FOR OFFICIAL USE

Mark

NATIONAL QUALIFICATIONS 2013

TECHNOLOGICAL STUDIES
INTERMEDIATE 2

TUESDAY, 21 MAY
9.00 AM – 11.30 AM

X0361101

X036/11/01

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth
Day Month Year

Scottish candidate number

1 Answer all the questions in Section A and any **two** questions in Section B.

2 Read each question carefully before you answer.

3 Write your answers in the spaces provided.

4 **Show all working and units.**

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

6 **Do not sketch in ink.**

7 Reference should be made to the Standard Grade and Intermediate 2 Data Booklet (2008 edition) which is provided.

8 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.

Use blue or black ink. Pencil may be used for graphs and diagrams only.

X0361101

SECTION A

Attempt ALL questions (Total 60 marks)

1. A control diagram for the automatic positioning of a telescope is shown in Figure Q1.

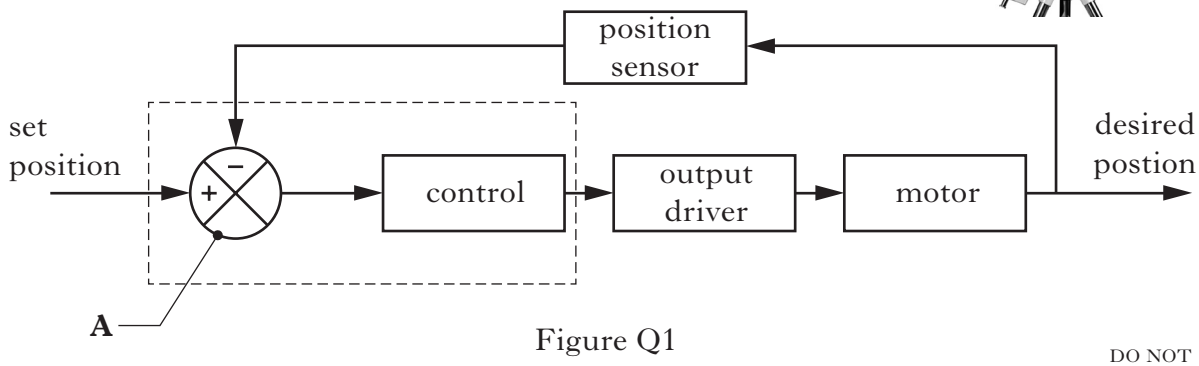

Figure Q1

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Marks

(*a*) State the name of part **A**, shown in Figure Q1.

_____ **1**

(*b*) (i) State the type of feedback used in the telescope system.

_____ **1**

(ii) Describe why this feedback is used.

_____

_____ **1**

(*c*) Describe, with reference to Figure Q1, the operation of the telescope system.

_____

_____

_____

_____ **3**

(6)

2. A pneumatic circuit used in a production line is shown in Figure Q2.

Marks

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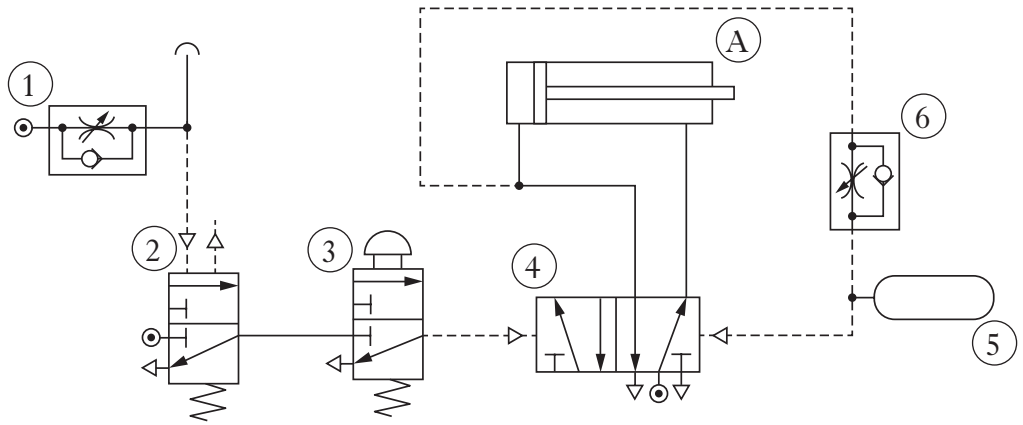


Figure Q2

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

Component (5) _____

Valve (2) _____ **2**

(*b*) Describe, using appropriate terminology, the operation of the pneumatic circuit.

