2011 Technological Studies

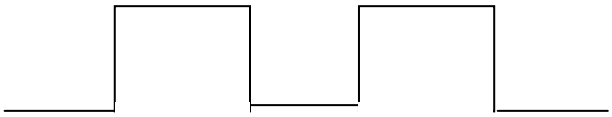
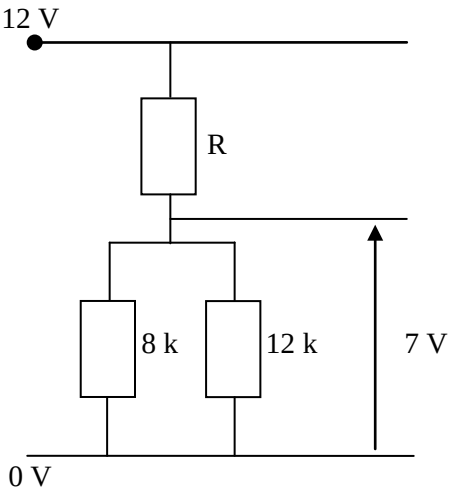
Advanced Higher

Finalised Marking Instructions

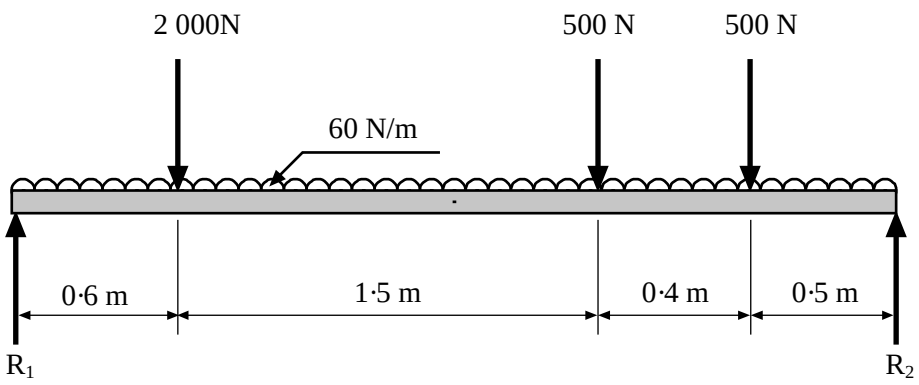
Section A

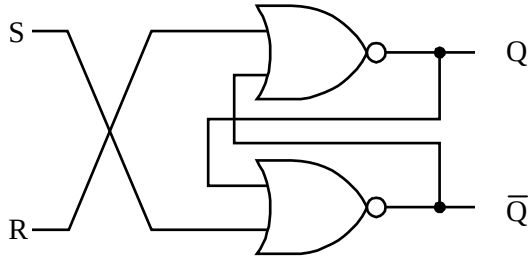
			Marks	
Q1				
(a)	$f = \frac{1 \cdot 44}{(R + 2R_2)C}$	$R_T = R_1 + 2R_2$		
	$250 = \frac{1 \cdot 44}{R_T C}$		½	
	$R_T = \frac{1 \cdot 44}{250 \times 1 \times 10^{-6}}$		½	
	$R_T = 5760$		½	
	$R_2 = \frac{(5760 - 2000)}{2}$		1	
	$R_2 = 1880\ \Omega$		½	**3**
(b)	See Worksheet Q1			**5**
				(8)

Q2	main:	btfss	PORTB,0				½	
		goto	main				½	
		movlw	d‘6’	}				
		movwf	COUNTER	}			½	
	loop:	bsf	PORTB,7				½	
		movlw	d‘1’	}				
		call	pause	}			½	
		bcf	PORTB,7				½	
		movfw	DELAY	}				
		call	pause	}			½	
		rrf	DELAY,F				½	
		decfsz	COUNTER,F				½	
		goto	loop				½	
		bsf	PORTB,6				½	
		btfsc	PORTB,2				½	
		bsf	PORTB,5				½	
		movlw	d‘30’)				½	
		call	wait)					
		bcf	PORTB,6				½	
		movlw	d‘250’				½	
		movwf	COUNTER				½	
	check:	btfsc	PORTB,1				½	
		goto	release				½	
		movlw	d‘1’	OR	movlw	d‘100’ }		
		call	wait		call	pause }	½	
		decfsz	COUNTER,F				½	
		goto	check				½	
		bsf	PORTB,4				½	
		end					½	
	release:	bsf	PORTB,3					
		end						**12**
								(12)

		Marks	
Q3			
(a)	Wein bridge		**1**
(b)		**1**	
	This waveform is used due to: rapid transition of state; only two states; useful for providing clock pulse	**1**	**2**
(c)			
	$1/R_p = 1/8000 + 1/12000$ $R_p = 4800\Omega$	½	
	$V_{out} = \frac{R_P}{R_P + R}$		
	$7 = \frac{4800}{4800 + R} \times 12$	1	
	$R + 4800 = \frac{4800 \times 12}{7}$	½	
	$R = 8828{\cdot}6 - 4800$ $R = 3429\Omega = 3430\Omega$	½ ½	**3**

	Marks	
Q3 continued		
(d) $V_{out} = -\frac{1}{RC}\int Vin\ dt$ $\quad -8 = -\frac{1}{6000C}Vint$	½	
$-8 = -\frac{1}{6000C} \times 12t$	½	
$-8 = -\frac{1}{6000C} \times 12 \times 0 \cdot 02$	½	
$C = \frac{1 \times 12 \times 0 \cdot 02}{8 \times 6000}$	½	
$C = 5.0 \times 10^{-6}\,F$	½	
$= 5.0\ \mu F$	½	**3**
		(9)

