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4040/31/01

	KU	RNA
Total Marks		

NATIONAL
QUALIFICATIONS
2012

FRIDAY, 4 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

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Scottish candidate number

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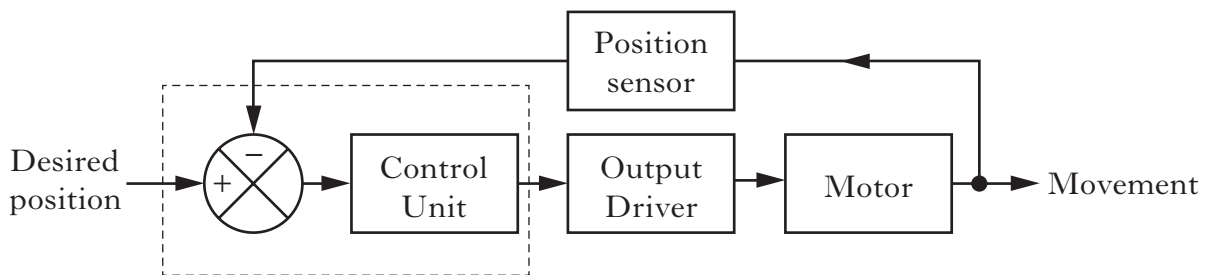
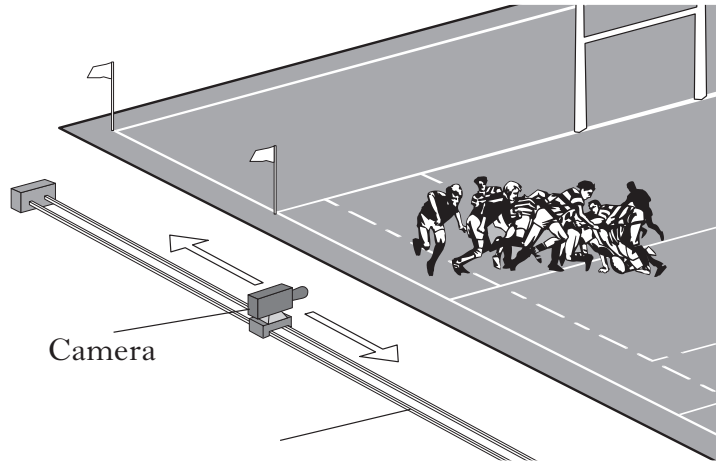
Number of seat

- 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 (2008 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. A mobile pitch-side camera system is used during a rugby match.



(a) Describe, with reference to the control diagram, the operation of the system.

The camera system makes use of closed loop control.

(b) Explain the difference between open loop and closed loop systems.

