



2015 Technological Studies

Higher

Finalised Marking Instructions

© Scottish Qualifications Authority 2015

The information in this publication may be reproduced to support SQA qualifications only on a non-commercial basis. If it is to be used for any other purposes written permission must be obtained from SQA's NQ Assessment team.

Where the publication includes materials from sources other than SQA (secondary copyright), this material should only be reproduced for the purposes of examination or assessment. If it needs to be reproduced for any other purpose it is the centre's responsibility to obtain the necessary copyright clearance. SQA's NQ Assessment team may be able to direct you to the secondary sources.

These Marking Instructions have been prepared by Examination Teams for use by SQA Appointed Markers when marking External Course Assessments. This publication must not be reproduced for commercial or trade purposes.

Part One: General Marking Principles for: Technological Studies Higher

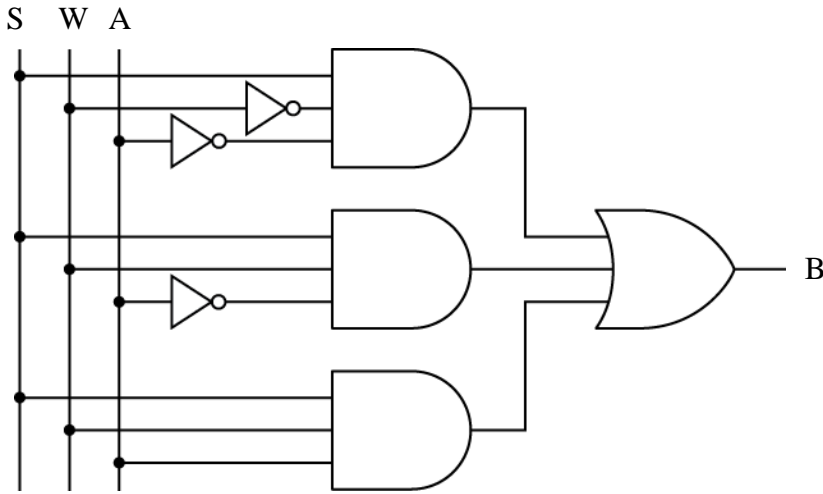
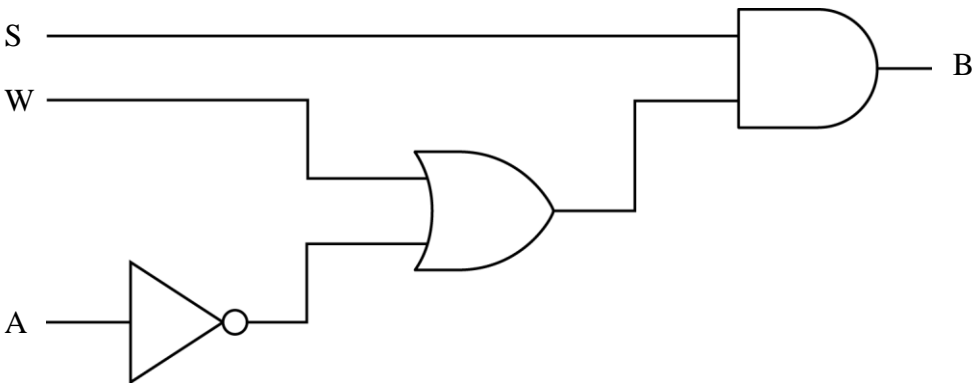
This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

- (a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.
- (b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Technological Studies Higher

The marking schemes are written to assist in determining the “minimal acceptable answer” rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates’ evidence, and apply to marking both end of unit assessments and course assessments.

