2013 Technological Studies

Standard Grade – Credit

Finalised Marking Instructions

Part One: General Marking Principles for Technological Studies – Standard Grade – Credit

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Technological Studies – Standard Grade – Credit

The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

Mark Allocation

Marks	
KU	**RNA**

1. A treadmill uses closed loop control to maintain a constant speed.

(a) Describe closed loop control.

2

It uses feedback (1 KU) to monitor the output (1 KU). **1**

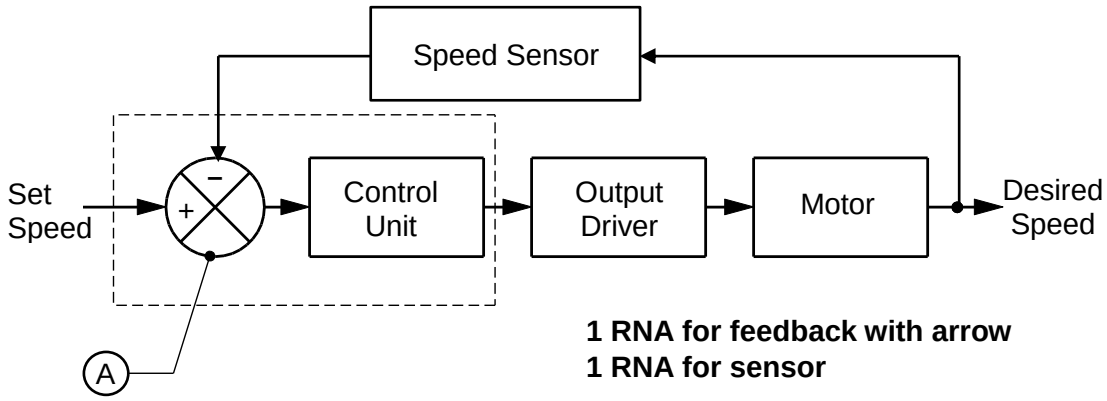
It compares feedback (1 KU)/output to the desired input (1 KU) **0**

An incomplete control diagram for the treadmill is shown below.

(b) (i) State the name of symbol (A) .

1

Error detector **1 KU** **0**



1 RNA for feedback with arrow
1 RNA for sensor

2

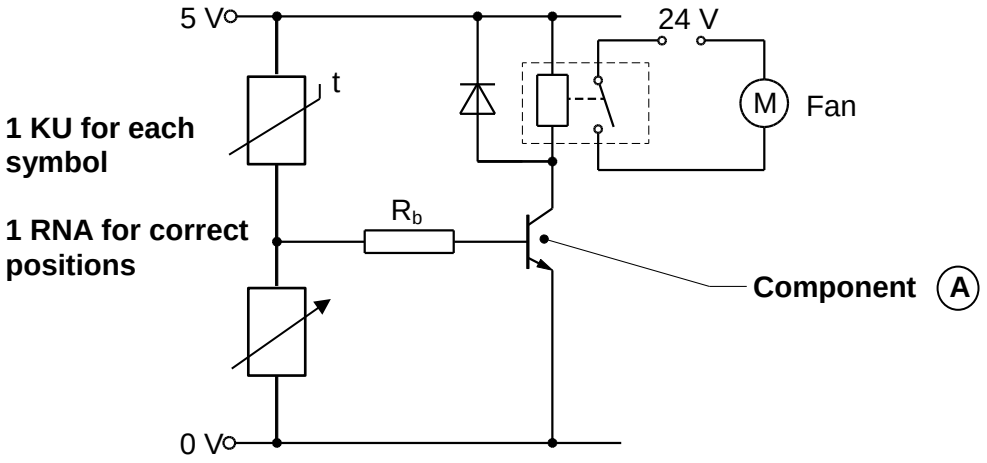
(ii) Complete the control diagram above. **1**

0

	Marks	
	KU	RNA

2. A cooling system turns on a fan when the temperature in a room gets too high.

(a) Complete the circuit to show a temperature sensor, with sensitivity control.