			Marks	
Q4				
(a)				
		Take moments about R $\Sigma CWM = \Sigma ACWM$		
		$(60 \times 3 \times 1{\cdot}5) + (2000 \times 0{\cdot}6) + (500 \times 2{\cdot}1) + (500 \times 2{\cdot}5) = 3R_2$	1	
		$R^2 = \frac{3770}{3}$		
		$R^2 = 1257$ N	½	
		$\Sigma F_V = 0$ $R_1 = [2000 + 500 + 500 + (3 \times 60)] - 1257$ $R_1 = 1923$ N	½	**2**
(b)	(i)	See Worksheet Q4		**3**
	(ii)	From LHE 0m and 3m = 0 Nm	½	
		$0 \cdot 6\text{m} : (0 \cdot 6 \times 1923) - \left(\frac{0 \cdot 6^2}{2} \times 60\right) = 1143$ Nm	1	
		$1\text{m} : (1 \times 1923) - (0 \cdot 4 \times 2000) - \left(\frac{1^2}{2} \times 60\right) = 1093$ Nm	1	
		$1 \cdot 6\text{m} : (1 \cdot 6 \times 1923) - (1 \times 2000) - \left(\frac{1 \cdot 6^2}{2} \times 60\right) = 1000$ Nm	1	
		$2 \cdot 1\text{m} : (2 \cdot 1 \times 1923) - (1 \cdot 5 \times 2000) - \left(\frac{2 \cdot 1^2}{2} \times 60\right) = 906$ Nm	1	
		$2 \cdot 5\text{m} : (2 \cdot 5 \times 1923) - (2 \times 2000) - \left(\frac{2 \cdot 5^2}{2} \times 60\right) = 621$ Nm	1	
		½ for plotting points	½	**6**
				(11)

		Marks
Q5		
(a) See Worksheet Q5		**7**
(b) 		
Cross-coupled NORs	1	
Correct labels	1	**2**
		(9)

					Marks	
Q6	main:	bsf	PORTB,5		½	
		movfw	MARK		½	
		call	pause		½	
		bcf	PORTB,5		½	
		movfw	SPACE	)	½	
		call	pause	)		
		call	adcread		½	
		movlw	d‘160’		½	
		subwf	DATA,W		½	
		btfss	STATUS,C		½	
		goto	incmk		½	
		movfw	DATA		1	
		sublw	d‘150’		1	
		btfss	STATUS,C		½	
		goto	main		½	
		movfw	DATA		½	
		addwf	MARK		½	
		goto	main		½	
	incmk:	movfw	DATA		½	
		addwf	SPACE		½	
		goto	main		½	**11**
						(11)

			Marks	
Q7				
(a)	(i)	More area resisting bending depth material depth (or any acceptable answer)	½	
		Greater resistance to air flow, wind	½	**1**
	(ii)	Better strength to weight ratio		**1**
(b)	(i)	$I = 5.45 \times 10^4 mm^4$, $y = 15mm$, $\sigma = 100N/mm^2$		
		$\sigma = \frac{my}{I}$		
		$M = \frac{\sigma I}{y}$	½	
		$M = \frac{5 \cdot 45 \times 10^4 \times 100}{15}$	½	
		$= 363.3\,kNm$	½	
		$M = \frac{FL}{4}$		
		$M = \frac{4M}{L}$	½	
		$= \frac{4 \times 363.3 \times 10^3}{1500}$	½	
		$= 969N$	½	**3**
	(ii)	$\text{deflection} = \frac{FL^3}{48\,EI}$	½	
		$E(\text{mild steel}) = 196 \times 10^3\,N/mm^2$	½	
		$d = \frac{969 \times 1500^3}{48 \times 196 \times 10^3 \times 5 \cdot 45 \times 10^4}$	½	
		$= 6.38mm$	½	**2**

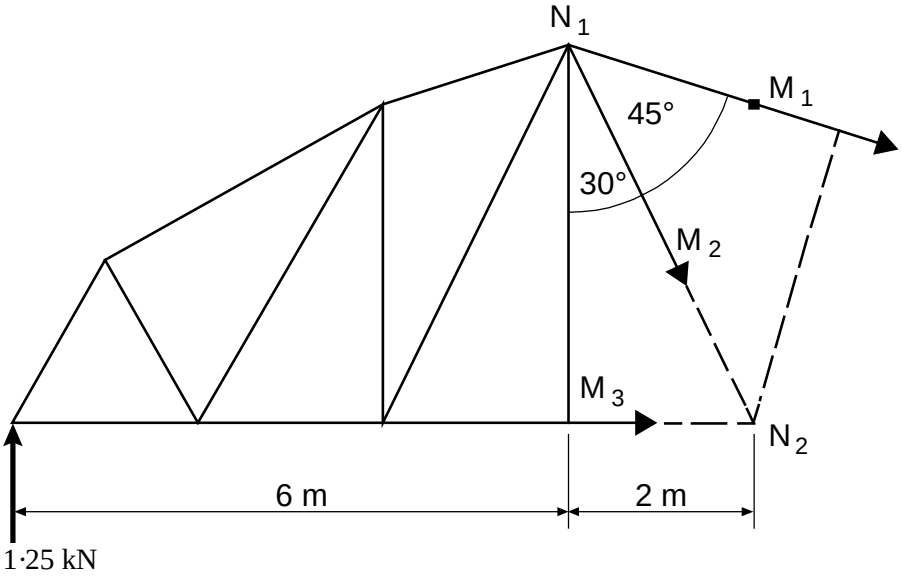
		Marks	
Q7	(continued)		
(c)	$M = \frac{FL}{4}$	½	
	$M = \frac{1000 \times 1500}{4}$	1	
	$M = 375000\text{Nmm}$	½	
	$\sigma = \frac{my}{I}$	½	
	$I = \frac{my}{\sigma} = \frac{375000 \times 12{\cdot}5}{90}$		
	$I = 52083\text{mm}^4$	½	
	$I = \square - \bigcirc$	½	
	$I\square = 52083 - \frac{\pi D^4}{64}$		
	$52083 - 19175$		
	$I\square = 32908\text{mm}^4$	½	
	$I = \frac{BD^3}{12}$	½	
	$\frac{12I}{D^3} = B$		
	B=25.3mm	½	**5**
(d)	$\frac{M}{I} = \frac{E}{R}$		
	$R = \frac{EI}{M}$	½	
	$R = \frac{70 \times 10^3 \times 52083}{375000}$	1	
	R = 9720mm	½	**2**

