2009 Technological Studies

Standard Grade – Credit

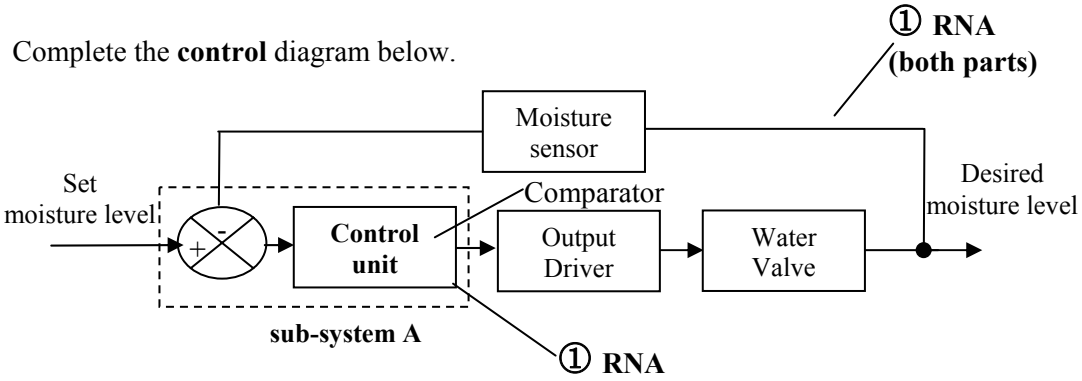
Finalised Marking Instructions

Mark Allocation

Marks	
KU	**RNA**

1. The moisture level in a greenhouse is controlled automatically.

(*a*) Complete the **control** diagram below.



2
1
0

(*b*) State the type of control produced by this automatic system.

Closed loop ① **KU**

1
0

(*c*) State a suitable electronic device which could be used for the output driver sub-system.

Transistor ① **KU** **– Amplifier – Transducer Driver**

1
0

(*d*) Describe the operation of **sub-system A**.

① **KU** ① **KU**

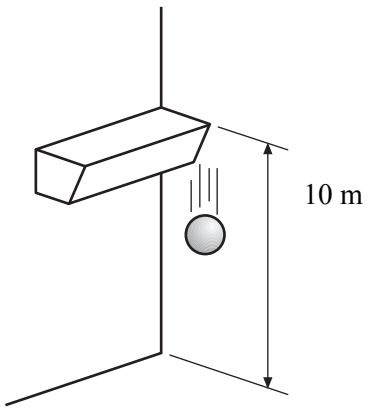
It controls the operation by comparing the two inputs and switching the output on or off. (Error detector – 1 KU)

2
1
0

Mark Allocation

Marks	
KU	**RNA**

2. A 0·7 kg ball is dropped from a 10 m high balcony.



(*a*) Calculate, **showing all working and units**:

(i) the potential energy of the ball at the balcony;

E_p = mgh
= 0·7 × 9·81 × 10 ① **RNA substitution**
= 68·67 J ① **RNA correct answer from given working**

2
1
0

(ii) the maximum velocity of the ball.
(Assume that all E_p is converted into E_k.)

$$\mathbf{v} = \sqrt{\frac{2E_k}{m}}$$ **FTE**

$$= \sqrt{\frac{2 \times 68 \cdot 67}{0 \cdot 7}}$$ ① **RNA substitution**

= 14 m/s ① **RNA correct answer from given working**

2
1
0

(*b*) When the ball bounces, it does not reach its original height.

State the two main forms of **energy** which are lost when the ball bounces.

(i) **Heat** ① **KU**

(ii) **Sound** ① **KU**

2
1
0

Renewable energy can be generated from a number of different sources.

(*c*) State **one disadvantage** for each of the following renewable sources.
(**Give a different disadvantage for each source**.)

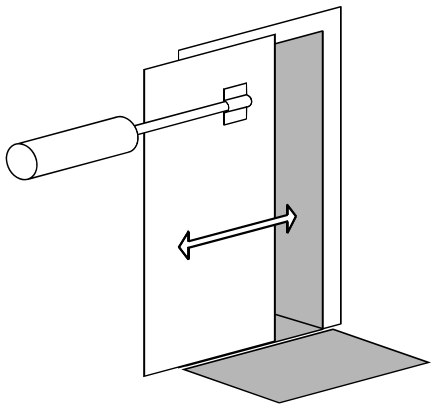
Tidal **Restricted location, damage to marine life etc** ① **KU**

