Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Education
June 2008
Advanced Subsidiary Examination

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS **ELE1**
Unit 1 Foundation Electronics

Friday 16 May 2008 9.00 am to 10.30 am

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

Time allowed: 1 hour 30 minutes

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 on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information
- The maximum mark for this paper is 72.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3			
4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Data Sheet

- A perforated *Data Sheet* is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

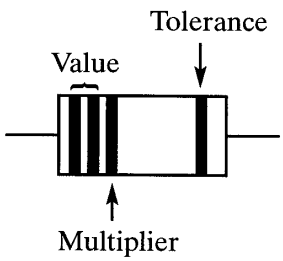
Data Sheet

Resistors Preferred values for resistors (E24) series:
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 ohms and multiples that are ten times greater.

Resistor Printed Code (BS 1852) This code consists of letters and numbers:
R means $\times 1$
K means $\times 1000$ (i.e. 10^3)
M means $\times 1\,000\,000$ (i.e. 10^6)
Position of the letter gives the decimal point
Tolerances are given by the letter at the end of the code, F = ± 1%, G = ± 2%, J = ± 5%, K = ± 10%, M = ± 20%.

Resistor Colour Code

Number	Colour
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Grey
9	White



Tolerance, gold = ± 5%, silver = ± 10%, no band ± 20%.

Silicon diode $V_F = 0.7\,V$

Silicon transistor $V_{be} \approx 0.7\,V$ in the on state
$V_{ce} \approx 0.2\,V$ when saturated

Resistance

$$R_T = R_1 + R_2 + R_3 \quad \text{series}$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \text{parallel}$$

Capacitance

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \text{series}$$

$$C_T = C_1 + C_2 + C_3 \quad \text{parallel}$$

Time constant $T = CR$

A.C. theory

$$I_{rms} = \frac{I_o}{\sqrt{2}}$$

$$V_{rms} = \frac{V_o}{\sqrt{2}}$$

$$X_C = \frac{1}{2\pi fC} \quad \text{reactance}$$

$$X_L = 2\pi fL \quad \text{reactance}$$

$$f = \frac{1}{T} \quad \text{frequency, period}$$

$$f_o = \frac{1}{2\pi\sqrt{LC}} \quad \text{resonant frequency}$$

Operational amplifier

$G_V = \frac{V_{out}}{V_{in}}$ voltage gain

$G_V = -\frac{R_f}{R_1}$ inverting

$G_V = 1 + \frac{R_f}{R_1}$ non-inverting

$V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$ summing

Astable and Monostable using NAND Gates

$f \approx \frac{1}{2RC}$ astable

$T \approx RC$ monostable

555 Astable and Monostable

$T = 1.1RC$ monostable

$t_H = 0.7(R_A + R_B)C$
$t_L = 0.7R_BC$] astable

$f = \frac{1.44}{(R_A + 2R_B)C}$ two resistor circuit

Electromagnetic Waves

$c = 3 \times 10^8\ m\,s^{-1}$ speed in vacuo

List of BASIC Commands

DIM variable [(subscripts)]

DO [{**WHILE** | **UNTIL**} condition]
    [statement block]
LOOP

DO
    [statement block]
LOOP [{**WHILE** | **UNTIL**} condition]

FOR counter = start **TO** end [**STEP** increment]
    [statement block]
NEXT counter

GOSUB [label | line number]
    [statement block]
RETURN

IF condition **THEN**
    [statement block 1]
ELSE
    [statement block 2]

INKEY$

INP (port %)

INPUT [;] ["prompt" {;1, }] variable list (comma separated)

LPRINT [expression list] [{ ;1, }]

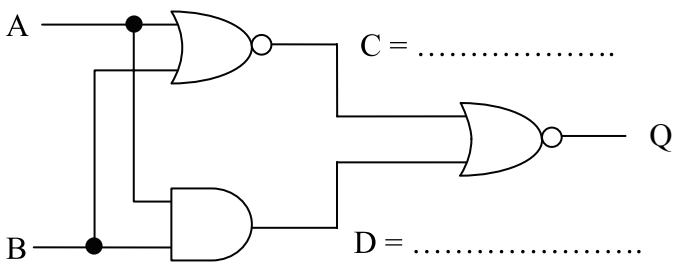
OUT port%, data%

PRINT [expression list] [{;1,}]

REM remark

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

1 A logic circuit diagram is shown below.



1 (a) Write the simplest Boolean expressions for the logic signals at points C and D on the diagram above in the spaces provided. *(2 marks)*

1 (b) (i) Write the simplest Boolean expression for Q in terms of C and D only.

