GCSE (9-1)

eduqas
Part of WJEC

WJEC Eduqas GCSE (9-1) in

ELECTRONICS

ACCREDITED BY OFQUAL
DESIGNATED BY QUALIFICATIONS WALES

SAMPLE ASSESSMENT MATERIALS

Teaching from 2017
For award from 2019

wjec
cbac

Contents

Candidate Name	Centre Number					Candidate Number				

GCSE ELECTRONICS

COMPONENT 1

Discovering Electronics

SAMPLE ASSESSMENT MATERIAL

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	8	
2.	8	
3.	9	
4.	4	
5.	9	
6.	10	
7.	13	
8.	13	
9.	6	
Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Answer **all** questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **9**.

INFORMATION SHEET

Resistor colour codes

black	0
brown	1
red	2
orange	3
yellow	4

green	5
blue	6
violet	7
grey	8
white	9

The fourth band colour gives the tolerance as follows:

gold ± 5%

silver ± 10%

Resistor E24 series values

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91

Useful equations

$$P = \frac{V^2}{R}$$

$$V_{OUT} = \frac{R_2}{R_1 + R_2} V_{IN}$$

$$I_D = g_M (V_{GS} - 3)$$

$$I_C = h_{FE} I_B$$

$$\overline{A + B} = \overline{A} . \overline{B}$$

$$\overline{A . B} = \overline{A} + \overline{B}$$

$$G = \frac{V_{OUT}}{V_{IN}}$$

$$G = 1 + \frac{R_F}{R_1}$$

$$G = -\frac{R_F}{R_{IN}}$$

$$V_{OUT} = -R_F \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + ... \right)$$

$$T = 1.1RC$$

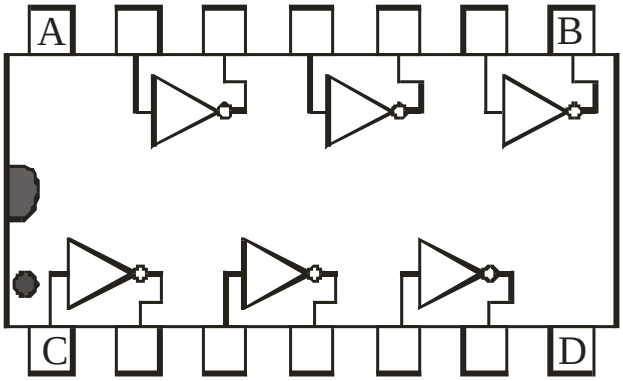
$$f = \frac{1}{T}$$

$$f = \frac{1.44}{(R_1 + 2R_2)C}$$

$$\frac{T_{ON}}{T_{OFF}} = \frac{R_1 + R_2}{R_2}$$

Answer **all** *questions.*

1. *(a)* The diagram shows the pin out for an IC (integrated circuit).



(i) State the number of logic gates on this IC. …… [1]

(ii) State the number of inputs on each gate. …… [1]

(iii) State which pin (**A**, **B**, **C** or **D**) is pin 1 on this IC. …… [1]

(iv) Name the type of logic gate found on this IC. …… [1]

(b) Draw the logic gate symbol for:

(i) an AND gate; [1]

(ii) a NOR gate. [1]

(c) Here are five truth tables:

A.

Input		Output
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

B.

Input	Output
A	Q
O	1
1	0

C.

Input		Output
A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

D.

Input		Output
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

E.

Input		Output
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

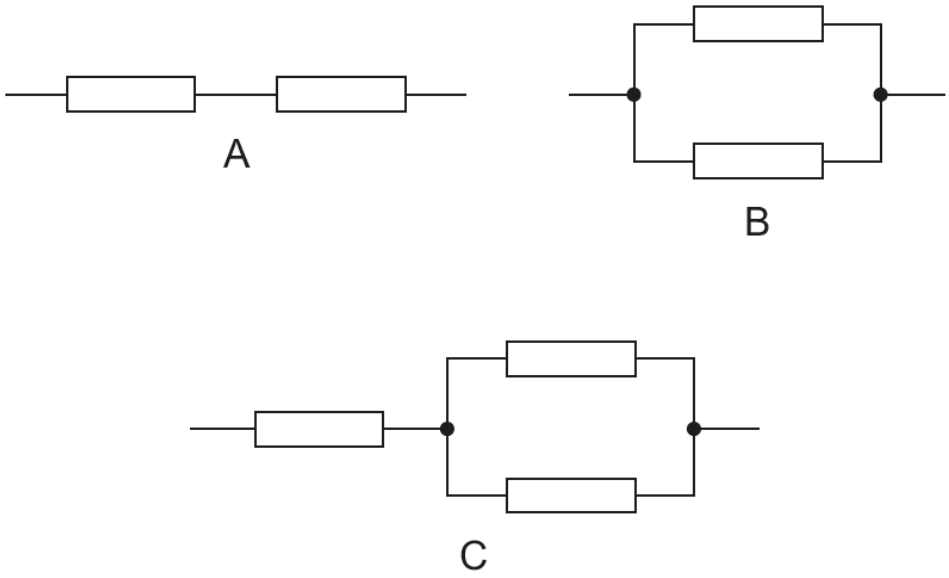
State which table is the truth table for:

(i) a NOT gate; …… [1]

(ii) a NAND gate. …… [1]

8

2. *(a)* Here are some different combinations of resistors. Each resistor has the **same** value.



State which combination has the smallest resistance. ..... [1]

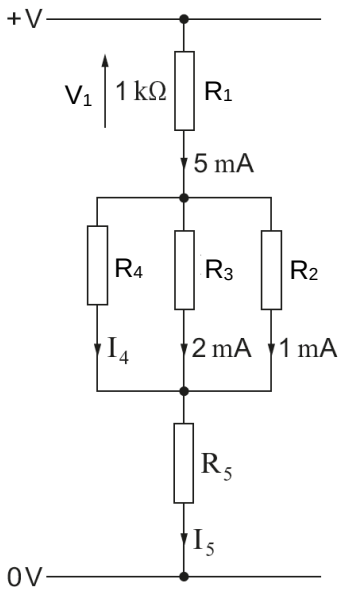
(b) The following resistor values are available to a student.

$10\,\text{k}\Omega$ $15\,\text{k}\Omega$

Resistor values may be selected **once, more than once** or **not at all.**

In the space below, draw a labelled network of **three** resistors that will produce a combined resistance $20\,\text{k}\Omega$. [2]

(c) The diagram shows part of a circuit.



(i) State which of the following is true. [1]

A. I_5 is bigger than 5 mA.

B. I_5 is equal to 5 mA.

C. I_5 is smaller than 5 mA.

Answer .....

(ii) Calculate the value of I_4. [1]

I_4 = ... mA

(iii) State what is the E24 colour code for resistor R_1. [3]

Band 1 ……

Band 2 ……

Band 3 ……

8

3. *(a)* Electronic sub-systems can be classed as either sensing, signal processing or output sub-systems.

For example, a transducer driver is a **signal processing** sub-system.

Here are five other sub-systems:

latch lamp unit NAND gate switch unit solenoid unit

Complete the table by adding the name of each sub-system in the correct column. [3]

Sensing sub-system	Signal processing	Output sub-system
	transducer driver	

(b) Design an electronic system for road works on a motorway. The road works often go on for many miles so hazard warning lamps are placed alongside the road works to warn drivers of the dangers.

Specification for the system
The lamps:

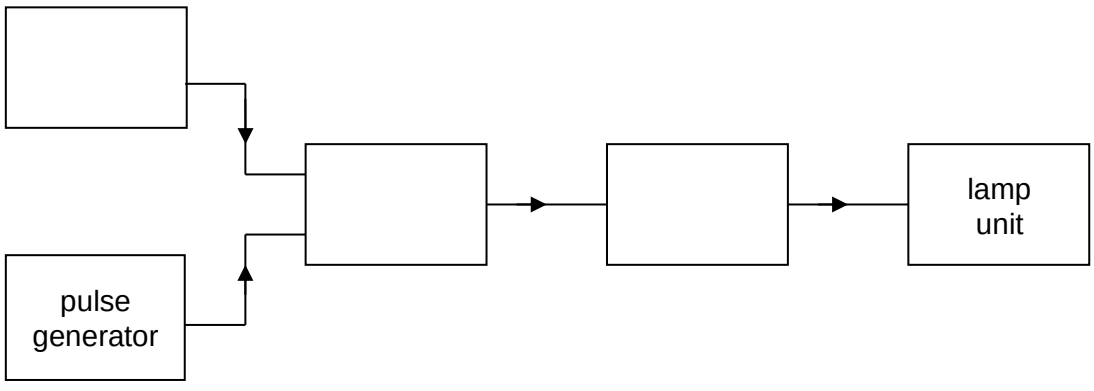
- need to switch on when it gets dark
- flash on and off continuously
- switch off when it gets light.

