Surname

Other Names

Candidate Signature

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2009

Electronics   ELEC1

Unit 1   Introductory Electronics

Monday 18 May 2009   9.00 am to 10.00 am

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

Time allowed
- 1 hour

Instructions
- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- A Data Sheet is provided as a loose insert to this question paper.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 67.
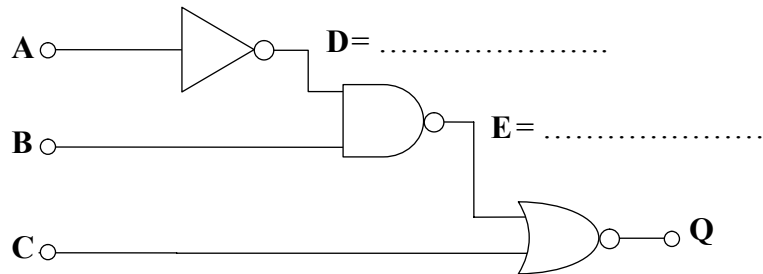- Any correct electronics solution will gain credit.

ELEC1

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ANSWER IN THE SPACES PROVIDED

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

1 (a) Write the Boolean expressions for the logic signals at points **D** and **E** on the diagram below in the spaces provided.

A○—▷○— **D**= …………………

B○

E= …………………

C○— **Q**

(3 marks)

1 (b) (i) Write a Boolean expression for **Q** in terms of **C** and **E** only.

Q = ...
(1 mark)

1 (b) (ii) Write a Boolean expression for **Q** in terms of **A**, **B** and **C**.

Q = ...
(2 marks)

1 (c) Complete the truth table to show the logic values of **D**, **E** and **Q** for all the combinations of variables **A**, **B** and **C**.

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)

1 (d) Describe in words the logic levels at the input of this circuit that will make **Q** = 1.

....
(1 mark)

Turn over ▶

*Areas outside
the box will
not be scanned
for marking*

2 A student designs an electronic system to sound a warning signal when the temperature and the light intensity both fall below set levels.

2 (a) Choosing appropriate input, process, and output subsystems from the list, draw a system diagram below to show a possible design including any other subsystems required.

audible warning device	**comparator**	**driver**
light sensor	**logic gate**	**temperature sensor**

(7 marks)

2 (b) In which subsystem could

2 (b) (i) a MOSFET be used, ...
(1 mark)

2 (b) (ii) an op-amp be used, ...
(1 mark)

2 (b) (iii) a thermistor be used? ....
(1 mark)

2 (c) The whole system operates from a 9 V power supply and draws a current of 10 mA when the audible warning device is off.
The current increases to 160 mA when the audible warning device sounds.

Calculate

2 (c) (i) the current through the audible warning device, ...
(1 mark)

2 (c) (ii) the maximum input power to the circuit. ....

....
(2 marks)

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3 A battery tester for 9 V batteries lights a green LED as a 'good' indicator if the battery voltage is more than 9.0 V.

A yellow LED lights as a 'satisfactory' indicator, if the battery voltage is more than 6.3 V, but less than 9.0 V.

