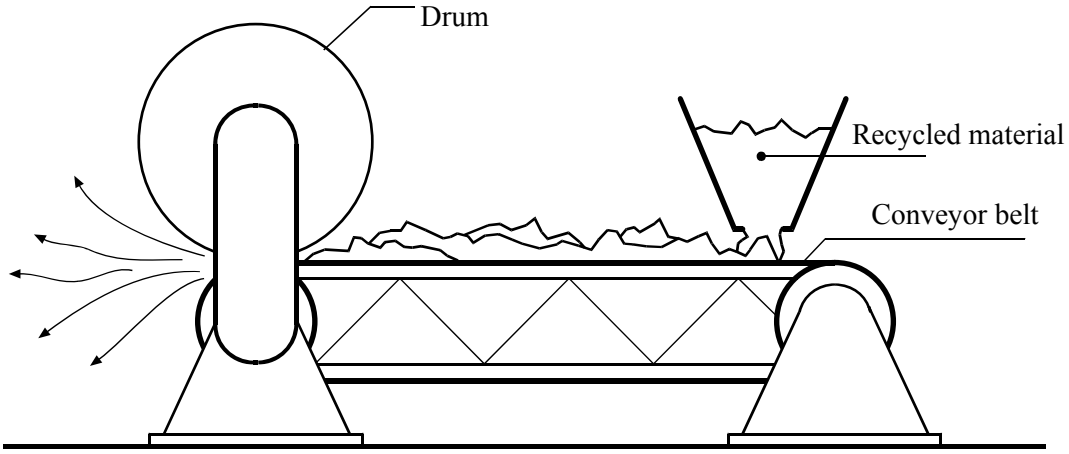
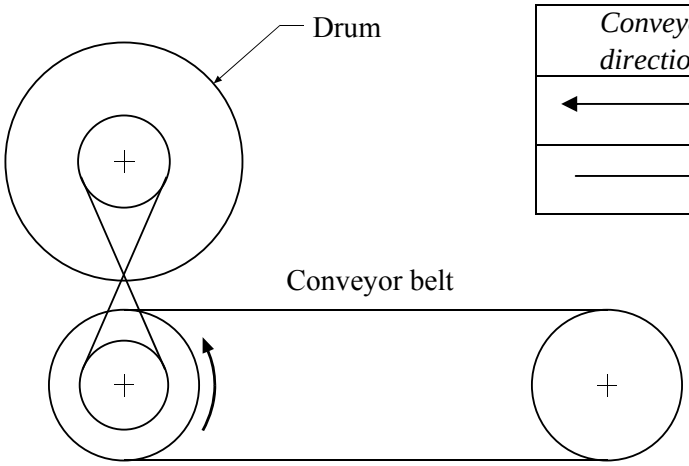
7. A conveyor belt system is used in a recycling process.



(*a*) Indicate (✓) on the tables below the direction of movement of the conveyor belt and the drum.

Drum direction	
✓	

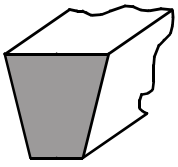


Conveyor belt direction at **X**	
←	
→	✓

X

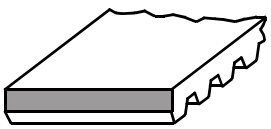
	2
	1
	0

Three different types of belt are shown below.



(1) V belt

(2) Flat belt



(3) Toothed belt

(*b*) State which belt (1, 2 or 3) is used for:

(i) crossed belt drives;

(2) flat belt

1	
0	

(ii) positive (non-slip) drives.

(3) toothed belt

1	
0	

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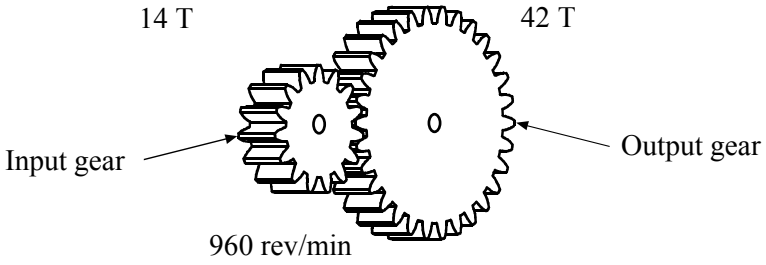
An electric motor drives the conveyor belt system through a simple gear train.



(*c*) Calculate the speed of the output gear when the input gear rotates at 960 rev/min.

$(N \times T)_{DRIVER}$ = $(N \times T)_{DRIVEN}$

N_{DRIVEN} = $\frac{960 \times 14}{42}$ **1 substitution** **2**

N_{DRIVEN} = 320 rev/min **1 Answer from given working** **1 0**

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8. An automatic bicycle rack for a car is operated by a microcontroller.

The sequence of operations for **lowering** a bicycle is listed below.