		Marks	
Q7	(continued)		
(e)	range is $0 - 63$	½	
	$\frac{32}{63} \times 6\text{v} = 3 \cdot 048\text{V}$ (msb)	½	
	$\frac{20}{R_6} \times 5 = 3 \cdot 048$	½	
	$R_6 = \frac{20 \times 5}{3 \cdot 048} = 32 \cdot 8\,\text{k}\Omega$	½	
	$R_5 = 2 \times 32 \cdot 8 = 65 \cdot 6\ \text{k}\Omega$		
	$R_4 = 4 \times 32 \cdot 8 = 131 \cdot 2\ \text{k}\Omega$		
	$R_3 = 8 \times 32 \cdot 8 = 262 \cdot 5\ \text{k}\Omega$		
	$R_2 = 16 \times 32 \cdot 8 = 525\ \text{k}\Omega$		
	$R_1 = 32 \times 32 \cdot 8 = 1050\ \text{k}\Omega$	1	
	Sketch on Worksheet	2	**5**
(f)	$101111 = 47 = \frac{47}{63} \times 6 = 4 \cdot 48\text{V}$		**1**
			(20)

Q8

					Marks	
(a)	grab:	bsf	PORTB,4)			
		bcf	PORTB,5)		½	
		movlw	d‘50’ *			
		call	wait *			
		bcf	PORTB,4		½	
		movlw	d‘20’ *			
		call	wait *			
		bsf	PORTB,5		½	
		movlw	d‘50’ *			
		call	wait *	* 3 delays	½	**2**
		return				
(b)						
	dump:	bsf	PORTB,7)			
		call	adcread)		½	
	check:	movfw	ACTUALPOS		½	
		sublw	d‘50’		½	
		btfss	STATUS,Z)			
		goto	check)		½	
		bcf	PORTB,7)			
		movlw	d‘10’)			
		call	wait)			
		bsf	PORTB,4)		½	
		movlw	d‘20’)			
		call	wait)			
		bcf	PORTB,4)			
		return	)		½	**3**
(c)						
	main:	movlw	d‘4’)			
		movwf	COUNTER)			
		btfss	PORTB,1)			
		goto	main)		½	
		movlw	d‘100’)			
		movwf	DESIREDPOS)		½	
	loop:	bsf	PORTB,6)			
		call	adcread)		½	
		movfw	DESIREDPOS)			
		subwf	ACTUALPOS)		½	
		btfss	STATUS,Z)			
		goto	loop)		½	
		call	grab)			
		call	dump)		½	
		movlw	d‘50’)			
		addwf	DESIREDPOS)		½	
		decfsz	COUNTER)			
		goto	loop)			
		goto	main)	(+ labels)	½	
						4

Q8 (continued)

		Marks	
(d)	Take moments about R_A		
	$\Sigma CWM = \Sigma ACWM$		
	$(8 \times 2{\cdot}5) + (10 \times 2{\cdot}5) = 12R_B$	½	
	$R_B = 3{\cdot}75$ kN	1	
	$\Sigma F_V = R_A = (2{\cdot}5 + 2{\cdot}5) - 3{\cdot}75$ $= 1{\cdot}25$ kN	½	**2**
(e)			
	Take moments about N_1 $\quad M_1$ and $M_2 = 0$		
	$\Sigma CWM = \Sigma ACMW$		
	$6 \times 1{\cdot}25 = 4M_3$		
	$M_3 = \frac{6 \times 1{\cdot}25}{4}$		
	$M_3 = 1{\cdot}875$kN (TIE)	2	