1 KU for each symbol

1 RNA for correct positions

	2	
	1	**1**
	0	**0**

(b) State the name of **Component (A).**

Transistor/npn Bipolar Transistor 1 KU

	1	
	0	

Component (A) is fully switched on at 0·7 V.

(c) State the name given to this condition.

Saturated 1 KU

	1	
	0	

(d) A diode is normally connected in parallel across devices such as relays. State the function of the diode.

Protect the transistor (from back EMF) 1 KU

	1	
	0	

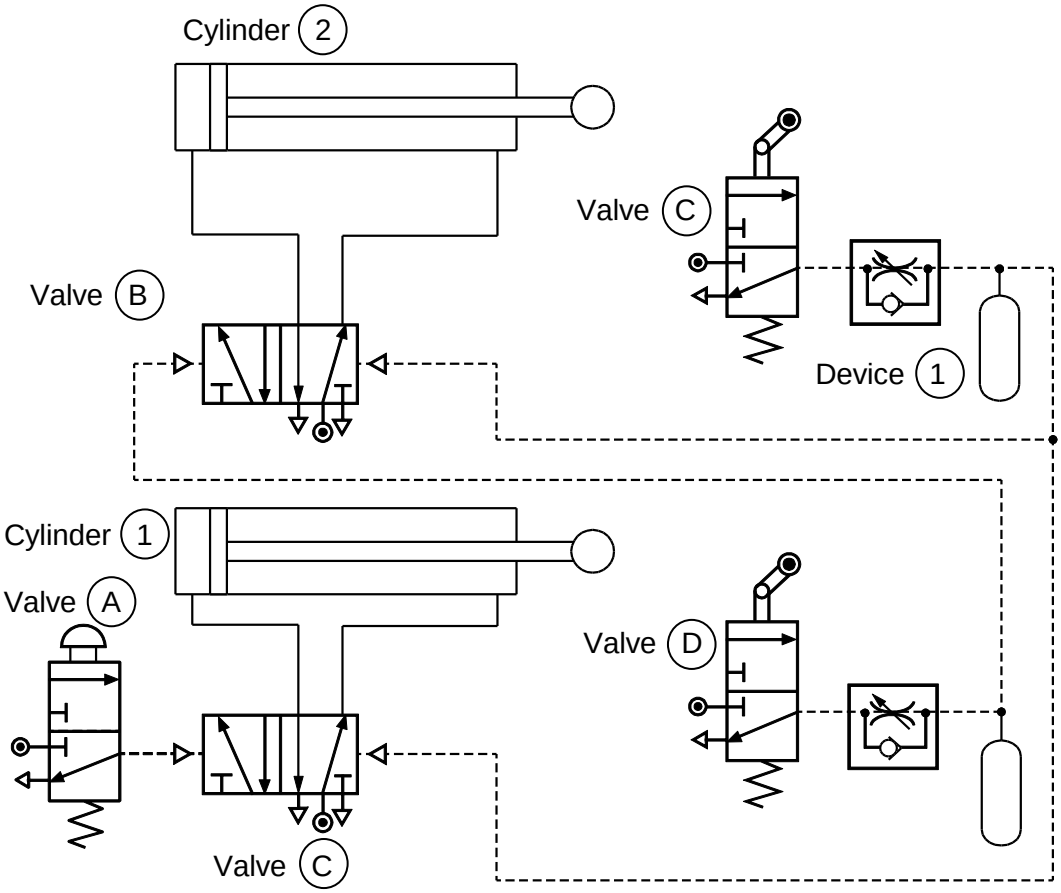
(e) Explain why an engineer may test a new circuit with simulation software before constructing a prototype.

Prevents expensive components being damaged/quicker fault finding etc 1 KU

	1	
	0	

	Marks	
	KU	RNA

3. A pneumatic system controls the movement of a 'low-rider' car. When activated, two cylinders raise the front and rear of the car.



(a) Describe, using appropriate terminology, the operation of the circuit.

When Valve (A) is actuated a pilot signal (1) actuates Valve (C).
Cylinder (1) (1) outstrokes and actuates (1) Valve (D). After a delay (1),
Valve (B) is actuated (1) and Cylinder (2) outstrokes (1) and actuates
Valve (C) (1). After a delay (1), both Valves (B) and (C) are actuated (1)
causing both cylinders to instroke (1).