The following sub-systems are available.

lamp unit **OR gate** **thyristor** **light sensing unit** **buzzer unit**

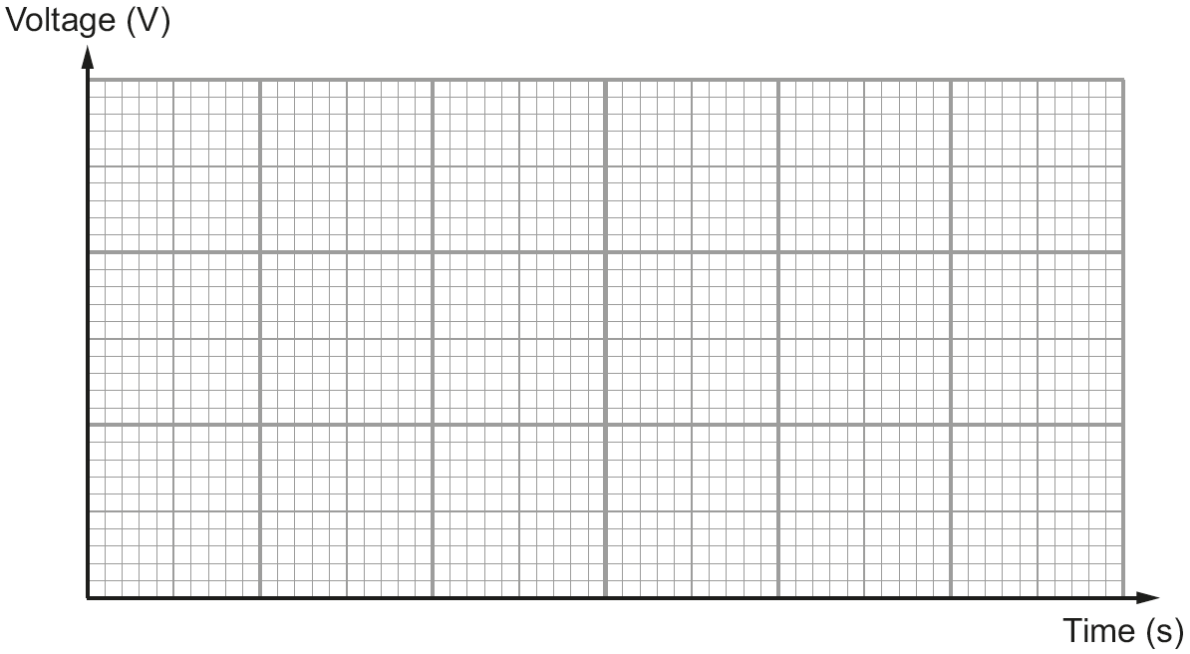
time delay **temperature sensing unit** **AND gate** **MOSFET**

Select the correct sub-systems to complete the block diagram design. [3]



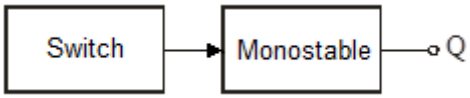
(c) The pulse generator is constructed from a 555 IC which has a mark-space ratio of 3:1 and a frequency of 2 Hz. On the grid below:

- draw two cycles of the output of the astable [3]
- clearly label the mark and space
- add a suitable scale to the time axis.



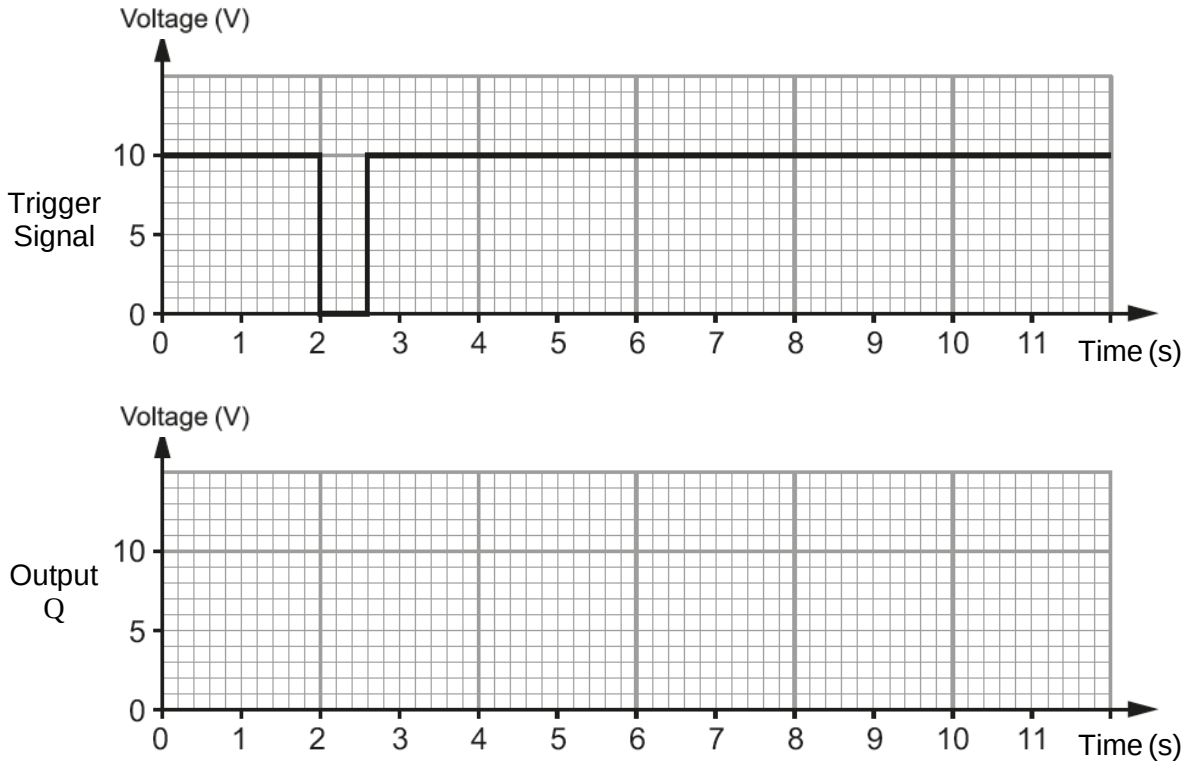
9

4. A switch sub-system is used to trigger a monostable sub-system.



(a) Draw the circuit diagram for the switch sub-system so that it produces a logic 0 output when a switch is pressed. [2]

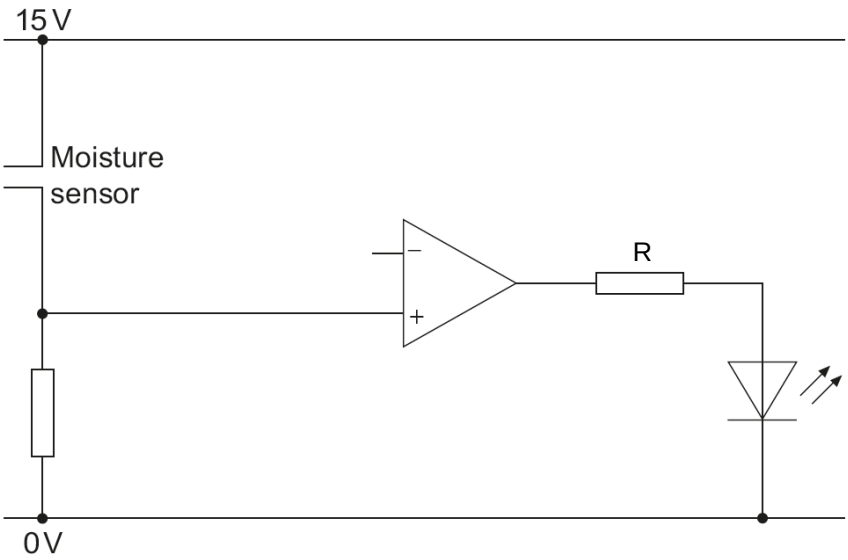
(b) The graph below shows the trigger signal to the monostable. Draw the output at Q if the period of the monostable is 6 s. [2]



4

5. A comparator is used in a system to warn when a plant needs watering.
A moisture sensor is placed in the plant pot. It is connected to the comparator, which lights a high intensity LED when the soil in the plant pot is too dry.

Part of the circuit diagram is shown below.



The comparator has saturation values of 14 V and 0 V.

(a) **Add to the diagram** a single component to provide a variable voltage at the inverting input of the comparator. [2]

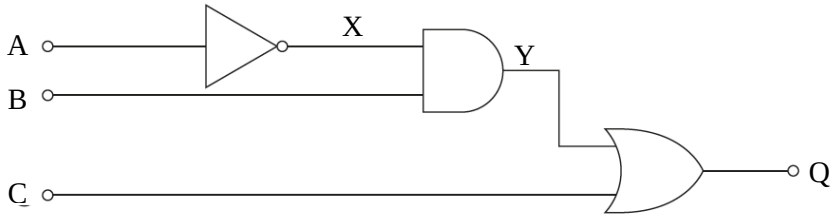
(b) When lit, the LED has a 2 V voltage drop across it, and a current of 40 mA. Calculate the resistance of resistor R, needed to protect the LED when the output of the comparator is in positive saturation. [4]

resistance = ...