An increase in pressure is sensed . . .

_____

_____

_____

_____

_____ **4**

The circuit shown in Figure Q2 uses AND control.

(*c*) (i) State the name of the pneumatic valve that is used to produce **OR** control.

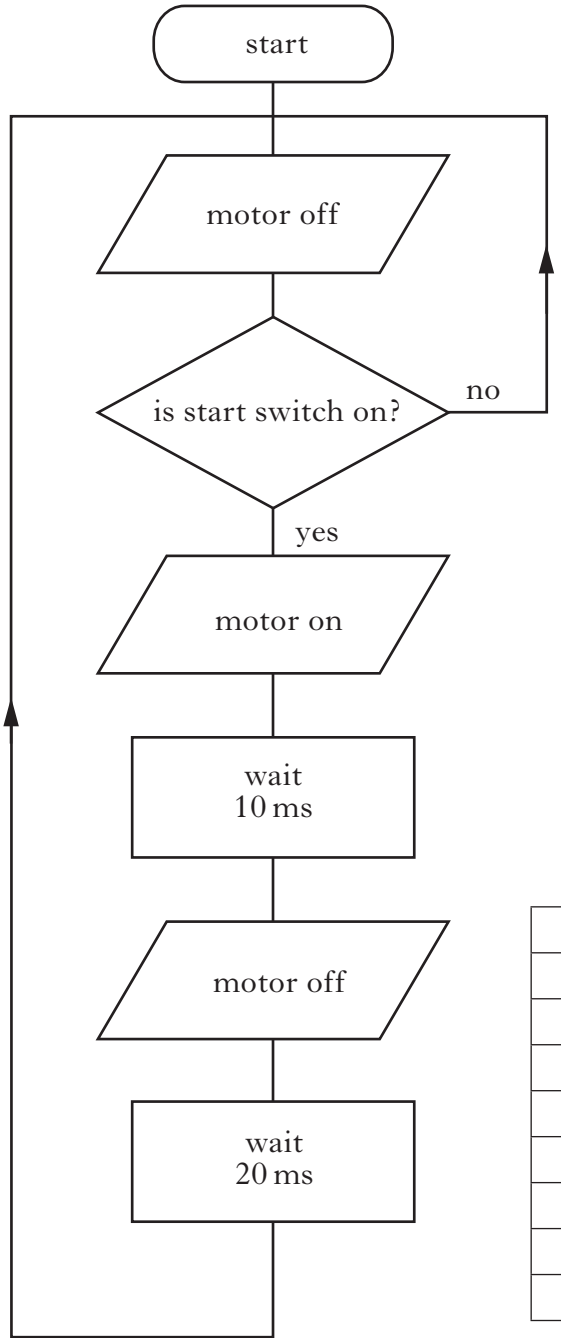
_____ **1**

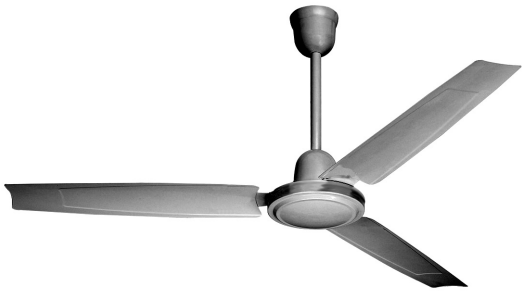
(ii) Draw the symbol for this valve in the space below.