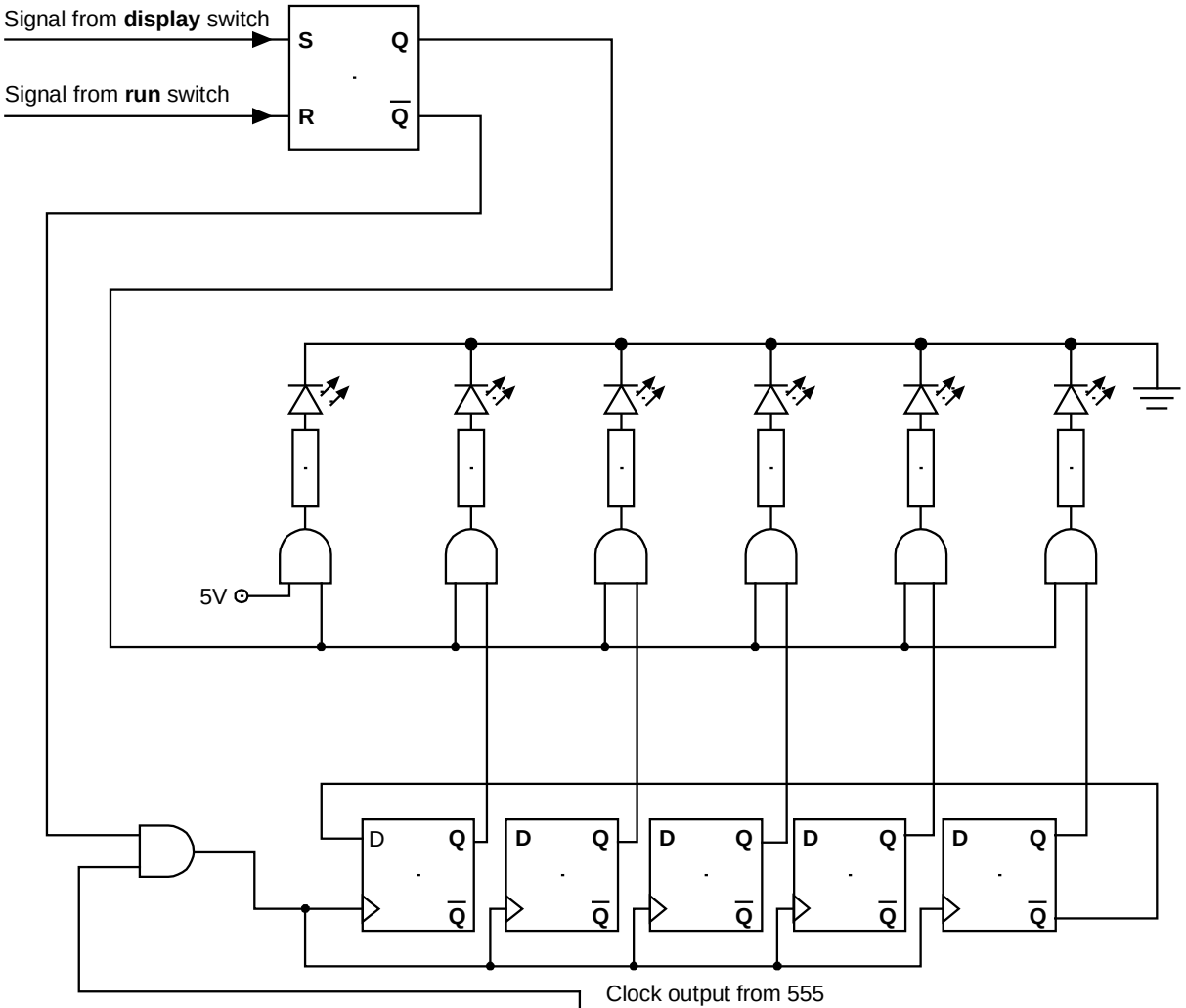
Q8 (continued)

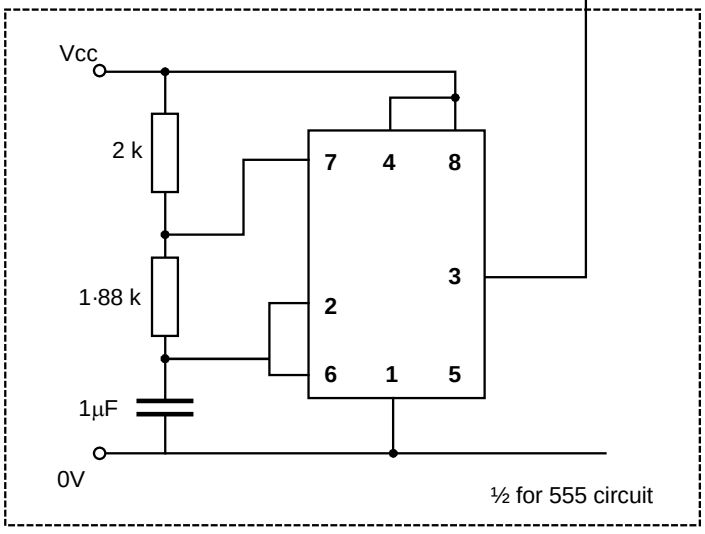
		Marks	
(e)	Take moments about N_2		
	$\Sigma CWM = \Sigma ACMW$		
	$3\cdot 34M_1 + 8\times 1\cdot 25 = 0 \quad \left(\frac{x = 4.47\times\sin 48.5^\circ}{= 3\cdot 34m}\right)$	1	
	$M_1 = \frac{-8\times 1\cdot 25}{3\cdot 34}$		
	$= 2\cdot 99kN$ (STRUT)	3	
	Σ Horizontal forces $= 0$		
	$1.875 + M_{2\,horiz} - 2\cdot 99\cos 15 = 0$		
	$M_{2\,horiz} = 2\cdot 99\cos 15 - 1\cdot 875$		
	$M_{2\,horiz} = 1.013kN$		
	$M_2 = \frac{1.013}{\sin 26.6^\circ}$		
	$M_2 = 2\cdot 26kN\,(TIE)$	3	**9**
			(20)

		Marks	
Q9			
(a)	Time based – each step ends after a set time	½	
	event based – A sensor being actuated ends step.	½	**1**
(b)	See Worksheet Q9(a)		**3**
(c)	$V_0 = \frac{1}{RC}\int V_{in}\ dt$ $\quad V_{out} = \frac{1}{RC}\int 9\times10^{-7}t\ dt$	1	
	$V_0 = \frac{1}{10\times10^6\times C}\times 9t \quad = \frac{1\times9\times10^{-7}}{1\times10^6\times100\times10^{-6}\times2C}\times t^2$	1	
	$= \frac{4.5\times10^{-9}}{C}t^2$	1	
	$V_0 = \frac{0.9\times10^{-6}t}{C}$		**3**
(d)	• The voltage divider sets a reference for the inverting input.	½	
	• As the capacitor charges the non-inverting input increases when it is greater than the inverting input the transistor switches the relay.	½ ½	
	• The relay then discharges the capacitor and the process repeats.	½	
	• The larger the input voltage the faster the capacitor charges and the faster the frequency.	½ ½	**3**