(c) Determine the power dissipated in this **resistor** when the LED has a current of 40 mA flowing through it. [3]

power = ...

6. The diagram below shows a logic system.



(a) Write down in terms of the inputs A, B and C the Boolean expressions for: [3]

(i) Output X ……

(ii) Output Y ……

(iii) Output Q ……

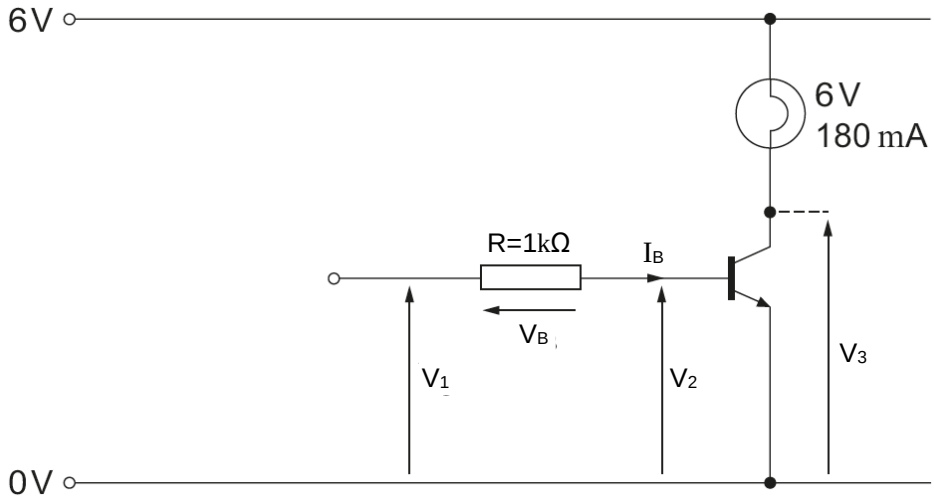
(b) Complete the following truth table for this logic system. [3]

C	B	A	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			

(c) (i) Redraw the logic circuit using NAND gates only. [3]

(ii) Cross out all redundant gates on the diagram above in *(c)* (i). [1]

7. The circuit diagram shows a transistor switch used as a transducer driver.



(a) The input voltage V_1 = 0.2 V. Complete the table below.
The transistor is switched off. [2]

Input voltage, V_1 (V)	**V_2**	**V_3**
0.2		

(b) The lamp is rated at 6 V, 180 mA.
Calculate the power dissipated in the lamp when it is switched on fully. [2]

power = ... mW

(c) The input voltage is changed until the transistor is saturated. The transistor has a current gain (h_{FE}) of 90.

Calculate:

(i) the base current I_B; [2]

I_B = ... mA

(ii) the voltage V_B across the base resistor; [2]

V_B = ... V

(iii) the input voltage V_1 from the sensing system; [1]

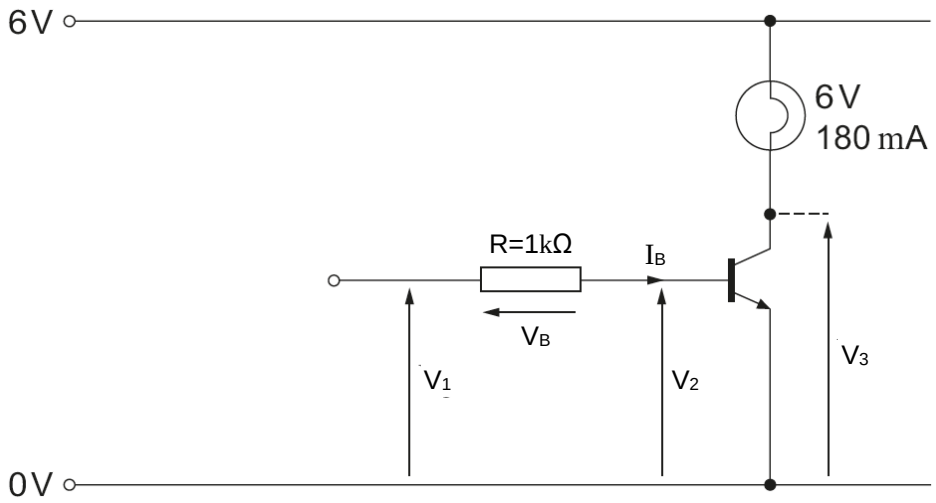
V_1 = ... V

(iv) state the new values of V_2 and V_3. [2]

V_2 = …….

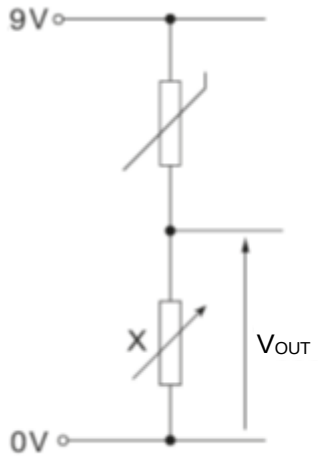
V_3 = …….

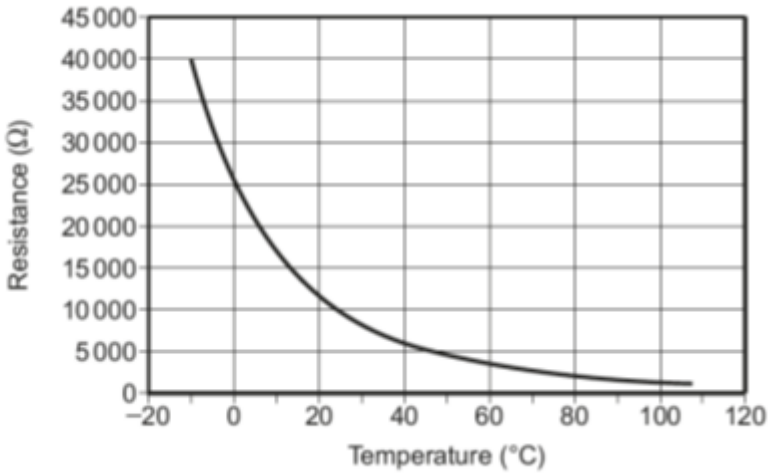
(d) Complete the circuit by adding a suitable light sensing circuit to the input of the transistor switch on the circuit diagram below, so that the lamp comes on in the dark. [2]



13

8. Here is the circuit diagram for a temperature sensing unit and the characteristic curve for the thermistor.





(a) (i) State the resistance of the thermistor at 0 °C. [1]

.....

(ii) The variable resistor is set at a resistance of 5 kΩ. Calculate V_{OUT} at 0 °C. [3]

V_{OUT} = ... V

(b) What happens to V_{OUT} when the temperature increases? [1]

.....

.....

(c) At 40 °C, V_{OUT} needs to be 5.4 V. Determine the new resistance of the variable resistor at 40 °C. [4]

resistance = ... kΩ

(d) The temperature sensor is now connected to a MOSFET. When the temperature is 40 °C a fan is switched on which produces cool air. The fan draws a current of 3 A.

(i) Determine the minimum value of g_M for the MOSFET. [2]

g_m = ... S

(ii) Complete the circuit diagram below to show the final design of the cooling system. [2]

9. Describe a method to investigate the forward-biased I-V characteristics of a silicon diode and explain how to obtain and analyse a series of measurements. [6 QER]

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END OF PAPER

GCSE ELECTRONICS

COMPONENT 1 – Discovering Electronics – SAMPLE ASSESSMENT MATERIAL

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.

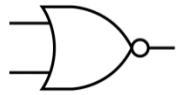
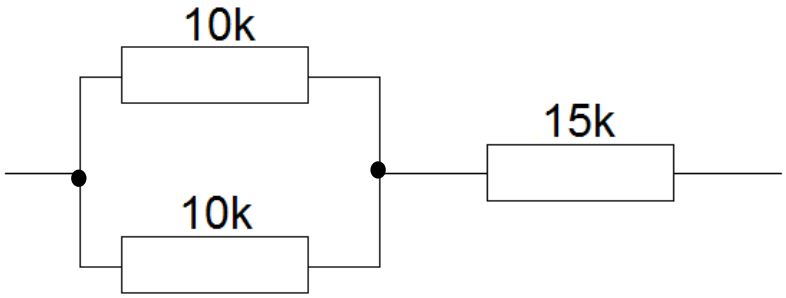
Extended response question

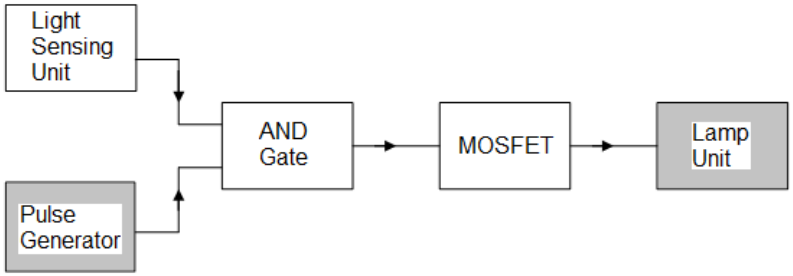
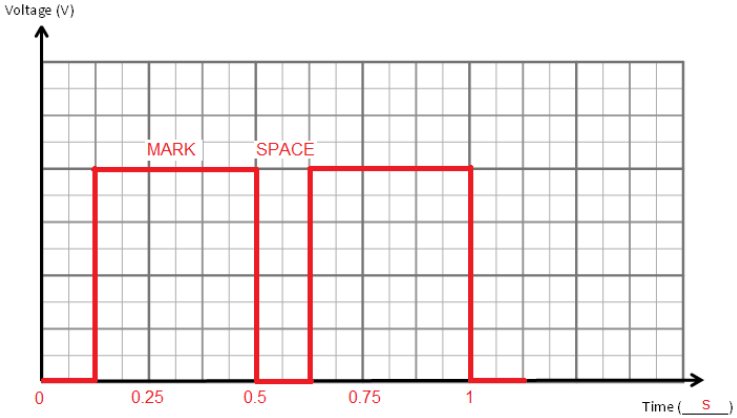
A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide 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.

