

FOR OFFICIAL USE

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Total
Marks

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X036/201

NATIONAL
QUALIFICATIONS
2008

WEDNESDAY, 4 JUNE
1.00 PM – 3.30 PM

TECHNOLOGICAL
STUDIES
INTERMEDIATE 2

Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Date of birth

Day Month Year

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Scottish candidate number

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Number of seat

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- 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 (2006 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.



SECTION A

Marks

Attempt ALL questions (Total 60 marks)

1. Figure Q1 shows a simplified sub-system diagram of an oil-fired power station.

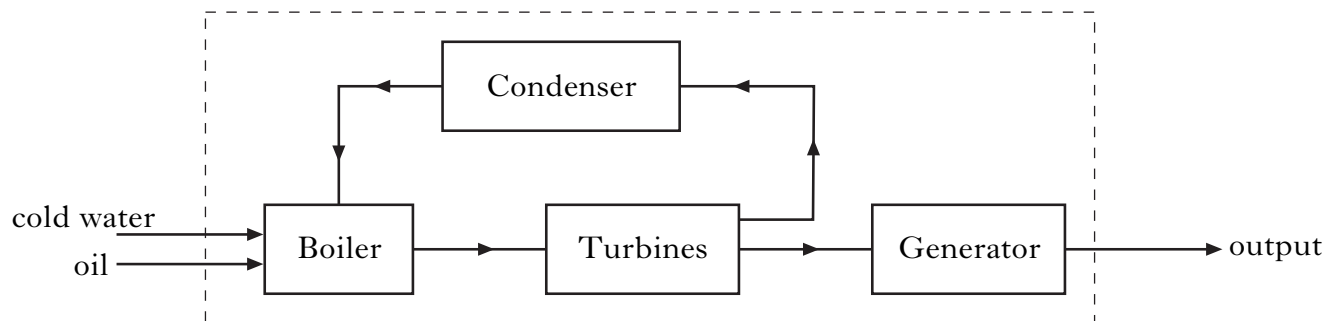


Figure Q1

- (a) State the form of **output energy** from the following sub-systems.

Boiler _____

Turbines _____

Generator _____

3

- (b) Oil is a fossil fuel. State the names of two other fossil fuels.

1. _____

2. _____

2

- (c) State two harmful effects on the environment as a result of burning fossil fuels.

1. _____

2. _____

2

- (d) State the name of two forms of **renewable** energy.

1. _____

2. _____

2

(9)

Marks

2. A control system is used to automatically water plants in a garden centre. The moisture level is monitored by a sensor, which will activate a sprinkler when the soil is too dry.

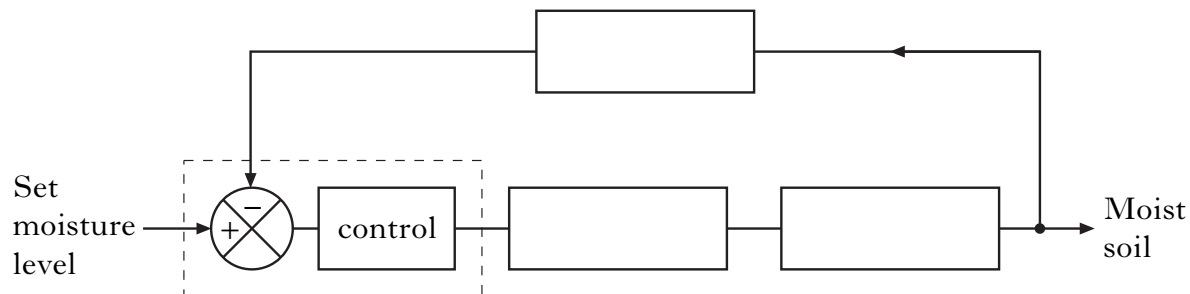


Figure Q2

- (a) Complete the control diagram (in Figure Q2) for the system. 3
- (b) (i) State the type of control shown in Figure Q2. 1
- _____
- (ii) Explain the reason for your answer in (b)(i). 1
- _____
- _____
- (c) Describe the difference between automatic and manual control systems. 2
- _____
- _____ (7)

[Turn over

Marks

3. A microcontroller is used to operate a set of warning lights on a model railway. The input and output connections to the microcontroller are shown in Figure Q3(a).