					Marks	
Q9	(continued)					
(e)	See Q9(b) Worksheet				4	**4**
(f)	delay:	movlw	d‘3’			
		movwf	COUNT		½	
	loop:	movfw	TIMEVAL			
		call	wait		½	
		decfsz	COUNT		½	
		goto	loop			
		return			½	**2**
(g)	main:	movlw	d‘5’			
		movwf	COUNTER		½	
	check:	btfss	PORTB,3			
		goto	check		½	
	loop:	bsf	PORTB,7		½	
		movfw	TIMEVAL	)		
		call	delay	) *		
		bcf	PORTB,7		½	
		movfw	TIMEVAL	)		
		call	delay	) *	½	
		movlw	d‘3’			
		subwf	TIMEVAL		½	
		decfsz	COUNTER,F		½	
		goto	loop			
		goto	main		½	**4**
						(20)

Worksheet Q1

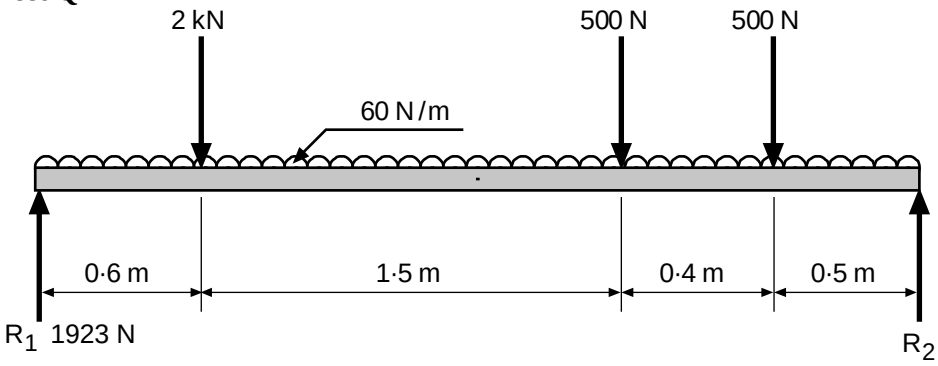




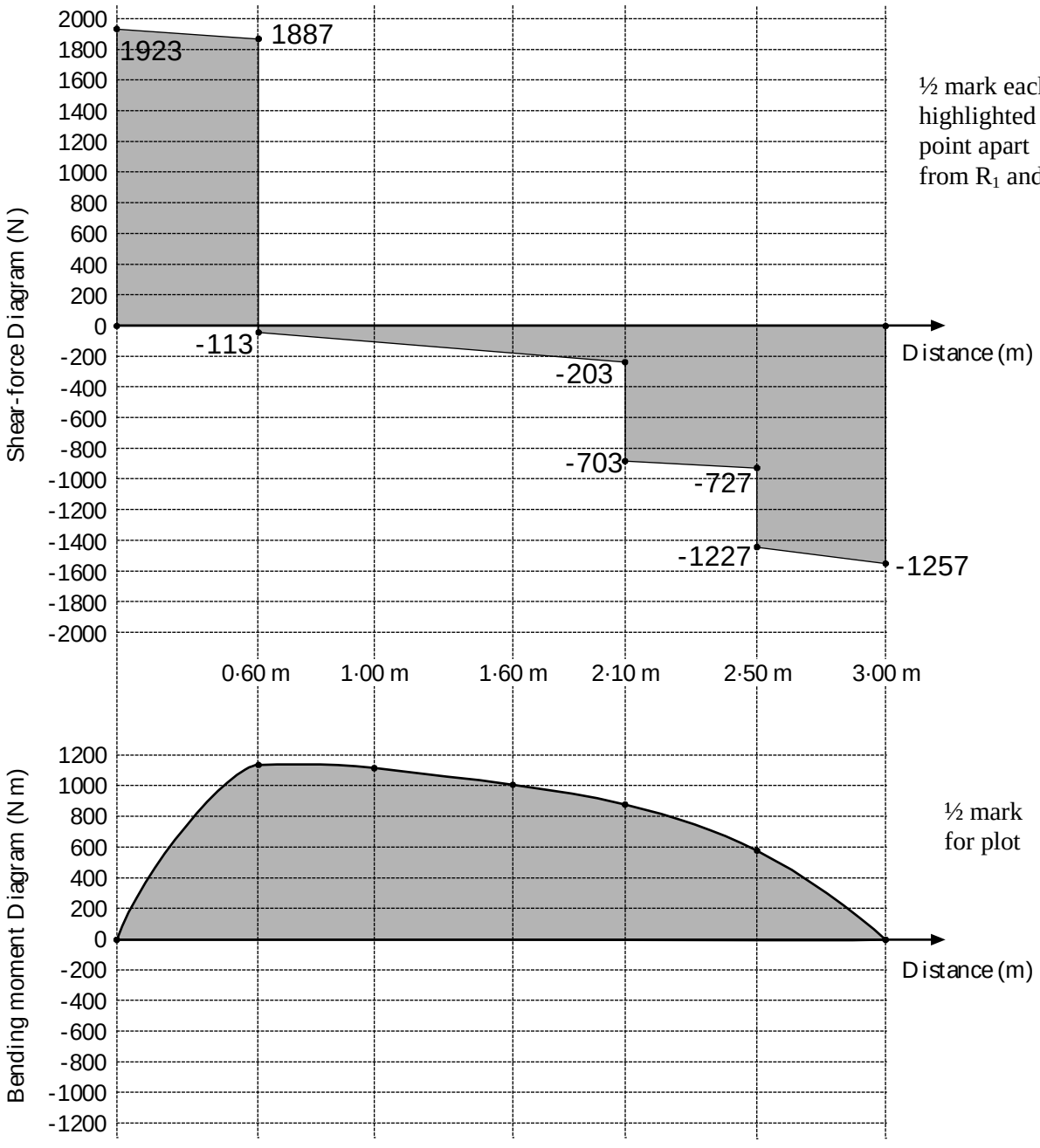
1 for 5 AND → CKK
1 for 5RQ → AND
1 for 5RQ → 6ANDS
1 for pin3 → AND
1 for 5 × Q → AND

