FOR OFFICIAL USE

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	KU	RNA
Total Marks		

4040/402

NATIONAL QUALIFICATIONS 2008

WEDNESDAY, 7 MAY
2.35 PM – 4.05 PM

TECHNOLOGICAL STUDIES
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

1 Answer all the questions.

2 Read every question carefully before you answer.

3 Write your answers in the spaces provided.

4 Do **not** write in the margins.

5 Do **not** sketch in ink.

6 All dimensions are given in millimetres.

7 **Show all working and units where appropriate.**

8 Reference should be made to the Standard Grade and Intermediate 2 Data Booklet (2006 edition) which is provided.

9 Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

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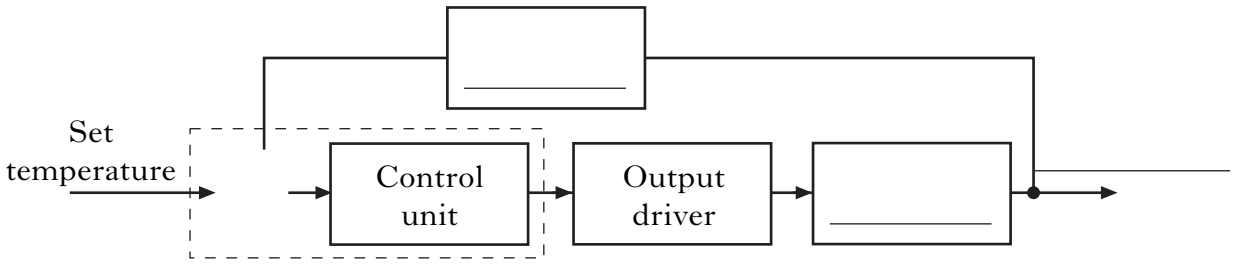
1. An air conditioning system is operated by closed loop control.