Input connections	Pin	Output connections
	7	Red
	6	Green
	5	
	4	
	3	
	2	
Sensor 2	1	
Sensor 1	0	

Figure Q3(a)

- (a) Select (✓) the command from the table below that will set up the input/output port for this system.

	(Tick one box)
let dirs = %00000011	
let dirs = %11000000	
let dirs = %11000011	

1

- (b) Convert each of the following binary numbers into decimal.

Binary	Decimal
%00010101	
%10010100	
%01101000	

3

*Marks***3. (continued)**

A reed switch, as shown in Figure Q3(c), is used to sense the position of the model train as it approaches and leaves the crossing.



Figure Q3(c)

- (c) State an advantage in using a reed switch in preference to a push switch in this system.

1

- (d) State the device used to activate a reed switch.

1**(6)****[Turn over]**

Marks

4. A design for a pneumatic circuit to produce reciprocating motion is shown in Figure Q4.

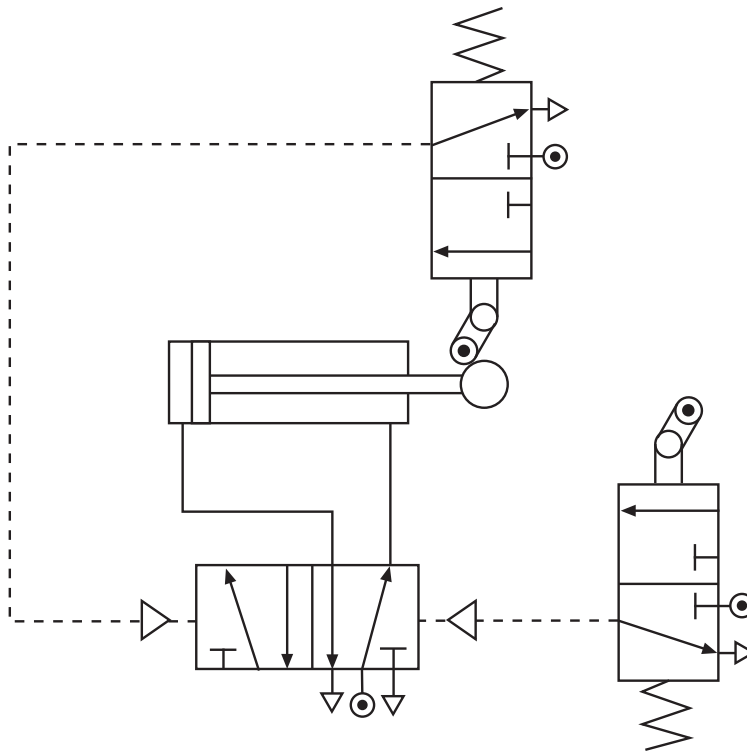


Figure Q4

The design does not allow the circuit to be turned on and off without disconnecting the air supply. It was decided to add a 3/2 lever spring return valve to solve this problem.

- (a) (i) Sketch, in the space below, the pneumatic symbol for a 3/2 lever spring return valve.

2

- (ii) Indicate on Figure Q4 with a cross (X) where this valve should be added to allow the circuit to be stopped with the piston **instroked**.

1

4. (continued)*Marks*

The design was modified to include speed control.

- (b) Air should be restricted as it **leaves** a cylinder rather than as it enters it. State the reason for this.

_____ **1**

- (c) (i) State the name of the component that will allow the speed of a piston to be reduced in **one direction** only.

_____ **1**

- (ii) Sketch, in the space below, the symbol for this component and clearly show the direction of free flowing air.

2

- (d) State **two** safety precautions that must be followed when working with pneumatic equipment.

