Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Electronics ELEC1

Unit 1 Introductory Electronics

Tuesday 14 May 2013 9.00 am to 10.00 am

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

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.

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

1 A student designs a safety control system for an electric motor which drives a machine tool. The **motor** can be switched on by either using a **push button** or a **foot switch**, and will only operate when a safety guard presses on a **microswitch** when the guard is in place. All switches give a logic 1 when pressed.

1 (a) Draw a system diagram for this in the space below.

(6 marks)

1 (b) A system is designed to monitor the motor current and switch the motor off if the current rises above a set level. A 0.1 Ω resistor is connected in series with the motor.

1 (b) (i) Calculate the voltage across the 0.1 Ω resistor when the motor current is 5 A.

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(2 marks)

1 (b) (ii) What subsystem could be used to give a logic 1 when its input voltage is greater than this, but gives a logic 0 when its input voltage is less?

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(1 mark)

1 (b) (iii) What type of semiconductor device could be used in this subsystem?

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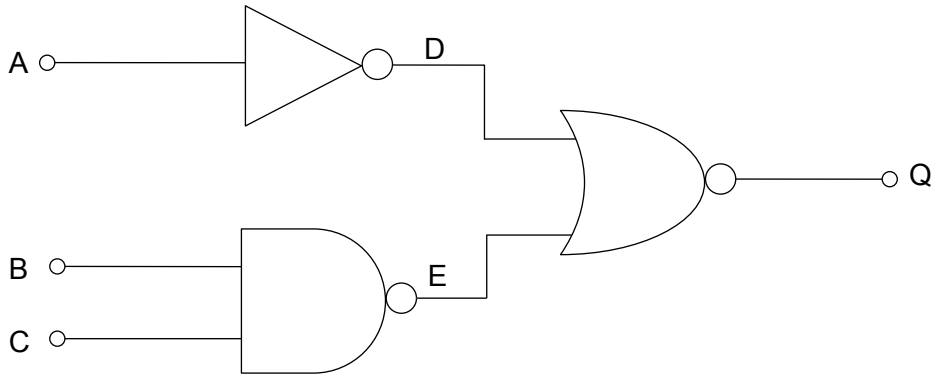
(1 mark)

10

2 As part of his project, a student constructs the following logic circuit.



2 (a) Write down the Boolean expressions for:

D = ...

(1 mark)

E = ...

(2 marks)

2 (b) Write down the Boolean expression for Q in terms of D and E.

Q = ...

(2 marks)

2 (c) Complete the truth table below for the logic circuit above.

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

(4 marks)

2 (d) His supervisor suggests that the logic circuit can be simplified. What single logic gate would have the same function as the whole circuit above?

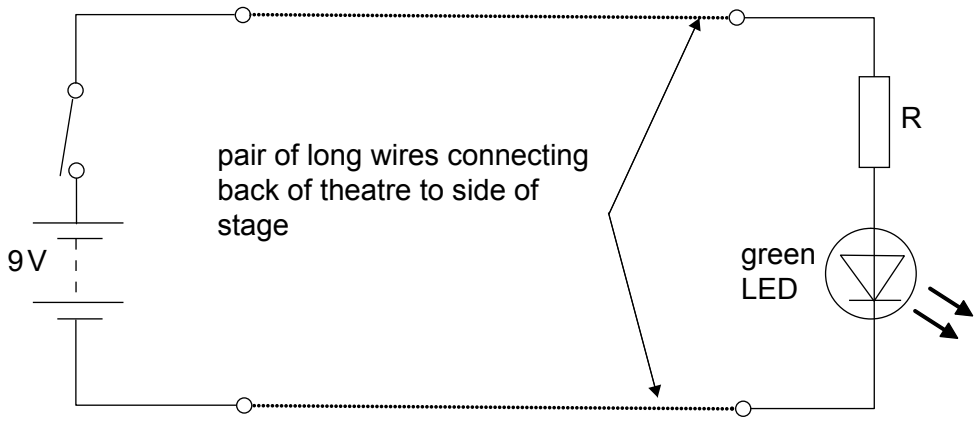
.....