1

(8)

3. The speed of the motor used in a ceiling fan is operated by a microcontroller. The flowchart and the input and output connections are shown in Figure Q3.





input connection	pin	output connection
	7	
	6	motor
	5	
	4	
	3	
start switch	2	
	1	
	0	

Figure Q3

Marks

3. (continued)

(*a*) Complete the PBASIC program, with reference to Figure Q3 and the Data Booklet.

```
init:       let dirs = %01000000

main:
```

5

(*b*) For the type of motor speed control used in the program:

(i) state its **full** name;

_____ **1**

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

_____ **1**

(7)

[Turn over

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4. The Boolean statement used to describe part of the operation of a coffee machine is shown. *Marks*

$$(\overline{A} \cdot B) + (A \cdot B) = Z$$

(*a*) Complete the truth table below, for the Boolean statement.

A	B	Z
0	0	
0	1	
1	0	
1	1	

4

(*b*) Complete, with reference to the Boolean statement, the logic diagram for the coffee machine using NOT, AND and OR gates.

A ○

○ Z

B ○

4

The circuit is to be constructed from the 4000 series family of Integrated Circuits (ICs).

(*c*) State the name of this IC logic family.

_____

1

(9)

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Marks

5. A fairground swing is shown in Figure Q5.

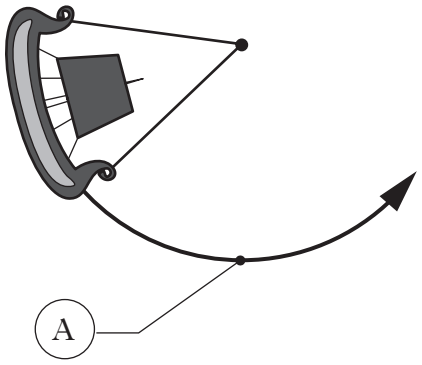

Figure Q5

The swing and passengers have a combined mass of 2500 kg.

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

(i) the kinetic energy at its lowest point (A) when the velocity is 15 m/s;

2

(ii) the maximum height the swing will reach. (Assume no loss of energy).

3

(*b*) In reality, there will be some loss of energy in the swing.

(i) State **one** possible cause of energy loss.

_____

1

(ii) State how this energy loss could be reduced.

_____

1

(7)

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Marks

6. A circuit used to warn when a vehicle is reversing is shown in Figure Q6.

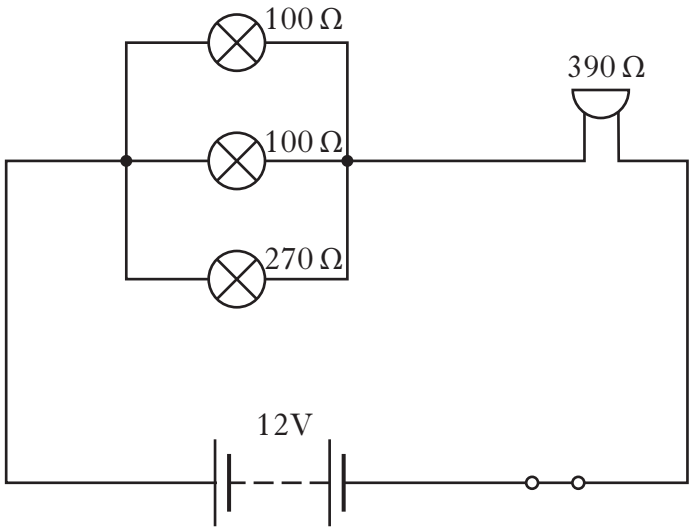

Figure Q6

(*a*) Calculate:

(i) the equivalent resistance of the three lamps;

3

(ii) the total circuit resistance;

1

(iii) the total circuit current;

2

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Marks

6. (*a*) (continued)

(iv) the power used by the circuit.

2

(*b*) Indicate on **Figure Q6**, with a cross (X), where an ammeter would be placed to measure the current through the **270** Ω lamp.