In multiple connections
½ for 3+

Worksheet Q4



(b) (i) 3 marks



½ mark each highlighted point apart from R_1 and R_2

B(ii) 6 marks

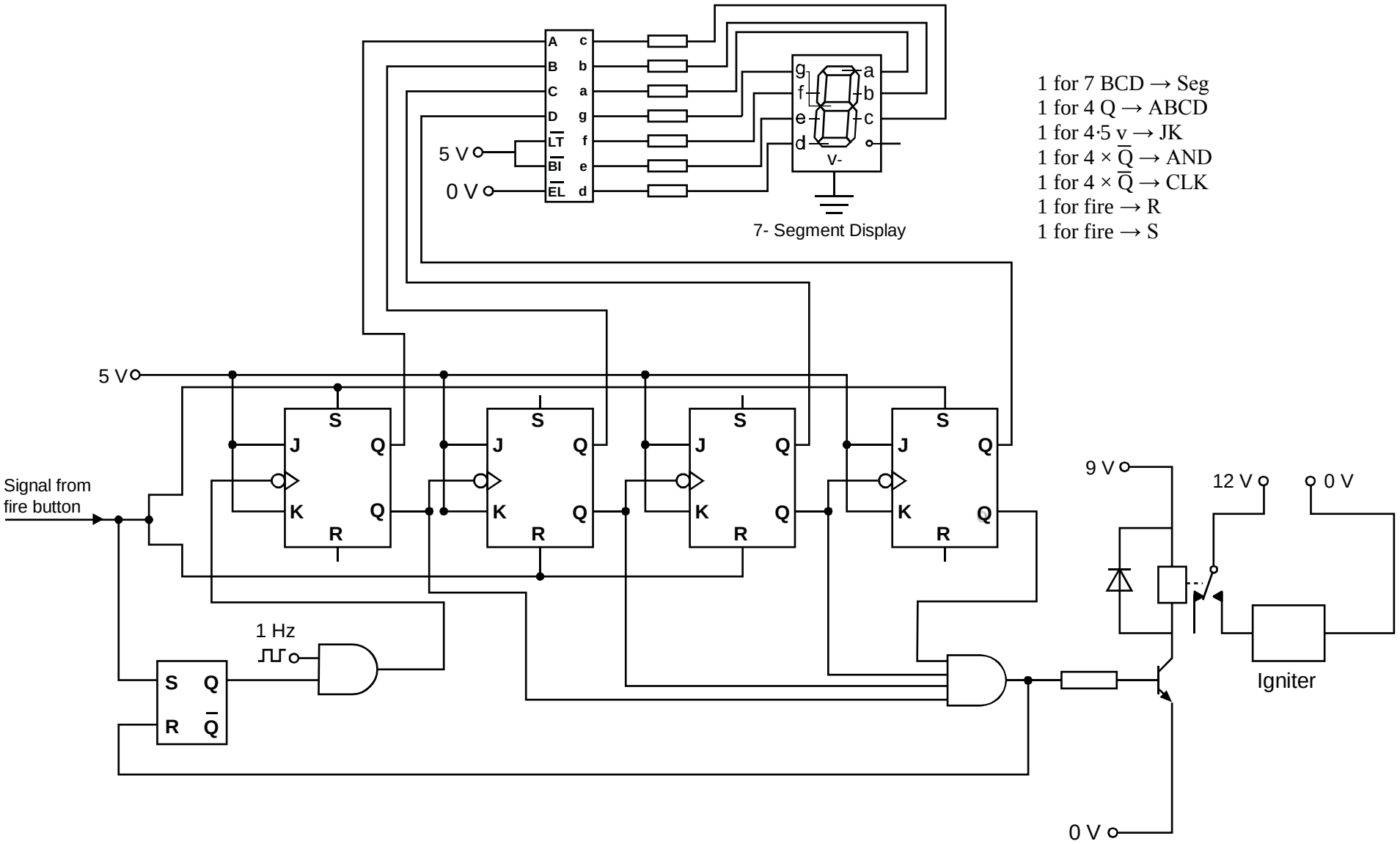
½ mark for plot

DISTANCE FROM LEFT END (m)	0·00	0·60	1·00	1·60	2·10	2·50	3·00
BENDING MOMENT (Nm)	0	1143	1093	1000	906	621	0
		(1)	(1)	(1)	(1)	(1)	

(½)