Part Two: Marking Instructions for each Question

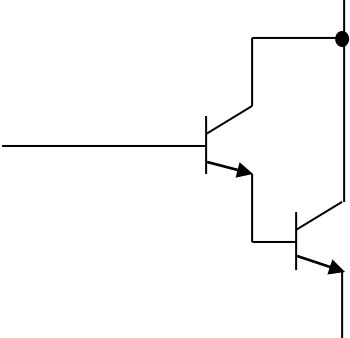
Question		Mark Allocation	Marks																																				
1	(a)	<table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th>S</th> <th>W</th> <th>A</th> <th>B</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td></tr> </tbody> </table> <p>3 marks for all B output 2 marks 7 or 6 B correct 1 mark 5 or 4 B correct 0 marks 3 or less correct</p>	S	W	A	B	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	1	1	0	1	0	1	1	0	1	1	1	1	1	3
	S	W	A	B																																			
	0	0	0	0																																			
0	0	1	0																																				
0	1	0	0																																				
0	1	1	0																																				
1	0	0	1																																				
1	0	1	0																																				
1	1	0	1																																				
1	1	1	1																																				
(b)	$B = S \cdot \bar{W} \cdot \bar{A} + S \cdot \bar{W} \cdot A + S \cdot W \cdot A$ (1 mark) for each correct combination OR $B = S(W+A)$	4																																					
(c)	 <p style="text-align: right; margin-right: 20px;">NOT AND OR</p> <p>OR</p> 	<table style="margin-left: auto; margin-right: auto;"> <tr><td>1</td></tr> <tr><td>1</td></tr> <tr><td>1</td></tr> </table>	1	1	1	3																																	
1																																							
1																																							
1																																							

Question		Mark Allocation	Marks		
1	(d)	<p>NOT equivalent AND equivalent OR equivalent Cancellation</p>	1 1 1 1	4	
					(14)
2	(a)	$\Sigma F_H = 0$ $F \times \cos 70 = 8.08 \times \cos 80$ $F = 4.10 \text{ kN}$	<p>2 components answer including units</p>	2 1	3
	(b)	$\Sigma F_V = 0$ $W = 8.08 \times \cos 10 + 4.10 \times \cos 20$ $W = 11.8 \text{ kN}$	<p>2 terms @ 1 answers (units not required)</p>	2 1	3
	(c)	$\Sigma M_A = 0$ $8.08 \cos 10 \times 5 = 11.8 \times L$ $L = 3.37 \text{ m}$	<p>2 moments @ 2 each answers including units</p>	4 1	5
					(11)

Question		Mark Allocation			Marks
3	(a)	Find b2 - Number of degrees = $360 \times 1.3 = 468$	OR Find b2 - $360/1.8 = 200$ steps/rev	answer	1
		No of pulses = $468/1.8 = 260$	$200 \times 1.3 = 260$	substitutions answer	1 1
		No of loops = $260/4$ b2 = 65		substitutions answer	1 1
		Find b8 - 1 Rev requires $360/1.8 = 200$ steps	OR Find b8 - 6 rev/min = 1 rev in 10s	answer	1
		no of steps per minute = $200 \times 6 = 1200$	$10/200 = 0.05$ s/steps	answer	1
		time for 1 step = $60000/1200$ b8 = 50ms	b8 = 50ms	substitutions answer	1 1
3	(b)	extrudrev: for b0 = 1 to 25 pins = %01100000 pause 14 pins = %01010000 pause 14 pins = %10010000 pause 14 pins = %10100000 pause 14 next b0 return	2 for calculating 25	1 for command calculate 25 – $180/1.8 = 100$ $100/4 = 25$ pause 14 reversing step order all 4 pauses label + return	3 1 1 1 1
					7
					(16)

Question		Mark Allocation	Marks
4	(a)	Closed loop (1) proportional (1)	2
	(b)	<p style="text-align: right;"> set speed (or desired speed) 1 error detector & error amplifier (labels no essential) 1 driver (transistor) 1 fuel regulator 1 generator & output (change of speed) 1 tachogenerator 1 </p>	6
	(c)	Gain = $196/18 = 10.9$ answer 1 Error = $2.8/10.9$ = 0.257 substitution 1 answer 1 V at non-inverting input = $6.8 + 0.257$ substitution 1 = $7.06V$ answer 1 R = $20 \times 8.94/7.06$ substitution 1 = $25.3 \text{ k}\Omega$ answer including units 1	7
(15)			

