



# **GCE AS MARKING SCHEME**

**SUMMER 2022** 

AS ELECTRONICS – COMPONENT 1 B490U10-1

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#### INTRODUCTION

This marking scheme was used by WJEC for the 2022 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

## EDUQAS AS ELECTRONICS – COMPONENT 1

# **PRINCIPLES OF ELECTRONICS**

## SUMMER 2022 MARK SCHEME

## **GENERAL INSTRUCTIONS**

#### Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response question).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

## Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

#### Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

# Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only ecf = error carried forward

	ucoti		Morking dotailo	Marks available				
Q	uesii	511		A01	AO2	AO3	Total	Maths
1.	(a)	(i)	$X = \overline{C}.\overline{B}.\overline{A} + C.\overline{B}.\overline{A} + C.B.\overline{A} $ (1)	1			1	
		(ii)	Correct map (1) two groups of 2 identified (ecf) (1) Simplest overall expression (1)		1 1 1			
			$X = \overline{B}.\overline{A} + C.\overline{A} \text{ or } \overline{A}.(\overline{B} + C)$				3	
		(iii)						
			Correct use of NOT gate(s) (1) Correct use of AND gates(s) (1) Correct use of OR gate (1)	1				
			ecf (ii)	1			3	
	(b)		$D_0$ , $D_4$ and $D_6$ connected to logic 1 AND $D_1$ , $D_2$ , $D_3$ , $D_5$ and $D_7$ connected to logic 0 (1)		1		1	
	(c)							
			NAND replacement of NOT gate (1) NAND replacement of OR gate (1) One redundant pair identified (1)	1 1 1			3	
			Question 1 total	7	4	0	11	0

	uooti	on	Marking dataila		Ма	rks avai	lable	
	uesu	on		AO1	AO2	AO3	Total	Maths
2.	(a)	(i)	$ \begin{array}{l} \text{RC} = 21.6 \text{ s} & (1)  (\text{can be implied}) \\ \text{t} = \text{RCxln2} = 21.6 \text{ x} \ 0.60  (1) \\ \text{t} = 15 \text{s}  (1) \end{array} $	1	1 1			1 1 1
		(ii)	$ \begin{array}{lll} \mbox{Selects formula} & V_{C} = V_{0}(1 - e^{-(t/RC)}) & (1) \\ \mbox{Correct substitution} & = 12(1 - e^{-(30/21.6)}) & (1) \\ & = 9.0V & (1) \\ \mbox{(credit answers which use 2 x half-life method)} \end{array} $	1	1 1			1 1 1
		(iii)	5RC = 5 x 21.6 = 108s (1) range 108 – 130s		1		7	1
	(b)	(i)	Suitable scales on axes (1) 3 points correctly plotted (1) Smooth curve through points (1) ecf (a)		1 1 1			1 1 1
		(ii)	21.2 s range 20 -24s (allow calculated answer) ecf (i)		1		4	1
	(c)	(i)	360µF (1)	1				1
		(ii)	Doubles the time/twice the value from (b) (ii) (1)	1			2	
			Question 2 total	4	9	0	13	12

	uacti	<b>.</b>	Marking dataila	Marks available				
Q	uestio	on		A01	AO2	AO3	Total	Maths
3.	(a)	(i)	10000111 (1)	1				
		(ii)	4B (1)	1			2	2
	(b)		Indicative content:					
			AO1 allocation: Demonstrates knowledge of flowcharts 1 mark					
			<b>AO3 allocation:</b> Analyses the specification and flowchart and explains its step-by-step operation 5 marks					
			<ul> <li>The Counter is set to 0</li> <li>The instruction 'Read' checks the state of Port A and the 6-bit code is entered via the keypad is stored in a variable called 'Input'.</li> <li>The counter is increased by 1</li> <li>If the correct code '0100101' has been entered in binary, 135 in decimal the 'Yes' path is followed, and</li> <li>A logic 1 is outputted via Port B which energised the solenoid</li> <li>For 10s before switching off</li> <li>If the code is incorrect but the counter is less than 3 the program returns to the beginning allowing another attempt at entering the correct code.</li> </ul>					
			<b>5-6 marks</b> All stages of the process fully analysed and explained in a logical step-by- step way. The 3 attempts at the correct code input before lock-out is highlighted.					
			There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant to the argument.					