1. _____

2. _____

2

(9)

[Turn over]

Marks

5. An electrical circuit is shown in Figure Q5(a).

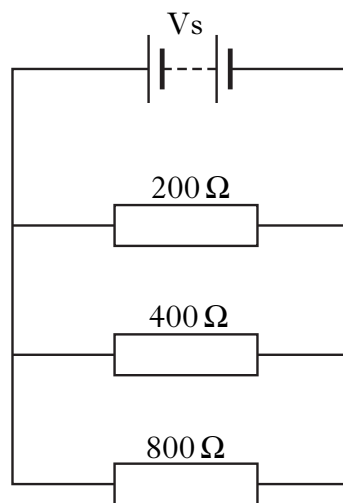


Figure Q5(a)

Calculate, **showing all working and units:**

- (a) (i) the total circuit resistance;

3

- (ii) the total circuit current, if 40 mA flows through the $200\ \Omega$ resistor.

3

Marks

5. (continued)

(b) Complete the circuit shown in Figure Q5(b) to allow meter readings to be taken for:

(i) the **current** through the resistor;

2

(ii) the **voltage** across the resistor.

2

(10)

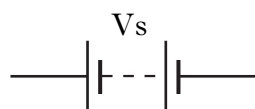


Figure Q5(b)

[Turn over]

Marks

6. Figure Q6 shows an electronic circuit which has been designed to turn on a warning lamp when the temperature drops below 0°C .

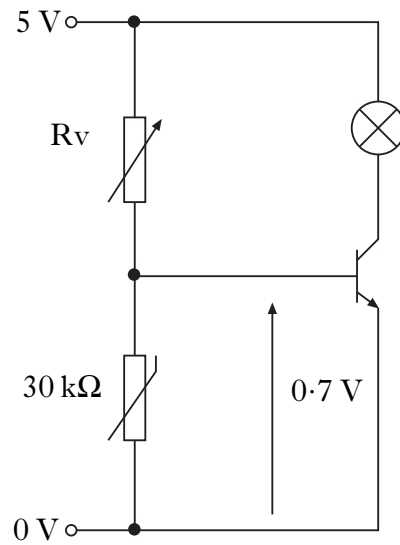


Figure Q6

- (a) State, with reference to the Data Booklet, the thermistor which has a resistance of $30\text{ k}\Omega$ at 0°C .

1

The transistor is fully switched on with a voltage of 0.7 volts across the base-emitter junction.

- (b) State the name of this condition.

1

Calculate, for the conditions shown in Figure Q6:

- (c) (i) the voltage across R_v ;

1

- (ii) the resistance of R_v .

2

- (d) The circuit is currently used to sense coldness. State how the circuit could be altered to sense high temperatures.

1

Marks

7. Figure Q7 shows a logic circuit for a digital electronic system.

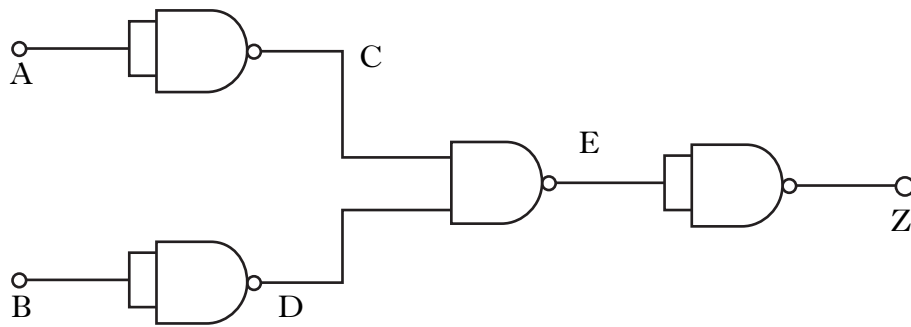


Figure Q7

(a) Complete the truth table below for the logic circuit given in Figure Q7.

A	B	C	D	E	Z
0	0				
0	1				
1	0				
1	1				

4

(b) Write, with reference to the truth table, the Boolean expression for output Z in terms of inputs A and B.

Z =

1

(c) State the single logic gate that could be used to replace the four NAND gates in Figure Q7.