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



2
1
0

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

_____

1
0

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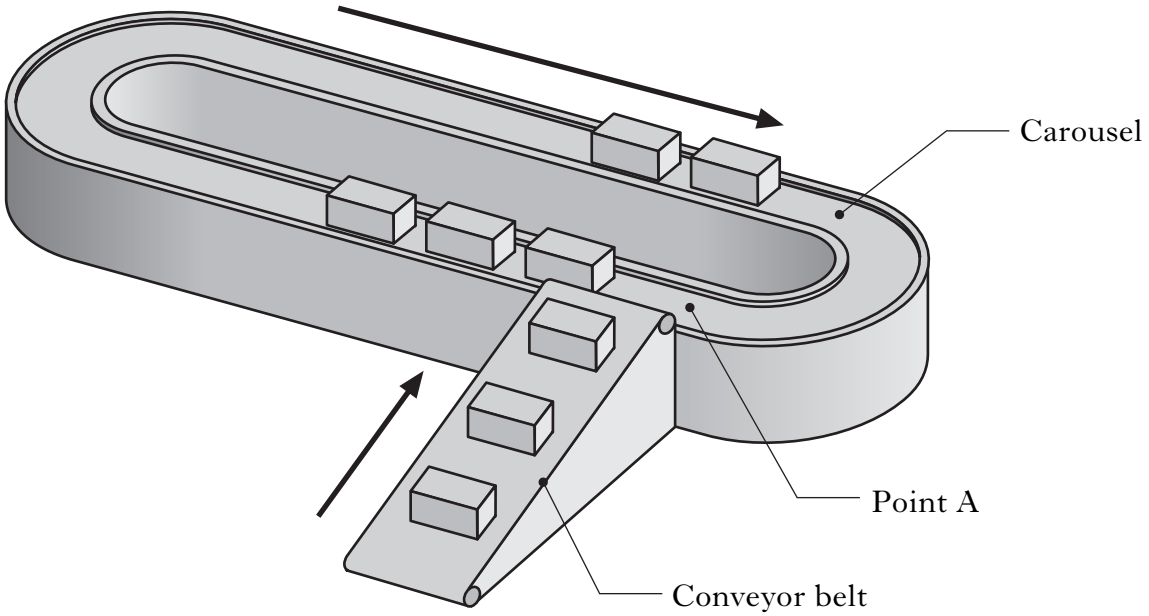
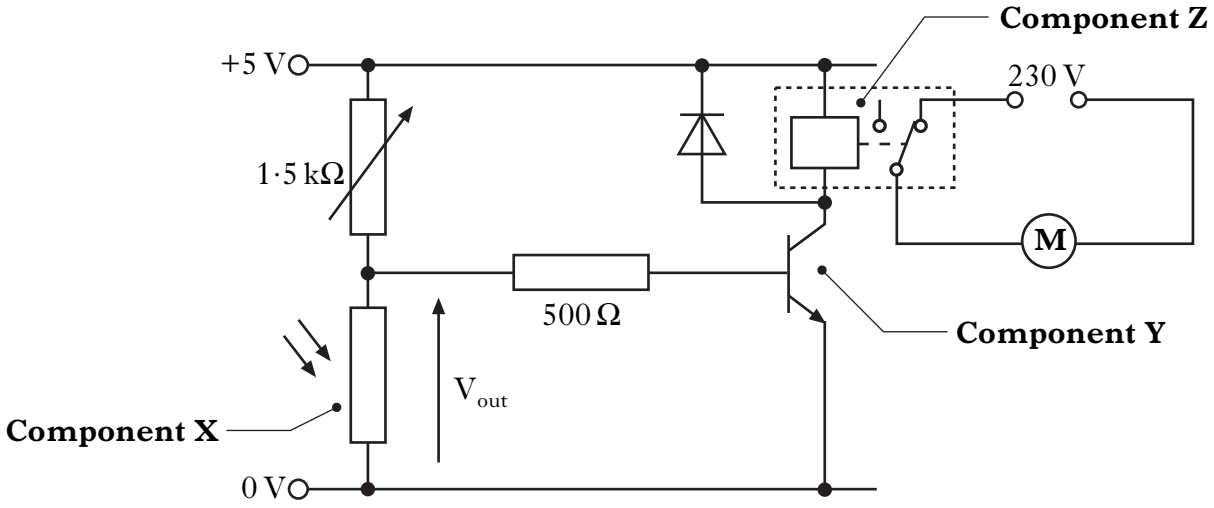
2. Detail of a luggage delivery system used in an airport is shown below.



Bags are added to the carousel by a conveyor belt. If bags are detected at point A, the conveyor belt will automatically halt until there is space on the carousel for more bags.

The control circuit is shown below.



(*a*) State the purpose of the variable resistor in the circuit.

_____ **1 0**

(*b*) State the **full name** of component X.

_____ **1 0**

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2. (continued)

(*c*) Determine, with reference to the Data Booklet, the resistance of component X, when the light level is at 50 lux.

_____ **1 0**

(*d*) Describe the operation of this voltage divider sub-system.

_____

_____ **3 2 1 0**

_____

(*e*) Calculate the value V_{out} from the voltage divider sub-system at 50 lux.

2 1 0

(*f*) State the name of component Y.

_____ **1 0**

(*g*) State the voltage at which component Y saturates.

_____ **1 0**

(*h*) Calculate the current through the 500 Ω resistor, when component Y is saturated.

3 2 1 0

(*i*) State the purpose of the diode in the control circuit.

_____ **1 0**

(*j*) State the name of component Z.