1 RNA for each correct statement up to 5 marks

	5
	4
	3
	2
	1
	0

	Marks	
	KU	RNA

3. (continued)

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

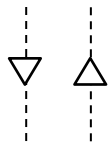
(i) Valve (C) **5/2 (1 KU) Pilot (1 KU) Pilot (1 KU)** — **3 2 1 0**

(ii) Device (1) **Reservoir 1 KU** — **1 0**

(c) (i) State the name of the **actuator** that is often used with an air bleed to sense changes in air pressure.

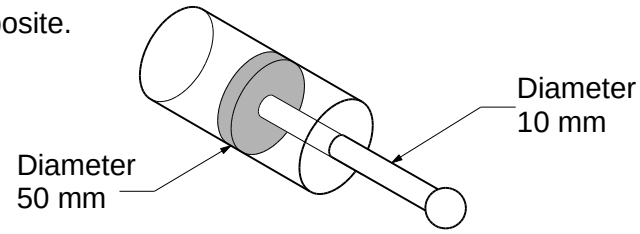
Diaphragm 1 KU — **1 0**

(ii) Draw the symbol for this actuator.



1 KU follow through error where appropriate — **1 0**

Detail of Cylinder (1) is shown opposite.



(d) Calculate the **effective** area of the piston when the piston rod is **instroking**.

Area = $\pi \times 25^2 - \pi \times 5^2$ **1 RNA substitution**

= 1884 mm^2 **1 RNA answer** — **2 1**

or 1 RNA for an area calculation using 25 or 5 mm — **0**

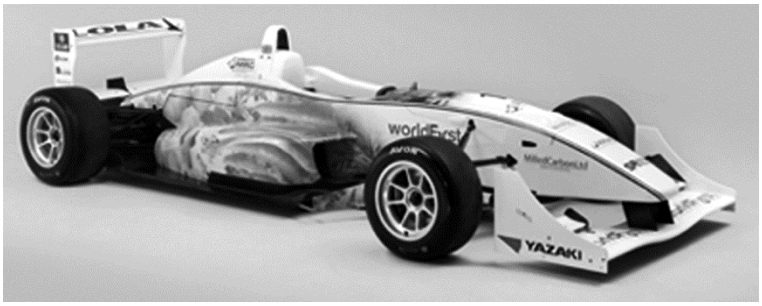
(e) Describe the **function** of main air and pilot air.

Main air: **Powers the cylinders 1 KU** — **2 1**

Pilot air: **Actuates the valves 1 KU** — **0**

	Marks	
	KU	RNA

4. An environmentally friendly racing car has a mass of 600 kg.



(a) Calculate, showing all working and units, the velocity of the car when it has 925 kJ of kinetic energy.

$$\mathbf{V = \sqrt{\frac{2Ek}{m}} = \sqrt{\frac{925000 \times 2}{600}} = 55\,m/s}$$

1 RNA for substitution
1 RNA for answer

2 1 0

When the car uses 150 MJ of fuel it produces 63 MJ of useful energy.

(b) Calculate the efficiency of the car.

$$\mathbf{\eta \frac{63}{150} = 0 \cdot 42} \textit{ or } \mathbf{42\%}$$

1 RNA for substitution
1 RNA for answer

2 1 0

As the car slows its kinetic energy reduces.

(c) Explain what happens to this kinetic energy.

It is converted (1) to heat and sound (1) in the brakes.

1 RNA form of energy

1 RNA cause of loss

2 1 0

	Marks	
	KU	RNA

4. (continued)

Solar power is increasingly being used as an alternative source of energy in place of fossil fuels.

(d) Describe **one** advantage and **one** disadvantage of using solar power.

Advantage **Energy source is free and readily available or pollution issues** **1 KU** — **2**

Disadvantage **Inconsistent supply as some days are cloudy** **1 KU** / **Less efficient** — **1 0**

(e) Describe **one** reason why fossil fuels are still being used.