1

(6)

[Turn over

Marks

8. The drive mechanism used on a bicycle is shown in Figure Q8.

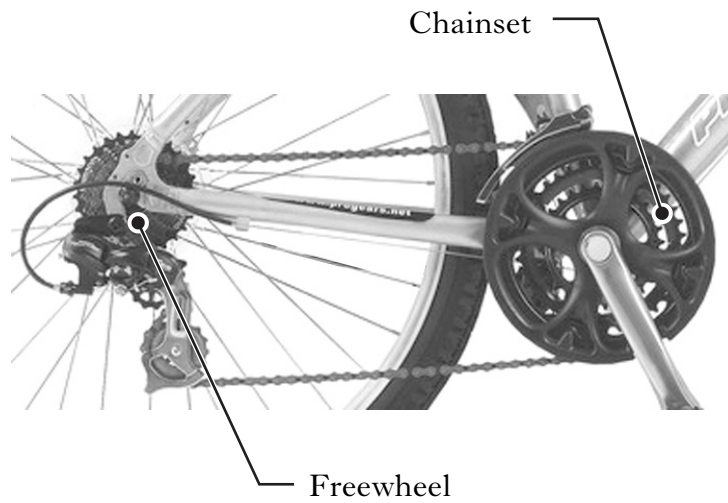


Figure Q8

(a) (i) State the name of the drive mechanism used on the bicycle.

1

(ii) State a general **disadvantage** of using this type of mechanism compared with a belt drive.

1

The bicycle shown in Figure Q8 has a 21 speed gearing system which can be made up from the gears in the table below.

Freewheel	Chainset
12 teeth	24 teeth
16 teeth	36 teeth
20 teeth	48 teeth
24 teeth	
28 teeth	
32 teeth	
36 teeth	

(b) Select, from the table, the freewheel and chainset that will produce the largest velocity ratio.

Freewheel _____ Chainset _____

1

8. (continued)

Marks

- (c) (i) State the most appropriate size of **chainset** sprocket when going up a very steep hill.

1

- (ii) Explain your selection in (c)(i).

1

The chainset sprocket of 36 teeth and a freewheel sprocket of 12 teeth are selected.

- (d) Calculate the speed of the freewheel if the chainset turns at 0.5 rev/s.

2

(7)

[END OF SECTION A]

[Turn over for SECTION B on Page fourteen]

SECTION B

Marks

DO NOT
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Attempt any TWO questions (Total 40 marks)

