Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2011

Electronics ELEC1

Unit 1 Introductory Electronics

Tuesday 17 May 2011 1.30 pm to 2.30 pm

For this paper you must have:
- a pencil and ruler
- a calculator
- a Data Sheet.

Time allowed
- 1 hour

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 67.

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Answer **all** questions in the spaces provided.

1 A student designs a flood warning system. When the humidity goes above a set level, a signal is produced that can only be stopped by operating a reset switch manually. The signal activates a low power pulsing signal that is used to operate a high power siren.

1 (a) Draw a system diagram by choosing appropriate input, process, and output subsystems from the list below.

astable	**audible warning device**	**comparator**
driver	**humidity sensor**	**latch**
reset switch	**set level**	

(8 marks)

1 (b) In which subsystem(s) could the following be used?

1 (b) (i) a potentiometer .....

(1 mark)

1 (b) (ii) an op-amp .....

(1 mark)

1 (b) (iii) a MOSFET .....

(1 mark)

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2 The truth table for a logic system is:

A	B	C	D	E	F	G	Q
0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	0	0	1	0	1
1	0	0	0	0	0	0	0
1	0	1	1	0	0	1	1
1	1	0	0	1	0	1	1
1	1	1	1	1	1	1	1

2 (a) Write down Boolean expressions for the logic signals at D, E and F in the truth table in terms of the inputs A, B and C.

D = ...

E = ...

F = ...

(3 marks)

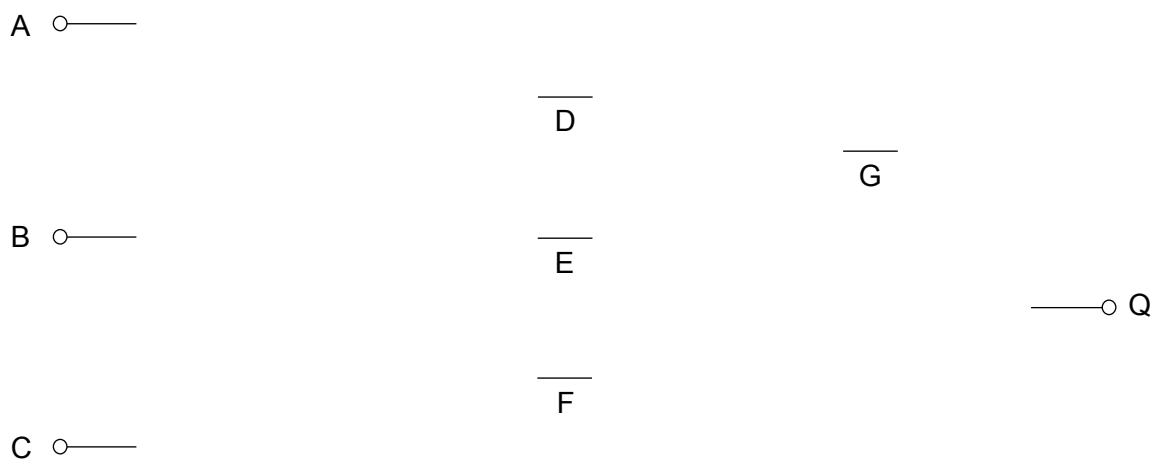
2 (b) Write down Boolean expressions for G and Q in terms of the inputs A, B and C.

G = ...

Q = ...

(2 marks)

2 (c) Complete the logic circuit with the correct gates that would give the logic signals in the table.



(5 marks)

2 (d) Describe the action of this logic circuit.