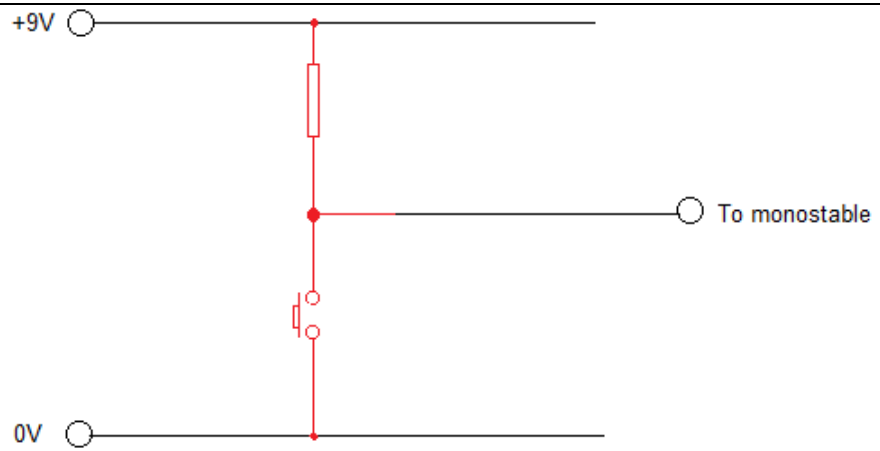
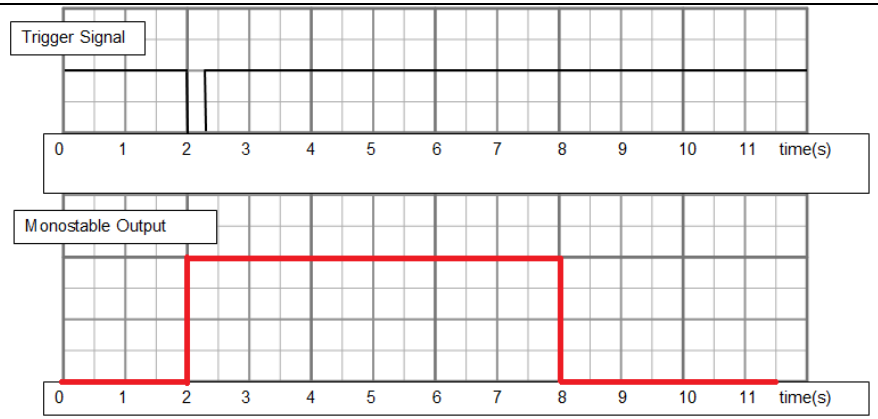
Marking abbreviations

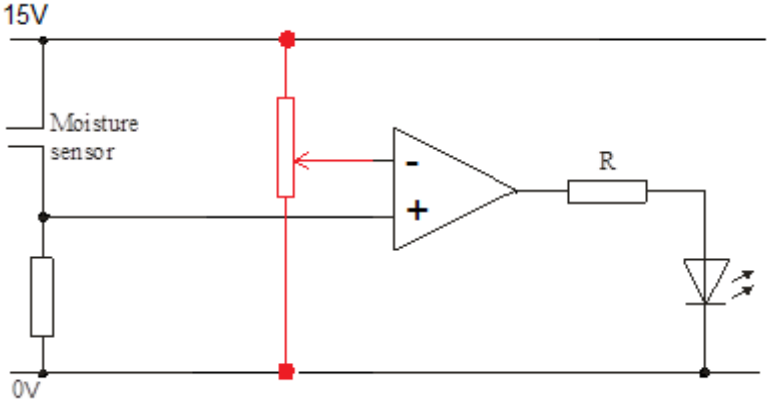
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
1	*a*	i	6	1			1	
		ii	1	1			1	
		iii	C	1			1	
		iv	NOT	1			1	
	b	i		1			1	
		ii		1			1	
	c	i	B	1			1	
		ii	C	1			1	
			Question 1 total	**8**	**0**	**0**	**8**	**0**
2	*a*		B		1		1	
	b		 2 x 10k in parallel (1) 15k in series with parallel branch (either way around) (1)		2		2	1
	c	i	B		1		1	
		ii	I_4 = 5mA – (1mA + 2mA) = 2mA		1		1	
		iii	Band 1 = Brown (1) Band 2 = Black (1) Band 3 = Red (1)	3			3	
			Question 2 total	**3**	**5**	**0**	**8**	**1**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3	*a*		<table><tr><th>Sensing subsystems</th><th>Signal processing</th><th>Output subsystems</th></tr><tr><td>Switch Unit</td><td>Transducer driver</td><td>Lamp Unit</td></tr><tr><td></td><td>Latch</td><td>Solenoid Unit</td></tr><tr><td></td><td>NAND Gate</td><td></td></tr></table> each correct column (1) (no half marks)		3		3	
	b		 each correct sub-system (1)			3	3	
	c		 Correct Ratio (1) Correct identification of Mark & Space (1) Suitable time axis scale (1)	3			3	3
			Question 3 total	**3**	**3**	**3**	**9**	**3**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4	*a*		 Switch and resistor between power rails (1) Switch in lower part of circuit (1)			2	2	
	b		 Pulse starts at 2 s (1) Pulse duration of 6 s (1)		2		2	2
			Question 4 total	**0**	**2**	**2**	**4**	**2**

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths
5	*a*		 Potentiometer added between power rails (1) Correctly connected to comparator input. (1)	2			2	
	b		Voltage across resistor = 14-2 = 12 V (1) Recall $V=IR$ manipulate $I = \frac{V}{R}$ (1) $= \frac{12}{40}$ mA (1) = 300 Ω (1)		4		4	3
	c		Recall $P = I^2R$ (1) $P = (40 \times 10^{-3})^2 \times 300$ (ecf) (1) $P = 0.48$W (1) Accept alternative methods – $P=VI$ or $\frac{V^2}{R}$	3			3	2
			Question 5 total	**5**	**4**	**0**	**9**	**5**