Wave **Difficult to maintain, danger to shipping, calm etc** ① **KU**

2
1
0

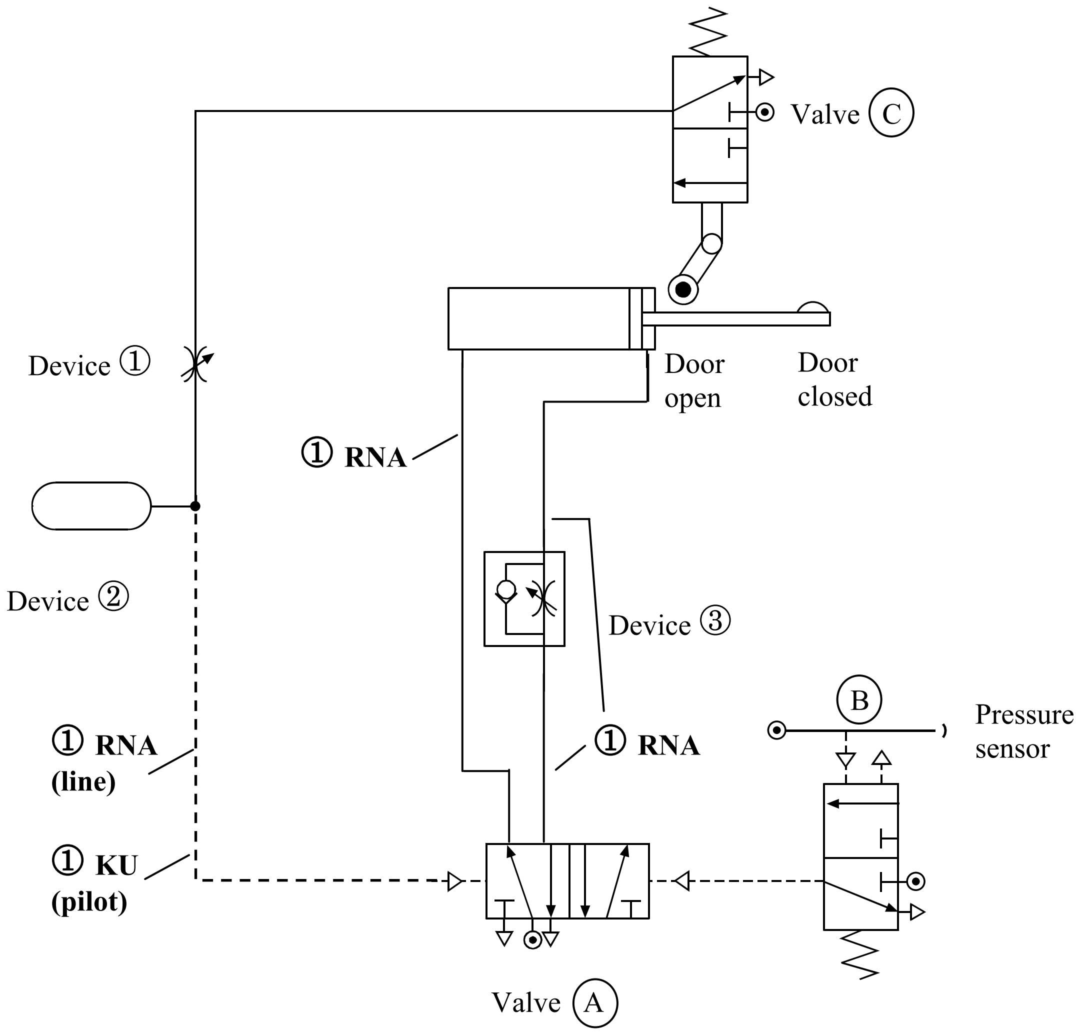
Mark Allocation

3. A pneumatic circuit is used to control the operation of an automatic door.



When a person steps on to the pressure sensor, the piston will instroke and open the door. After an 8 second delay, the piston will automatically outstroke and slowly close the door.