0	uaati	• •	Marking dataila		Ма	rks avai	lable	
Q	uestic	on	Marking details	A01	AO2	AO3	Total	Maths
			<ul> <li>3-4 marks Most stages of the process are fully analysed and explained in a logical step- by-step way. One or two minor errors or omissions are made There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument. 1-2 marks Some attempt is made to analyse the flow chart but there are significant errors and omissions. There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument. 0 marks</li></ul>					
			No attempt made or no response worthy of credit.	1		5	6	
	(c)	(i)	To protect the MOSFET (from back emf) when the solenoid switches off. (1)	1				
		(ii)	$g_M = I_D/(V_{GS} - 3)$ selects and re-arranges equation (1) = 3/(5-3) (1) = 1.5 S (1)	1	1 1			1 1 1
		(iii)	$      r_{DSon} = P/I^2  \text{recalls and re-arranges the equation (1)} \\ = 1.5/3^2  (1) \\ = 0.17\Omega  (1)  (\text{allow } 0.166 \text{ or } 0.167) $	1	1 1			1 1 1
			Question 3 total	6	4	5	15	8

0	lootio					Ma	ulina dai			Ма	Marks available O2 AO3 Total Maths 3			
	Jestio	m				IVIA	rking de	AO	)1	AO2	AO3	Total	Maths	
4.	(a)		$\overline{Q}$ connections then Clock to C with output OR Clock with $\overline{Q}$ to For corrections	ected to D x3 (1) $C_A$ and Q to clock input on the next IC x2 (1) puts A,B and C to correct Q's (1) ck to $C_A$ and $\overline{Q}$ to clock input on the next IC x2 to outputs A, B and C ect diagram of UP counter 1 <sup>st</sup> mark only				1 1 1 2				3		
	(b)		Initial state On the 3rd clock pulse On the 5th clock pulse Three clock Five clock	OUTPUT C 1 1 0 c k pulse pulse of	OUTPUT B 1 0 1 e outputs coutputs c	OUTPUT A 1 0 0 correct correct	LED ON RED YELLOW GREEN (1) (1)			1		2		
	(c)	(i)	NOT gates AND gate ecf (b) Alternative NOT A, NO	s correct correct es: NOF OT B th	ct (1) (1) R AB then	Connected to LED n AND w , then AN	<i>i</i> ith C ND with (			1 1		2		

0.	uactio		Marking dataila					
	Question		Marking details	A01	AO2	AO3	Total	Maths
		(ii)	Voltage across R = $(5-2.1) = 2.9V$ (1) I = 2.9/120 select and substitute (1) ecf V <sub>R</sub> = 0.024 A or 24 mA (1)		1 1 1		2	1 1
			Question 4 total	3	7	0		2

	uastia		Marking dataila		Ма	rks avai	lable	
	uestic	חכ		A01	AO2	AO3	Total	Maths
5.	(a)		$ \begin{array}{ll} V_{X} = -30/(1.2/5+2.0/10) & (1)+(1) & \text{substitution of each} \\ & \text{term correct} \\ = -13.2  [V] & (1)  \text{cao} \\ \hline \textbf{OR} \\ V_{X} = -(30/5  \text{x1.2+30/10 x2.0}) & (1)+(1)  \text{substitution of} \\ & \text{each term correct} \\ = -13.2  [V] & (1)  \text{cao} \\ \end{array} $	2	1		3	3
	(b)		To invert the signal from $V_X$ (1)	1			1	
	(c)	(i) (ii)	Amplitude= $\pm 6V$ (1)(= 30/5x1)Inverted sine wave of the same frequency(1)Sine wave of amplitude 6V drawn(1)ecf (i)Centred around -6V(between 0 and -12)(1)	1	1 1 1		4	1 1 1
			Question 5 total	4	4	0	8	6

0	Question		Marking dataila	Marks available				
	uestio	n		A01	AO2	AO3	Total	Maths
6.	(a)	(i)	NOR gate (1)	1				
		(ii)	T = C.B  (1)	1				
			$Q = (\overline{B + \overline{A}}).C.B$ (1) or correct simplification eg ( $\overline{C} + \overline{A}$ )	1			3	2
	(b)		$\begin{array}{ll} (C + A).(\overline{B}.A) & (1+1) \text{ application of deMorgan (first bracket essential)} \\ = C . \overline{B}.A + A.\overline{B}.A \text{ or } = \overline{B}.A (C + 1) & (1) \\ = \overline{B}.A & (1) \\ \text{Input C not needed} & (\text{Must be stated to get full marks}) \end{array}$		1 1 1		4	4
			Question 6 total	3	4	0	7	6