1

(9)

[Turn over

7. A model railway uses a microcontroller to operate a barrier.

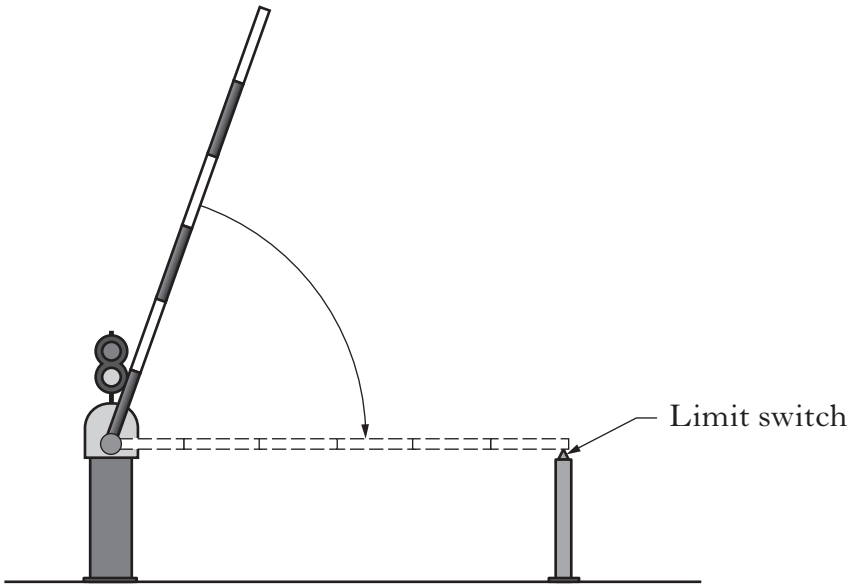

Figure Q7

The operation of the system is shown below.

- When a train is sensed the barrier should lower.
- When a limit switch is pressed the barrier will stop.
- When the train is no longer sensed, wait for ten seconds.
- Barrier will rise.
- After three seconds the barrier will stop.
- Sequence will then repeat.

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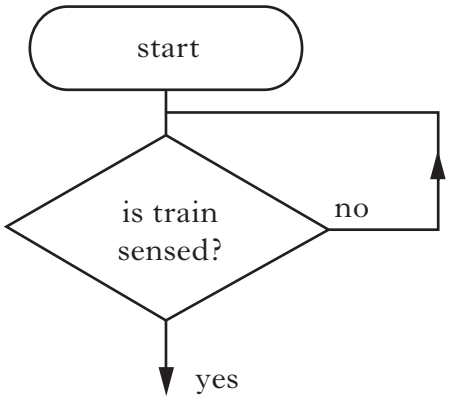
7. (continued)

Complete the flowchart for the barrier operation, with reference to the Data Booklet.



(7)

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8. A gearing system used in a wind turbine is shown in Figure Q8.

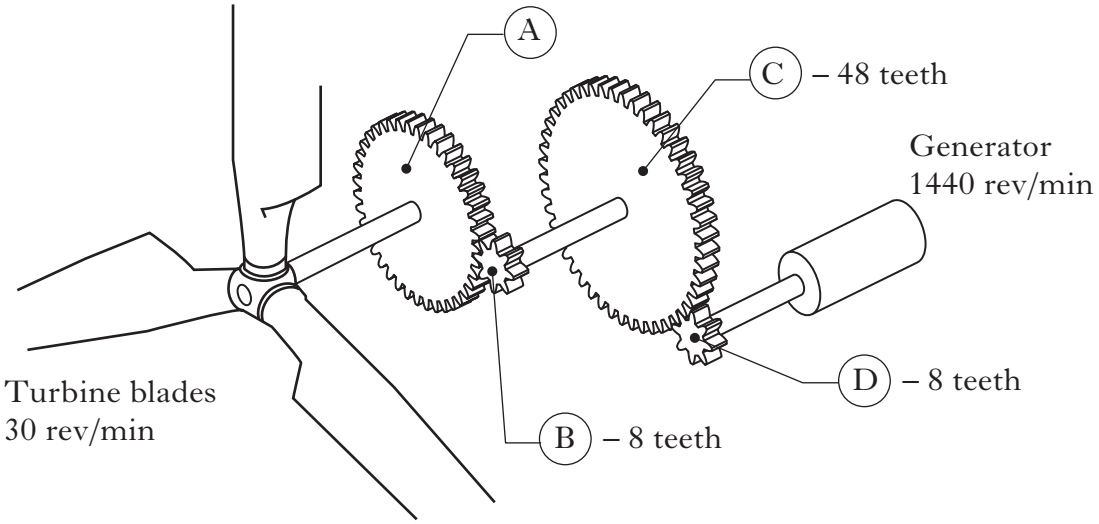

Figure Q8

(*a*) (i) State the name of the type of gearing system shown in Figure Q8.