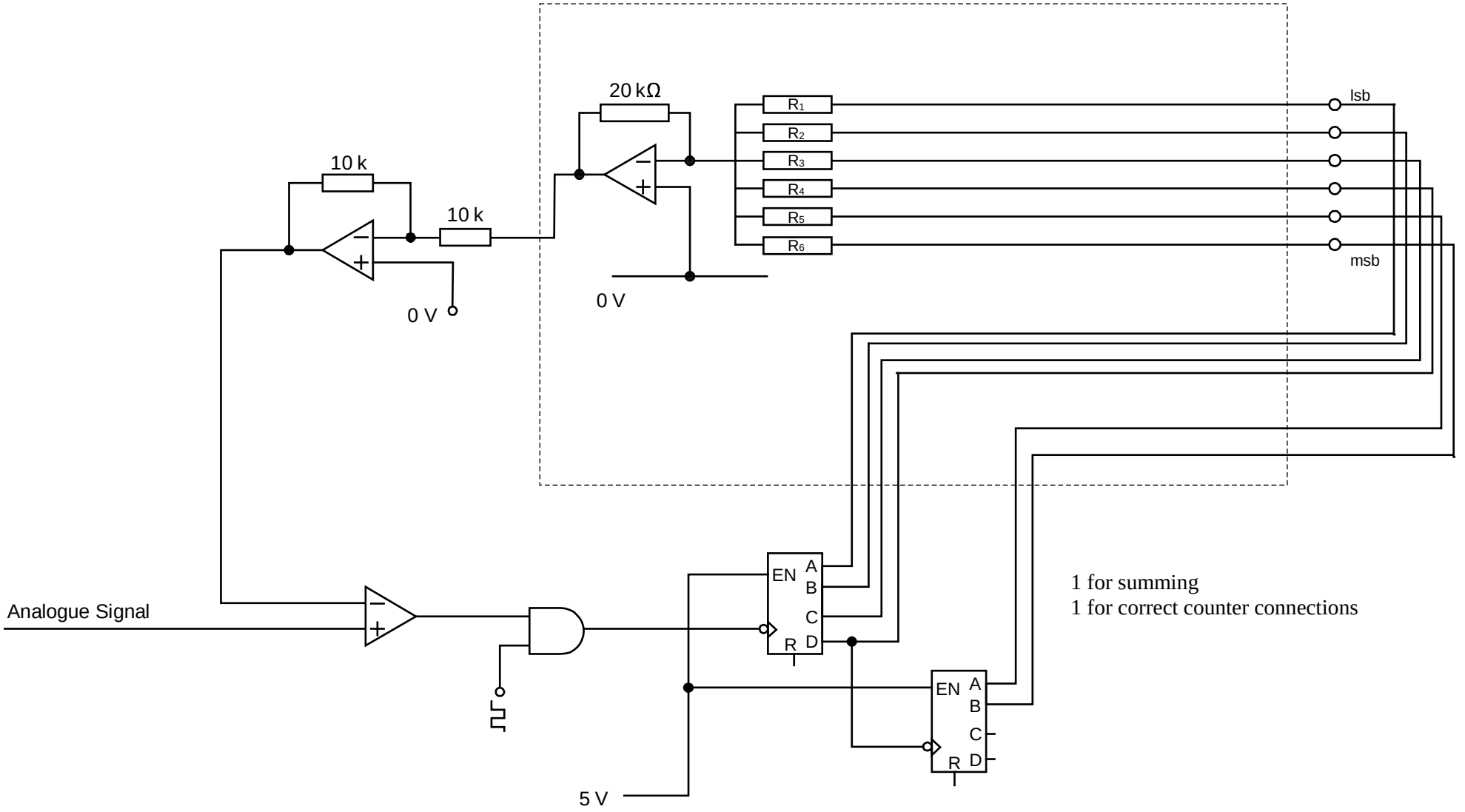
Mark for both

Worksheet Q5



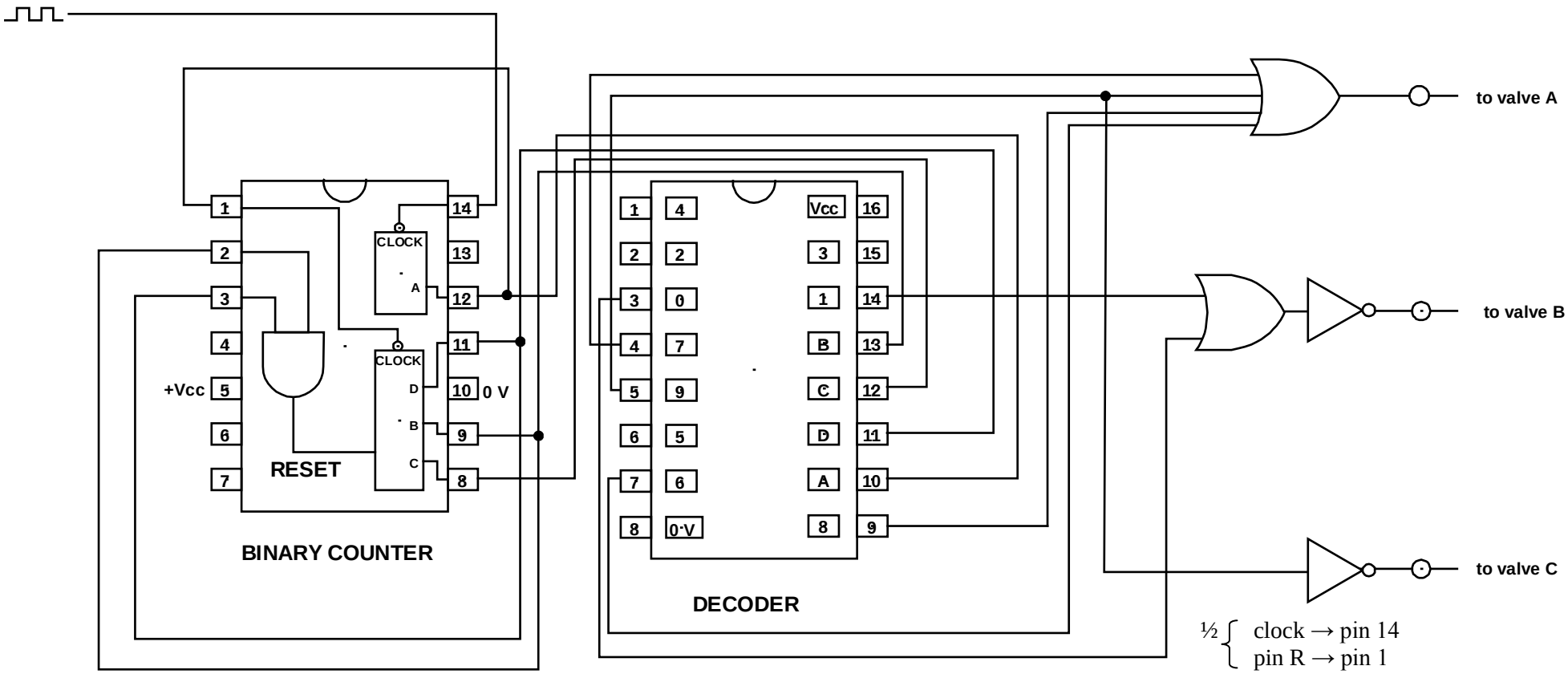
1 for 7 BCD → Seg
1 for 4 Q → ABCD
1 for 4·5 v → JK
1 for 4 × $\overline{Q}$ → AND
1 for 4 × $\overline{Q}$ → CLK
1 for fire → R
1 for fire → S