There is an existing supply chain/expensive to convert to other sources etc / **More efficient** **1 KU** — **1 0**

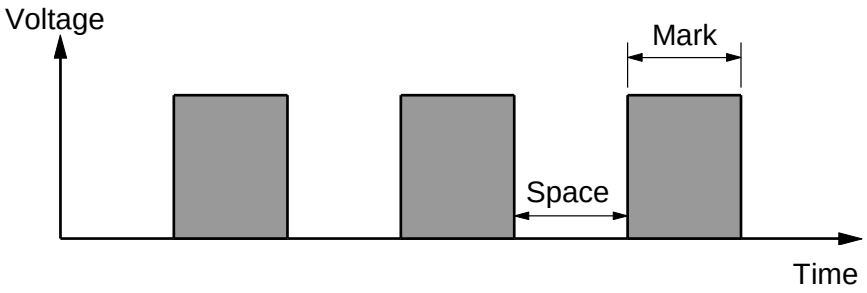
(f) Describe **two** reasons why systems should be made as efficient as possible.

It reduces waste energy/it is more cost effective/they are less likely to wear out **1 KU for each, up to 2 marks** — **2 1 0**

	Marks	
	KU	RNA

5. A motorised telescope is operated by a microcontroller.

The microcontroller uses PWM to control the speed of the motor.



(a) State the full name of PWM.

Pulse Width Modulation **1 KU** | **1 0**

(b) Describe, using appropriate terminology, how PWM could be used to vary the speed of a motor.

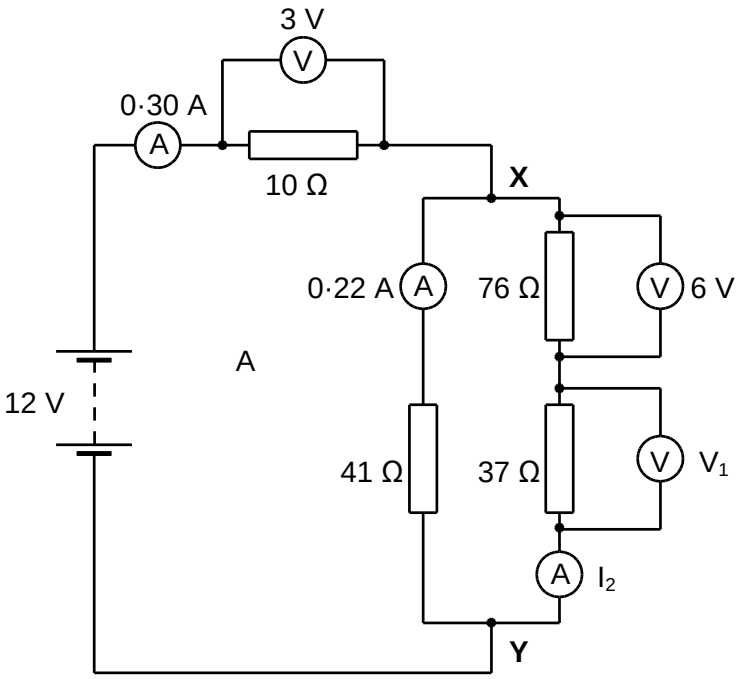
2

1 KU for identifying that mark/space ratio must change | **1**

1 KU for indicating that greater ratio = greater speed | **0**

Marks	
KU	RNA

6. An Electronic Engineer has built the prototype circuit shown below.



(a) (i) Calculate the overall resistance between points **X** and **Y**.

$$\mathbf{R_P = \frac{41 \times (76 + 37)}{41 + (76 + 37)} = 30{\cdot}1\ \Omega}$$

1 RNA for series calculation		**3**
1 RNA for substitution		**2**
1 RNA for answer from given working		**1**
		0

(ii) Calculate the total resistance of the circuit.

		1
R_T = 30·1 + 10 = 40·1 Ω	**1 RNA for answer**	**0**

(b) Calculate the current I_2.

