



GCE AS MARKING SCHEME

SUMMER 2023

**AS
ELECTRONICS – COMPONENT 1
B490U10-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2023 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 2023 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

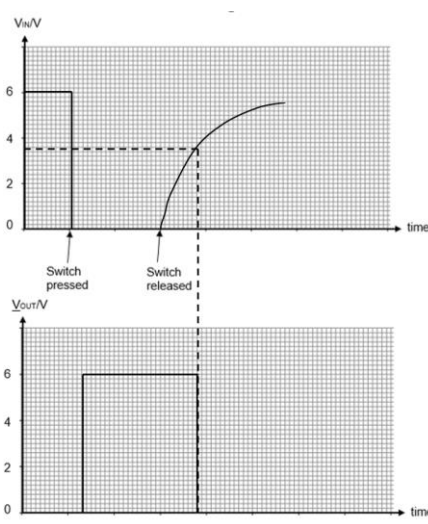
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
1.	(a)	(i)	\bar{B} (1)	1			1	1
		(ii)	$\bar{B}.A$ (1)	1			1	1
	(b)		<p> $Q = D.\bar{A} + C.B.A + \bar{C}.\bar{B}.\bar{A}$ Correct map (1) One group of 4 and two of 2 identified (ecf map) (1) Any correct term from groups identified (1) Simplest overall expression (1) </p>	1	1		4	4

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
	(c)	$Q = \overline{\overline{A} \cdot B} + (\overline{B + C}) \quad (1)$ $= \overline{\overline{A}} + \overline{B} + \overline{B \cdot C} \quad (1)$ <p>OR</p> $Q = A + \overline{B} + (\overline{B + C}) \quad (1) + (1) \quad \text{OR} \quad = \overline{\overline{A} \cdot B \cdot B} + \overline{\overline{A} \cdot B \cdot C} \quad (1)$ <p>(one mark for each use of DMT) $= \overline{\overline{A} \cdot B} + \overline{\overline{A} \cdot B \cdot C} \quad (1)$</p> $\text{Then } = A + \overline{B} + \overline{B \cdot C} \quad (1) \qquad \qquad \qquad = \overline{\overline{A} \cdot B} \quad (1)$ $= A + \overline{B} \quad (1) \qquad \qquad \qquad = A + \overline{B} \quad (1)$		4		4	4
		Question 1 total	3	7	0	10	10

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
2.	(a)		Max gain = $58/2 = -29$ (1) Min gain = $2/2 = -1$ (1) penalise missing minus sign once only	1	1		2	2
	(b)	(i)	Inverse sloping line through 0,0 (1) Correct gradient (passes through 0.5, -10) (1) Saturation at 18 volts x2 [0.9, -18] (1)	2	1		3	3
		(ii)	Horizontal line at gain of 20 (1) becoming Downward sloping line (1) passing through point (24,14) with this point indicated on diagram or clear from calculation (1)	2	1		3	2
	(c)		Slew rate = $18/(11 - 2)$ (1) or by implication = 2.0 (1) unit : $V\mu s^{-1}$ or $V/\mu s$ or MVs^{-1} or MV/s (1)	1	2		3	2
			Question 2 total	6	5	0	11	9

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3.	(a)	(i)	Use of $t_{1/2} = \ln 2 \times RC$ or select and use $3 = 6(1 - e^{-t/RC})$ (1) {can be implied for mark e.g. $t_{1/2} = 0.047 \times \ln 2$ or 0.047×0.69 } $t_{1/2} = 0.0326\text{s}$ or 33ms (1)	1	1		2	1
		(ii)	Select and use equation: $V_{OUT} = V_0(1 - e^{-t/RC})$ (1) Correct substitution: $V_{OUT} = 6(1 - e^{-(100/47)})$ (1) $V_{OUT} = 5.3\text{V}$ (1)	1	2		3	3
		(iii)	$5 \times RC = 5 \times 0.047 = 0.235\text{s}$ or $6 \times 0.047 = 0.282$	1			1	1
	(b)	(i)	To prevent multiple counts from a single switch press (owtte) (1)	1			1	
		(ii)	 <p>Graph for charging capacitor starting at switch release. (1)</p> <p>Rising edge of output correct (1) Falling edge of output corresponds to 3.5V on graph above (1)</p>	1	2		3	3
Question 3 total				5	5	0	10	8