(1 mark)

10

Turn over ▶

3 A theatre has a simple signalling system, so that someone sitting at the back can signal the next act to come on. The system uses a 9 V battery, a switch and a green LED as shown below.



3 (a) Why is it important that the battery is connected the correct way round?

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(1 mark)

3 (b) What is the purpose of resistor R?

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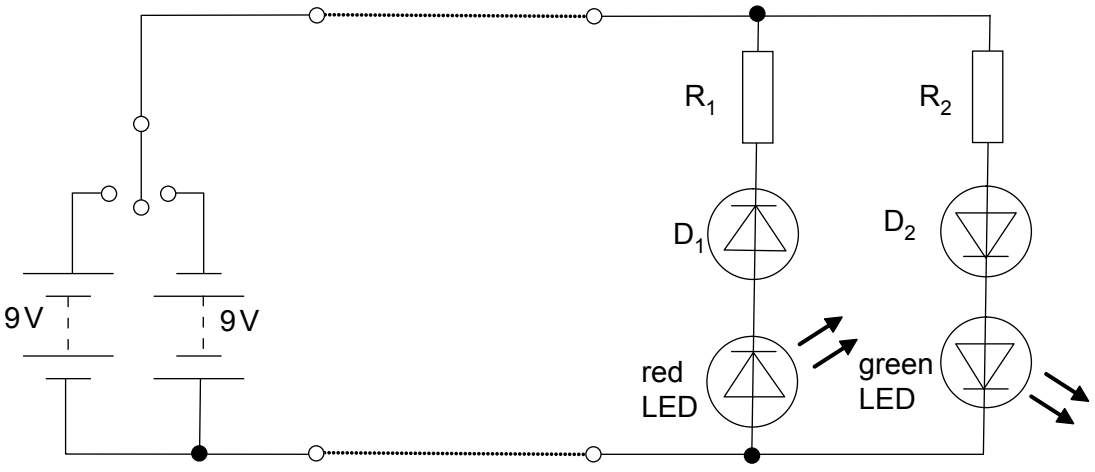
(1 mark)

The system is modified to include a red LED as a warning signal in addition to the green LED. To avoid the use of additional wires the circuit shown below is used.



The table shows data for the two LEDs.

	forward voltage, V_f	**rated current at V_f**	**maximum reverse voltage**	**maximum forward current**
red LED	2.0 V	20 mA	5 V	30 mA
green LED	2.2 V	20 mA	5 V	25 mA

3 (c) When a current of 20 mA flows through the red LED and D_1,

3 (c) (i) calculate the voltage across R_1

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(2 marks)

3 (c) (ii) calculate the required value of R_1

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.....

(2 marks)

3 (c) (iii) select a suitable value for R_1 from the E24 series. Explain your choice.

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(2 marks)

3 (d) In operation and with both LEDs operating at their rated current, the red LED is found to be much brighter than the green LED. State a change that you could make to make the brightness of the two LEDs similar.

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(1 mark)

3 (e) Explain the purpose of diodes D_1 and D_2.

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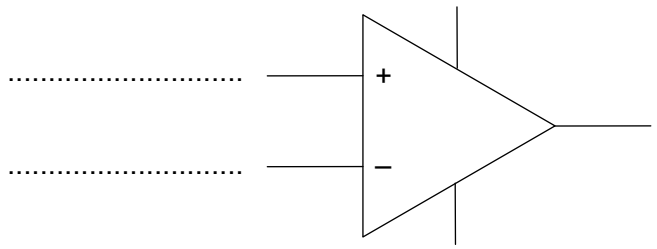
(2 marks)

11

Turn over ▶

4 (a) (i) An op-amp has two inputs. Label on the diagram the correct name for each input.



(2 marks)

4 (a) (ii) Explain how the op-amp works as a comparator, making reference to the two op-amp inputs.