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="4">Marks available</th><th></th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th></tr>
<tr><td>6</td><td>a</td><td>i</td><td>$X = \overline{A}$ accept $\overline{C}.\overline{B}.\overline{A} + \overline{C}.B.\overline{A} + \overline{C}.B.A + C.B.\overline{A}$</td><td></td><td>1</td><td></td><td>1</td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>$Y = \overline{A}.B$ accept $\overline{C}.B.\overline{A} + C.B.\overline{A}$</td><td></td><td>1</td><td></td><td>1</td><td>1</td></tr>
<tr><td></td><td></td><td>iii</td><td>$Q = \overline{A}.B + C$ accept $\overline{C}.B.\overline{A} + C.B.\overline{A} + C$</td><td></td><td>1</td><td></td><td>1</td><td>1</td></tr>
<tr><td></td><td>b</td><td></td><td>
<table>
<tr><th>C</th><th>B</th><th>A</th><th>X</th><th>Y</th><th>Q</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
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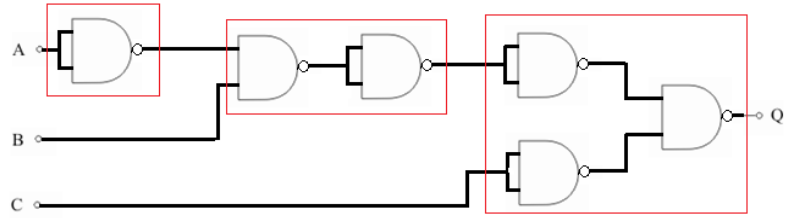
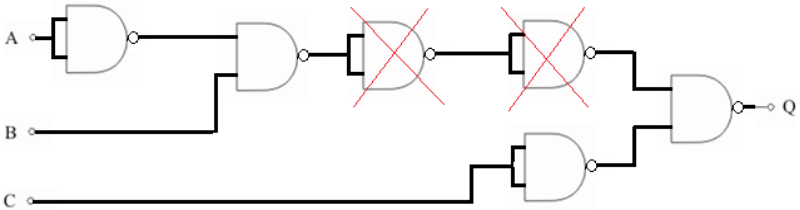
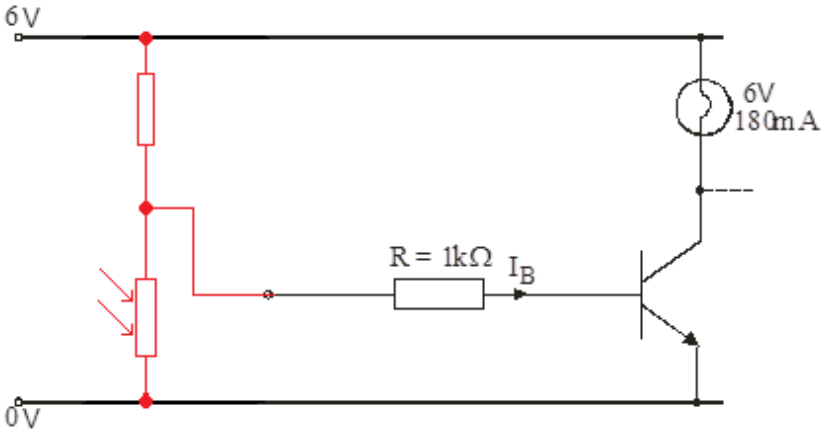
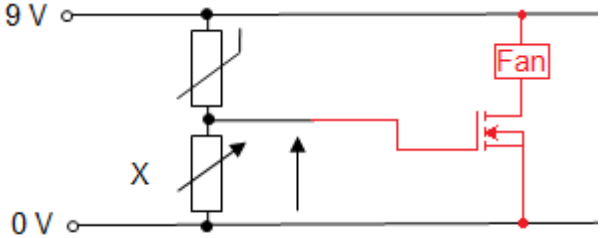
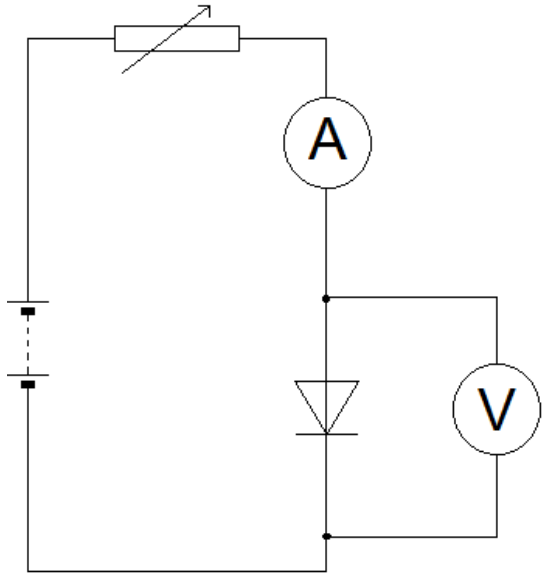
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
</table>
1 mark for each correct column</td><td></td><td>3</td><td></td><td>3</td><td></td></tr>
<tr><td></td><td>c</td><td>i</td><td> 

1 mark for each correct gate replacement</td><td>3</td><td></td><td></td><td>3</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td> 
</td><td>1</td><td></td><td></td><td>1</td><td></td></tr>
<tr><td colspan="3"></td><td>Question 6 total</td><td>4</td><td>6</td><td>0</td><td>10</td><td>3</td></tr>
</table>

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
7	*a*		$V_2 = 0.2\,V$ (1) $V_3 = 6\,V$ (1)	2			2	
	b		Recall Power = Voltage × Current (1) Power = 6 V × 180 mA = 1080 mW accept 1.08 W (1)	1	1		2	1
	c	i	Selection and manipulation $I_C = h_{FE} I_B$ $I_B = \frac{I_C}{h_{FE}} = \frac{180mA}{90}$ (1) Answer = 2 mA (1)		2		2	2
		ii	$V_B = I_B \times R$ (1) $V_B = 2\,mA \times 1\,k\Omega = 2\,V$ (1)	1	1		2	1
		iii	$V_1 = V_B + 0.7$ $V_1 = 2\,V + 0.7\,V = 2.7\,V$	1			1	
		iv	$V_2 = 0.7\,V$ (1) $V_3 = 0\,V$ (1)	2			2	
	d		 LDR and Resistor (accept variable resistor) between power rails (1) LDR at bottom (accept photo diode or photo transistor) (1)			2	2	
			Question 7 total	**7**	**4**	**2**	**13**	**4**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8	*a*	i	25 000 Ω (accept 25 kΩ) ±500 Ω		1		1	
		ii	Correct equation (1) $V_{OUT} = \frac{R_2}{R_1+R_2} \times V_{IN}$ Substitution / correct multipliers (1) $V_{OUT} = \frac{5k}{5k+25k} \times 9$ Answer (1) $= 1.5\ V$ (accept alternative solutions of ratios or using current divider)	1 1	 1		3	2
	b		the output voltage increases.		1		1	
	c		Correct equation (1) $V_{OUT} = \frac{R_2}{R_1+R_2} \times V_{IN}$ Substitution / correct multipliers (1) $5.4 = \frac{R_2}{6k+R_2} \times 9$ Manipulation (1) $5.4(6k + R_2) = 9R_2$ $32.4k + 5.4R_2 = 9R_2$ $32.4k = 9R_2 - 5.4R_2$ $R_2 = \frac{32.4k}{3.6}$ Answer (1) $= 9k\Omega$	1	 1 1 1		4	3
	d	i	Selection and manipulation $I_D = g_M(V_{GS} - 3)$ $3 = g_M \times (5.4-3)$ $g_M = \frac{3}{(5.4-3)}$ (1) Answer $= 1.25\ S$ (1)		2		2	2
		ii	 Correct components (1) Correct connection of components (1)			2	2	2
			Question 8 total	**3**	**8**	**2**	**13**	**9**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9			Indicative Content:  Suitable circuit drawn or described that will generate the I-V pairs required to produce the I-V characteristic. Description of varying resistance. **– AO3 allocation** Description of collecting I-V pairs for at least ten different voltage readings by variable resistor. **– AO1 allocation** Plot of I (*y*-axis) – V (*x*-axis) graph to show the characteristic curve. **– AO2 allocation** **5-6 marks** A circuit diagram or a detailed description of the circuit (which is fully functional) is provided. A description of how to collect a full range of results to produce the characteristic is clear. Detailed description of which graph to plot. *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.*	2	3	1	6	

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9			**3-4 marks** A basic circuit diagram or a description of a suitable circuit is provided for obtaining the results required– possibly missing a method of varying the voltage / current. There is a plan to collect $I - V$ measurements with an attempt to describe which graph to plot to show the characteristic curve. *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 produce a circuit diagram or a description of the circuit setup, even though it may not produce the results required. Limited description of the need to collect a variety of results, or no explanation of how a variety of results could be obtained. *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 circuit diagram or any appropriate suggestion of how to collect the relevant data to show the characteristic of a diode. *Response not creditworthy or not attempted.*					
			Question 9 total	**2**	**3**	**1**	**6**	**0**
			TOTAL	**35**	**35**	**10**	**80**	**27**

Candidate Name	Centre Number					Candidate Number				

GCSE ELECTRONICS

COMPONENT 2

Application of Electronics

SAMPLE ASSESSMENT MATERIAL

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	7	
2.	4	
3.	9	
4.	10	
5.	8	
6.	10	
7.	6	
8.	13	
9.	7	
10.	6	
Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Answer **all** questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **10**.

INFORMATION SHEET

Resistor colour codes

black	0
brown	1
red	2
orange	3
yellow	4

green	5
blue	6
violet	7
grey	8
white	9

The fourth band colour gives the tolerance as follows:

gold ± 5%

silver ± 10%

Resistor E24 series values

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91

Useful equations

$$P = \frac{V^2}{R}$$

$$V_{OUT} = \frac{R_2}{R_1 + R_2} V_{IN}$$

$$I_D = g_M (V_{GS} - 3)$$

$$I_C = h_{FE} I_B$$

$$\overline{A + B} = \overline{A}.\overline{B}$$

$$\overline{A.B} = \overline{A} + \overline{B}$$

$$G = \frac{V_{OUT}}{V_{IN}}$$

$$G = 1 + \frac{R_F}{R_1}$$

$$G = -\frac{R_F}{R_{IN}}$$

$$V_{OUT} = -R_F \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + ... \right)$$