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4.	(a)	(i)	Q = 0 when R is taken to logic 0 or system resets (1)	1			1	
		(ii)	Switch and resistor in series across supply rails with R connected to centre (1) Switch connected to 0V rail (1)	2			2	
	(b)	(i)	When S ₁ closed the BLUE LED goes off (1) and the Yellow LED comes on (1) When switch is opened they stay latched as above (1) (Treat as neutral any reference to LED's before S ₁ is closed)		3		3	
		(ii)	Q goes logic 0-1 on rising edge of clock pulse (1) Q goes logic 1-0 on falling edge of reset pulse (1)	2			2	
	(c)	(i)	Q _A = 120 kHz (1)		1		1	
		(ii)	Q _C or \bar{Q}_C (1)		1		1	
		(iii)	Q _A changes state on each rising edge of the clock (1) Q _B pulses correct duration (2 x Q _A period) (1) Q _B pulses correct timings (Rising on the falling edge of Q _A) (1)	3			3	
			Question 4 total	8	5	0	13	0

Question		Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths
5.	(a)		All points plotted correctly ± 0.5 small square division (2) Minus 1 for each incorrectly plotted point (minimum 0) Line drawn (1)	1	2		3	3
	(b)	(i)	Uses gradient to calculate g_M (1) Suitable triangle chosen (uses $\geq \frac{1}{2}$ of the slope) e.g. $(10-2) / 6.1-3.5 = 8/2.6$ (1) $g_M = 3.1S$ range (2.9-3.4) (1) OR Substitution of values taken from the linear part of the graph into g_M equation (1) V_T taken as 3.0V (1) Value of g_M between 2.9 and 3.4 S (1)	1	2		3	2
		(ii)	$V_{GS} = 6.4V$ range (6.2–6.6) (1)		1		1	1
	(c)		Use of $I_D = 11A$ (1) allow range 10.4 to 11 A $r_{Dson} = 1.38/11$ (1) (1.38/10.4) $= 0.125\Omega$ (1) (range 0.123 to 0.133)		3		3	2
			Question 5 total	2	8	0	10	8

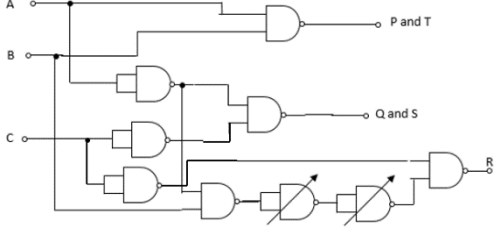
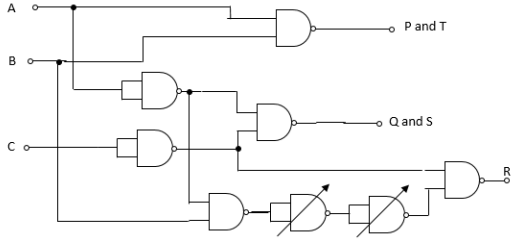
Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
6.	(a)	<p>Selection and correct substitution into voltage divider equation: $V_+ = 12 \times 5.6 / (2.9 + 5.6) \quad (1)$ $= 7.91V \quad (1)$</p>		2		2	2
	(b)	<p>Indicative content:</p> <p>AO2 content: applies knowledge op. amp comparator circuits, voltage dividers and transistor switches.</p> <p>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.</p> <p>Method:</p> <ul style="list-style-type: none"> • Attempts to calculate comparator switching thresholds • Attempts relevant transistor calculations • Discusses improvements to meet specification • Reverses direction of diode 					