_____ **1**

(ii) State **one** advantage of using this type of gearing system compared to a simple gear train.

_____

_____ **1**

(*b*) Calculate:

(i) the velocity ratio of the gearing system shown in Figure Q8;

2

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Marks

8. (*b*) (continued)

(ii) the number of teeth on gear (A).

3
(7)

[*END OF SECTION A*]

[Turn over

SECTION B

Attempt any TWO questions (Total 40 marks)

Marks

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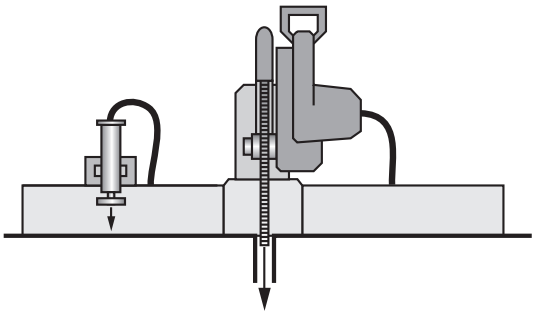
9. Figure Q9(*a*) shows the circuit diagram used to control an electric motor for a wood saw.



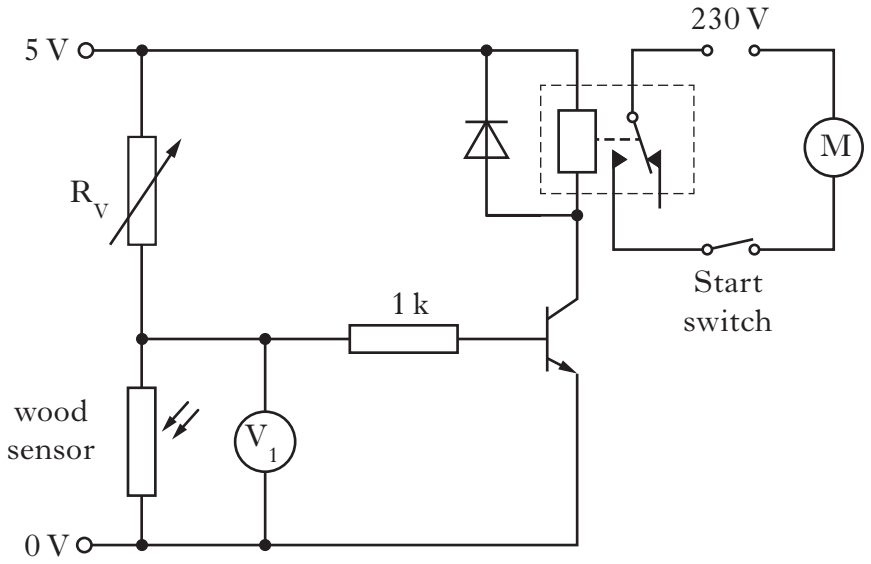


Figure Q9(*a*)

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

When wood covers the sensor . . .

4

Marks

9. (continued)

(*b*) (i) Determine the resistance of the LDR for a light level of 300 lux, with reference to the Data Booklet.

_____ **1**

(ii) State the full name for the LDR.

_____ **1**

Calculate:

(*c*) (i) the base current, I_B, when the current in the relay is 48 mA and the current gain, h_{FE}, is 80;

2

(ii) the voltage V_1, when the transistor is saturated.

2

A SPDT relay is used in the circuit.

(*d*) (i) State the **full** name of this relay.

_____ **1**

(ii) Explain why a relay is required in the circuit.

_____

_____ **1**

[Turn over

9. (continued) *Marks*

A pneumatic cylinder used to clamp wood in place as it is being sawn is shown in Figure Q9(*b*).