The circuit diagram shows a voltage divider operating from the tester's 12 V supply.
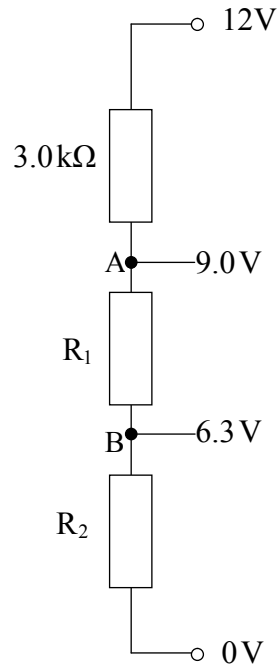
3 (a) Calculate the value of resistors R_1 and R_2, so that the voltage at point A is 9.0 V and the voltage at point B is 6.3 V.
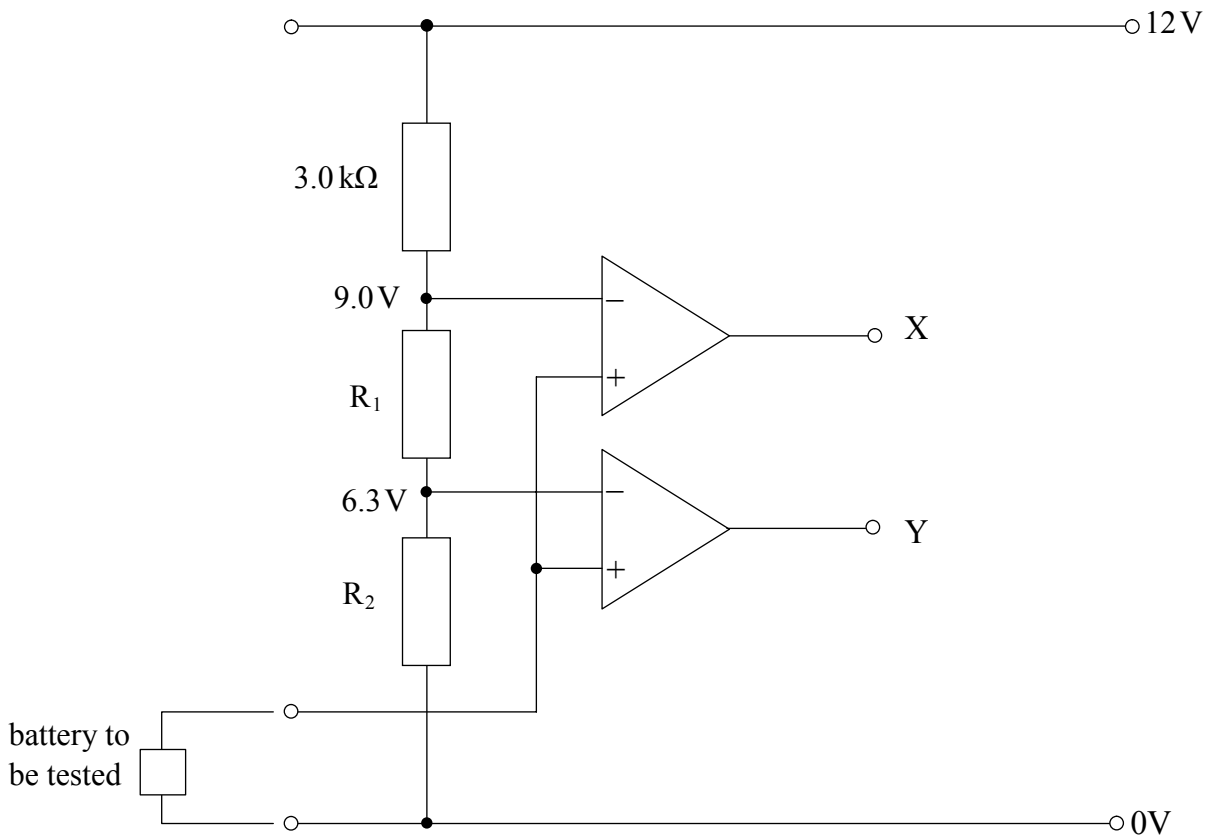
R_1 ....

....

R_2 ....

....

(2 marks)

Question 3 continues on the next page

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3 **(b)** This voltage divider is connected to two op-amps. The battery to be tested is connected between 0 V and the non-inverting input of the op-amps.

State the function of an op-amp when connected in this way.

....