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
		<p>Calculations, analysis and improvements to meet spec:</p> <p>Comparator switching thresholds: $V_- = 12 \times 6.8 / (6.8 + 3.6) = 7.85V$ $V_+ = 7.91V$ (at 38°C) ecf (a) Therefore, the comparator would switch to high output at about 38°C, but since resistors have a tolerance it would be better to replace any of the fixed resistors with a variable resistor or use a potentiometer to set the switching threshold at V_-.</p> <p>Transistor: $I_B = (11.6 - 0.7) / 4.7 = 2.32mA$ $I_C = 2.32 \times 40 = 92.8mA$ This is well under the 120mA needed so either replace 4.7kΩ with smaller value (e.g. 3.63kΩ) or use a transistor with a higher h_{FE} (e.g. $h_{FE} = 52$)</p> <p>Output: Reverses diode across the motor. Replacing Transistor with MOSFET is neutral as current is in mA.</p>					

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
		<p>5-6 marks Comprehensive analysis of circuit performance measured against specification and supported by appropriate calculations for both the comparator switching and the transistor circuits. Conclusions drawn with reference to the evidence and relevant improvements suggested. Diode error corrected. <i>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.</i></p> <p>3-4 marks Either comparator or transistor calculations done completely or partially correct attempts at both. Some comment based on analysis carried out and/or diode error corrected. <i>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.</i></p> <p>1-2 marks Limited analysis with an attempt at least one calculation. <i>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.</i></p> <p>0 marks <i>No attempt made or no response worthy of credit.</i></p>	1	2	3	6	4
		Question 6 total	1	4	3	8	6

Question			Marking details	Marks available																																																																			
				AO1	AO2	AO3	Total	Maths																																																															
7.	(a)	(i)	M/S = (2.2 + 2.2)/2.2 (1) = 2:1 (1)	1	1		2	2																																																															
		(ii)	Select and substitute: $t_L = 0.7 \times 2.2 \times 10^3 \times 680 \times 10^{-6}$ (1) = 1.05 s (1) Graph shows a mark:space ratio of 2:1 (1) with mark of 2s duration and space 1s on labelled time axis (1) allow ecf	1	3		4	4																																																															
		(iii)	f = 1/3.15 (1) or use of formula from data sheet = 0.32 Hz (1) (accept 0.33)	1	1		2	2																																																															
	(b)		Outputs C and A selected (1) and connected to inputs of NAND gate with output to R (1)	2			2																																																																
	(c)		<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Clock pulse</th> <th>C</th> <th>B</th> <th>A</th> <th>P</th> <th>Q</th> <th>R</th> <th>S</th> <th>T</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>2</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>3</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>4</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>5</td> <td colspan="8" style="text-align: center;">Counter resets here</td> </tr> </tbody> </table> <p>P and T correct (1) Q and S correct (1) R correct (1)</p>	Clock pulse	C	B	A	P	Q	R	S	T	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	1	2	0	1	0	1	0	1	0	1	3	0	1	1	0	1	0	1	0	4	1	0	0	1	1	1	1	1	5	Counter resets here									3		3	3
Clock pulse	C	B	A	P	Q	R	S	T																																																															
0	0	0	0	1	0	0	0	1																																																															
1	0	0	1	1	1	0	1	1																																																															
2	0	1	0	1	0	1	0	1																																																															
3	0	1	1	0	1	0	1	0																																																															
4	1	0	0	1	1	1	1	1																																																															
5	Counter resets here																																																																						

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
	(d)	<p>A NAND B to P,T (1) A OR C to Q,S (1) NOT A AND B OR C to R (1) ecf from table</p>	3			3	

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
(e)		 <p>A NAND B to P,T (1) OR gate replaced by NAND's for A,C to Q,S (1) Correct NAND replacements for NOT, AND OR for R output (1) as above (As candidates are not asked for minimum number of gates accept the use of extra NAND gates on A and C rather than utilising those used for the other outputs.) One pair of redundant gated identified and crossed out (1)</p> <p>Alternative solution:</p> 	2		2	4	
		Question 7 total	11	7	2	20	10