_____ **1 0**

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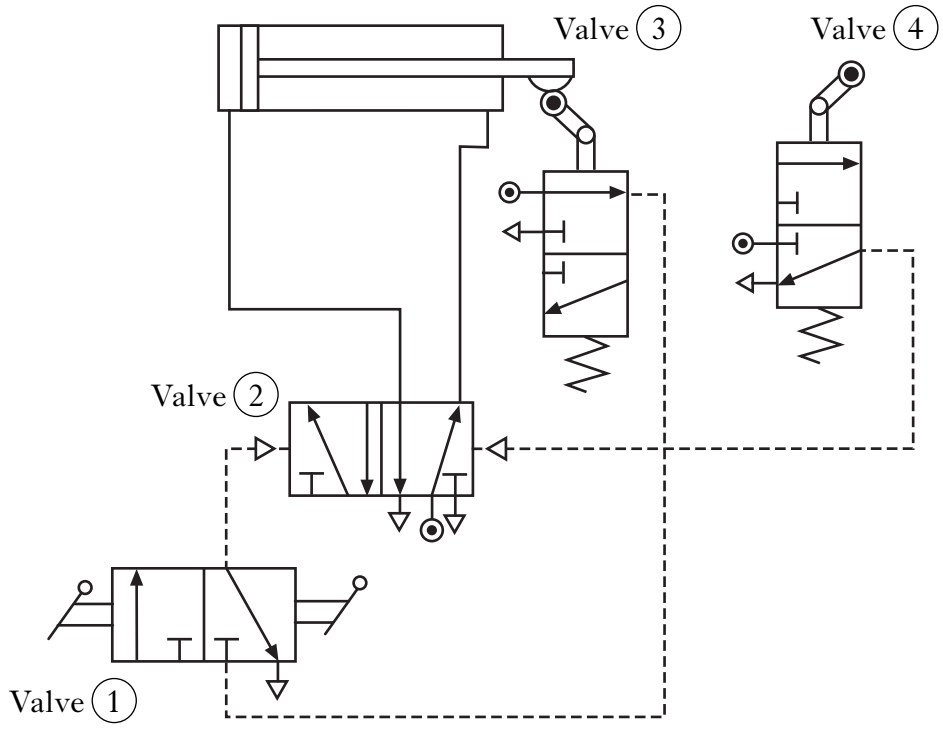
3. A road drill is operated by using the pneumatic circuit shown below.



(*a*) State the **full name** of Valve (2) .

3 2 1 0

_____

(*b*) Describe the operation of the circuit as it outstrokes the piston rod.

_____

_____

_____

3 2 1 0

_____

_____

A solenoid actuated, 3/2, spring return valve was inserted into the circuit to stop the drill if the operator let go.

(*c*) Sketch the solenoid actuator below.

1 0

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3. (continued)

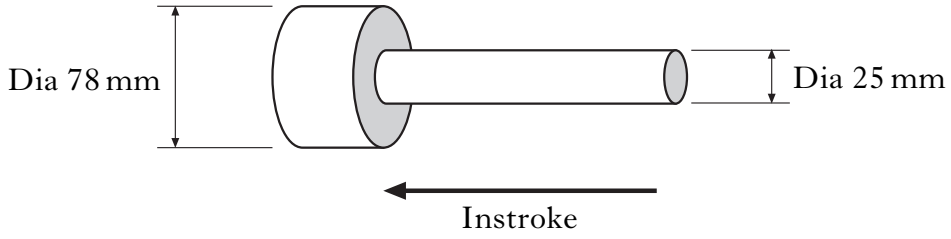
(*d*) (i) State the type of logic control which Valves (1) and (3) provide. **1 0**

_____

(ii) Complete the truth table below for this arrangement.

Value (1)	**Value (3)**	**Piston rod**
0	0	Instroke
0	1	
1	0	
1	1	

1 0



Air is supplied at a pressure of 22·5 N/mm^2.