(1 mark)

3 **(c)** The op-amps are powered from the 0 V and 12 V lines; assume that they behave as ideal op-amps. Complete the table below to show the voltages at the op-amp outputs X and Y, when the battery has the voltages shown in the table.

voltage of battery to be tested	voltage at X	voltage at Y
less than 6.3 V		
between 6.3 and 9.0 V		
more than 9.0 V		

(3 marks)

3 (d) (i) Add to the diagram in part (b) an LED labelled "green" to show that the battery being tested is 'good', which will light if the voltage is more than 9.0 V. Include a series resistor.

(2 marks)

3 (d) (ii) Explain why a series resistor is needed.

....

(1 mark)

3 (d) (iii) Calculate the value of the series resistor required if the LED has a forward voltage of 2.0 V and is designed to operate with a current of 20 mA.

....

....

(3 marks)

3 (e) Add to the diagram in part (b) an LED labelled "yellow" and its series resistor to show that the battery being tested is 'satisfactory', which will only light if the battery voltage is between 6.3 V and 9.0 V.
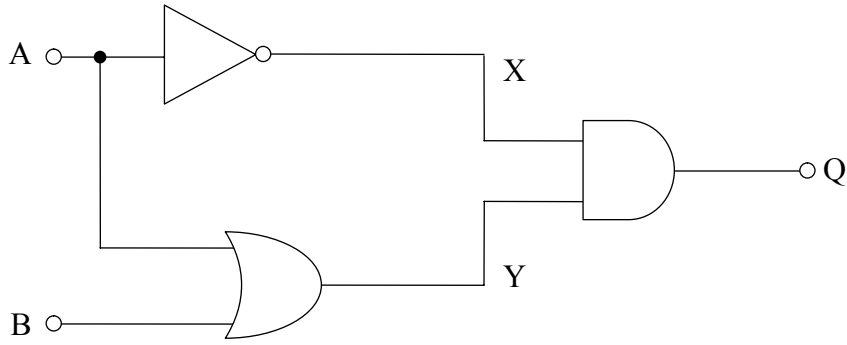
(3 marks)

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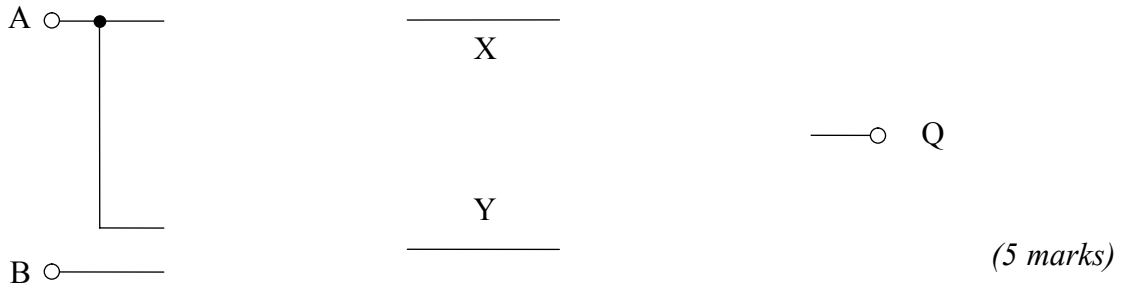
Turn over for the next question

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4 A student develops the logic circuit shown below. It is part of an alarm system that will give an output of logic 1 when a certain combination of logic signals is present at the inputs.
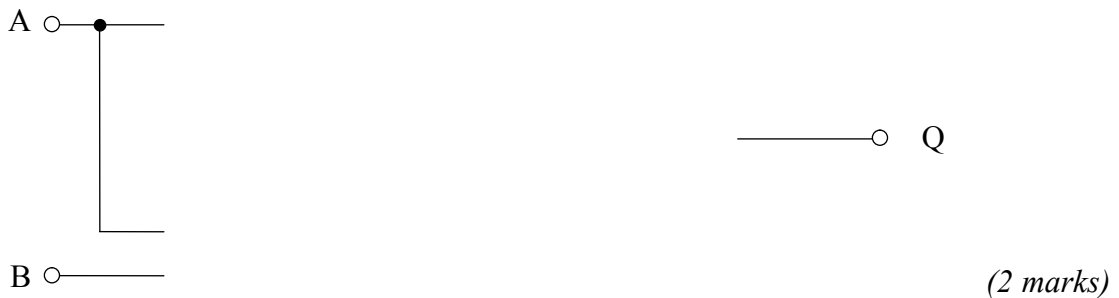

4 **(a)** This circuit is to be converted into one using only NOR gates. Re-draw the logic circuit replacing each gate with its NOR gate equivalent.