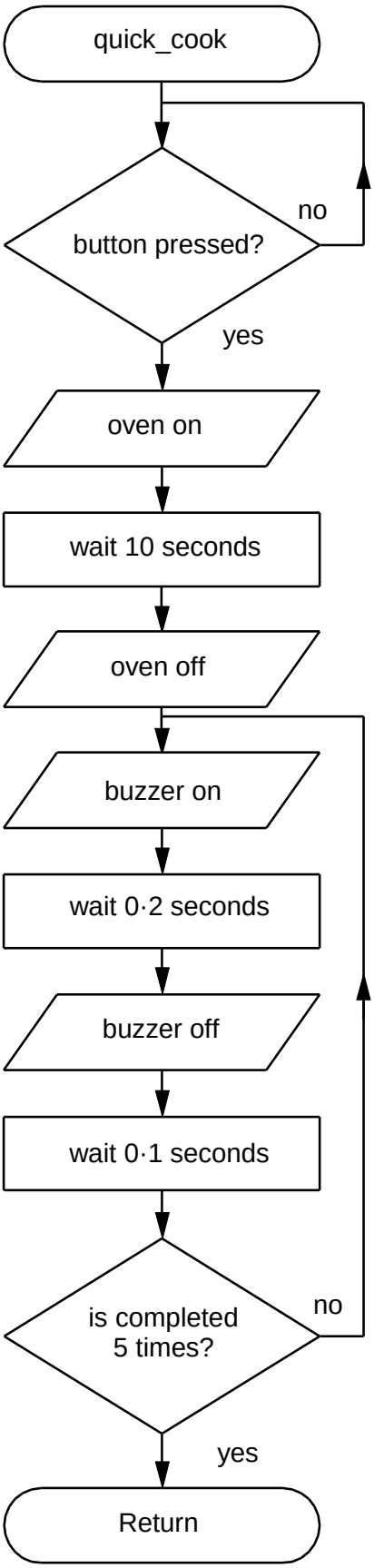
		2
		1
I_2 = 0·3 − 0·22 = 0·08 A	**1 RNA for substitution**	**0**
	1 RNA for answer	

(c) Calculate the voltage V_1.

V = I × R = 0·08 × 37 = 2·96 V		**2**
OR	**1 RNA for substitution**	**1**
V_1 = 12 – 3 – 6 = 3 V	**1 RNA for answer**	**0**

7. A microwave oven is operated by a microcontroller.

The program makes use of a sub-procedure 'quick_cook', shown on the flowchart.



Marks	
KU	RNA

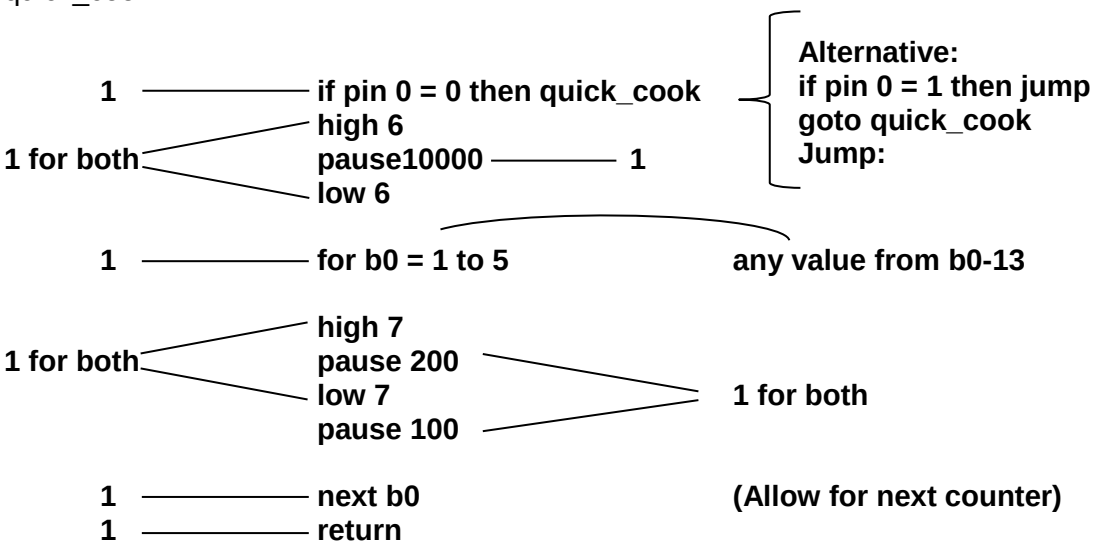
7. (continued)

Input and output connections to the microcontroller are shown in the table below.