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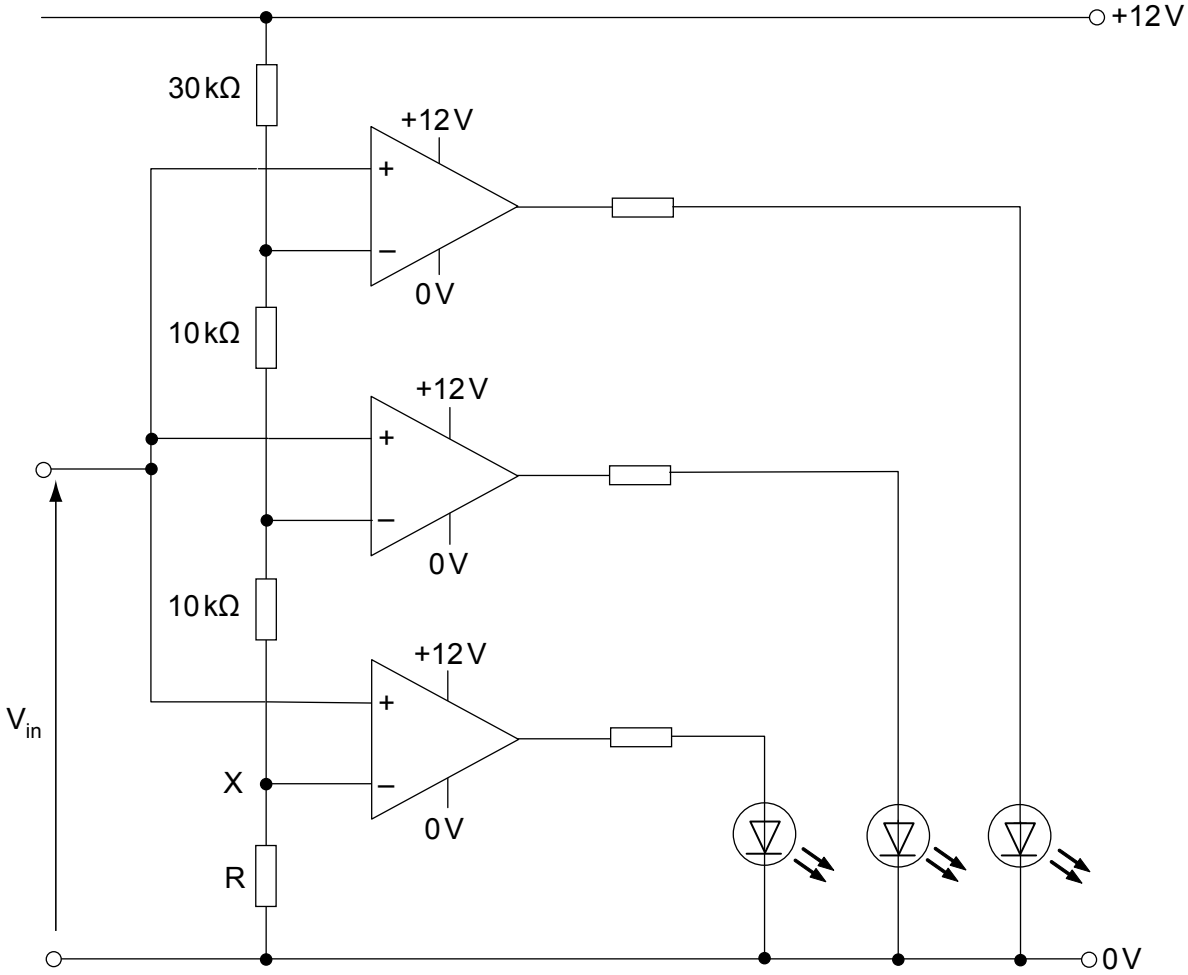
(2 marks)

4 (b) The circuit shown below is a simple tester for 9V batteries. When the input voltage, V_{in}, is below 7V, all the LEDs should be off. As the input voltage is increased the LEDs come on one at a time until they are all lit.



4 (b) (i) Calculate the value of R to make the voltage at point X equal to 7V.

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(2 marks)

4 (b) (ii) Calculate the minimum input voltage, V_{in}, at which all LEDs are lit.

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(2 marks)

Turn over ▶

4 (c) The circuit is built using red LEDs. When this circuit was tested with the input voltage below 7 V, all LEDs should have been off but remained on dimly. Explain why replacing the red LEDs with blue LEDs solved this problem.