(*e*) Calculate:

(i) the effective area of the piston when the piston rod is instroking; **3 2 1 0**

(ii) the instroking force. **2 1 0**

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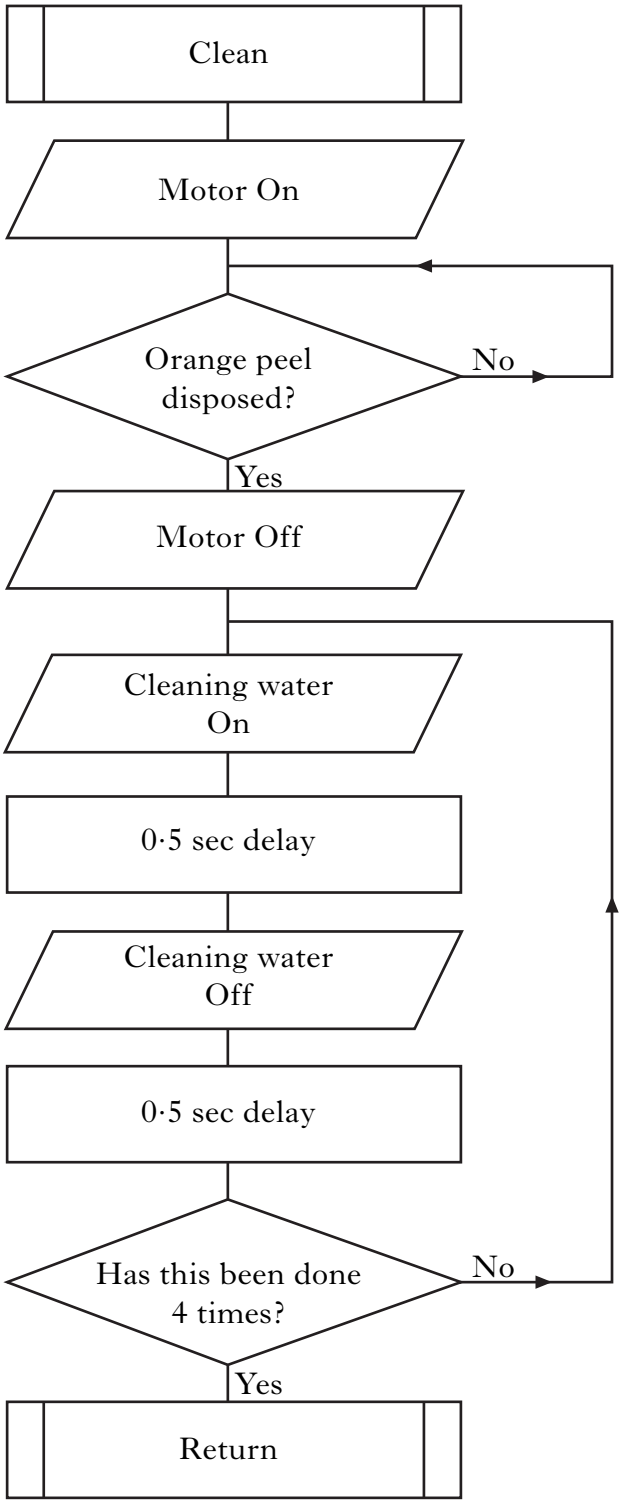
4. An automatic orange juicer is operated by a microcontroller.

The sequence of operations for the "Clean" sub-procedure is shown in the flowchart below.



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4. (continued)

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

Input Connection	Pin	Output Connection
	7	Motor (1 = on, 0 = off)
	6	
	5	
	4	
	3	
	2	
Orange peel sensor (1 when peel is sensed, 0 when disposed)	1	
	0	Cleaning water (1 = on, 0 = off)

Write, with reference to the flowchart, Data Booklet, and the input/output table, the PBASIC control program for the sub-procedure, "Clean".