Input Connection	Pin	Output Connection
	7	Buzzer
	6	Oven
	5	
	4	
	3	
	2	
	1	
Button	0	

Complete the PBASIC program for sub-procedure 'quick_cook'. Make reference to the flowchart, Data Booklet, and the input/output connections.

quick_cook:

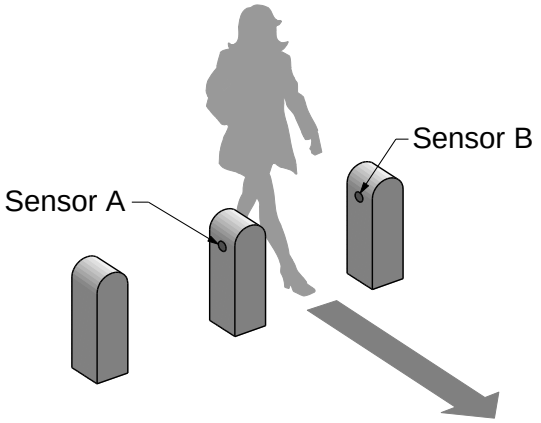


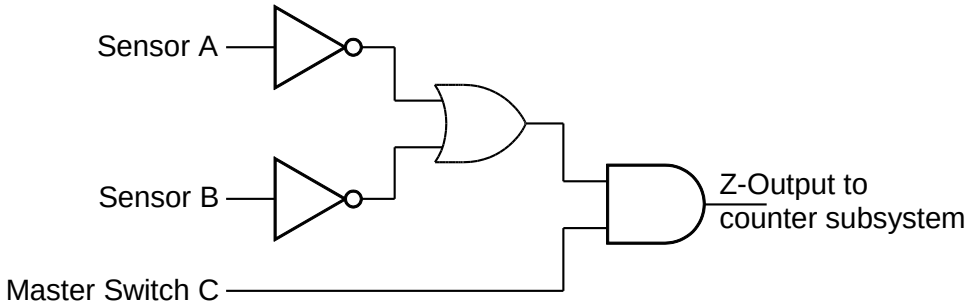
Alternative:
if pin 0 = 1 thenjump
goto quick_cook
Jump:

8
7
6
5
4
3
2
1
0

	Marks	
	KU	RNA

8. A museum uses an electronic entry system to count the number of visitors. It is activated by a master switch. The logic diagram for part of the system is shown below.





(a) Complete the Boolean expression for Z in terms of A, B and C, with reference to the logic diagram above. **3 2 1 0**

Z = **$\overline{(A + B)} \cdot C$** **1 RNA for NOT F^{NS}**
1 RNA for OR F^{N}
1 RNA for AND F^{N} (including brackets)

(b) State, with reference to the Data Booklet, the Integrated Circuit (IC) **numbers** required to construct the circuit. The first one is given. **1 0**

IC number: 7408, 7404 , 7432 1 RNA for both

(c) State the **full** name of the 7408 IC. **1 0**

Quad 2 input AND **1 KU**

Marks	
KU	RNA

8. (continued)

(d) Complete the table to match the characteristics to the correct logic families.

	Logic Family	
Characteristic	**CMOS**	**TTL**
Higher power consumption		✓
Larger fan out	✓	
Easily damaged by static electricity	✓	
Can use supply voltages between 3-18 volts	✓	
Faster switching speeds		✓

4
3
2
1
0

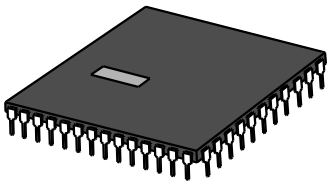
(e) State the purpose of the dot on an IC.