Question	Marking dataila		Ма	Marks available O2 AO3 Total Maths				
Question		A01	AO2	AO3	Total	Maths		
7.	Indicative content:							
	<ul> <li>AO1 content: uses knowledge 555 timer astable circuits and calculations.</li> <li>(1 mark)</li> <li>AO3 content: analyses the circuit and uses appropriate calculations to determine whether or not the specification is met. Suggests any improvement(s) needed to fully meet the specification. (5 marks)</li> </ul>							
	<ul> <li>Method:</li> <li>Attempts to calculate frequency and hence the periodic time</li> <li>Attempts to calculations mark:space ratio</li> <li>Compares calculated values with specification</li> <li>Suggests appropriate changes to meet the specification</li> <li>Calculations,analysis and improvements to meet spec:</li> <li>Mark:space ratio = (4.8 + 9.6)/9.6 = 1.5 or 3:2 therefore this meets the specification.</li> <li>LED is ON during the 'space' time therefore needs to be connected to 0V to be on during 'mark' time.</li> <li>Frequency f = 1.44/(4.8 + 2x9.6) x10<sup>3</sup>x30x10<sup>-6</sup> = 2.0Hz. This is a factor of 10 too high. LED on for only 0.3s each cycle.</li> <li>The easiest way to sort this is to increase C to 300µF.</li> <li>Changing R values is more complex as they must maintain the same ratio</li> </ul>							
	<ul> <li>5-6 marks</li> <li>Comprehensive analysis of circuit performance measured against specification and supported by appropriate calculations for both the frequency and mark:space ratio. Conclusions drawn with reference to the evidence and relevant improvements suggested.</li> <li>There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant to the argument.</li> </ul>							

Question	Marking dataila		Ма	rks avai	ilable	
Question	AO1 AO2 A				Total	Maths
	<ul> <li>3-4 marks Either frequency or mark:space ratio calculations done completely or partially correct attempts at both. Some comment based on analysis carried out. There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument. 1-2 marks Limited analysis with an attempt at least one calculation. There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument. 0 marks No attempt made or no response worthy of credit.</li></ul>					
		1		5	6	4
	Question 7 total	1	0	5	6	4

	unction	Marking dataila	Marks available				
Q	uestion		AO1	AO2	AO3	Total	Maths
8.	(a)	Propagation delay is the time taken for the output to respond to a change in input (1)	1			1	
	(b)	B starts at logic 1 (1) B goes to logic 0 at 45 ns (1) C goes to logic 0 at 25 (1) ecf for B C is 30 ns notch (1) Q inverted C with 10 ns delay (1) $\int_{end}^{1} \int_{end}^{1} $	1	1 1 1		5	
	(c)	Pulse reduced (1) can be implied Pulse between 35 and 45ns <b>or</b> pulse duration=10ns (1)	1	1		2	
		Question 8 total	3	5	0	8	0

0	uasti	<b>.</b>	Marking dataila	Marks available				
Q	uesii	on		A01	AO2	AO3	Total	Maths
9.	(a)		<ul> <li>Any 2 from:</li> <li>increased bandwidth</li> <li>greater stability</li> <li>reduced sensitivity to external changes</li> <li>reduced distortion</li> <li>allow us to specify (or choose) the voltage gain/reduce gain</li> <li>Accept 'improves input and/or output impedance' (e-notes)</li> </ul>	2			2	
	(b)		With negative feedback the two inputs are at the same voltage. <b>OR</b> With negative feedback the difference between the inputs of an op. amp is 'virtually' zero. (1) As $V_{+} = 0V$ then $V_{-} = 0V$ also (1)	2			2	
	(c)	(i)	360/5 = 72 (1) Range of gain is 0 to 72 (1)	1	1			1 1
		(ii)	Inverted sine wave (1) Same frequency (1) Clipped at ±17V (1)	1 1	1		5	
	(d)	(i) (ii)	Drawing of op. amp voltage follower with: Input correct (1) Feedback correct (1) Infinite / Very large / stated value >10MΩ (1)	1 1				
		(iii)	$V_{OUT} = 3.2V (DC)$ (1)		1		4	
			Question 9 total	10	3	0	13	2