Clean:

8 7 6 5 4 3 2 1 0

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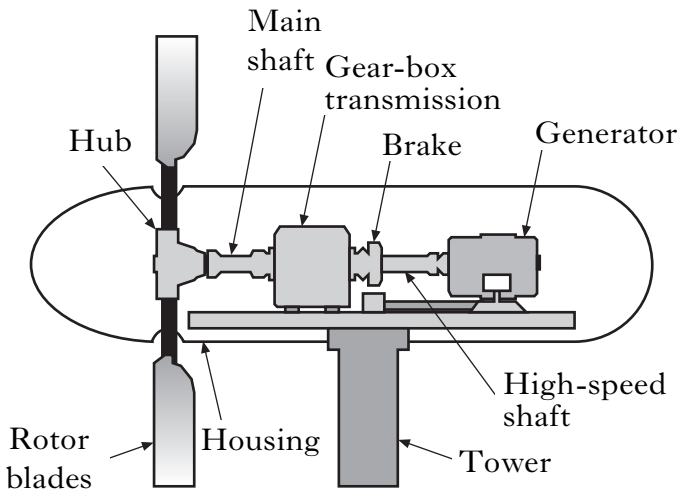
5. A common method of generating electricity is by using wind turbines.

A wind turbine is shown below.

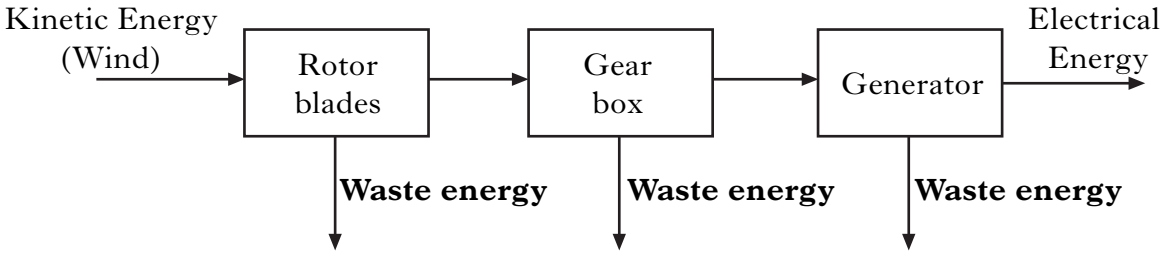


(*a*) State **two** methods which could be used to reduce friction in the wind turbine.

1 _____ **2**

2 _____ **1 0**

The wind turbine is simplified in the block diagram below.



The wind turbine produces 6 MJ of electrical energy and is 24% efficient.

(*b*) (i) Calculate the input energy to the system.

2 1 0

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5. (*b*) (continued)

(ii) If the output energy from the Rotor Blades is 16 MJ, calculate the efficiency of this sub-system.

2
1
0

(*c*) State **one** form of waste energy given out from the Gear Box sub-system.

_____

1
0

(*d*) State **two** examples of a **finite** energy source.

1 _____ **2**
1

2 _____ **0**

Wind power is one form of renewable energy.

(*e*) State **two advantages** (other than cost) of wind power.

1 _____ **2**
1

2 _____ **0**

(*f*) State **two disadvantages** (other than cost) of tidal energy.

1 _____ **2**
1

2 _____ **0**

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6. An electronic security system for a car will automatically lock the doors (Z) when the engine is running and the doors are closed. In the event of an accident, when the airbags have been deployed, the doors will unlock.

(*a*) Complete the truth table for the system below.

A	B	C	Z
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

KEY

A	Door sensor (1 when closed)
B	Engine sensor (1 when running)
C	Airbag sensor (1 when deployed)
Z	1 when locked

1 0

(*b*) Develop, from the truth table above, the Boolean expression for output Z, in terms of A, B and C.

Z =

2 1 0

(*c*) The system uses TTL Integrated Circuits (ICs).

(i) State a suitable supply voltage (V_{cc}) for TTL ICs.

_____

1 0

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

_____

1 0

(iii) State **one advantage** of using TTL over the type of ICs chosen in (ii).

_____

1 0

(iv) State **one disadvantage** of using TTL over the type of ICs chosen in (ii).