9. A pneumatic circuit used to place components on a production line is shown in Figure Q9(a).

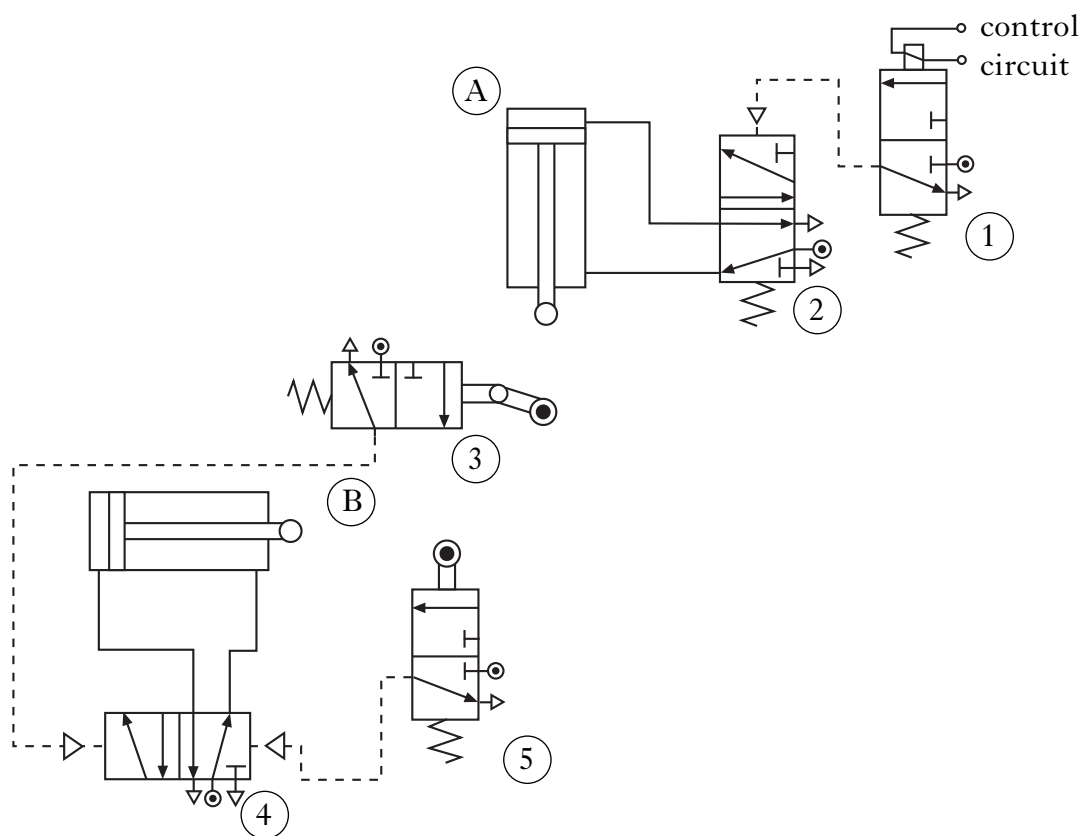


Figure Q9(a)

- (a) Describe, using appropriate terminology, how the pneumatic circuit operates.

When valve ① is activated _____

6

Marks

9. (continued)

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

Valve (2) _____

Valve (3) _____

2

- (c) Calculate, **showing all working and units**;

- (i) the effective area of the piston in the cylinder shown in Figure Q9(c) as it instrokes with a force of 200 N and is supplied with an air pressure of 1.5 N/mm^2 ;

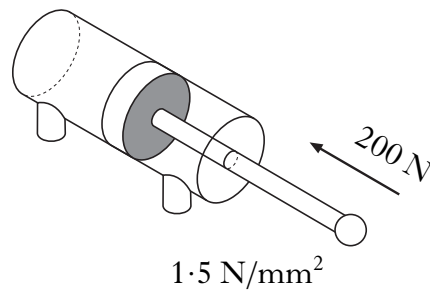


Figure Q9(c)

2

- (ii) the cylinder diameter when the piston rod has a diameter of 5mm.

3

[Turn over

Marks

9. (continued)

The control circuit used to activate the pneumatic system is shown in Figure Q9(d).

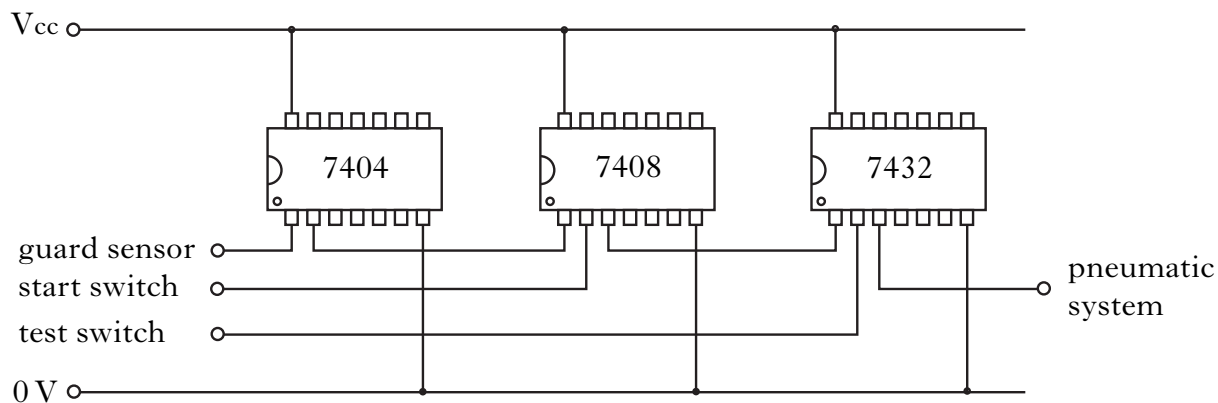


Figure Q9(d)

(d) Complete, with reference to Figure Q9(d) and the Data Booklet, the logic diagram below for the control circuit.