Question		Mark Allocation	Marks
5	(a)	$\sigma = F/A$	
		$= 40/40$	substitution of value within elastic region 1
		$= 1 \text{ kN/mm}^2$	answer 1
		$\epsilon = \Delta L/L$	
		$= 0.51/100$	substitution of corresponding extension value 1
		$= 0.0051$	answer 1
	(b)	$E = \sigma/\epsilon$	
		$= 1/0.0051$	substitution 1
		$= 196 \text{ kN/mm}^2$	answer including correct units 1
	(c)	Mild steel/stainless steel/nickel alloy	
		UTS = 430N/mm ²	(from data book) 1
		WS = 430/8	substitution 1
		= 53.8N/mm ²	answer 1
		$A = F/\sigma = 6000/53.8$	substitution 1
= 112mm ²		answer 1	
$d = \sqrt{(4A / \pi)} = \sqrt{(4 \times 112 / \pi)}$		substitution 1	
= 12mm		answer including correct units 1	
			6
			1
			7
			(14)

Question		Mark Allocation	Marks
6	(a)	Protects transistor / from back e.m.f.	2
	(b)	$R = V/I = (5.8 - 0.7)/(4.4 \times 10^{-3})$ $= 1.16 \text{ k}\Omega$	Use of -0.7 1 substitution 1 answer including unit 1 3
	(c)	$I_c = P/V$ $= 20/6$ $= 3.33 \text{ A}$	substitution 1 answer, unit not required 1
		$h_{FE} = I_c/I_b$ $= 3.33/(4.4 \times 10^{-3})$ $= 757$	substitution 1 answer, no unit 1 4
	(d)		two npn transistors 1 base connections 1 collector connections 1 3
	(e)	$I_b = 3.33/1020$ $= 3.26 \times 10^{-3}$	substitution 1 answer 1 use of 1.4 1
		$R = V/I = (5.8 - 1.4)/3.26 \times 10^{-3}$ $= 1.35 \text{ k}\Omega$	substitution 1 answer including units 1 5
(f)	Draws negligible (no) current from input OR high input (gate) resistance (impedance). No base resistor required. Can provide high output current. High switching speed. Low power consumption. Voltage controlled	any 2 @ 1 2 (19)	

<i>Question</i>		<i>Mark Allocation</i>		<i>Marks</i>			
7	(a)		main:	if pin0 = 1 then heater	2	15	
			low 5		1		
			low 4	(mark awarded below)			
			goto main		1		
			heater:	high 4	high 4 low 4		1
			if pin1 = 1 then onfull		2		
			gosub adcread		1		
			DATA = DATA/10		1		
			high 5	(mark awarded below)			
			pause DATA		1		
			low 5	high 5 low 5	1		
			pause 12		1		
			goto main	including label	1		
			onfull:	high 5	1		
goto main		1					
7	(b)		Pulse Width Modulation (PWM)		1		
					(16)		

Question		Mark Allocation	Marks		
8	(a)	Op-amp A – Summing Amplifier Op-amp B – Inverting Amplifier	1 1	2	
	(b)	$V_1 = R_f \left(\frac{V_1}{R_1} + \frac{V_3}{R_3} \right)$ $V_1 = -8 (5/100 + 5/50)$ $= -1.2 \text{ V}$ $V_{\text{out}} = -1 \times -1.2 = 1.2 \text{ V}$	all substitutions answer including units	3 1	4
	(c)	$3.6 = -8(5/200 + 5/50 + 5/R) \times -1$ $3.6 = 0.2 + 0.8 + (40/R)$ $3.6 - 1 = 40/R$ $R = 40/2.6$ $R = 15.4 \text{ k}\Omega$	3 substitutions answer including units	3 1	4
	(d) (i)	Max hot drink output – tea/milk/sugar			1
	(ii)	$V_{\text{out}} = 1.2 + 2.6$ $= 3.8 \text{ V}$ $\text{Supply} = 3.8 \times 100/85$ $= 4.47 \text{ V}$	substitutions answer use of “saturation” answer including units	1 1 1 1	4
					(15)