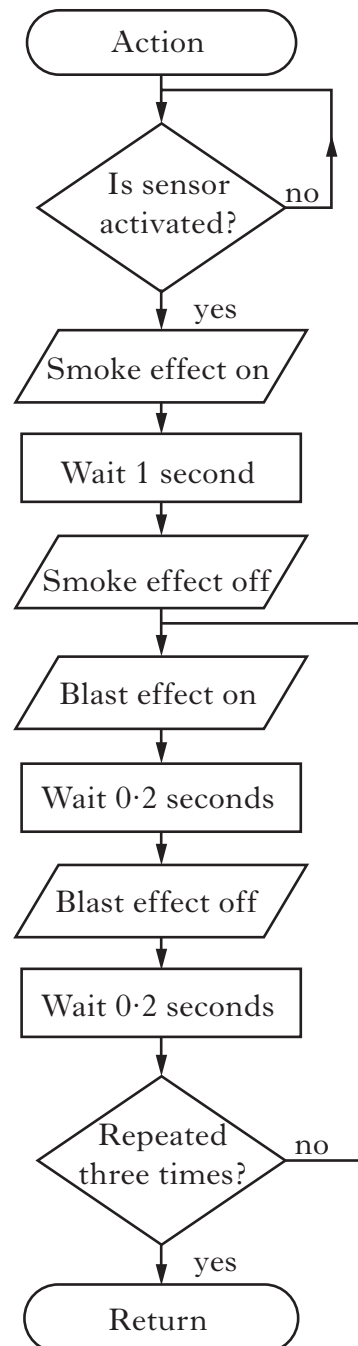
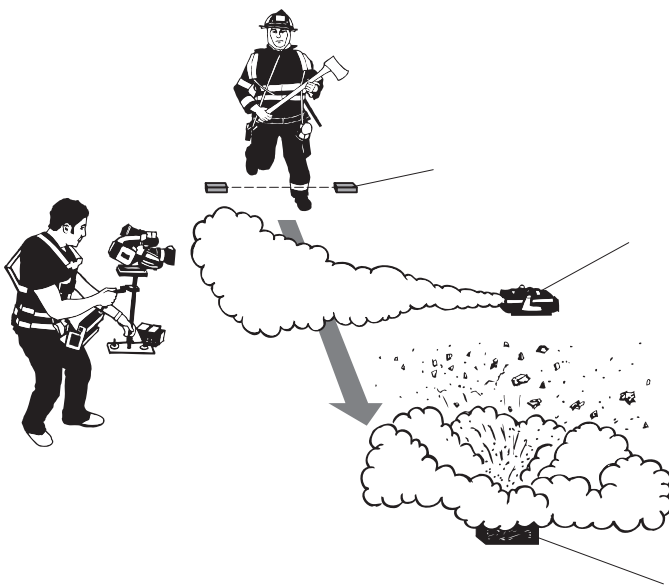
KU	RNA
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2
1
0

2
1
0

2. An action film sequence uses a number of special effects operated by a microcontroller.

The program makes use of a **sub-procedure** “Action”, shown on the flowchart below.



2. (continued)

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

Input Connection	Pin	Output Connection
	7	Smoke effect
	6	Blast effect
	5	
	4	
	3	
	2	
	1	
Sensor	0	

Complete the PBASIC program for sub-procedure “Action”, with reference to the flowchart, Data Booklet, and the input/output connections.

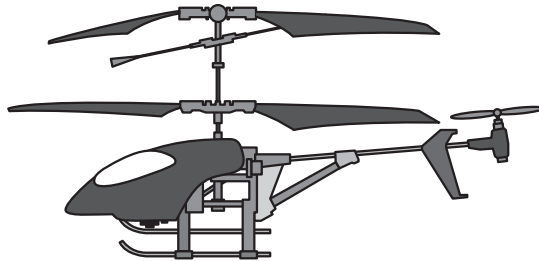
Init: let dirs = %11000000
 symbol counter = b0

Action:

KU	RNA
	7
	6
	5
	4
	3
	2
	1
	0

3. A digital electronic system is used to control part of an electronic toy as shown in the truth table below.

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



(a) Complete, with reference to the truth table, a Boolean expression for **Z** in terms of **A**, **B** and **C**.

Z = _____

(b) Complete a logic diagram for the **following** Boolean expression.

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

A ○ ———

B ○ ———

C ○ ———

————— ○ Z

KU	RNA
	2 1 0
1 0	3 2 1 0

3. (continued)

- (c) State, with reference to the Data Booklet, the **full name** of the following two ICs (Integrated Circuits) required to form part of the circuit.

IC Number **7408**

Full Name _____

IC Number **7404**

Full Name _____

- (d) State **two** characteristics of a 7400 series IC (Integrated Circuit).

