

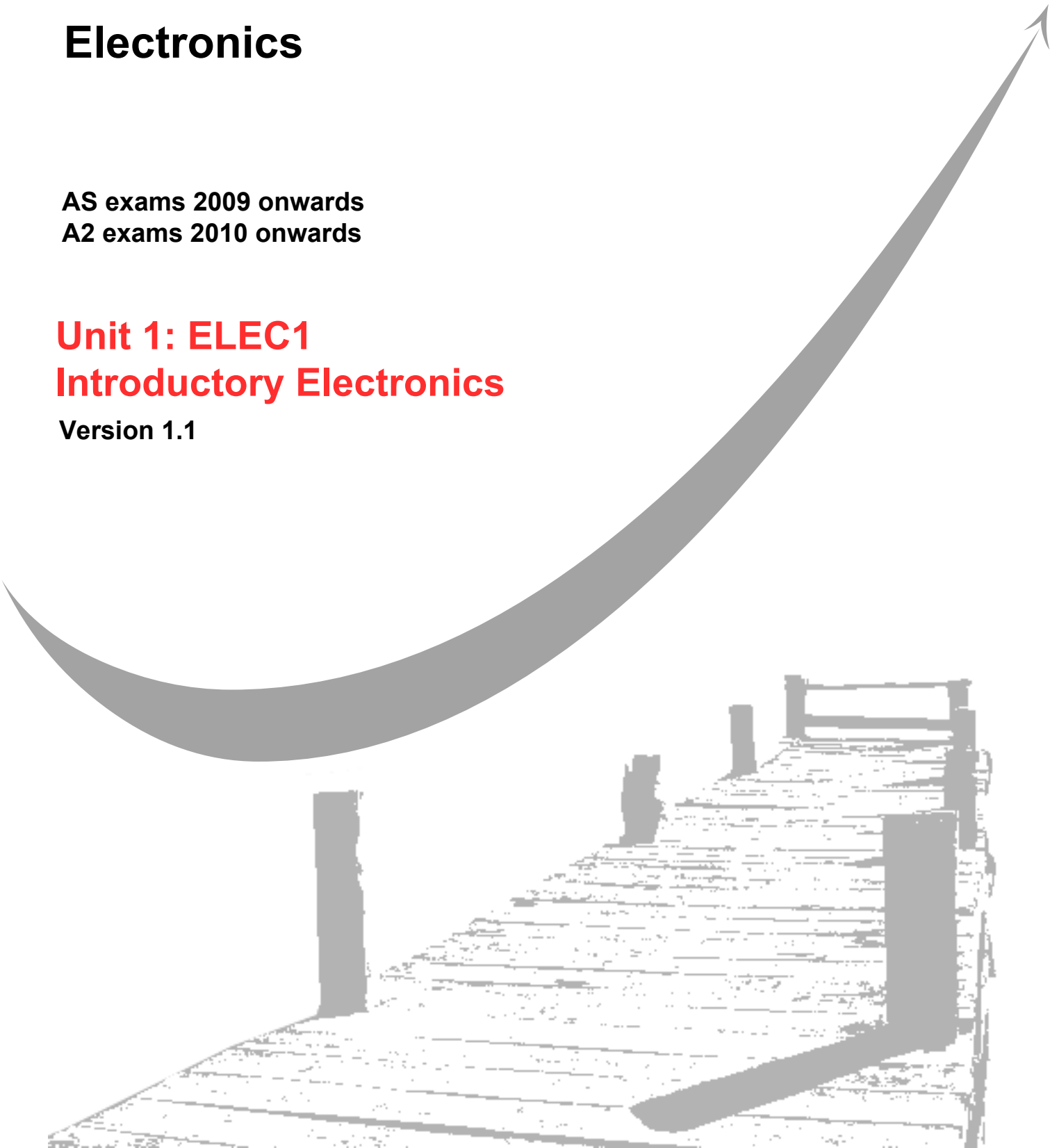
**GCE**  
**AS and A Level**

# **Electronics**

**AS exams 2009 onwards**  
**A2 exams 2010 onwards**

## **Unit 1: ELEC1** **Introductory Electronics**

**Version 1.1**



Surname					Other Names				
Centre Number					Candidate Number				
Candidate Signature									

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General Certificate of Education  
Advanced Subsidiary Examination  
version 0.2



**ELECTRONICS**  
**Unit 1    Introductory Electronics**

**ELEC1**

SPECIMEN PAPER

**For this paper you must have:**

- a pencil and a ruler
- a calculator.