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



– 1 RNA for incorrect position of HDR

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

Mark Allocation

Marks	
KU	**RNA**

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

(i) Actuator (B) **Diaphragm** ① **KU** — **1 0**

(ii) Device ③ **Unidirectional restrictor** ① **KU** — **1 0**

(iii) Valve (C) **Roller trip actuated/3/2/spring return** — **3 2 1 0**

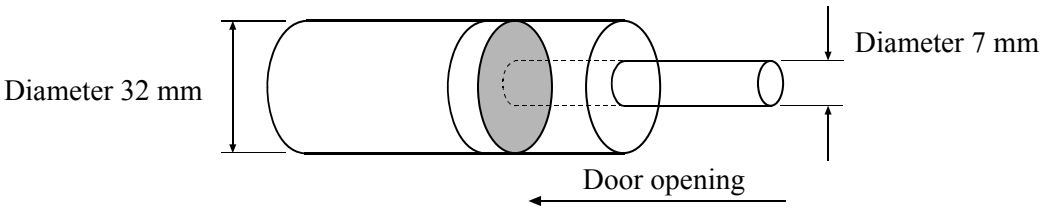
① **KU** ① **KU** ① **KU**

(*c*) Describe, using appropriate terminology, the operation of Device ③.

It slows down the air in one direction only — **2 1 0**

① **KU** ① **KU**

(*d*) Calculate the instroking force when the air pressure is 2·32 N/mm^2.



A	=	**πR^2**		**A_{EFF}**	=	**A – a**	
	=	**$3{\cdot}14 \times 16^2$**			=	**803·84 – 38·46**	
	=	**803·84 mm^2**	① **RNA**		=	**765·38 mm^2**	① **RNA**
a	=	**πr^2**		**F**	=	**Pa**	
	=	**$3{\cdot}14 \times 3{\cdot}5^2$**			=	**2·32 × 765·38**	
	=	**38·46 mm^2**	① **RNA**		=	**1775·7 N**	① **RNA**

Answer from working — **4 3 2 1 0**

(*e*) (i) State the name of Device ②.

Reservoir ① **KU** — **1 0**

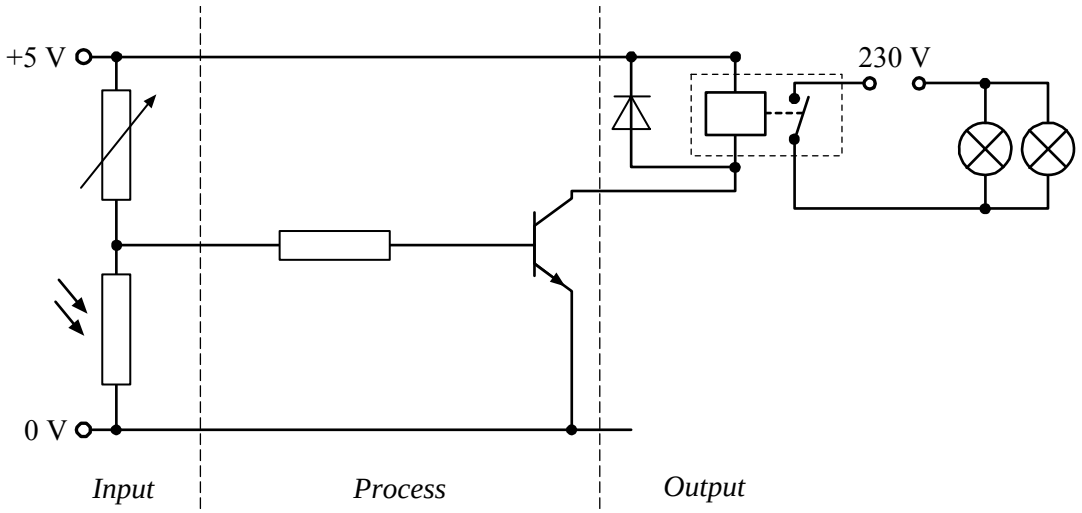
(ii) Describe why Device ② is rarely used on its own to produce a pneumatic time delay.

Not adjustable ① **KU** — **1 0**

Mark Allocation

Marks	
KU	**RNA**

4. An automatic lighting system has been developed so that it only switches on when someone is sensed in the room. The circuit diagram is shown below.



(*a*) Describe, using appropriate terminology, the operation of the:

(i) Input sub-system — **When someone passes in front of the sensor it gets dark, which increases R, which increases output V. Variable resistor to adjust sensitivity.**

KU	RNA
	2
	1
	0

(ii) Process sub-system — **When voltage increases, transistor switches on output. Resistor to protect transistor.**

KU	RNA
	2
	1
	0

(iii) Output sub-system — **Relay closes to switch on external circuit. Diode to protect transistor from back emf.**