Q = ...

1 (b) (ii) Write a simple Boolean expression for Q in terms of A and B only.

Q = ...

(3 marks)

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

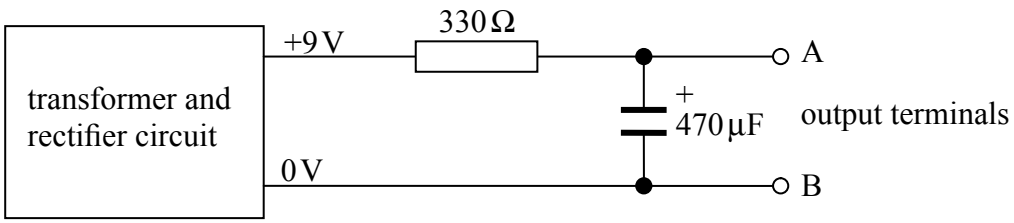
A	B	C	D	Q
0	0			
0	1			
1	0			
1	1			

(4 marks)

1 (d) Draw a logic circuit diagram in the space below using a single logic gate that would have the same function as the original circuit.

(2 marks)

2 The output stage of a power supply is shown below.



2 (a) (i) Calculate the current through the resistor when the output terminals are connected together.

.....

2 (a) (ii) Calculate the power dissipation of the resistor at this current.

.....

(4 marks)

2 (b) (i) Calculate the time constant of this circuit, assuming no load is connected to its output.

.....

2 (b) (ii) The 9 V supply is switched on and the capacitor is initially uncharged. Approximately how long will it take for the output voltage to reach 9 V?

.....

2 (b) (iii) A load resistance of 10 kΩ is connected between the output terminals. Calculate the approximate time taken for the output voltage to reach 0 V after the 9 V supply is switched off.

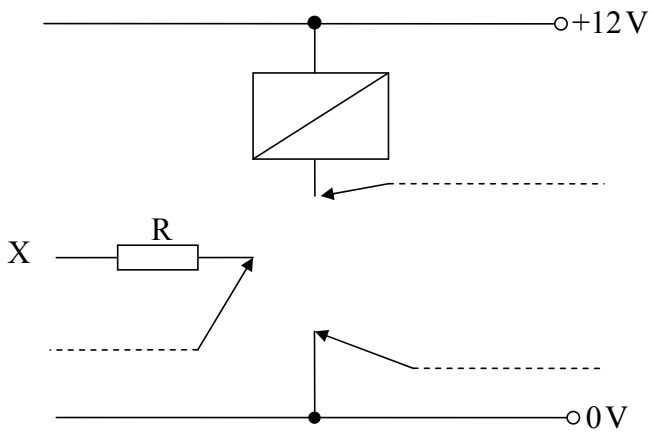
.....

(6 marks)

10

3 An npn junction transistor is to be used as a switch to control an electromagnetic relay.

3 (a) (i) Complete the circuit diagram to show how the transistor is connected, label the leads of the transistor in the spaces shown.



3 (a) (ii) Add to the diagram the component required to protect the transistor from the back emf of the relay.

(6 marks)

3 (b) The relay coil has a resistance of 240 Ω.

3 (b) (i) Calculate the collector current of the transistor when the relay is switched on.

.....

.....

3 (b) (ii) The transistor has a current gain (ratio of collector current to base current) of 50. Calculate the minimum base current when the relay is switched on.

.....

.....

3 (b) (iii) The input voltage at X which saturates the transistor is 4.7 V. Calculate the value of R, the resistor required.

.....

.....

3 (b) (iv) Choose the most appropriate value for R from the E24 series.

.....

(5 marks)

11

4 A student designs a very simple light level detector which indicates when the light level falls, as a reminder to switch on a reading lamp to avoid eye strain.

Since the detector is to be battery powered, it must have a **minimum** power consumption.

The following data is gathered about the devices that could be used.