$$T = 1.1RC$$

$$f = \frac{1}{T}$$

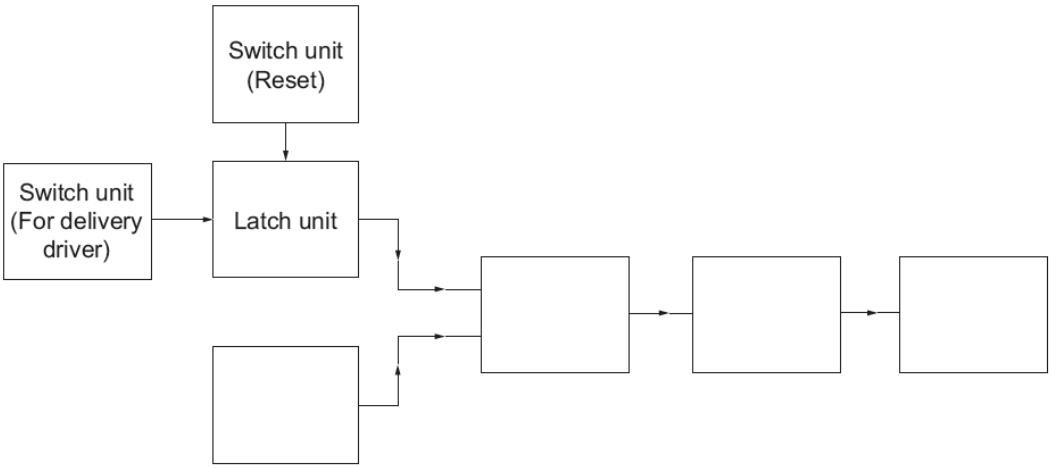
$$f = \frac{1.44}{(R_1 + 2R_2)C}$$

$$\frac{T_{ON}}{T_{OFF}} = \frac{R_1 + R_2}{R_2}$$

Answer **all** *questions*.

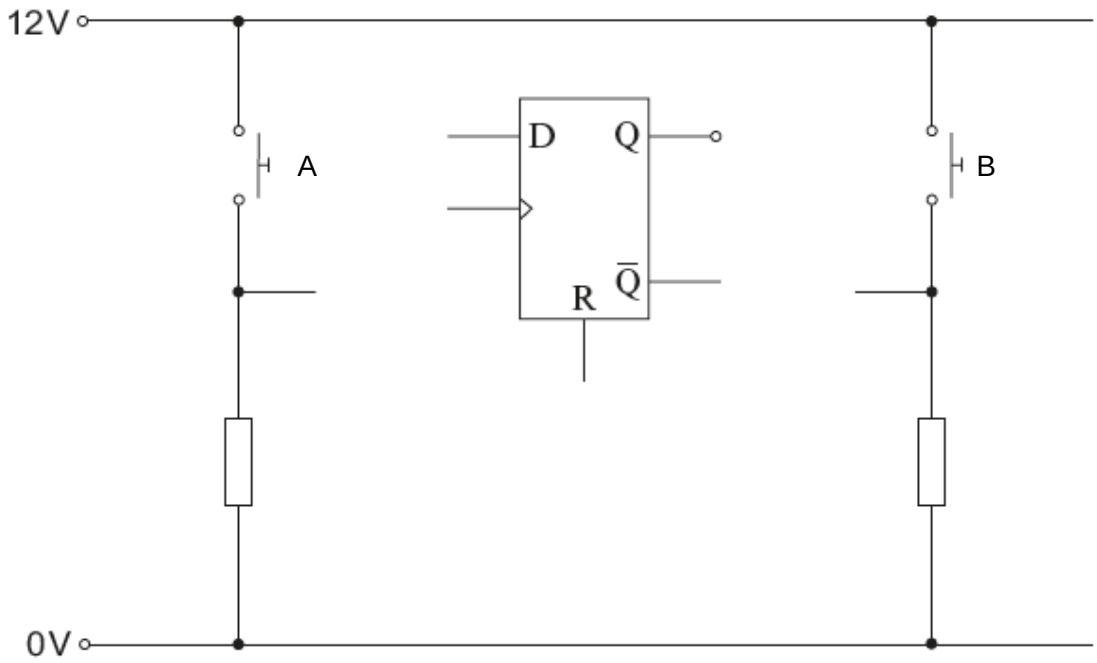
1. A shop owner requires a notification system to alert the staff when a delivery driver arrives.

(a) The system must produce a high power flashing light. Once triggered it must continue to flash until reset. Complete the design for the notification system. [4]

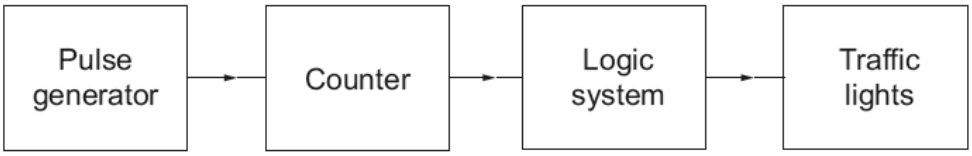


(b) A D-type flip-flop is used as the latch.
Complete the circuit diagram of the latch below so that: [3]

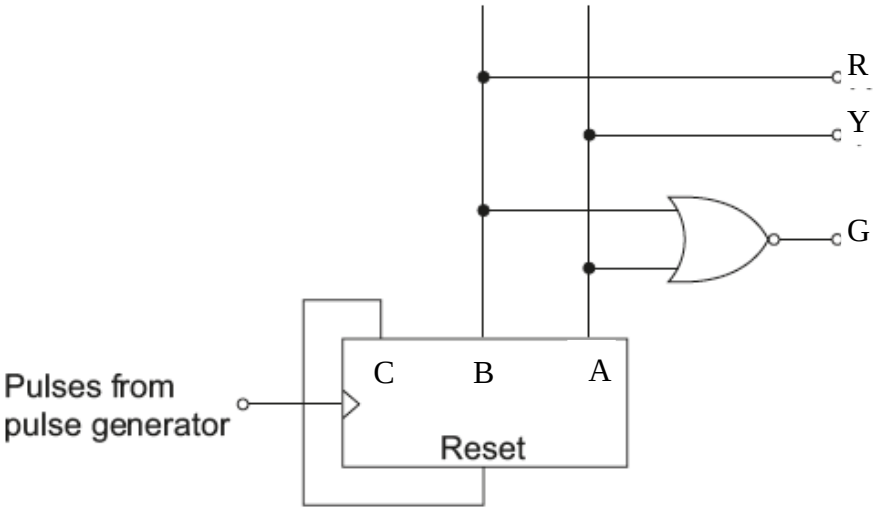
- switch A will set (trigger) the latch;
- switch B will reset the latch.



2. A student designs a set of traffic lights for a model village.
Here is the block diagram for the control system.



The circuit diagram for the counter is shown below.



(a) State the Boolean equation for output G. [1]

.....

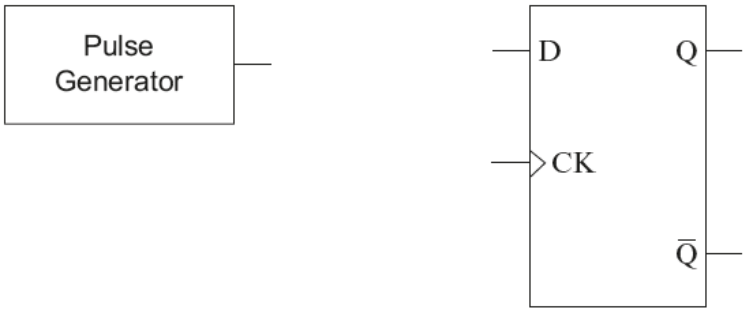
(b) The table shows the possible output states for the counter.

Pulse number	Counter outputs			Outputs		
	C	**B**	**A**	**R**	**Y**	**G**
0	0	0	0	0	0	1
1	0	0	1			
2	0	1	0			
3	0	1	1			
4	1	0	0	Reset		

Use the counter outputs to decide what signals are sent to the traffic lights.
Complete the table to show whether logic 0 or logic 1 signals are sent to the **R, Y and G outputs**. [3]

4

3. A D-type flip-flop can be used as a one-bit counter.



(a) Complete the diagram of the one-bit counter: [2]

(i) by adding the connections required on the diagram;

(ii) by connecting the pulse generator.