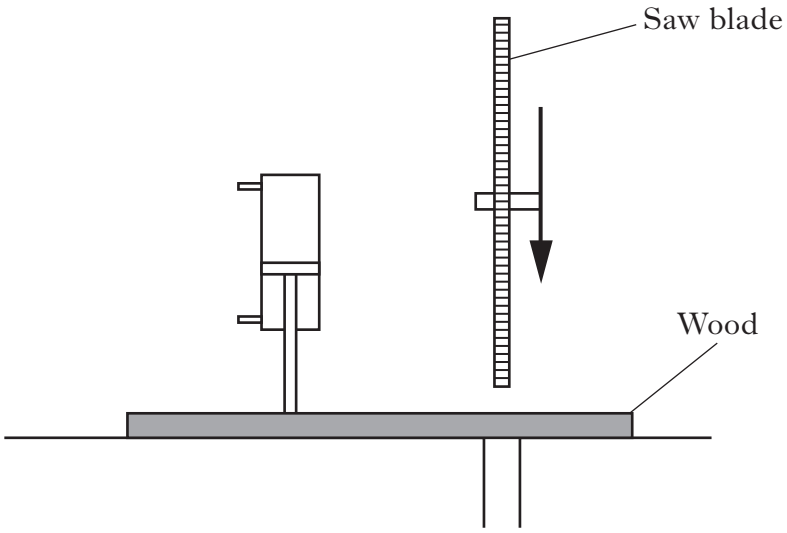


Figure Q9(*b*)

(*e*) Calculate the clamping force of the piston, as it outstrokes, if it has a diameter of 30 mm and air is supplied at a pressure of $0{\cdot}5\ N/mm^2$. **2**

9. (continued)

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Marks

The clamp is remodelled to include a lever as shown in Figure Q9(*c*).

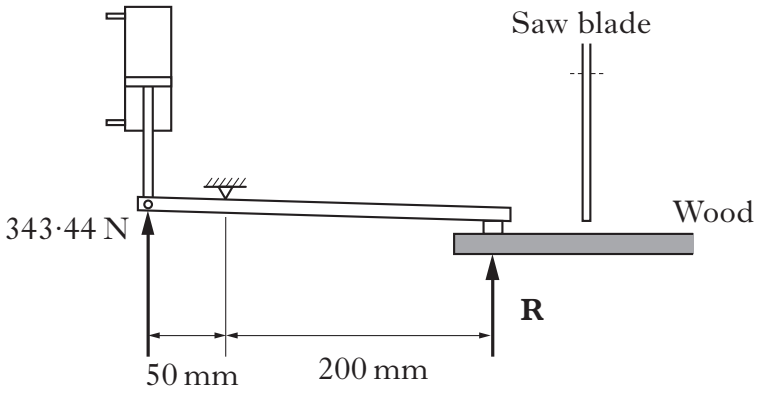

Figure Q9(*c*)

The 30 mm diameter piston has an instroking force of 343·44 N. Air is supplied at a pressure of 0·5 N/mm^2.

Calculate:

(*f*) (i) the effective area of the piston;

1

(ii) the diameter of the piston rod;

2

(iii) the force, **R**. (Apply the principle of moments).

2

(*g*) Describe why the instroking force in a pneumatic cylinder is always less than the outstroking force.

_____

_____

1

(20)

10. The drive system used in a fairground ride is shown in Figure Q10(*a*).

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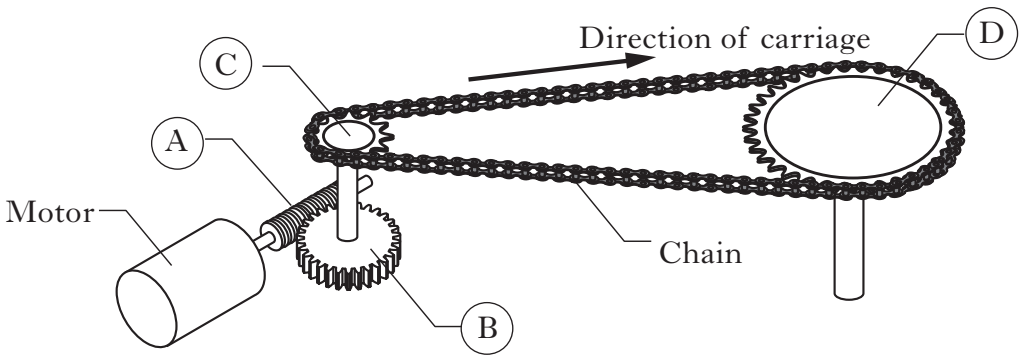

Figure Q10(*a*)

Calculate:

(*a*) (i) the speed of rotation of gears (B), (C) and (D) and complete the table below;

Gear	*Number of teeth*	*Speed*
A	1	1000 rev/min
B	24	
C	12	
D	36	

4

(ii) the linear speed in **m/s** at which the ride carriage will travel if the effective diameter of gear D is 500 mm.