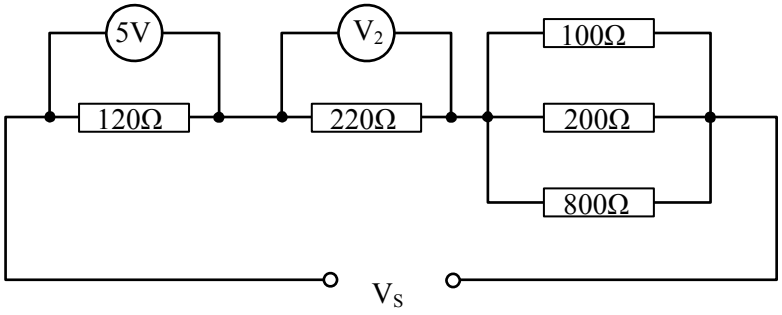
KU	RNA
	2
	1
	0

① RNA for each valid point. Up to a maximum of ② RNA for each sub-system.

Mark Allocation

Marks	
KU	**RNA**

Another part of the lighting system uses the following circuit.



(b) Calculate:

(i) the current through the 120 Ω resistor;

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

$$\mathbf{= \frac{5}{120}}$$ ① **RNA substitution** — **2 1**

$$\mathbf{= 0 \cdot 04\ A}$$ ① **RNA correct answer from given working** — **0**

(ii) the voltage V_2;

$$\mathbf{V = IR}$$

$$\mathbf{= 0 \cdot 04 \times 220}$$ ① **RNA substitution (Allow FTE)** — **2 1**

$$\mathbf{= 8{\cdot}8\ V}$$ ① **RNA correct answer from given working** — **0**

Mark Allocation

Marks	
KU	**RNA**

(iii) the total resistance of the three parallel resistors;

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{100} + \frac{1}{200} + \frac{1}{800}$$ **① RNA substitution** — **3 2**

$$= \frac{8+4+1}{800}$$ **① RNA reciprocal** — **1 0**

$$R_T = \frac{800}{13} = 61{\cdot}54\ \Omega$$ **① RNA correct answer from given working**

(iv) the supply voltage V_S.

V = IR — **3**

= 0·04 × 61·54 **① RNA substitution** — **2**

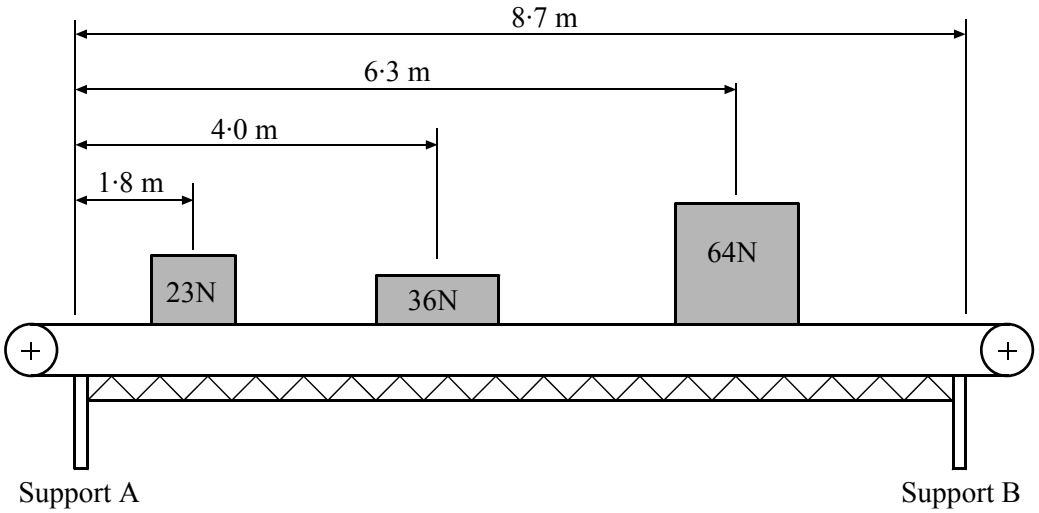
= 2·46 V **① RNA correct answer from given working** — **1**

V_S = 5 + 8·8 + 2·46 = 16·26 V **① RNA correct answer from given working** — **0**