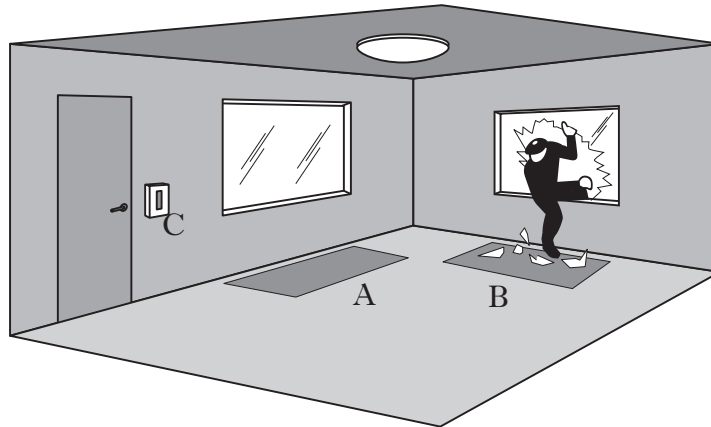
1 _____

2 _____

KU	RNA
2	
1	
0	
2	
1	
0	

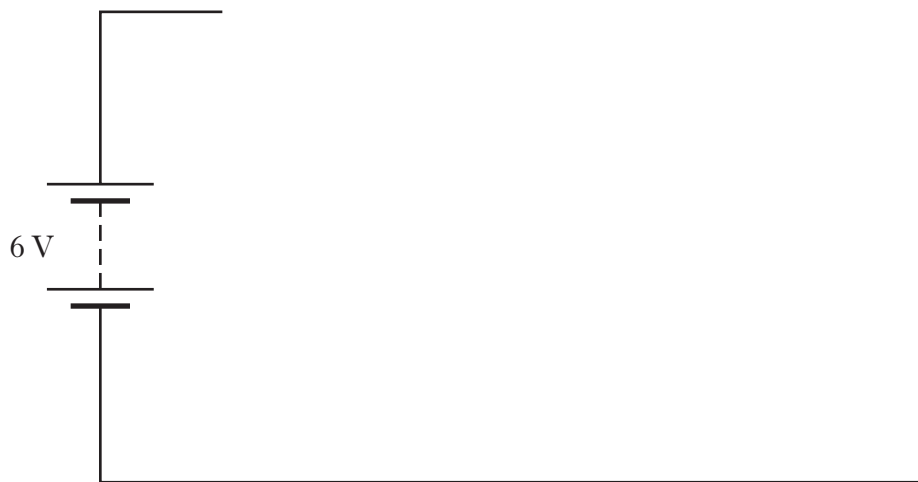
[Turn over

4. A prototype for a burglar alarm system is required.



A buzzer will sound if master switch **C** is on and either pressure switch **A** or **B** is also pressed.

(a) Complete the circuit below using three SPST switches and a buzzer.



KU	RNA
2	2
1	1
0	0

4. (continued)

The circuit is adapted so that an LED switches on when the system is active.

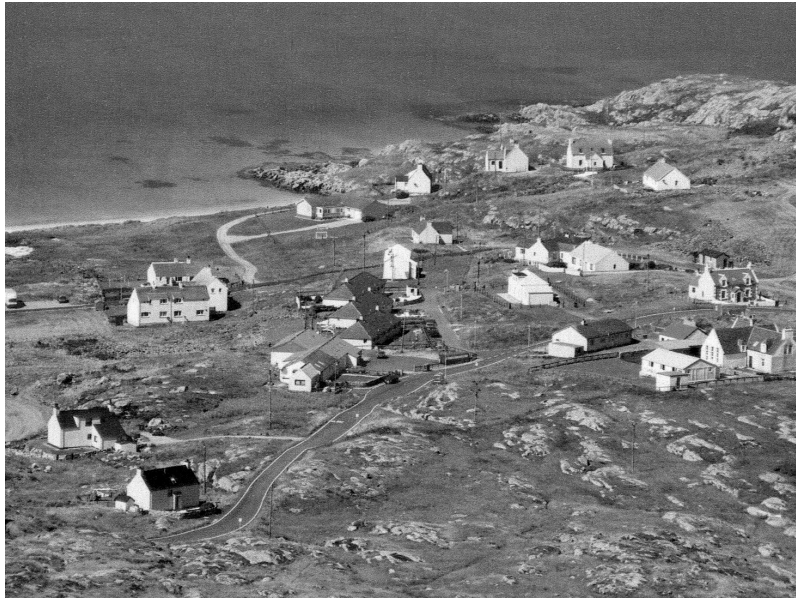
(b) Draw the symbol for an LED.