_____

1 0

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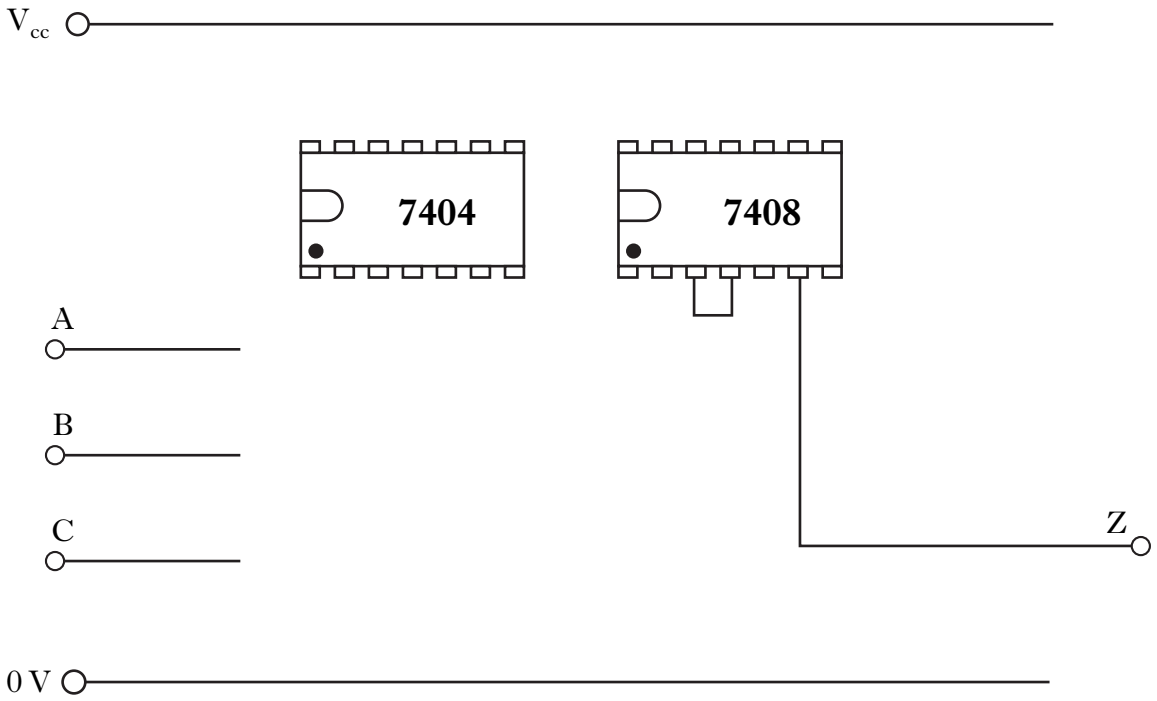
6. (continued)

(*d*) Complete, with reference to the Data Booklet, the wiring diagram for the car security system.



5 4 3 2 1 0

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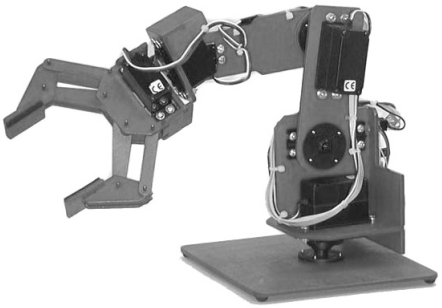
7. A robotic arm is operated by a microcontroller.

Pulse Width Modulation (PWM) is used to provide a slow, smooth controlled speed of the arm movement.



(*a*) Explain, with the aid of a sketch, how PWM can be used to control the speed of a motor.

_____

_____

_____

_____

_____

_____

3
2
1
0

Two PBASIC programs are shown below which provide this method of switching.

```
main:   high 5
        pause 10
        low 5
        pause 2
        goto main
```

PROGRAM 1

```
main:   high 5
        pause 30
        low 5
        pause 20
        goto main
```

PROGRAM 2

(*b*) (i) State which program would be used to provide the **fastest** rotational speed of the motor.