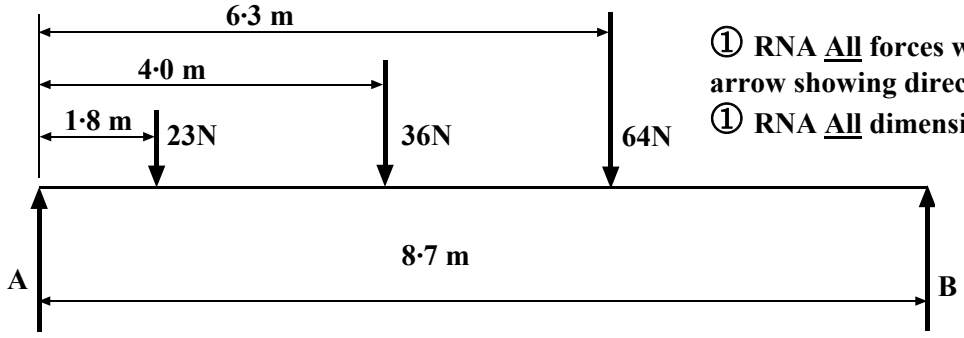
Mark Allocation

Marks	
KU	**RNA**

5. A conveyor belt is used to move packages in a warehouse. When the conveyor belt stopped, packages were in the position shown.



(*a*) Draw the free body diagram for the system.



① RNA All forces with arrow showing directions
① RNA All dimensions

2 1 0

(*b*) (i) Calculate, by taking moments about support A, the reaction at support B.

CWM = ACWM

$(1{\cdot}8 \times 23) + (4 \times 36) + (6{\cdot}3 \times 64) = 8{\cdot}7\ R_B$ **① RNA substitution**

$41{\cdot}4 + 144 + 403{\cdot}2 = 8{\cdot}7\ R_B$

$R_B = \dfrac{588{\cdot}6}{8{\cdot}7}$ **① RNA transposition**

$= 67{\cdot}6$ N ↑ **① RNA correct answer from given working**

3 2 1 0

(ii) Determine the reaction at support A.

↑ = ↓

$67{\cdot}6 + R_A = 23 + 36 + 64$ **① RNA substitution**

$R_A = 55{\cdot}4$ N↑ **① RNA correct answer from given working**

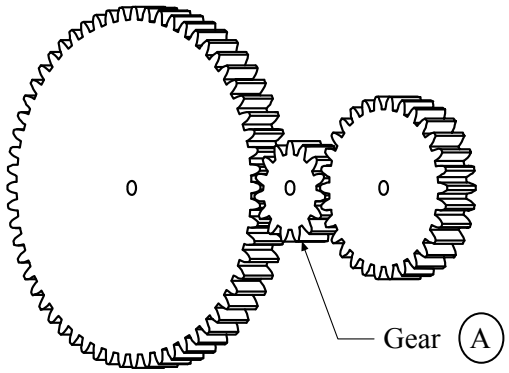
2 1 0

NB: Allow FTE

Mark Allocation

Marks	
KU	**RNA**

The conveyor belt is driven by a gear drive, part of which is shown below.



(*c*) State **one** advantage of using a gear drive over a belt drive.

No slippage ① **KU** — **1 0**

(*d*) (i) State the name of Gear (A).

Idler ① **KU** — **1 0**

(ii) Describe the effect Gear (A) has on the output speed **and** direction of the mechanism.

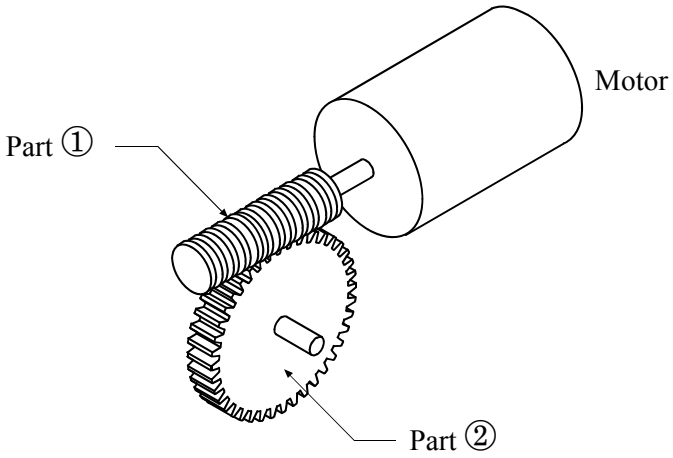
Speed – No effect ① **KU** — **2 1 0**

Direction – Input and Output gears – same direction ① **KU**

Mark Allocation

Marks	
KU	**RNA**

Another part of the system makes use of the mechanism shown below.



(e) State the name of the two parts of the mechanism show above.