Identifies the position of pin 1 1 KU
(NOT – shows which way round the IC goes)

1
0

Marks	
KU	RNA

9. A microcontroller makes use of three types of memory.



(a) Complete the following table to describe the function and characteristic of the named microcontroller memories.

Name	Function	Characteristic
RAM	*Stores data required when running the program*	*Data will not remain when power is switched off*
ROM	**Stores PBASIC language for microcontroller operations**	**Data remains when power is removed**
EEPROM	**Stores the program**	**Data remains when power is removed.** **Data can be re-written**

1 KU for each correct entry

4
3
2
1
0

	Marks	
	KU	RNA

9. (continued)

(b) State the **full name** of EEPROM.

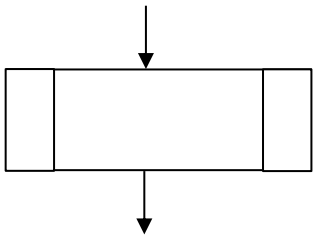
Electrically Erasable Programmable Read Only Memory 1 KU — **1 0**

The I/O port is another sub-system of the microcontroller.

(c) Describe the **function** of the I/O port.

Links the microcontroller to the outside world 1 KU — **1 0**

(d) Draw the shape of box required to jump to a sub-procedure.



1 KU — **1 0**

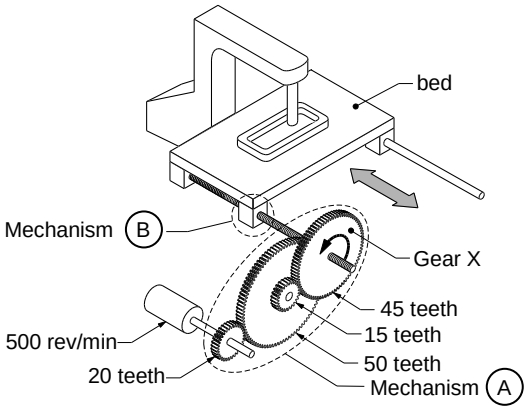
(e) State the PBASIC command to set up pins 0-2 as inputs and pins 3-7 as outputs.

(let dirs =) %11111000 — **2 1 0**

1 RNA **1 RNA**

	Marks	
	KU	RNA

10. The body of a mobile phone is machined by an automated system. One part is illustrated below.



(a) State the name of mechanism (A).

Compound Gear **1 KU** | **1** / **0**

(b) Calculate the speed of gear X.

$$\textbf{Output Speed} = 500 \times \left(\frac{20}{50} \times \frac{15}{45} \right) = 67 \text{ rev/min}$$

1 RNA **1 RNA**

1 RNA for substitution
1 RNA for answer

OR

500 × 20 = T_1 × 50	**1 RNA substitution**		**4**
T_1 = 200 rev/min	**1 RNA answer**		**3**
			2
200 × 15 = T_2 × 45	**1 RNA substitution**		**1**
T_2 = 67 rev/min	**1 RNA answer**		**0**

	Marks	
	KU	RNA

10. (continued)

The worm and nut (mechanism (B)) is used to convert rotational motion to linear motion. The worm has a pitch of 2 mm.

(c) Calculate the linear speed of the bed when the worm rotates at 50 rev/min.

Speed = 50 × 2 = 100 mm/min

		3
1 RNA substitution		**2**
1 RNA answer		**1**
1 RNA conversion	**0.00167 m/s**	**0**

(d) Describe a change to the worm and nut mechanism that would **reduce** the output linear speed.

	1
Reduce the size of the pitch 1 KU	**0**

A flat belt is often used to transmit rotational motion in mechanical systems.

(e) Describe **one** disadvantage of the flat belt.

	1
It can slip 1 KU	**0**

(f) State the names of **two** further types of belt.

	2
(i) **Toothed** (ii) **VEE**	**1**
1 KU for each	**0**

(g) State the name of a mechanism that will convert the following:

(i) rotary to reciprocating motion.

	1
Crank and Slider/Cam and Follower 1 KU	**0**

(ii) linear to rotational motion

	1
Rack and Pinion 1 KU	**0**

[END OF MARKING INSTRUCTIONS]