(c) Describe how an LED should be protected when wired in a circuit.

[Turn over

KU	RNA
1	0
2	1
0	0

5. A Scottish island community is looking to become self sufficient in energy production.



- (a) Describe an advantage that tidal power has over wind power.

1
0

- (b) Describe how a wind turbine typically produces electricity.

2
1
0

- (c) Describe **two** disadvantages of using **finite** energy sources.

2
1
0

KU RNA

5. (continued)

Holiday cottages on the island are installed with solar thermal panels to heat the cold water.



It was found that **100 kg** of water at **10 °C** entered the solar panels and absorbed 7 MJ of heat energy.

(d) (i) Calculate, with reference to the Data Booklet, the final temperature of the water.

(ii) Calculate the efficiency of the solar panels if the sun provided 11 MJ of heat energy.

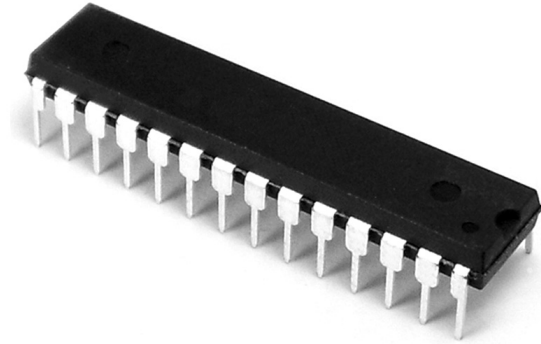
KU	RNA
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3
2
1
0

2
1
0

6. Microcontrollers are increasingly used in electronic control systems.

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(a) Explain why microcontrollers are often used instead of hard-wired electronic circuits.

2
1
0

(b) Complete the table below to match the microcontroller sub-system to its function.

Sub-system	Function
Clock	
_____	<i>Links the microcontroller to the outside world</i>
EEPROM	
ALU	

4
3
2
1
0

6. (continued)

(c) State the full name of EEPROM.

(d) Explain why sub-procedures are commonly used in a control program.

Microcontrollers use binary numbers in their calculations and operations.

(e) (i) Convert the following decimal value number to an **8-bit** binary number.

56 = % _____

(ii) Convert the following binary number to decimal.