Part ① **Worm** ① **KU**

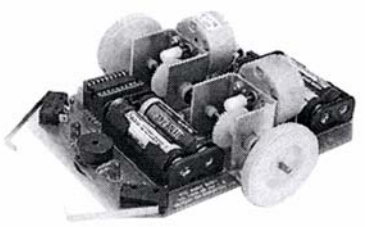
Part ② **Wheel** ① **KU**

2
1
0

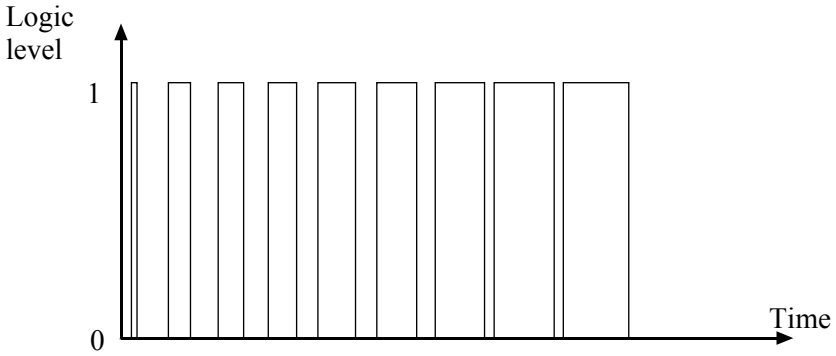
① **KU total if wrong way round**

Mark Allocation	Marks	
	KU	RNA

6. A student is programming a microcontroller to start and slowly accelerate a motorised buggy.



A graph showing the control required is given below.



(*a*) State the name given to the programming technique **where a motor is rapidly switched on and off**.

Pulse Width Modulation (accept PWM) ① **KU** — **1 0**

(b) For the programming technique you named in (a):

(i) state the name given to the **time** when the motor is **switched on**;

Mark ① **KU** — **1 0**

(ii) state the name given to the **time** when the motor is **switched off**.

Space ① **KU** — **1 0**

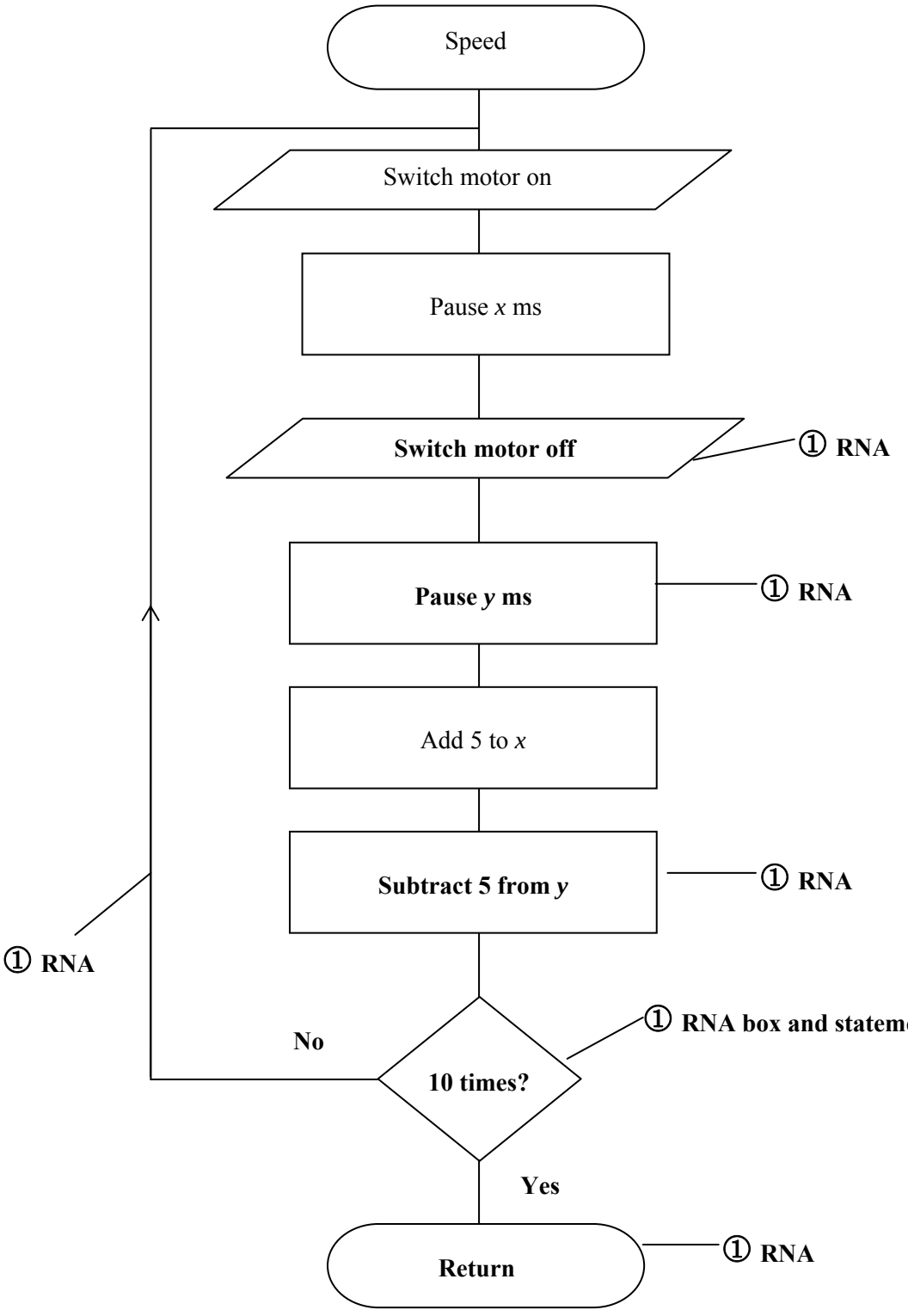
The student's initialisation and the PBASIC sub-procedure "speed", used to slowly accelerate the buggy, is shown below.

```
init:     symbol x = b0          'rename memory location b0 as x
          symbol y = b1          'rename memory location b1 as y
          symbol motor = 7       'rename pin 7 as "motor"
          let x = 0              'starting value of x is 0
          let y = 50             'starting value of y is 50

speed:    for b2 = 1 to 10       'start for ... next loop
              high motor         'motor on
              pause x            'pause x ms
              low motor          'motor off
              pause y            'pause y ms
              let x = x + 5      'add 5 to x
              let y = y – 5      'subtract 5 from y
          next b2                'complete for ... next loop

          return                 'return to main program
```