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8.	(a)	(i)	$V_R = 12 - 4.2 = 7.8V$ (1) $R_A = 7.8 / 0.04$ ecf $V_R(1)$ $= 195\Omega$ (1)	1	2		3	3
		(ii)	200Ω (1) ecf nearest preferred value above (i)	1			1	
	(b)	(i)	$C = 12 / (1.1 \times 16 \times 10^3)$ (1) select and substitute $= 682 \mu F$ (1) allow 680 μF	1	1		2	2
		(ii)	To provide a momentary logic zero pulse at pin 2 / If pin2 remains at logic 0 the monostable will not function correctly (1) Allow to make it edge-triggered	1			1	
	(c)	(i)	Relay coil between output of 555 and 0V (1) Switch of relay completes the AC circuit (1)	2			2	
		(ii)	Energy = Power x time = 1200×12 (1) $= 14400 J$ or 14.4kJ (1)	1	1		2	2

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
	(d)	<p>Decision box correct (1) Yes and No labelled (1) Output boxes correct (all 3 =2 marks any 1 =1 mark) Delay boxes correct (all 3) (1) Feedback loops correct (both) (1)</p>	2		4		
Question 8 total			9	4	4	17	0

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9.	(a)		Resistor between output and inverting input (1) Resistor between inverting input and 0V (1) V_{IN} connected directly to non-inverting input (1) Resistors in ratio 69:1 and both $\geq 1k\Omega$ (1) Resistors correctly labelled or clearly assigned (1) (preferred values not required)	2		3	5	1
	(b)	(i)	140 ± 2 mV (1)		1		1	1
		(ii)	$11.5/70 = 164$ mV (1) Use of graph clearly shown (1) Max pressure = 150 ± 4 kPa (1)	1	2		3	2
			Question 9 total	3	3	3	9	4

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
10.	(a)	<p>Indicative content:</p> <p>AO1 content: Knowledge of the action of rectifiers AO3 content: A FWR uses a diode bridge consisting of 4 diodes arranged in a ring with 4 terminals. Two terminals are connected to V_{AC} and the other two to R_{LOAD}. Current flows through 2 diodes during each half cycle of the AC. The diode bridge converts the AC input into a DC output of twice the frequency. A single AC wave becomes two positive pulses with the peak voltage reduced by 1.4V. The capacitor smooths the output, ideally to steady DC. When a load current flows a ripple appears on the output. When a second resistor is connected in parallel this doubles the load current and doubles the ripple voltage.</p> <p>Key Points:</p> <ul style="list-style-type: none"> • Diagrams drawn to assist explanation • Reference to 4 diodes in bridge • Current flows for both half cycles • converts AC to DC. • Peak voltage reduced • Frequency doubled • Capacitor smoothing • Reference to ripple voltage • Parallel resistance increases ripple voltage • Effects quantified 					

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
		<p>5-6 marks The majority (6-9) of the key points addressed. <i>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.</i></p> <p>3-4 marks At least half (4-6) of the key points addressed. <i>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.</i></p> <p>1-2 marks Some (2-4) of the key points addressed. <i>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.</i></p> <p>0 marks <i>No attempt made or no response worthy of credit.</i></p>					
	(b)	$V_R = 12 - 6.8 = 5.2V$ (1) $I_R = 250 + 10 = 260 \text{ mA}$ or $0.26A$ (1) $R = 5.2/0.26 = 20\Omega$ (1) no ecf	1	2		3	1

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
	(c)	Selects and uses $p = I \times V$ (1) $= 0.26 \times 6.8$ (1) correct value used $= 1.77 \text{ W}$ (1) ecf on I from (b)	1	2		3	2
		Question 10 total	4	4	4	12	3

AS ELECTRONICS – COMPONENT 1

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	3	7	0	10	10
2	6	5	0	11	9
3	5	5	0	10	8
4	8	5	0	13	0
5	2	8	0	10	8
6	1	4	3	8	6
7	11	7	2	20	10
8	9	4	4	17	0
9	3	3	3	9	4
10	4	4	4	12	3
TOTAL	52	52	16	120	58