(5 marks)

4 **(b)** Draw rings round each pair of redundant gates on the original logic circuit above.

(2 marks)

4 **(c)** **(i)** Draw the simplest logic circuit using only NOR gates that has the same function as the original.

(2 marks)

4 **(c)** **(ii)** State **two** advantages that this circuit has compared with the original.

....

....
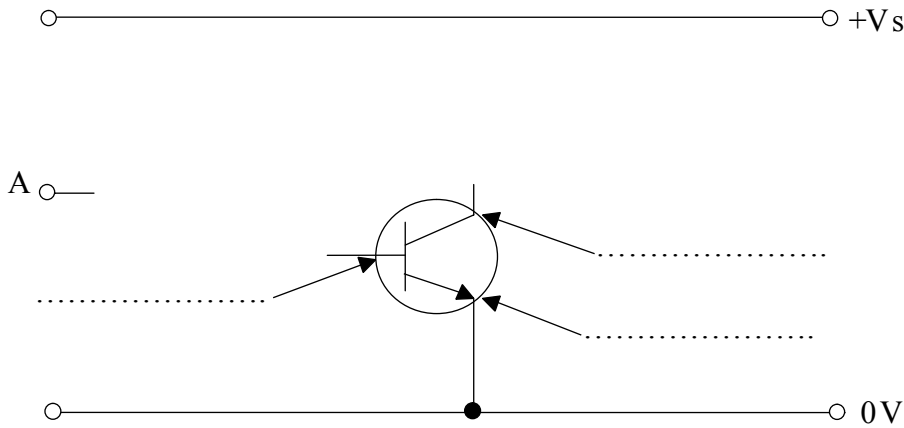
(2 marks)

5   A transistor is to be used as a switch to control an electric motor. The input terminal is A.

5   (a)   Complete the circuit diagram below by drawing a motor, base resistor and a protection diode, in their correct locations.
Label the leads of the transistor and its type in the spaces provided.

type of transistor ....

(5 marks)

5   (b)   The current through the motor when running is 300 mA. The transistor has a current gain (ratio of collector current to base current) of 60.
Calculate

5   (b)   (i)   the required base current. ....

(1 mark)

5   (b)   (ii)   the required value of the base resistor, if the input voltage at A that will cause the transistor to saturate is 5.6 V.

....

....

....

(3 marks)

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Turn over ▶

6 A Zener diode is used to regulate the output voltage of a power supply to 7.5 V when an input voltage between +12 V and +14.4 V is applied.

6 (a) Add a Zener diode and its current limiting resistor to complete the circuit diagram below.

+12 V to +14.4 V ○————————   ————————○ +7.5 V

0 V ○————————   ————————○ 0 V

(2 marks)

6 (b) The minimum Zener current should be 10 mA under all conditions.
The output current required is 100 mA.

6 (b) (i) Calculate the minimum voltage across the resistor.

....
(1 mark)

6 (b) (ii) What current flows through this resistor when the output current is 100 mA and there is the minimum voltage across it?

....
(1 mark)

6 (b) (iii) Calculate the required resistor value.

....
(1 mark)

6 (b) (iv) Which preferred E24 resistor value should be chosen?

....
(1 mark)

6 (b) (v) Give the colour code of this resistor assuming it is of 5 % tolerance.

....
(2 marks)

END OF QUESTIONS

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