Guard Sensor ◦

Start Switch ◦

◦ Pneumatic System

Test Switch ◦

3

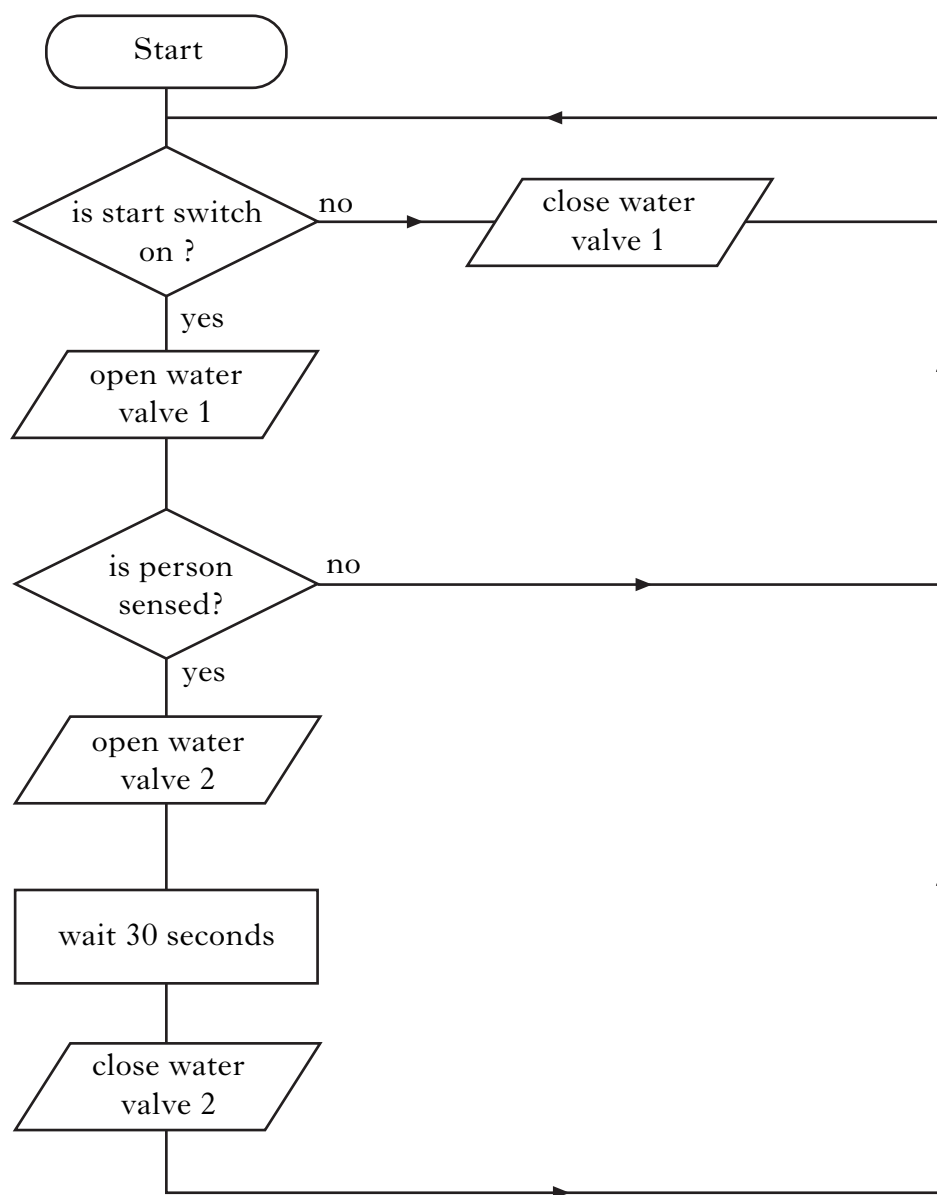
Marks

9. (continued)

- (e) State, for the control circuit shown in Figure Q9(d):
- (i) the **full** name of the following ICs, with reference to the Data Booklet;
- 7404 _____
- 7432 _____ **2**
- (ii) the name of the IC logic family used;
- _____ **1**
- (iii) the operating voltage required for this IC logic family.
- _____ **1**
- (20)**

[Turn over

10. A microcontroller is used to control the amount of water released in a water slide. The flowchart for the control of the water and the input and output connections are shown in Figure Q10(a).