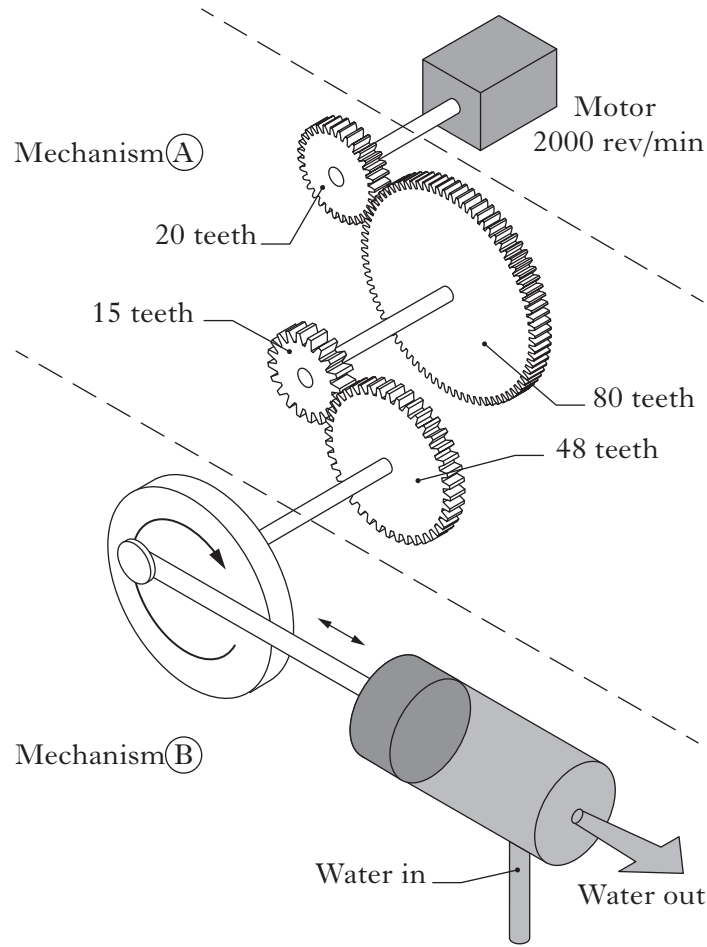
%11001101 = _____

(f) State the name of a method of controlling the speed of a motor using a microcontroller.

KU	RNA
1 0	
2 1 0	
	1 0
	1 0
1 0	

[Turn over

7. A solar-powered water-pumping system is being tested for use in developing countries.



The system consists of **two** separate mechanisms.

(a) State the name of the following mechanisms.

Mechanism (A) _____

Mechanism (B) _____

(b) Describe the change in motion produced by mechanism (B).

KU	RNA
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2	
1	
0	

1	
0	

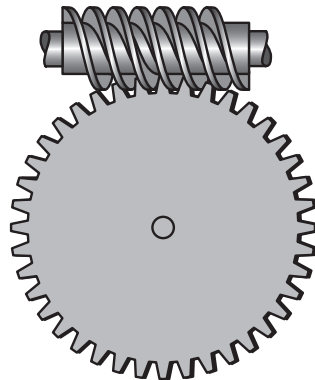
7. (continued)

(c) Calculate the output speed of mechanism (A).

KU	RNA
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4
3
2
1
0

Mechanism (A) is decided to be too bulky and is replaced by the following mechanism.



(d) State the name of this mechanism.

1
0

(e) Describe how friction could be reduced in a mechanical system.

1
0

(f) State the names of **two** mechanisms that will convert rotational motion into linear motion.

1 _____
2 _____

2
1
0

8. (continued)

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

Valve (C) _____

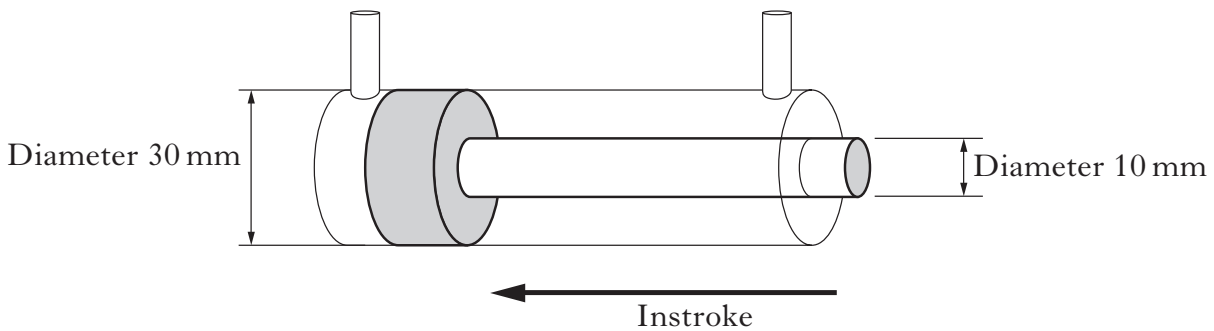
Device (E) _____

It was decided to control the dragon's mouth with an electronic control system.

(c) (i) State the name of the actuator that is used for electronic control of a pneumatic valve.

(ii) Draw the symbol for this actuator.

Air pressure is supplied to the double-acting cylinder at 0.2 N/mm^2 .