Mark Allocation

Marks	
KU	**RNA**

(*c*) Complete, with reference to the PBASIC "**speed**" sub-procedure and the Data Booklet, the flowchart below.

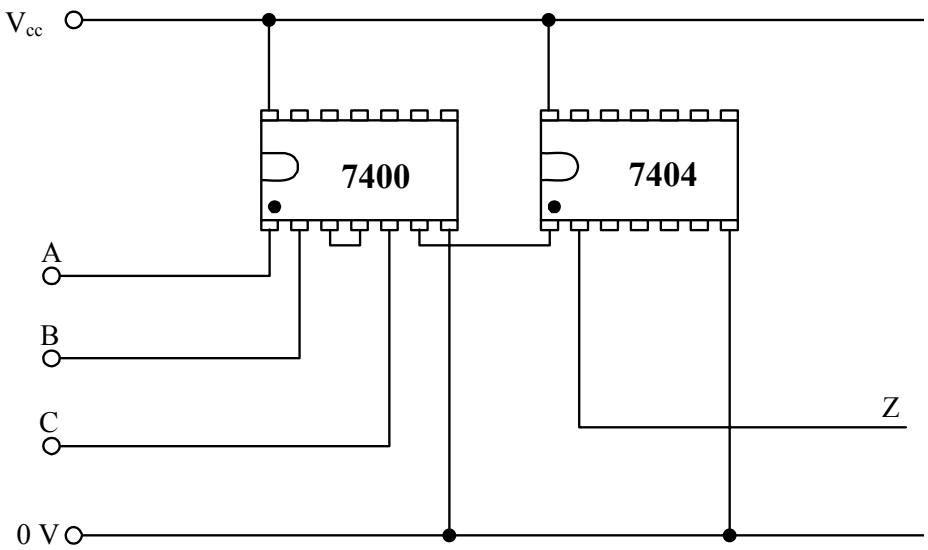


6
5
4
3
2
1
0

Mark Allocation

Marks	
KU	**RNA**

7. A set of DJ turntables has a number of indicator lights. Part of the circuitry for the control of these lights is shown below.



(*a*) State, with reference to the Data Booklet, the **full name** of the ICs required to build the circuit.