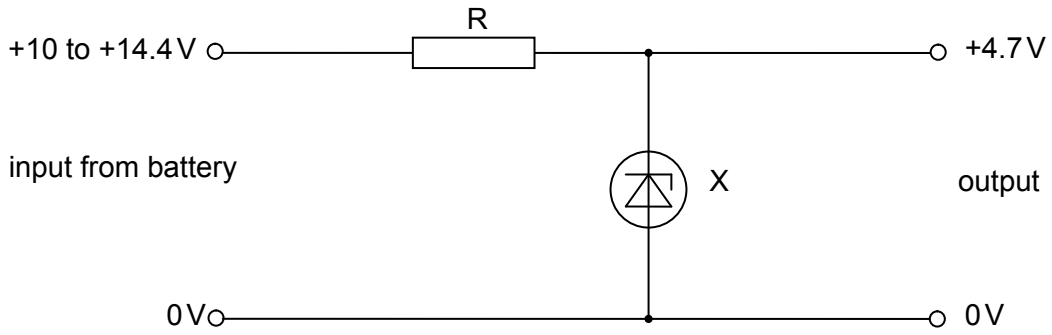
.....

(1 mark)

11

Turn over for the next question

3 A stable power supply voltage of 4.7 V at a maximum current of 100 mA is needed to power an MP3 player in a car.
The problem is that the car battery voltage can vary from as low as 10 V when the car is started on a cold day, up to 14.4 V when it is charging as the engine is running. The circuit below is designed to produce a constant 4.7 V output.



3 (a) (i) What is component X?

.....

(1 mark)

3 (a) (ii) What voltage rating should be chosen for X?

.....

(1 mark)

3 (a) (iii) In which bias direction is component X placed?

.....

(1 mark)

3 (b) The minimum current through component X is 5 mA. The maximum output current from this circuit is 100 mA.
R must be calculated when the value of the input voltage is at its lowest.

Calculate

3 (b) (i) the total current flow through R under these conditions

.....

(1 mark)

3 (b) (ii) the voltage across R when the input voltage is at its lowest

.....

(1 mark)

3 (b) (iii) the required value of R.

.....

(2 marks)

3 (b) (iv) Which preferred value should be chosen for R if the minimum current through X is not to fall below 5 mA?

.....

(1 mark)

3 (c) The preferred value of resistor determined in part (b)(iv) is not available, but a 33 Ω resistor is used. With the circuit powered up, and the engine running, the MP3 player is disconnected. Component X is then found to be hot.

3 (c) (i) Calculate the current through component X.

.....

.....

(2 marks)

3 (c) (ii) Calculate the power dissipated by component X.

.....

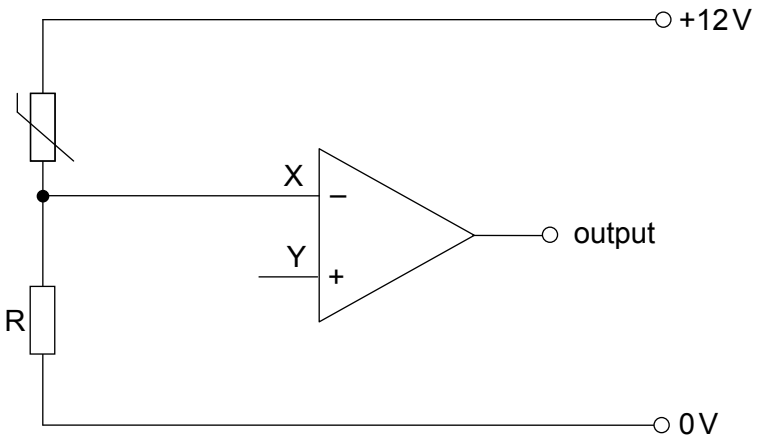
.....

(1 mark)

11

Turn over for the next question

4 A system to detect when the temperature in a room exceeds 20°C is needed as part of an energy saving scheme. Part of the system is shown below.