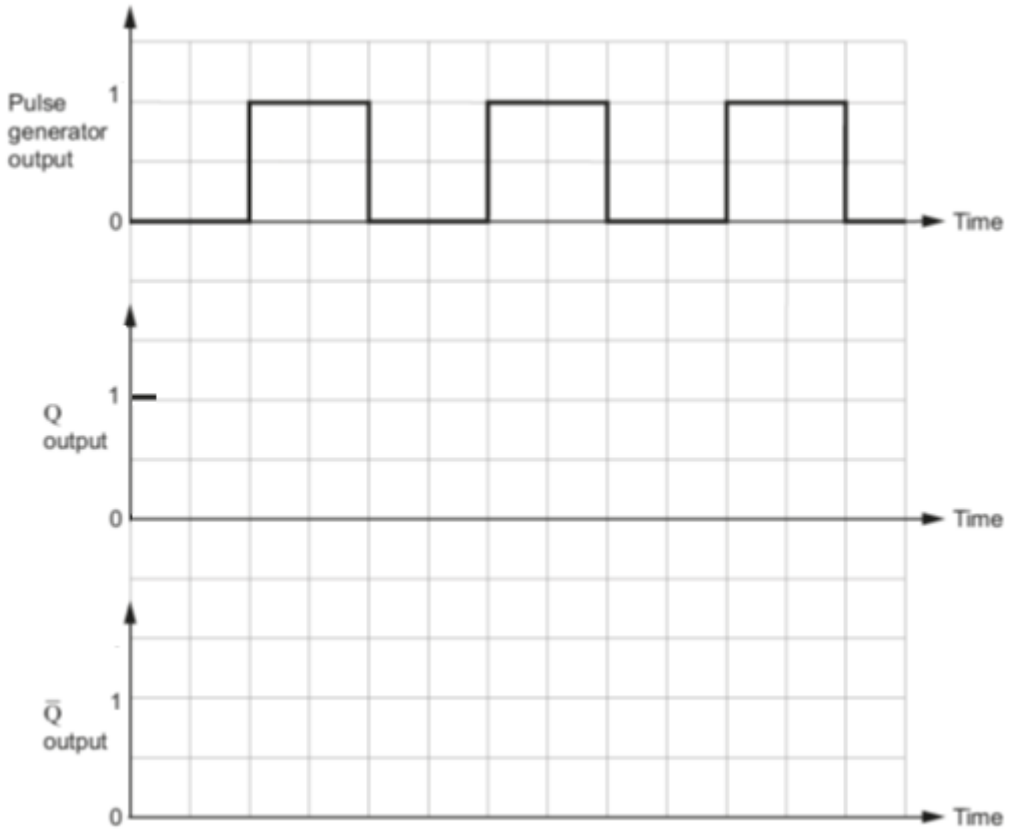
(b) The D-type flip-flop is rising-edge triggered.

On the graphs below:

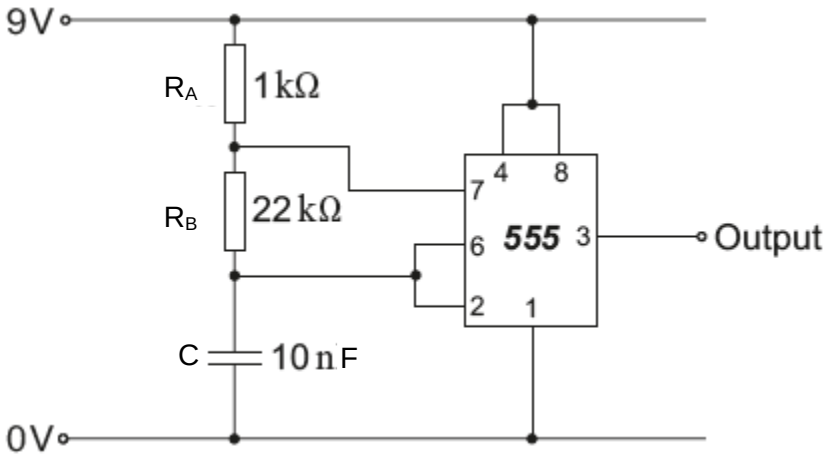
(i) Label a rising-edge on the pulse generator output. [1]

(ii) The Q output is initially at logic level 1. Complete its signal. [2]

(iii) Draw the signal at the $\overline{Q}$ output. [1]



(c) The pulse generator is made from the following 555 circuit sub-system.



Select and use a formula to calculate the output frequency. [3]

frequency = ...Hz

9

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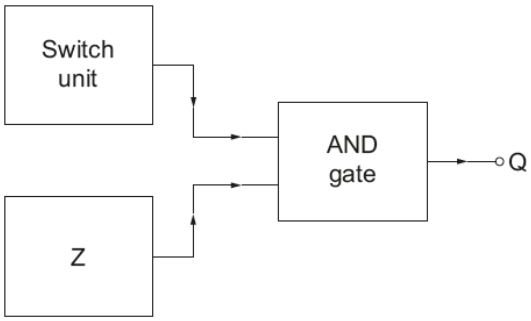
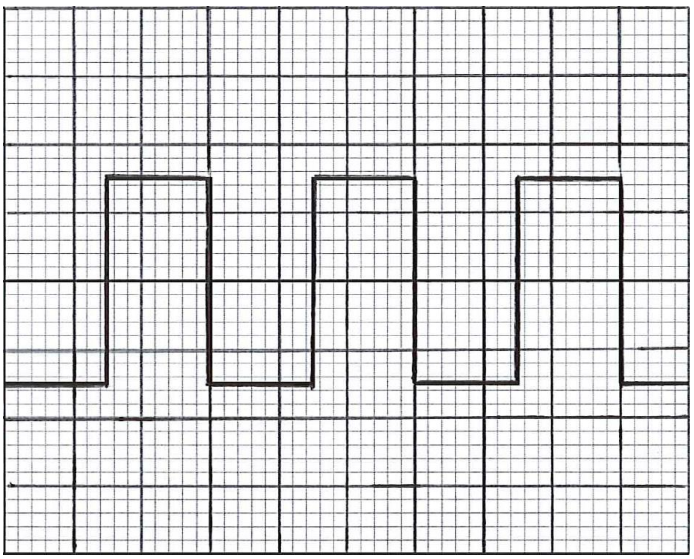
4. *(a)* Here is the block diagram for part of a counting system:



The waveform below shows the output signal produced by this system on an oscilloscope.



(i) State the name of sub-system Z. [1]

.....

(ii) The volt per division setting on the oscilloscope is set at 5 V/cm. Determine the amplitude of the output signal. [2]

amplitude = ... V

(iii) The time base setting on the oscilloscope is set at 20 ms/cm.

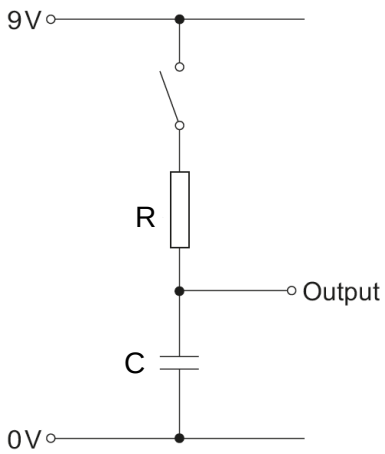
I Determine the period of the signal. [2]

period = ... ms

II Calculate the frequency of the output signal. [2]

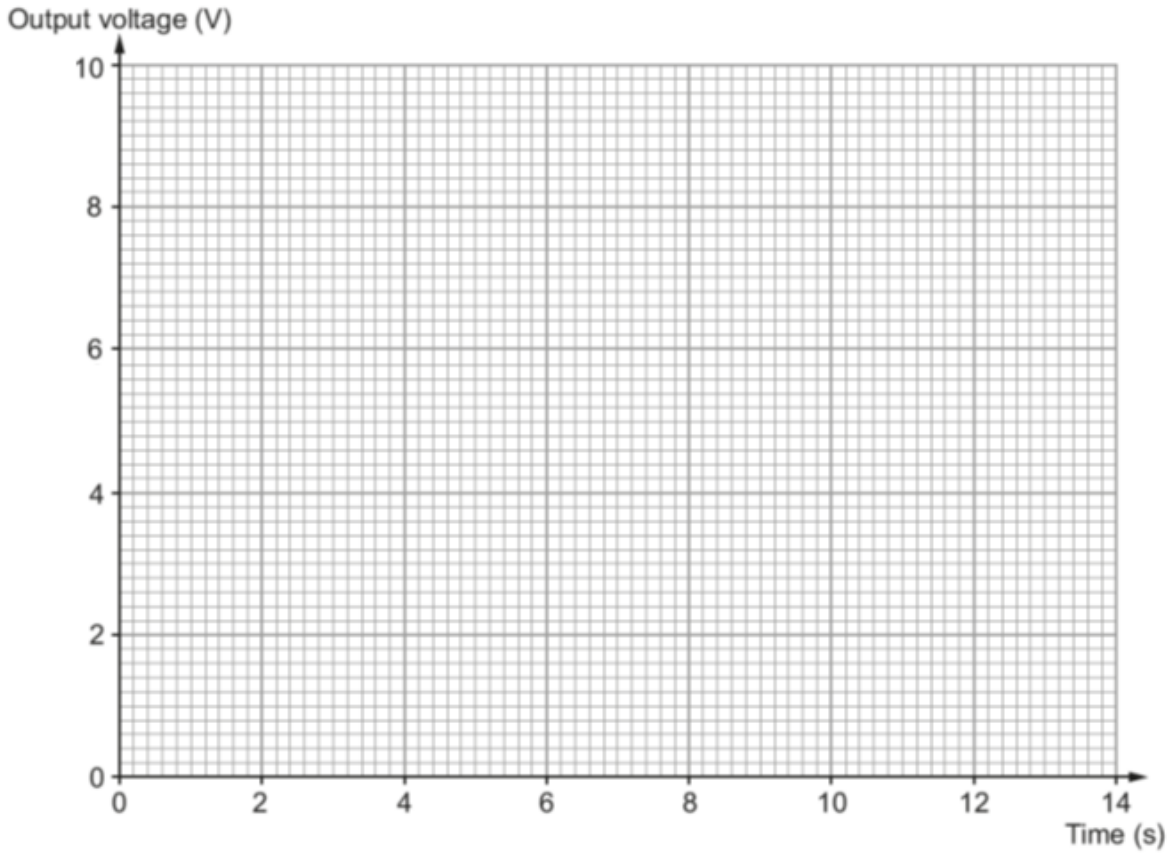
frequency = ...Hz

(b) Here is the circuit diagram for a different timing sub-system:



To begin with, the output is 0 V. The switch is then closed at time = 0.