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.
- Answer the questions in the space provided.
- Show the working of your calculations.
- 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 67.
- The marks for the questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- Any correct electronics solution will gain credit.
- You are reminded of the need for good English and clear presentation in your answers.

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



**Data Sheet**

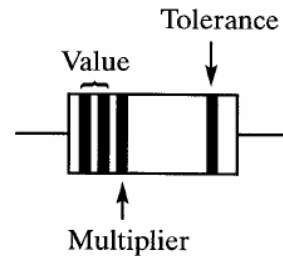
- A perforated *Data Sheet* is provided on pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- Detach this perforated sheet at the start of the examination.

## 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 =  $\pm 1\%$ , G =  $\pm 2\%$ , J =  $\pm 5\%$ , K =  $\pm 10\%$ , M =  $\pm 20\%$ .

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 =  $\pm 5\%$ , silver =  $\pm 10\%$ , no band =  $\pm 20\%$

**Silicon diode**  $V_F = 0.7\text{ V}$

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

**Resistance**  $R_T = R_1 + R_2 + R_3$  series  
 $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$  parallel

**Capacitance**  $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$  series  
 $C = C_1 + C_2 + C_3$  parallel

**Time constant**  $T = CR$ ,  $T_{1/2} = 0.69 CR$

**ac theory**

$$I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$$

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

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

$$X_L = 2\pi fL$$
 reactance

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

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$
 resonant frequency

Turn over ►

<b>Operational amplifier</b>	$G_V = \frac{V_{out}}{V_{in}}$	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
	$V_{out} = (V_+ - V_-) \frac{R_f}{R_1}$	difference
<b>555 Astable and Monstable</b>	$T = 1.1RC$	monostable
	$t_H = 0.7 (R_A + R_B)C$	astable
	$t_L = 0.7 R_B C$	
	$f = \frac{1.44}{(R_A + 2R_B)C}$	astable frequency
<b>Electromagnetic waves</b>	$c = 3 \times 10^8 \text{ m s}^{-1}$	speed in vacuo

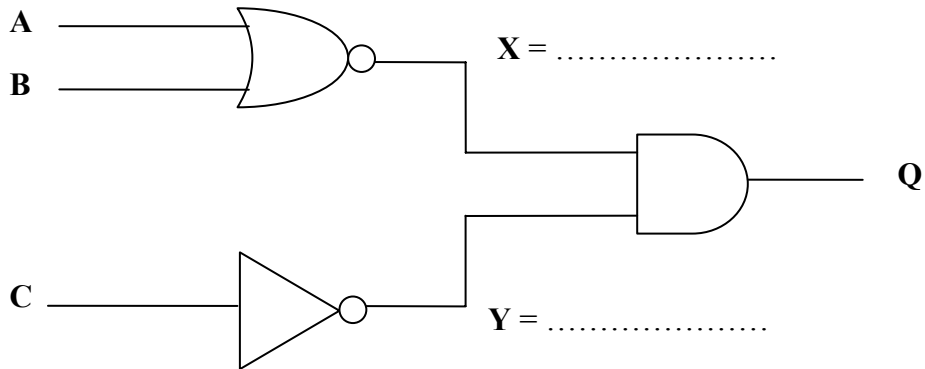
### Assembler language microcontroller instructions

Mnemonic	Operands	Description	Operation	Flags	Clock cycles
NOP	none	No operation	none	none	1
CALL	K	Call subroutine	stack $\leq$ PC PC $\leq$ K	none	2
RET	none	Return from subroutine	PC $\leq$ stack	none	2
INC	R	Increments the contents of R	(R) $\leq$ (R) + 1	Z	1
DEC	R	Decrements the contents of R	(R) $\leq$ (R) - 1	Z	1
ADDW	K	Add K to W	W $\leq$ W + K	Z, C	1
ANDW	K	AND K with W	W $\leq$ W • K	Z, C	1
SUBW	K	Subtract K from W	W $\leq$ W - K	Z, C	1
ORW	K	OR K and W	W $\leq$ W + K	Z, C	1
XORW	K	XOR K and W	W $\leq$ W $\oplus$ K	Z, C	1
JMP	K	Jump to K (GOTO)	PC $\leq$ K	none	2
MOVWR	R	Move W to the contents of R	(R) $\leq$ W	Z	1
MOVW	K, W	Move K to W	W $\leq$ K	Z	1
MOVRW	R	Move the contents of R to W	W $\leq$ (R)	Z	1

**Turn over for the first question**

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

1 A logic circuit is shown below.



1 (a) On the diagram above, write the Boolean expressions for the logic signals at points **X** and **Y** in the spaces provided.