On the diagram above name and label the device used as a

4 (a) (i) temperature sensor *(1 mark)*

4 (a) (ii) comparator. *(1 mark)*

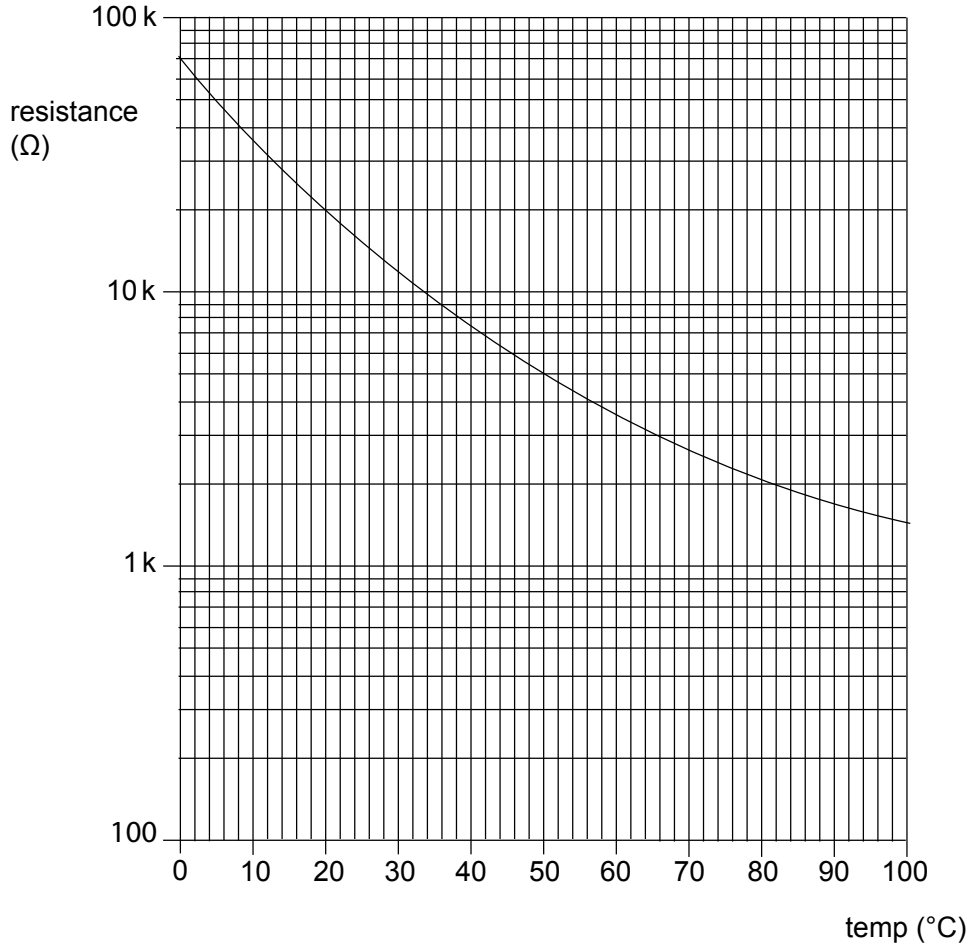
The comparator input Y requires a reference voltage of 4 V.

4 (b) (i) Draw **two** components and their connections to the circuit to show how this is achieved. *(2 marks)*

4 (b) (ii) Select suitable values for these components and mark these on the circuit diagram next to each component.

(1 mark)

4 (c) The temperature sensor data sheet gives the following graph.



4 (c) Calculate the value of R that would make the comparator switch at 20°C.

.....

.....

(3 marks)

4 (d) Give the output voltage from this circuit when the voltage at X is greater than the voltage at Y

4 (d) (i) for an ideal comparator .....

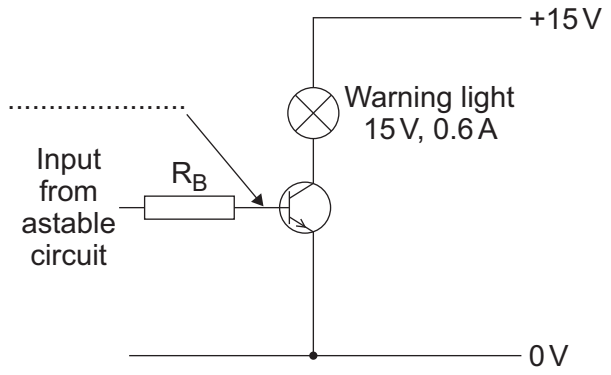
(1 mark)

4 (d) (ii) for a real comparator. .....