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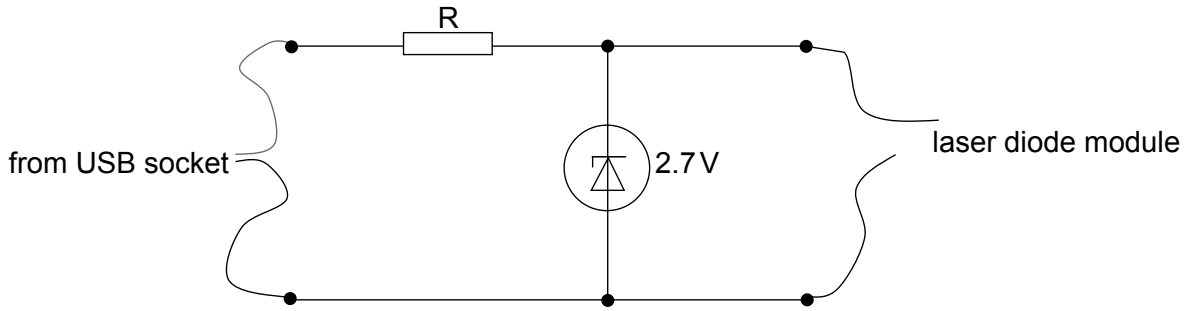
(2 marks)

10

5 The circuit shown below uses a 2.7 V Zener diode to convert the voltage supply from a USB socket on a PC to power a laser diode module.



Specifications for the laser diode module and the USB output are:

Laser diode module current: 88 mA
USB socket supply output: 4.40 V - 5.25 V

5 (a) If the voltage from the USB socket is 4.40 V, the current through the Zener diode is 10 mA and the laser diode module is connected, calculate the required value of series resistor, R.

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(4 marks)

5 (b) State what the Zener diode current will be if the laser diode module is now disconnected from the circuit.

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(1 mark)

5 (c) Zener diodes are available with ratings of $\frac{1}{8}$ W, $\frac{1}{4}$ W and $\frac{1}{2}$ W. Using a calculation determine which one should be used.

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(3 marks)

Turn over ▶

5 (d) Explain, without using calculations, what will happen in the circuit if the USB socket voltage rises to its maximum of 5.25 V.

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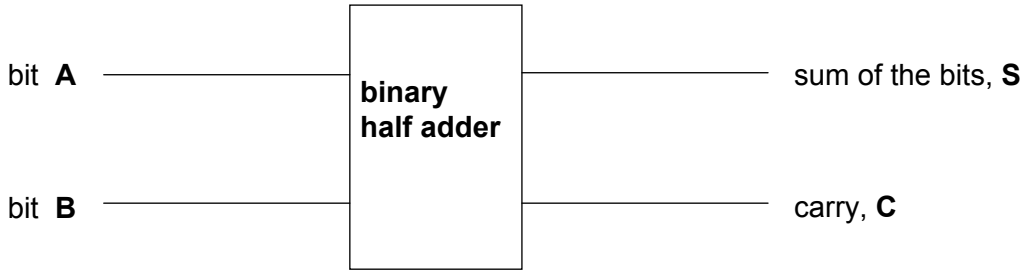
(3 marks)

11

6 Inside a microprocessor, a logic circuit called a binary half adder is used to add two 1-bit binary numbers. The basic building block of such a circuit is shown below:



The device operates as shown in the following truth table.

A	**B**	**S**	**C**
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

6 (a) Write Boolean expressions for **S** and **C**, in terms of **A** and **B**.

S = ...

(2 marks)

C = ...

(1 mark)

6 (b) Using NOT, AND, and OR gates only, draw the logic circuit that will generate **S** from the truth table above.

(5 marks)

Turn over ▸

6 (c) Draw a logic diagram using only NAND gates that performs the OR gate function.

(3 marks)

6 (d) Draw the simplest logic diagram that will give the output **S** using only NAND gates.

(3 marks)

6 (e) Give a reason why it is often an advantage to convert a circuit using a mixture of different gates into one that uses a single type of gate.

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(1 mark)

15

END OF QUESTIONS