Question		<b>o</b> n	Marking details	Marks available					
		on		A01	AO2	AO3	Total	Maths	
10.	(a)	(i)	$ \begin{array}{l} V_{OC} = 180 \ x \ 12/280  (1) \\ = 7.71 \ V  (1) \\ I_{SC} = 12/100 = 0.12  (1) \\ R_{EQ} = 7.71 \ / \ 0.12  (1) \\ = 64.25\Omega \ = 64.3 \ \Omega  (1) \end{array} $	1 1 1	1			1 1 1 1	
		(ii)	7.71ν Labelled diagram ecf (i) (1)	1			6		
	(b)		$V_{R} = 7.71 - 6 = 1.71  (1)$ $I_{LOAD} = 1.71/64.25 = 26.6 \text{ mA} = 27 \text{ mA}  (1)$ $27 < 50 \text{ so does NOT work as specified}  (1) \text{ Reason needed}$ Alternative: Voltage across eq. resistor = 50 x 64.3 (1) (50mA for alarm) = 3.21 V (1) Therefore 7.71 - 3.21 = 4.5 (1) 4.5V < 6 V so does NOT work as specified (1) Reason needed or other correct method and reasoning	1	1	1	3	1	

Question	Marking dataila	Mark AO1 AO2		ks available		
Question				AO3	Total	Maths
(c) (i)	$ \begin{array}{l} \mbox{Required: } I_C = 50 \mbox{mA so } I_B = 50/80 = 0.625 \mbox{ mA } (1) \\ V_R = 0.625 \mbox{ x } 4.7 = 2.94 \mbox{ V } (1) \\ V_T = 2.94 \mbox{ + } 0.7 = 3.64 \mbox{ V } (1) \\ \end{array} $	1	1 1			1 1 1
(ii)	(ii) Method 1 (using potential divider): Max current through pd = 6/280 mA = 21.4mA (1) Can be implied $V_T = 6 \times 180/280$ (1) or $0.0214 \times 180$ = $3.86 \vee (1)$ Current in voltage divider >10 x l <sub>B</sub> (1) [i.e 21.4 > 6.25] $V_T$ (3.86) > $3.64 \vee (1)$ therefore suitable (both pieces of evidence needed and statement must be given for full credit) Method 2 (using Theverin) $V_{OC} = 6 \times 180/280$ (1) = $3.86 \vee (1)$ (half $V_{OC}$ (7.71/2) from (a) or re-calculated (6x180/280)} $V_{64.7}$ = ( $3.86 - 3.64$ ) = $0.22 \vee (1)$ I = 0.22/64.3 = 3.42  mA (1) $3.42 > 0.625 \{I_B \text{ from (i)}\}$ therefore sufficient (1) $43.86 \vee (1)$ $3.86 \vee (1)$			1 1 1 1	8	1 1 1
	Question 10 total	6	5	6	17	15

Question		<b>o</b> n	Marking details		Mar	arks available		
		on		AO1	AO2	AO3	Total	Maths
11.	(a)	(i)	12 - 1.4 = 10.6V (1)		1			
		(ii)	Graph for full wave rectified output (1) Peaks at 10.6V ecf (1)	1	1			
			Small ripple voltage (1)	1			4	
	(b)		Similar graph to a(ii) with same peak and larger ripple (1)	1			1	
	(c)		Frequency =100Hz (1) Rearrange ripple voltage equation $I = V_r x f xC$ (1) Substitutes values: $I = 2.8 \times 100 \times 2200 \times 10^{-6}$ (1)* Answer $I_{MAX} = 0.62A$ (1)* * if frequency of 50Hz used allow 3 marks max	1	1 1		4	1 1 1
	(d)		$V_{R} = 12 - 8.2 = 3.8 V  (1)$ $I_{R} = 3.8/27 = 141 \text{ mA}  (1)$ $I_{LOAD} = 141 - 10 = 131 \text{ mA}  (1)$		1 1 1		4	1
			Question 11 total	5	7	0	12	5

## **COMPONENT 1**

# SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	7	4	0	11	0
2	4	9	0	13	12
3	6	4	5	15	8
4	3	7	0	10	2
5	4	4	0	8	6
6	3	4	0	7	6
7	1	0	5	6	4
8	3	5	0	8	0
9	10	3	0	13	2
10	6	5	6	17	15
11	5	7	0	12	5
Total	52	52	16	120	60

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