For the input sensor:

LDR type	resistance at 10 lux
a	200 kΩ
b	94 kΩ
c	20 kΩ

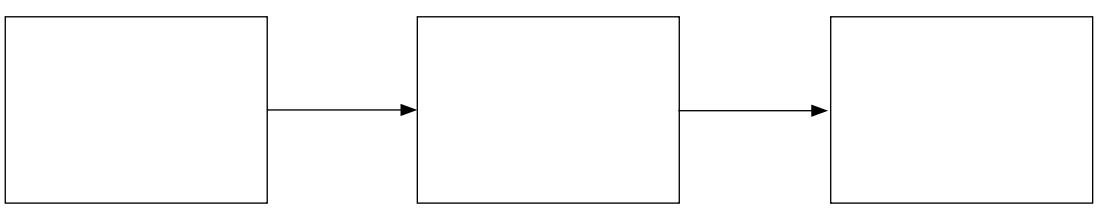
For the processing stage:

type	relevant information
NOT gate 4049	Power consumption 0.001 mW
op-amp TL081	Supply current 1.4 mA
op-amp 741	Supply current 1.7 mA

For the output stage:

device	relevant information
filament lamp	6 V 0.06 A
red LED	V_f 2V @ 10 mA

4 (a) Choosing from the tables above, select a suitable device and type for each of the subsystems that would result in the lowest current drawn from the battery. Label the system diagram with them.



(3 marks)

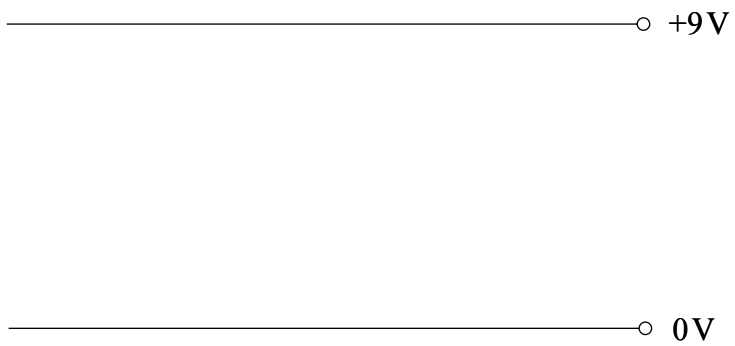
4 (b) The system could be designed to indicate low light by either switching the output device on or off. Which would be better? Give your reason.

.....

.....

(2 marks)

4 (c) The LDR has a resistance of 150 kΩ at the light level at which the system should alert the user. The chosen processing stage requires an input voltage of 4.5 V to switch. Draw the circuit diagram of a voltage divider that would give a rising voltage as the light level falls marking the output connection and suitable value for the component other than the LDR.



(3 marks)

4 (d) The output of the process stage is 7.3 V, and the minimum output current that will operate the output device is 3 mA at 1.9 V.

Calculate the value of a series resistor for the output device.

.....

.....

(2 marks)

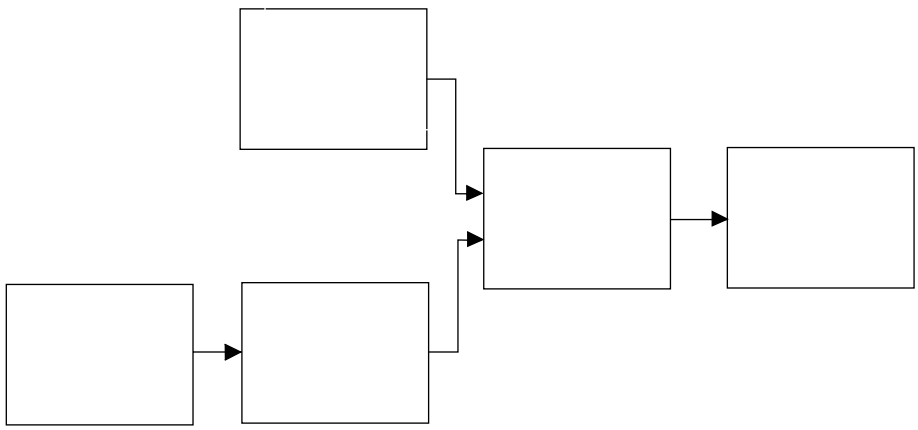
10

Turn over for the next question

5 A student designs a noise warning system to alert the user to the presence of a noise level likely to damage hearing. An LED flashes on and off when the noise level exceeds a safe value.