Worksheet Q7



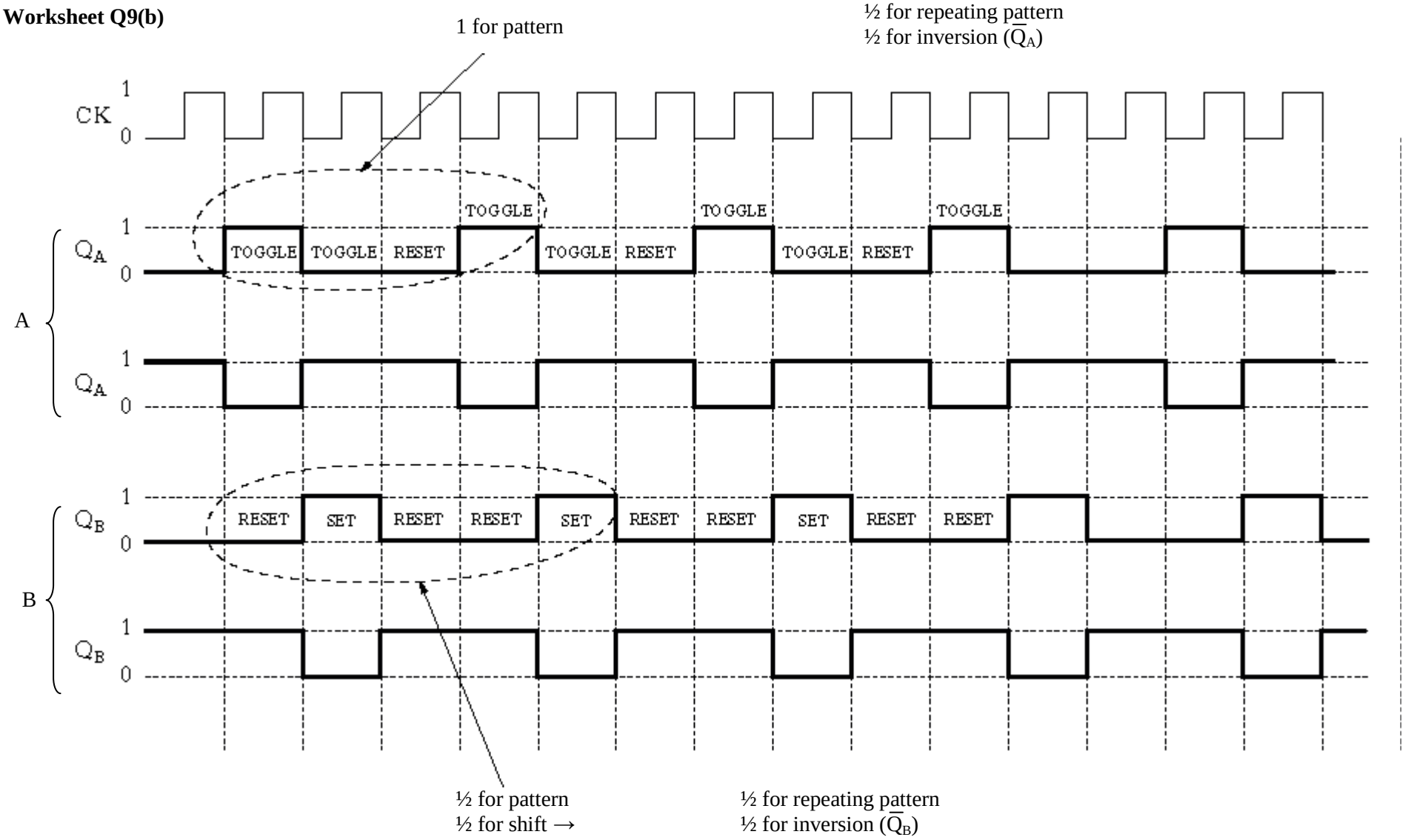
1 for summing
1 for correct counter connections

Worksheet Q9(a)



½ { clock → pin 14
pin R → pin 1
½ ABCD → ABCD
½ B&D → RESET
½ 6,7,8,9 → OR → VALVE A
½ 0,1 → OR → INV → VALVE B
½ 9 → INV → VALVE C

Worksheet Q9(b)



[END OF MARKING INSTRUCTIONS]