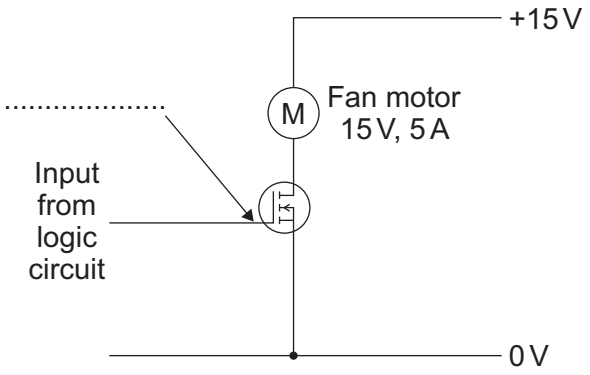
(1 mark)

10

5 A student is designing an emergency ventilation system for a greenhouse. When the temperature exceeds the safe level, a logic signal is to turn on a fan, and a large warning light is to be flashed on and off by an astable circuit.
The student decides to use two different electronic switch circuits, one for the lamp and one for the fan motor, as shown below.



Circuit **A**



Circuit **B**

5 (a) The input connections for each of the active devices shown are identified with arrows. Label on each circuit diagram, in the spaces provided, the name of each of these connections.

(2 marks)

5 (b) What is the name of the active device in circuit **B**?

.....

(1 mark)

5 (c) Explain the purpose of R_B in circuit **A**.

.....

.....

(2 marks)

An essential component is missing from circuit **B**.

5 (d) (i) Draw in the missing component on the circuit diagram above.

(2 marks)

5 (d) (ii) Give the name of the component, and explain why it is needed in the circuit.

Component name .....

Explanation .....

.....

.....

(2 marks)

5 (e) Explain why the device in circuit **B**, rather than that in circuit **A** has been chosen to switch the fan motor.

.....

.....

.....

.....

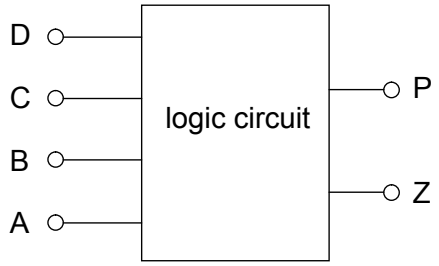
.....

(3 marks)

12

Turn over for the next question

6 A logic circuit forms part of a mathematical puzzle. It has a four-bit binary input, D, C, B and A, (A is the least significant bit), and gives a logic high output on P when the number represented by the input is a prime number.
The prime numbers in the range 1 to 15 are: 1, 2, 3, 5, 7, 11, 13.
Zero input gives a logic high output on Z.



6 (a) Complete the truth table for the logic circuit. Input A is the least significant bit.

D	C	B	A	P	Z
0	0	0	0	0	
0	0	0	1	1	
0	0	1	0	1	
0	0	1	1	1	
0	1	0	0	0	
0	1	0	1	1	
0	1	1	0	0	
0	1	1	1	1	
1	0	0	0	0	
1	0	0	1	0	
1	0	1	0	0	
1	0	1	1	1	
1	1	0	0	0	
1	1	0	1	1	
1	1	1	0	0	
1	1	1	1	0	

(1 mark)

6 (b) Explain why the Boolean expression for P is

$\overline{D}.\overline{C}.\overline{B}.A + \overline{D}.\overline{C}.B.\overline{A} + \overline{D}.\overline{C}.B.A + \overline{D}.C.\overline{B}.A + \overline{D}.C.B.A + D.\overline{C}.B.A + D.C.\overline{B}.A$

.....

.....

(2 marks)

6 (c) Using either Boolean algebra or a Karnaugh map, show that the expression for P simplifies to

$$\overline{D}.A + \overline{C}.B.A + C.\overline{B}.A + \overline{D}.\overline{C}.B$$

	A.B	$\overline{A}$.B	$\overline{A}.\overline{B}$	A.$\overline{B}$
C.D				
$\overline{C}$.D				
$\overline{C}.\overline{D}$				
C.$\overline{D}$				

(4 marks)

6 (d) Complete the logic circuit diagram below to give the output P.

(5 marks)

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END OF QUESTIONS

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