5 (a) Label each subsystem in the system diagram below to show a possible design for the noise warning system using the following subsystems:

NOR gate **astable** **comparator** **LED** **sound sensor**



(5 marks)

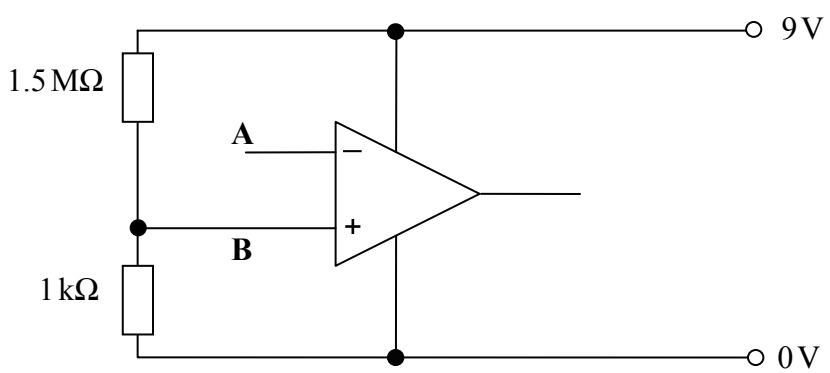
5 (b) In which subsystem could

5 (b) (i) an op-amp be used.....

5 (b) (ii) a 555 IC be used?.....

(2 marks)

5 (c) The comparator circuit diagram is shown below.



5 (c) (i) Calculate the voltage at point **B** in this circuit

.....

.....

The signal from the sound sensor is connected to point **A** in the comparator circuit. What voltage would you expect from the output of this circuit when

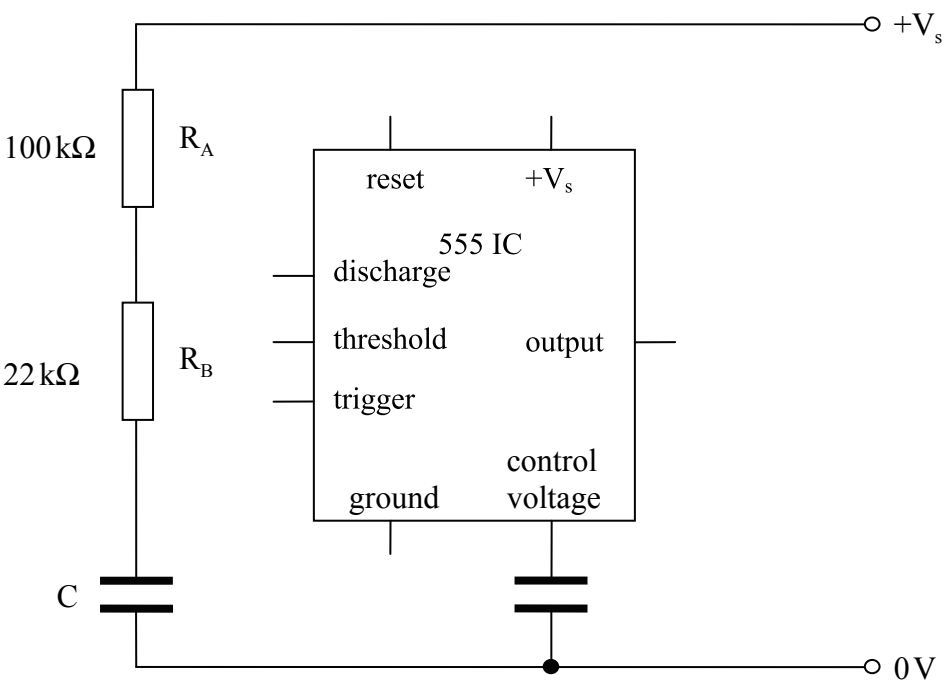
5 (c) (ii) the voltage at **A** is 4 mV .....

5 (c) (iii) the voltage at **A** rises to 10 mV? .....

(4 marks)

5 (d) Part of the astable circuit diagram is shown below.

5 (d) (i) Complete the circuit by drawing in the wire links required.



5 (d) (ii) Given the values shown on the circuit diagram for R_A and R_B, calculate the value of C required to give an output frequency of 2 Hz.

.....

.....

.....

(7 marks)

18

6 A zener diode is used to regulate the output voltage of a power supply to 5.1 V when an input voltage between 7 V and 9.6 V is applied.

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

(4 marks)

6 (b) The minimum zener current should be 5 mA under all conditions.
The maximum output current required is 60 mA.

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

.....

6 (b) (ii) What current flows through the resistor when the output current is 60 mA?

.....

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

.....

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

.....

6 (b) (v) Calculate the power dissipated by the resistor when the input voltage is 9.6 V and the output current is 60 mA.

.....

.....

6 (b) (vi) Explain whether a 0.25 W power rating would be suitable for the resistor.

.....

(8 marks)

12

END OF QUESTIONS