3

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

_____

1

10. (continued)

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Marks

The logic circuit to control a warning light for the fairground ride is shown in Figure Q10(*b*).

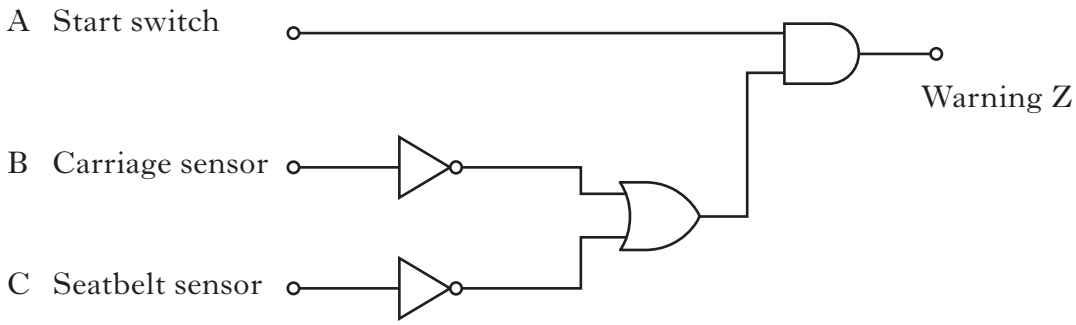

Figure Q10(*b*)

(*c*) Develop the Boolean expression for the output Z in terms of inputs A, B and C, with reference to the logic diagram Figure Q10(*b*).

Z = _____ **3**

(*d*) Complete, the wiring diagram Figure Q10(*c*), with reference to the Data Booklet and Figure Q10(*b*).

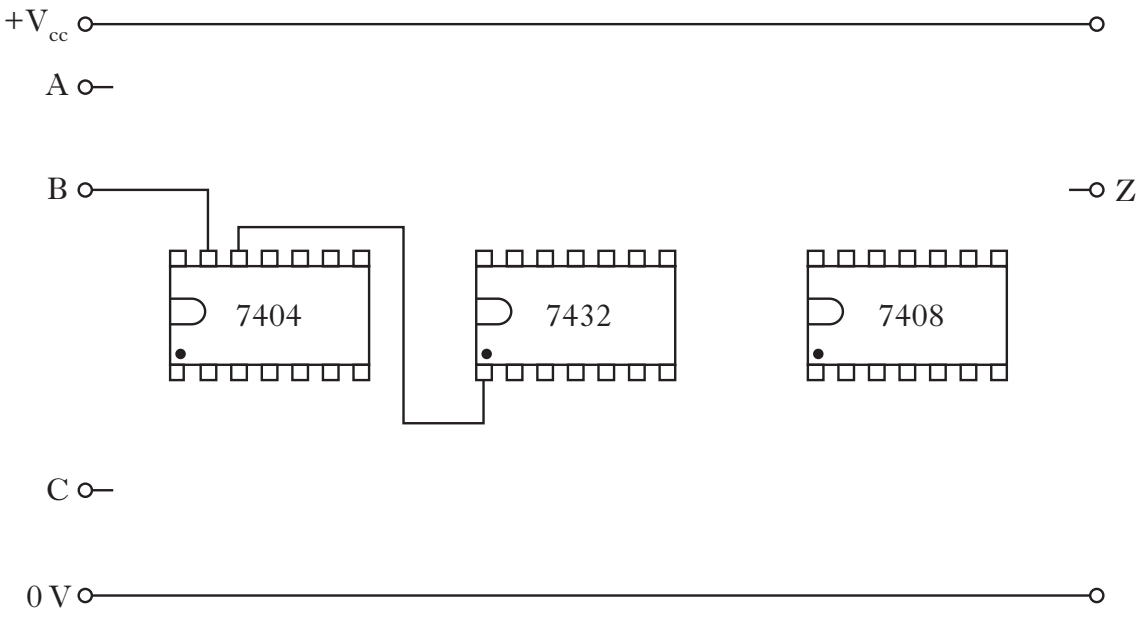

Figure Q10(*c*) **4**

10. (continued)