_____

1
0

(ii) Explain the reason for your answer to part (i).

_____

_____

_____

1
0

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7. (continued)

Manufacturing companies often use microcontrollers instead of hard wired electronic circuits.

(*c*) Describe **two** advantages of using microcontrollers when compared with hard wired electronic circuits.

1 _____

_____

2 _____ **2**

_____ **1 0**

(*d*) (i) State the **full name** for the term EEPROM as used in a microcontroller.

_____

_____ **1 0**

(ii) Describe the **function** of an EEPROM as used in a microcontroller.

_____

_____ **2**

_____ **1 0**

Some of the robotic arm's mechanical joints are driven by belt drive systems and some are driven by gear systems.

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

_____ **1 0**

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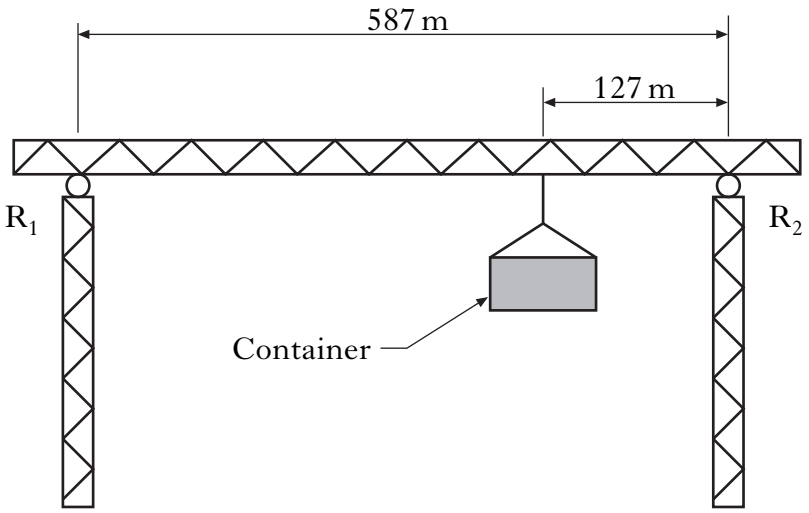
8. The structure shown below is used to transport a 5000 kg container.



(*a*) Calculate the weight of the 5000 kg container.

2
1
0

(*b*) Draw the Free Body Diagram of the structure, showing all forces and distances. (**Ignore the weight of the beam.**)

3
2
1
0

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8. (continued)

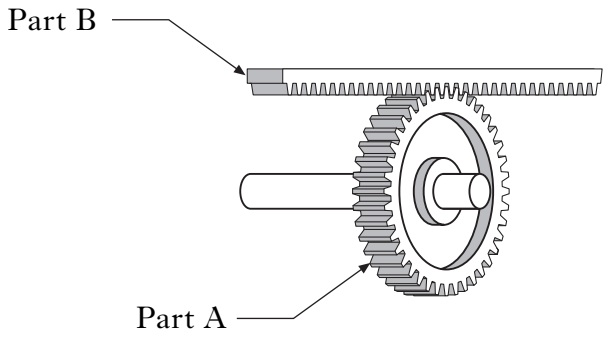
(*c*) (i) Calculate, by taking moments about R_2, the size of the reaction R_1.

3 2 1 0

(ii) Determine the size of the reaction R_2.

2 1 0

(*d*) (i) The container is moved using the mechanical system shown below.



State the names of the parts of the mechanical system.

Part A _____ **2 1 0**

Part B _____

(ii) State the change in motion that this mechanism produces. **2 1 0**

_____

[*END OF QUESTION PAPER*]

ACKNOWLEDGEMENTS

Question 4—Picture of Frucosol automatic orange juicer. Permission is being sought from Frucosol.

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