Question		Mark Allocation	Marks	
9	(a)	Voltage at non-inverting input of op-amp 2 increases. Non-inverting input becomes greater than inverting input. Op-amp output goes high and transistor switches on. Relay switches boiler on.	1 1 1 1	4
	(b)	T1 = 200kΩ	from data book	1
		T2 = 800kΩ	from data book	1
		R/800 = 200/18 R = 200 × 800/18 = 8.89 MΩ	ratios answer	1 1
	(c)	Role of V ₁ Resistance of Th ₁ decreases / V ₃ increases When V _{+ve} > V _{-ve} , op-amp switches on Output greater than V _{GS} Pump on.	1 1 1 1 1	5
(d)	Voltage at inverting input = 24 × 18/64 = 6.75	substitution answer	1 1	
	Voltage at non-inverting input = 24 × 18/48 = 9V	substitution answer	1 1	
	Error = 9 – 6.75 = 2.25V	answer	1	
	A _v = 2.3/2.25 = 1.02	substitution answer	1 1	
	R _f = 1.02 × 320 R _f = 326 kΩ	answer including units	1 1	
(e)	ΣM _h = 0 (Acos10 × 600) + (90cos15 × 100) – (240sin30 × 920) = 0 A × 591 = 110400 – 8693 A = 172 N	3 terms @ 2 each answer, including unit	6 1	7

Question		Mark Allocation	Marks	
9	(f)	$\Sigma F_V = 0$ ($\uparrow +ve$)		
		$+H_V - 90\cos 15 - 172\cos 10 + 240\sin 30 = 0$	three components @ 1 each	3
		$H_V = 86.9 + 169.3 - 120$		
		$H_V = 136 \text{ N } (\uparrow)$	answer (units not necessary)	1
		$\Sigma F_H = 0$ ($\rightarrow +ve$)		
		$+H_H - 90\sin 15 + 172\sin 10 - 240\cos 30 = 0$	three components @ 1 each	3
		$H_H = 23.3 - 29.9 + 207.8$		
		$H_H = 201 \text{ N } (\rightarrow)$	answer (units not necessary)	1
		$H = \sqrt{(136^2 + 201^2)}$	substitution	1
		$= 243 \text{ N}$	answer including unit	1
$\tan \theta = \frac{136}{201}$				
$\theta = 34.1^\circ$	answer	1		
			11	
			(40)	

Question		Mark Allocation	Marks	
10	(a)	<p><u>For AC:</u> $\Sigma F_V = 0$ $F_{AC} \sin 27^\circ = 1.18$ $F_{AC} = 2.6 \text{ kN}$ (TIE)</p> <p><u>For AB:</u> $\Sigma F_H = 0$ $F_{AB} = 2.6 \cos 27$ $F_{AB} = 2.32 \text{ kN}$ (STRUT)</p> <p><u>For CB:</u> $\Sigma F_V = 0$ $F_{BC} = 1.18 \text{ kN}$ (TIE)</p> <div style="text-align: center;"> </div> <p><u>For CD:</u> $\Sigma F_V = 0$ $F_{CD} \cos 63 = 1.18 + 1.18$ $F_{CD} = 5.2 \text{ kN}$ (STRUT)</p> <p><u>For CE:</u> $\Sigma F_H = 0$ $F_{CE} = 2.32 + 5.2 \cos 27$ $F_{CE} = 6.95 \text{ kN}$ (TIE)</p>	<p>substitution 1 answer with units 1 correct nature 1</p> <p>substitution 1 answer with units 1 correct nature 1</p> <p>answer with units 1 correct nature 1</p> <p>3 terms 3 answer with units 1 correct nature 1</p> <p>2 terms 2 answer with units 1 correct nature 1</p>	17
	(b)	<div style="text-align: center;"> </div>	<p>Two sensors 1 Two signal conditioners 1 Multiplexer 1 ADC 1 Microcontroller 1 Datalogger 1</p>	6