Marks

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(*e*) State, for the wiring diagram shown in Figure 10(*c*):

(i) the **full name** of the following Integrated Circuits (IC), with reference to the Data Booklet;

7404 _____

7408 _____ **2**

(ii) the name of the IC logic family used;

_____ **1**

(iii) a suitable value for $+V_{cc}$;

_____ **1**

(iv) the function of the dot on each IC.

_____ **1**

(20)

11. A motorised lift is used to transport workers in a mine.

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Figure Q11(*a*)

The motor uses 42 kW in 3 minutes to raise the lift and workers, with a combined mass of 1000 kg, to the top of the mine shaft.

Calculate:

(*a*) (i) the electrical energy used during this time;

2

(ii) the potential energy gained by the lift and miners if they are raised 500 m;

2

(iii) the efficiency of the lifting system.

2

(*b*) (i) State the main cause for the energy loss when raising the lift.

_____

1

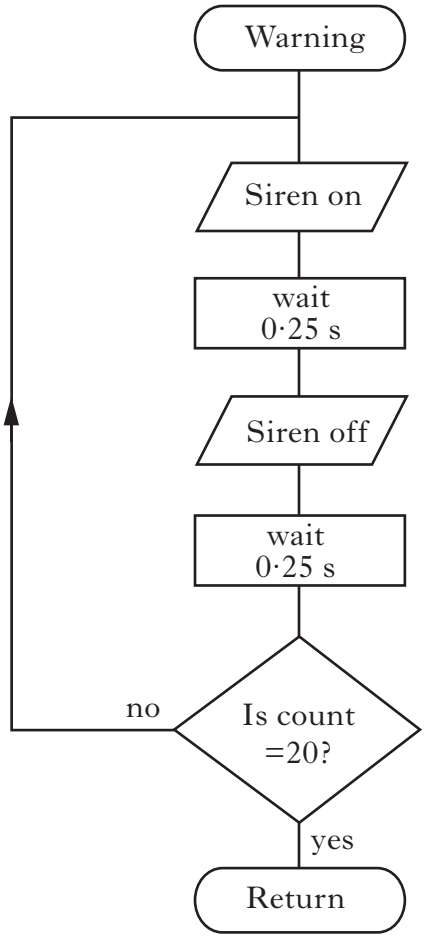
(ii) Describe **one** method of reducing this energy loss.

_____

1

11. (continued)

A microcontroller is used to operate the lifting system. A siren sounds before the lift moves. The flowchart for the *Warning* sub-procedure and the input and output connections are shown in Figure Q11(*b*).



input connection	pin	output connection
	7	siren
	6	
	5	
	4	
	3	
	2	
	1	
	0	

Figure Q11(*b*)

11. (continued)

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Marks

(*c*) Write, the PBASIC program for the sub-procedure *Warning*, with reference to Figure Q11(*b*) and the Data Booklet.

warning:

6

11. (continued)

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Marks

For the sub-procedure *Warning*:

(*d*) (i) calculate the length of time for the sub-procedure;

1

(ii) state the PBASIC command used to call the sub-procedure *Warning* in the main program.

_____ **1**

(*e*) Describe why sub-procedures are often used in PBASIC programs.

_____

_____ **1**

The PBASIC program is stored in the EEPROM on the microcontroller.

(*f*) (i) State the full name of EEPROM.

_____

_____ **1**

(ii) State **one** property of this type of memory.

_____ **1**

(iii) State **one** other type of memory found on a microcontroller.

_____ **1**

(20)

[*END OF SECTION B*]

[*END OF QUESTION PAPER*]

ADDITIONAL SPACE FOR ANSWERS

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