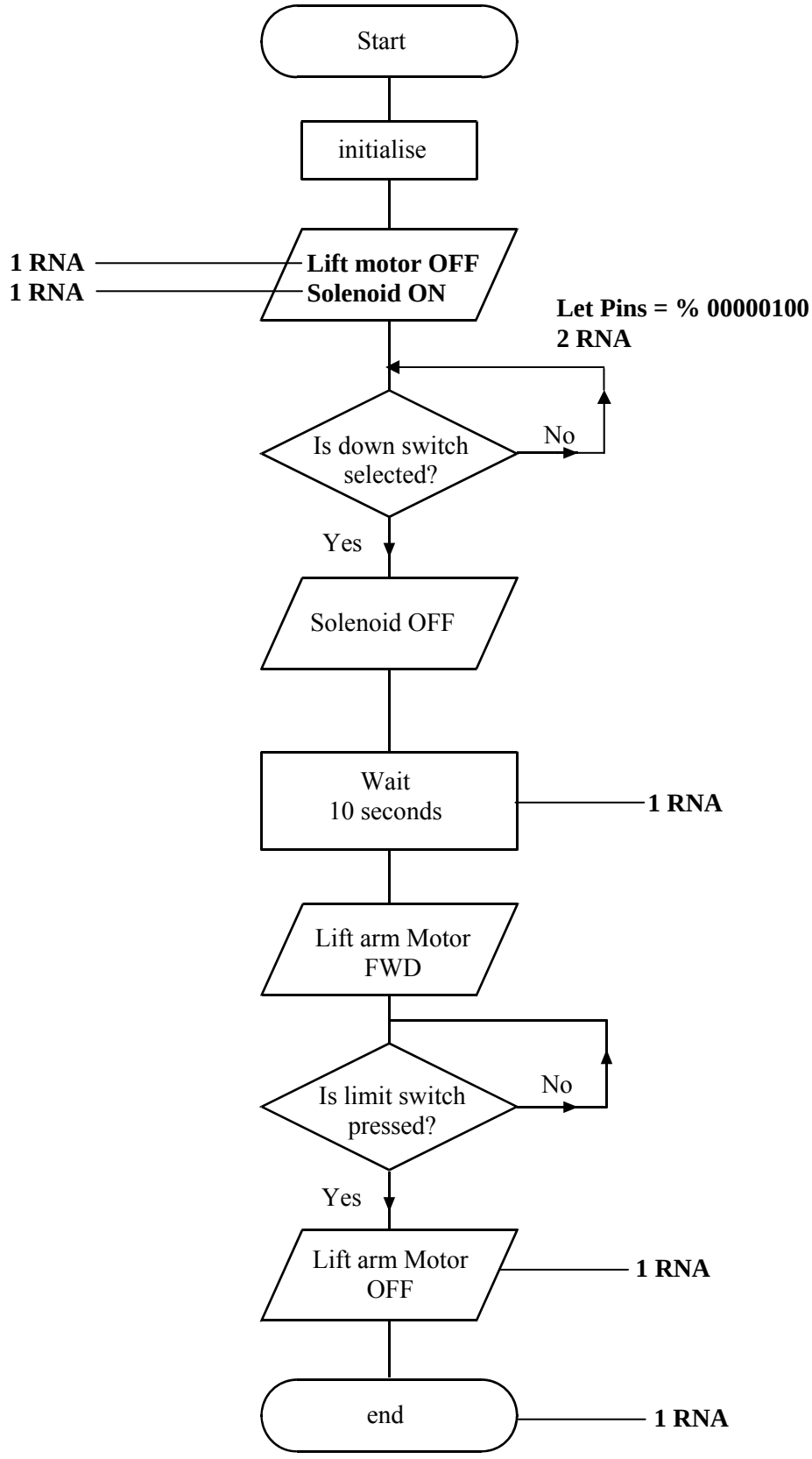
- The sequence begins with the lift arm motor off and locking solenoid on.
- When the 'down' switch is pressed the locking solenoid switches off then 10 seconds later the lift arm motor rotates forward.
- When the lift arm is in the fully lowered position a limit switch is activated which stops the motor.
- The sequence ends.

Input Connection	Pin	Output Connection
	7	
	6	
	5	
	4	
	3	Lift Arm Motor FORWARD
	2	Locking Solenoid
Limit Switch	1	
Down Switch	0	

Mark Allocation

Marks	
KU	**RNA**
	5 **4** **3** **2** **1** **0**

(*a*) Complete, with reference to the sequence of operations and Data Booklet, the flowchart by adding the correct symbols and instructions.



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(*b*) Complete, with reference to the microcontroller connections, Data Booklet and flowchart, the PBASIC program.

```
init:       let DIRS = %11111100      'set pins 0 and 1 as inputs, rest outputs
            let pins = 0              'switch all pins off

main:       let pins = %00000100      'solenoid ON and motor OFF
            if pin0 = 1 then label_1  'test pin0
            goto main                 'jump to main

label_1:    low 2/let pins = Ø        'solenoid OFF
            pause 10000               '10 second delay
            high 3                    'motor forward

label_2:    if pin 1 = 1 then label_3 'test pin 1
            goto label_2

label_3:    low 3                     'motor off, PIN 3 off
            end                       'end program
```

	5
	4
	3
	2
	1
	0

(*c*) State two advantages of using a microcontroller instead of a hardwired electronic circuit.

1	**More flexible/features/accurate/re-program**	**Smaller**	**Explain**	**2**
		Cheaper		**1**
2	**Easier assembly/less parts**			**0**

(*d*) State the **full name** and **function** of the following microcontroller terms.

(i) **ROM**

Full name **Read only memory** — **2** **1**

Function **Memory where program or data is stored** — **0**

(ii) **RAM**

Full name **Random access memory** — **2** **1**

Function **Working memory of controller** — **0**

(iii) **ALU**

Full name **Arithmetic logic unit** — **2** **1**

Function **To carry out mathematical functions/ the brain of the microcontroller** — **0**

(*e*) State the function of the clock in a microcontroller.

Synchronises the system — **1** **0**

[END OF MARKING INSTRUCTIONS]