Question	Mark Allocation	Marks
<p>10 (c)</p>	<pre> graph TD A[sample rate] --> B[/MPX low/] B --> C[windspeed] C --> D{Is DATA <70?} D -- Y --> E[b3 = 600] D -- N --> F{Is DATA <120?} F -- Y --> G[b3 = 300] F -- N --> H[b3 = 60] E --> I[/MPX high/] G --> I H --> I I --> J[readstrain] J --> K[pause b3] K --> L{looped 10 times?} L -- Y --> I L -- N --> M[return] </pre> <p style="text-align: right; margin-right: 20px;">sample rate & return MPX low/MPX high all other elements with associated links 9 @ 1</p>	<p style="text-align: right;">1 1 9 11</p>
<p>(d)</p>	<p>Non-inverting amp $V_{in} = 2V$ $V_{out} = 5 \times 186/255 = 3.65V$ $Gain = 3.65/2 = 1.83$ For non-inverting amplifier, $gain = 1 + R_f/R_i = 1.83$ $R_f/R_i = 0.83$ $R_f = 83\text{ k}\Omega$, $R_i = 100\text{ k}\Omega$ (or other suitable pair in k range)</p>	<p style="text-align: right;">1 1 1 1 1 6 (40)</p>

Question		Mark Allocation	Marks
11	(a)	steer: if pin1 = 1 then subtrim	2
		loop1: if pin2 = 1 then addtrim low 7 gosub adcread if TRIM > 128 then adddata if TRIM < 128 then suddata	2 1 1 2 2
		loop2: gosub steerangle return	1
		subtrim: TRIM = TRIM - 1 high 7 (mark allocated below) pause 100 (mark allocated below) goto steer	1 1
		addtrim: TRIM = TRIM + 1 high 7 (both high 7) pause 100 (both pause 100) goto loop1	1 1 1 1
		adddata: RESULT = TRIM - 128 DATA = DATA + RESULT goto loop2 (mark allocated below)	1 1 1
		subdata: RESULT = 128 - TRIM DATA = DATA - RESULT goto loop2 (both goto loop2)	1 1 1
	(b)	Sub A is summing amp; produces 2 voltages for fwd & back Sub B inverts signal for A to +ve Sub C produces a ref voltage for Sub D Sub D: when +ve > -ve input, T ₁ on; car forward when -ve > +ve input, T ₂ on; car backward	1 1 1 2 1
	(c)	$V_{ref} = 6 \times 8/28$ $= 1.71V$ substitutions answer with unit	1 1
			22
			6
			2

Question			Mark Allocation	Marks		
11	(d)	(i)	Diff amp: $V_0 = +6.7V$			
			$6.7 = \frac{300}{20} (1.71 - V_1)$	substitutions	1	
			$V_1 = 1.26V$	answer	1	
			Summing amp: $-1.26 = -10 \left(\frac{6.8}{R_1} \right)$	substitutions	1	
			$0.126 = \frac{6.8}{R_1}$		1	
			$R_1 = 54 \text{ k}\Omega$	answer	1	5
	(d)	(ii)	Diff amp			
			$-6.7 = \frac{300}{20} (1.71 - V_1)$	substitutions	1	
			$V_1 = 2.16V$	answer	1	
			Summing amp: $-2.16 = -10 \left(\frac{6.8}{54} + \frac{6.8}{R_2} \right)$	substitutions	1	
$0.216 = 0.126 + \frac{6.8}{R_2}$				1		
		$R_2 = 75.6 \text{ k}\Omega$		1	5	
				(40)		

[END OF MARKING INSTRUCTIONS]