(3 marks)

1 (b) (i) Write the Boolean expression for **Q** in terms of **X** and **Y** only.

**Q** = .....

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

**Q** = .....

(3 marks)



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

A	B	C	X	Y	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) Which single logic gate has the same function as the whole circuit on **page 6**?

.....

(2 marks)

**Turn over for the next question**

**Turn over ▶**

- 2 A student designs an electronic system to sound a warning when rain starts to fall.
- 2 (a) Choosing appropriate input, process, and output subsystems from the list below. Draw a system diagram to show a possible design including any other component or subsystem required.

Choose from:

**comparator, driver, humidity sensor, audible warning device (awd).**

(5 marks)

In which subsystem could

2 (b) (i) an op-amp be used, .....

2 (b) (ii) a siren be used, .....

2 (b) (iii) a MOSFET be used? .....

(3 marks)

The whole system operates from a 12 V power supply and draws a current of 15 mA when the awd is off.

The current increases to 265 mA when the awd is on.

Calculate

2 (c) (i) the awd current, .....

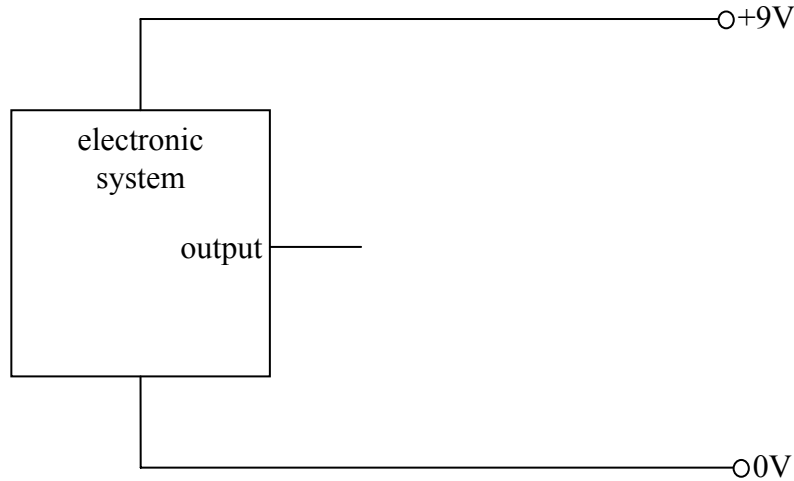
2 (c) (ii) the dc input power to the awd. ....

.....

(4 marks)

3 The diagram below shows an electronic system that has an output voltage of 5 V. An LED and its series resistor are to be connected to the output of this system so that the LED lights when the output is 5 V.

3 (a) Complete the diagram below to show how the LED and resistor are connected.



(3 marks)

The LED has a forward voltage drop of 2.4 V when operating at 10 mA.

3 (b) (i) What function does the resistor have in this circuit?

.....

3 (b) (ii) Calculate the voltage across the resistor when the LED is on.

.....

3 (b) (iii) Calculate the value of the resistance required.

.....

3 (b) (iv) Choose the most appropriate value for this resistor from the E24 series if the LED current should **not** exceed the stated 10 mA.

.....

3 (b) (v) Give the complete colour code for your chosen value if a 5% tolerance component is used.

.....

(11 marks)

4 A solenoid is switched to a 12 V supply by a MOSFET.

4 (a) (i) Draw a circuit diagram in the space below to show how the solenoid is connected to the MOSFET. Label the leads of the MOSFET.

\_\_\_\_\_○ +12V

\_\_\_\_\_○ 0V

4 (a) (ii) Draw on your circuit diagram the component required to protect the MOSFET from the back emf generated by the solenoid.

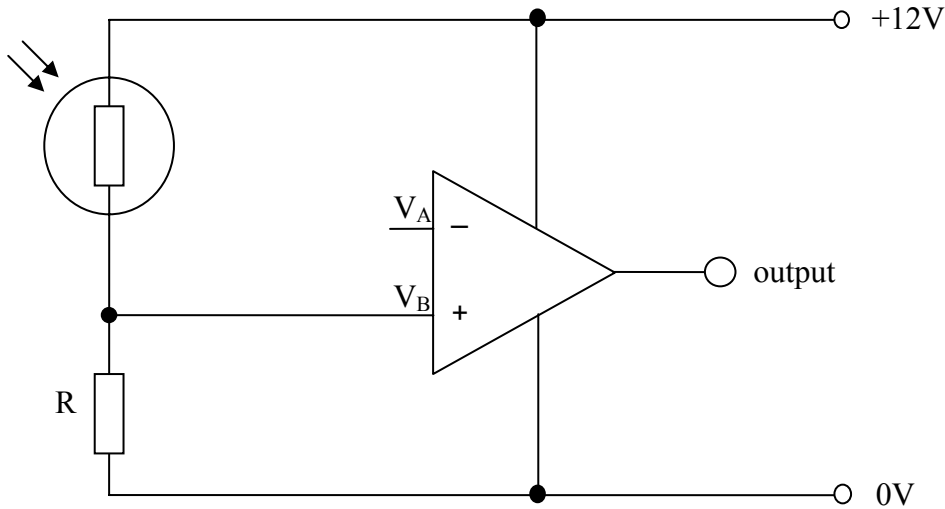
(7 marks)