Input connection	Pin	Output connection
	7	water valve 1
	6	water valve 2
	5	
	4	
person sensor	3	
start switch	2	
	1	
	0	

Figure Q10(a)

Marks

10. (continued)

An incomplete PBASIC program, used to control the flow of water is listed below.

- (a) Complete, with reference to the flowchart and input/output connections, the missing PBASIC commands.

init: _____ 'setup DDR(7-4 outputs, 3-0 inputs)

main: _____ 'test start switch

_____ 'close water valve 1

goto main 'loop to main

open: high 7 'open water valve 1

_____ 'test person sensor

_____ 'open water valve 2

_____ 'wait 30 seconds

low 6 'close water valve 2

goto main 'loop to main

6

[Turn over]

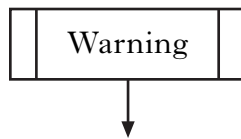
Marks

10. (continued)

A sub-procedure is to be added to operate a warning light when water valve 2 is open. The operation of the sub-procedure “warning” is given below.

- Warning light on for 0.5 seconds
- Warning light off for 0.5 seconds
- Repeat sequence 20 times
- Return to main program

- (b) Draw, with reference to the Data Booklet, the flowchart for the warning light sub-procedure.



5

- (c) Describe the **function** of the following microcontroller sub-systems.

(i) I/O Port _____

_____ 1

(ii) Clock _____

_____ 1

10. (continued)

Part of the control circuit used to activate water valve 2 is shown in Figure Q10(d).

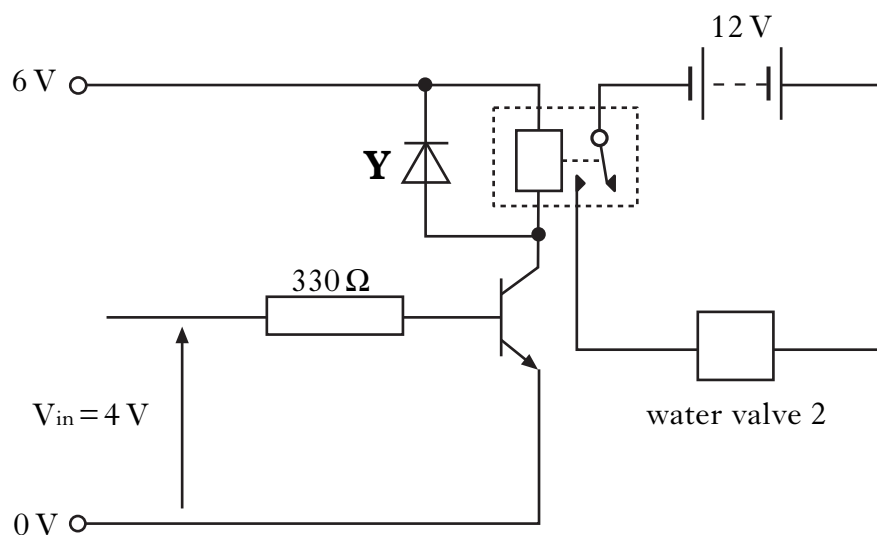


Figure Q10(d)

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

(i) the base current (I_b) when $V_{in} = 4\text{ V}$ and $V_{be} = 0.7\text{ V}$;

3

(ii) the collector current (I_c) through the relay when the transistor gain, $h_{FE} = 50$.

2

(e) (i) State the name of component **Y**.

1

(ii) State the **function** of component **Y** in the circuit.