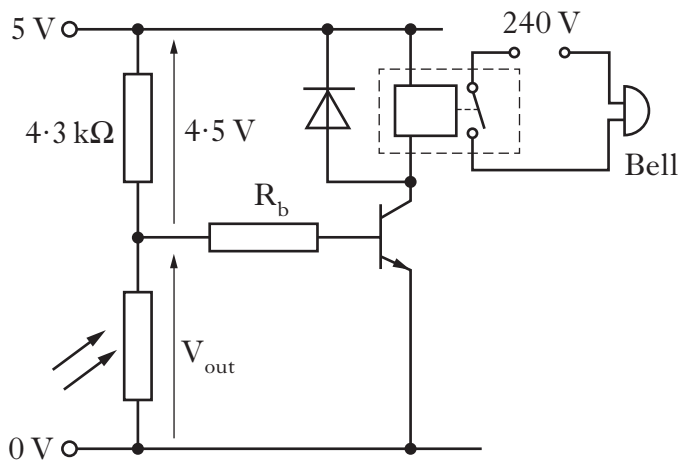


(d) Calculate the **instroking** force produced by the cylinder.

KU	RNA
3	
2	
1	
0	
1	
0	
1	
0	
1	
0	
4	
3	
2	
1	
0	

9. A game show contestant must perform a task without covering a light sensor. If it is covered then an alarm sounds.

The circuit is shown below.



- (a) Calculate the resistance of the LDR when V_{out} is 0.5 V.

During testing the light level is varied.

- (b) (i) Determine, with reference to the Data Booklet, the resistance of the LDR at 20 Lux.

- (ii) Calculate the base current (I_B) when V_{out} is 3.2 V and R_b is 1.5 kΩ.

KU	RNA
	2 1 0
	1 0
	3 2 1 0

9. (continued)

(c) Explain the **function** of the following components that are often used in this type of circuit.

(i) Relay _____

1
0

(ii) Base Resistor (R_b) _____

1
0

(iii) Diode _____

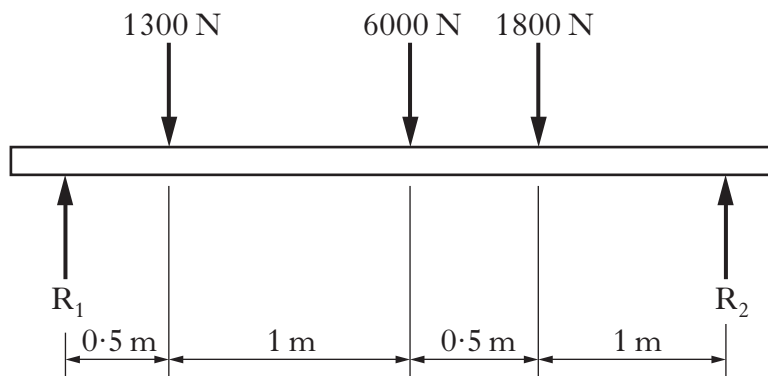
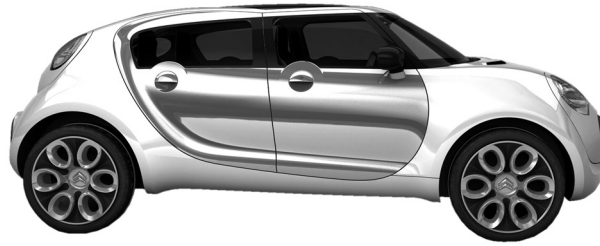
1
0

(d) Describe an advantage of testing an electronic circuit using computer simulation.

1
0

[Turn over

10. During the design of a new lightweight family car the forces acting on it are analysed.



The forces are shown on the diagram above.

- (a) State the name of this type of diagram.

- (b) Calculate the reaction force at R_2 .
(Take moments about R_1).

1
0

3
2
1
0

[END OF QUESTION PAPER]

ACKNOWLEDGEMENTS

Question 10—Image of Citroën car. Permission is being sought from Citroën UK.