4 (b) Complete the table below to describe the switching operation of the MOSFET using typical values of gate voltage and current that will apply to each state of the MOSFET.

	<b>MOSFET off</b>	<b>MOSFET on</b>
Gate voltage		
Gate current		
Drain voltage		

(5 marks)

5 A light sensor subsystem connected to part of a comparator circuit is shown below.



The op-amp input  $V_A$  requires a reference voltage of 6 V.

- 5 (a) (i) Draw a voltage divider connected to the circuit to show how this is achieved.
- 5 (a) (ii) Select suitable values for the components in your voltage divider and mark these on the circuit diagram next to each component. (4 marks)
- 5 (b) The LDR has a resistance of  $10\text{ k}\Omega$  at a certain light level. Calculate the value of R required to make the comparator switch at this light level, explain your working.

.....  
 .....  
(2 marks)

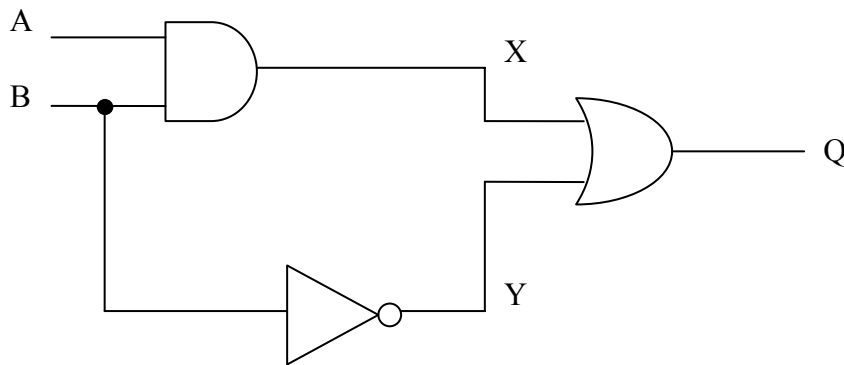
The LDR data sheet gives its resistance at two light levels.

Light level (lux)	Typical resistance ( $\text{k}\Omega$ )
5	20
100	5

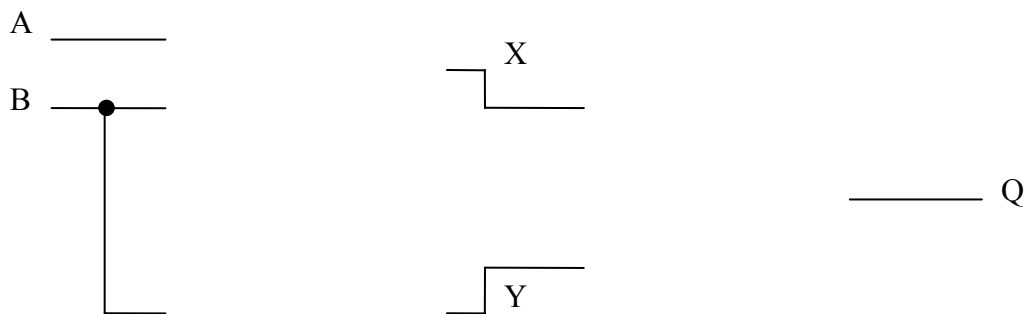
Give the output voltage from the op-amp at

- 5 (c) (i) 100 lux, .....
- 5 (c) (ii) 5 lux. .... (2 marks)

6 A student develops the logic circuit shown below.



6 (a) Convert this system into one using only NAND gates by replacing each of the gates shown above with its NAND gate equivalent.



(5 marks)

6 (b) Draw a ring round the pairs of redundant gates on the diagram in part (a). (2 marks)

6 (c) Draw the simplest logic circuit using only NAND gates that has the same function as the original. (2 marks)



(2 marks)

**END OF QUESTIONS**