1

(20)

[Turn over]

Marks

11. A motorised system used to raise and lower a lighting gantry is shown in Figure Q11(a).

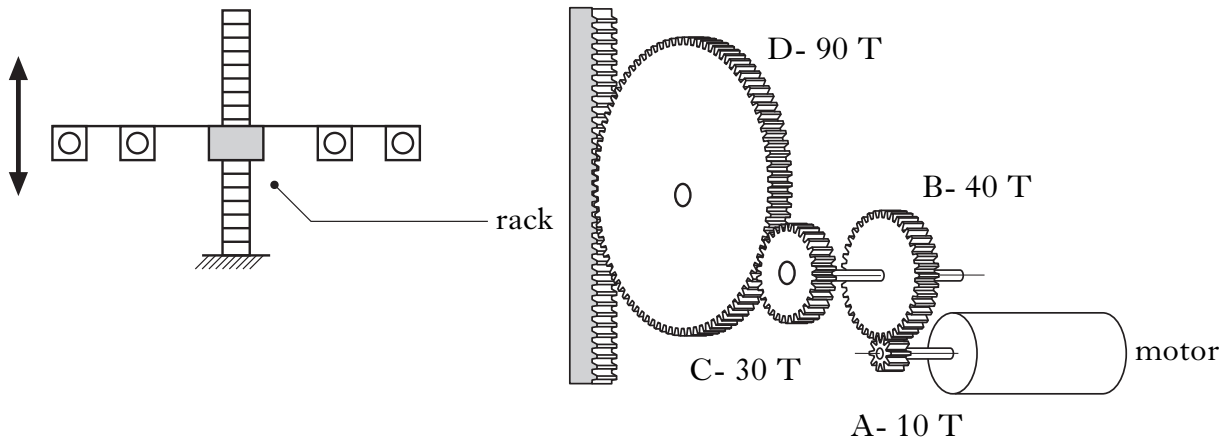


Figure Q11(a)

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

- (i) the rotational speed of gear D, if the motor shaft rotates at 1000 rev/min;

4

- (ii) the linear speed, in m/s, at which the lighting gantry will raise. The rack has 100 teeth per metre.

3

- (b) State the name of a suitable mechanism that could be used to stop gear D slipping down the rack.

1

*Marks***11. (continued)**

When fully loaded the lighting gantry has a mass of 400 kg.

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

(i) the work done raising the lighting gantry by 20 m;

3

(ii) the electrical energy supplied to the motor if the system is 85% efficient;

2

(iii) the power consumption of the motor in 50 seconds.

2

(d) State one method of reducing energy loss while raising and lowering the lighting gantry.

1**[Turn over]**

Marks

11. (continued)

The control diagram for the lifting system is shown in Figure Q11(e).

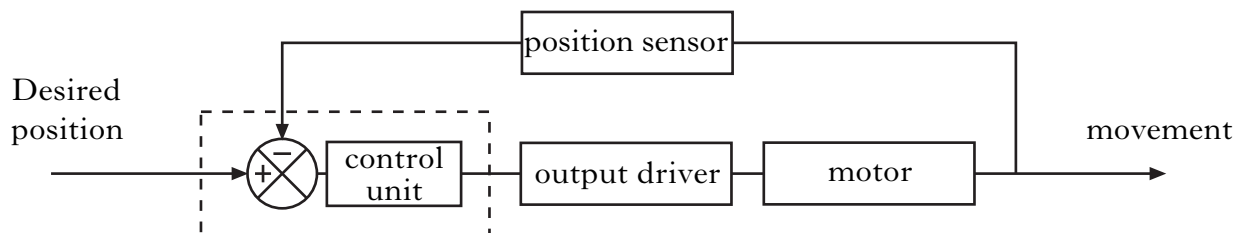


Figure Q11(e)

- (e) Describe, with reference to Figure Q11(e), the operation of the lifting system.

When a new position is set _____

3

- (f) Name a suitable transducer that could be used as a position sensor.

1**(20)**

[END OF QUESTION PAPER]