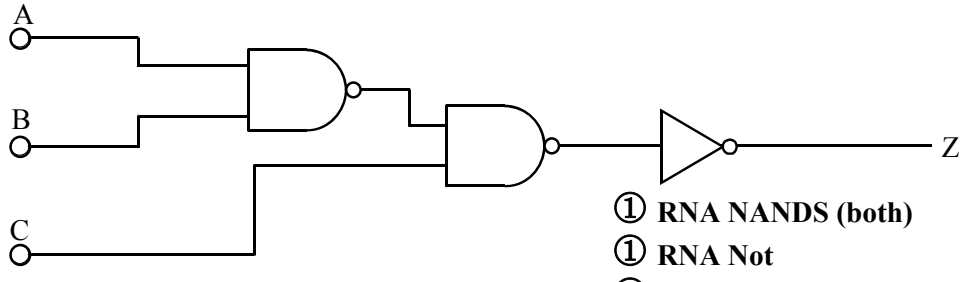
IC Number **7400**

Full Name **Quad 2 Input NAND** ① **KU**

IC Number **7404** **2**

Full Name **Hex Inverter** ① **KU** **1 0**

(*b*) Draw the logic diagram for the wiring circuit shown above.



① **RNA NANDS (both)**
① **RNA Not**
① **RNA Connections** **3 2 1 0**

Mark Allocation

Marks	
KU	**RNA**

(*c*) (i) State the name of the family which these ICs belong to.

TTL ① **KU** — **1 0**

(ii) State a suitable supply voltage (V_{cc}) for this family of ICs.

5 V ① **KU** **FTE** — **1 0**

(iii) State the name of another family of ICs.

CMOS ① **KU** **FTE** — **1 0**

(iv) State one **advantage** of using this family of ICs over the type named in (iii).

Faster switching ① **KU** **FTE** — **1 0**

(v) State one **disadvantage** of using this family of ICs over the type named in (iii).

Stabilised power supply required ① **KU** — **1 0**

(*d*) State the purpose of the dot on an IC.

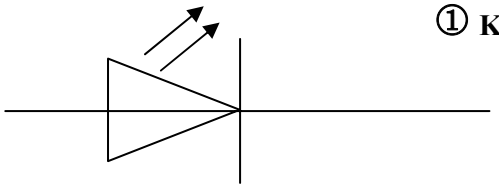
To indicate PIN 1 ① **KU** — **1 0**

An LED is used to show a high output from the circuit.

(*e*) (i) State the full name of an LED.

Light Emitting Diode ① **KU** — **1 0**

(ii) Draw the symbol for an LED below.



① **KU** — **1 0**

A resistor is normally used in series with an LED.

(*f*) State the purpose of this resistor.

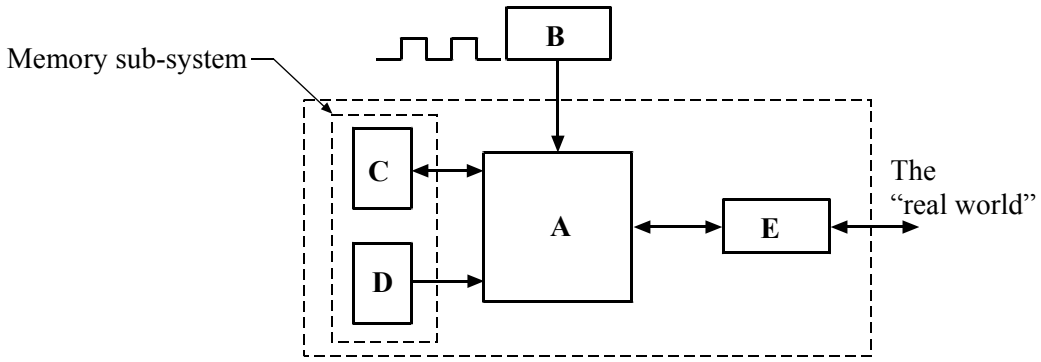
To protect the LED (from too much current.) ① **KU** — **1 0**

Mark Allocation

Marks	
KU	**RNA**

8. Microcontrollers are used in a variety of modern systems.

A simplified block diagram showing a microcontroller is given.



(*a*) State the name of the parts (**A** to **E**) shown on the diagram above.

A **ALU** ① **KU**

B **Clock** ① **KU**

C **RAM** ① **KU**

D **ROM** ① **KU**

E **I/O Unit** ① **KU**

5
4
3
2
1
0

(*b*) State the full name and function of the EEPROM sub-system used with a microcontroller.

Full name **Electronically Erasable Programmable Read Only Memory** ① **KU**

Function **To store data, program etc** ① **KU**

2
1
0

[END OF MARKING INSTRUCTIONS]