Draw on the graph below what happens when the switch is closed **and left closed**. [3]



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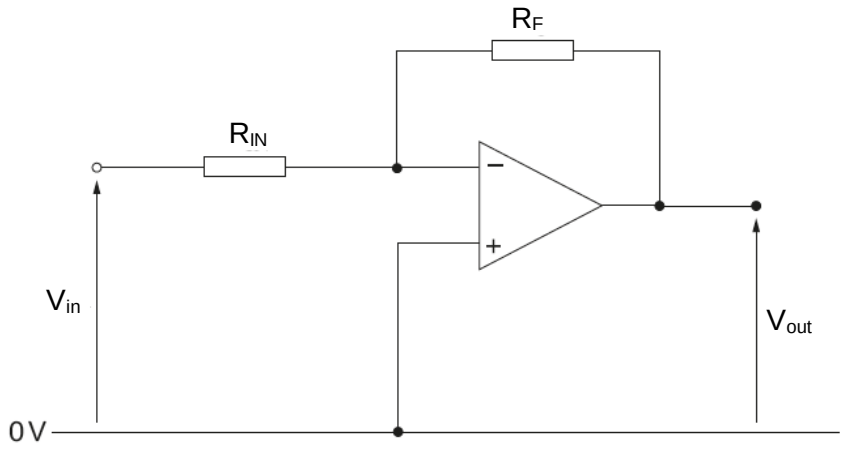
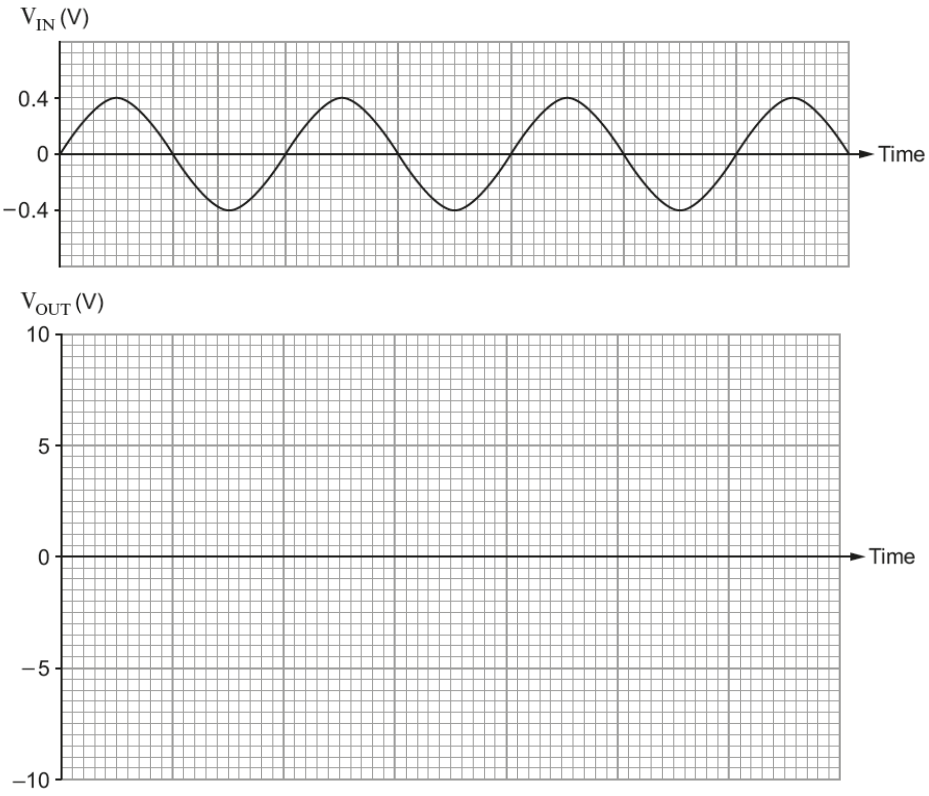
5. *(a)* The following circuit diagram shows an op-amp inverting amplifier. The power supply is ±15 V.



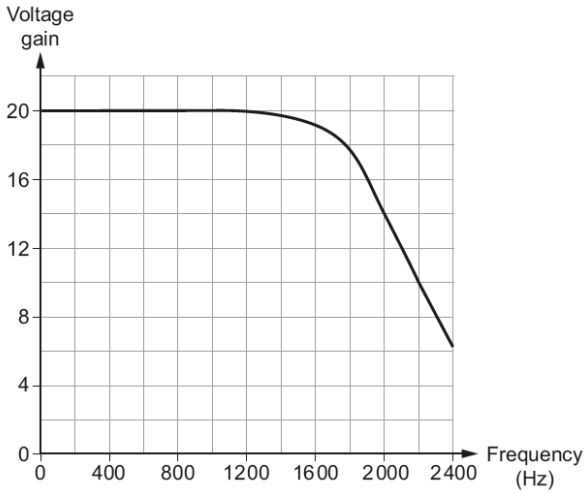
(i) A voltage gain of 20 is required. Choose suitable values for R_F and R_{IN}. [3]

R_F ..... R_{IN} .....

(ii) An AC voltage of peak value 0.4 V is applied to the input.
Complete the graph to show the corresponding output voltage. [3]



(b) The graph shows the effect on the amplifier's voltage gain of changing the signal frequency.



Determine the bandwidth of the amplifier. Show on the graph how you obtained your answer. [2]

Bandwidth = …….. Hz

8

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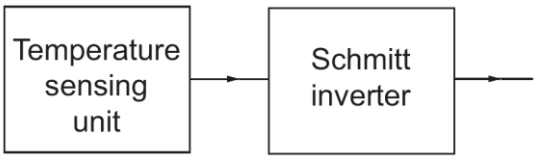
6. *(a)* A control system for a greenhouse includes a temperature sensing sub-system consisting of:

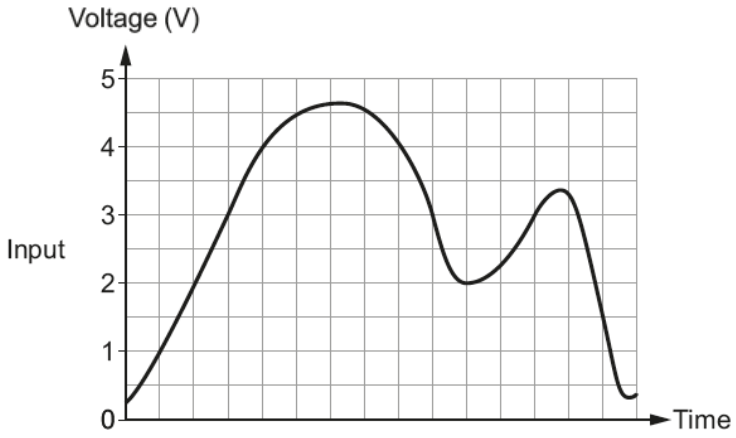


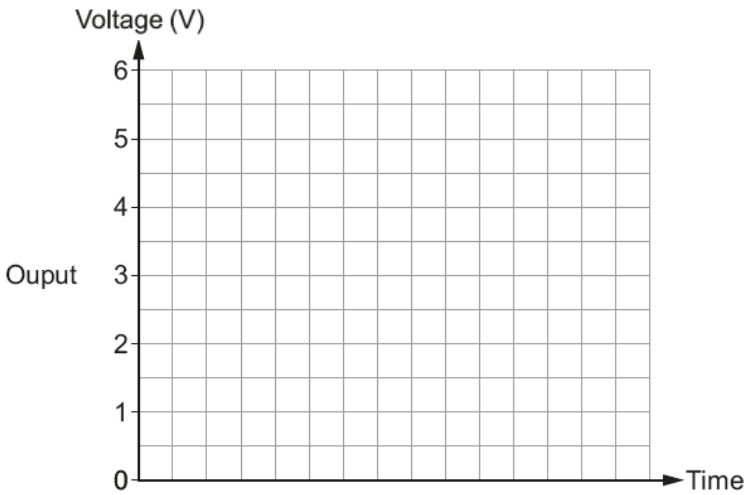
Here is part of the data sheet for the Schmitt inverter.

When connected to 5 V supply:

- Logic 0 = 0 V
- Logic 1 = 5 V
- The output changes from logic 1 to logic 0 when a **rising** input voltage reaches 3 V
- The output changes from logic 0 to logic 1 when a **falling** input voltage reaches 1 V

The output of the temperature sensing unit is shown below.
Use the axes provided to draw the resulting output signal produced by the Schmitt inverter. [4]

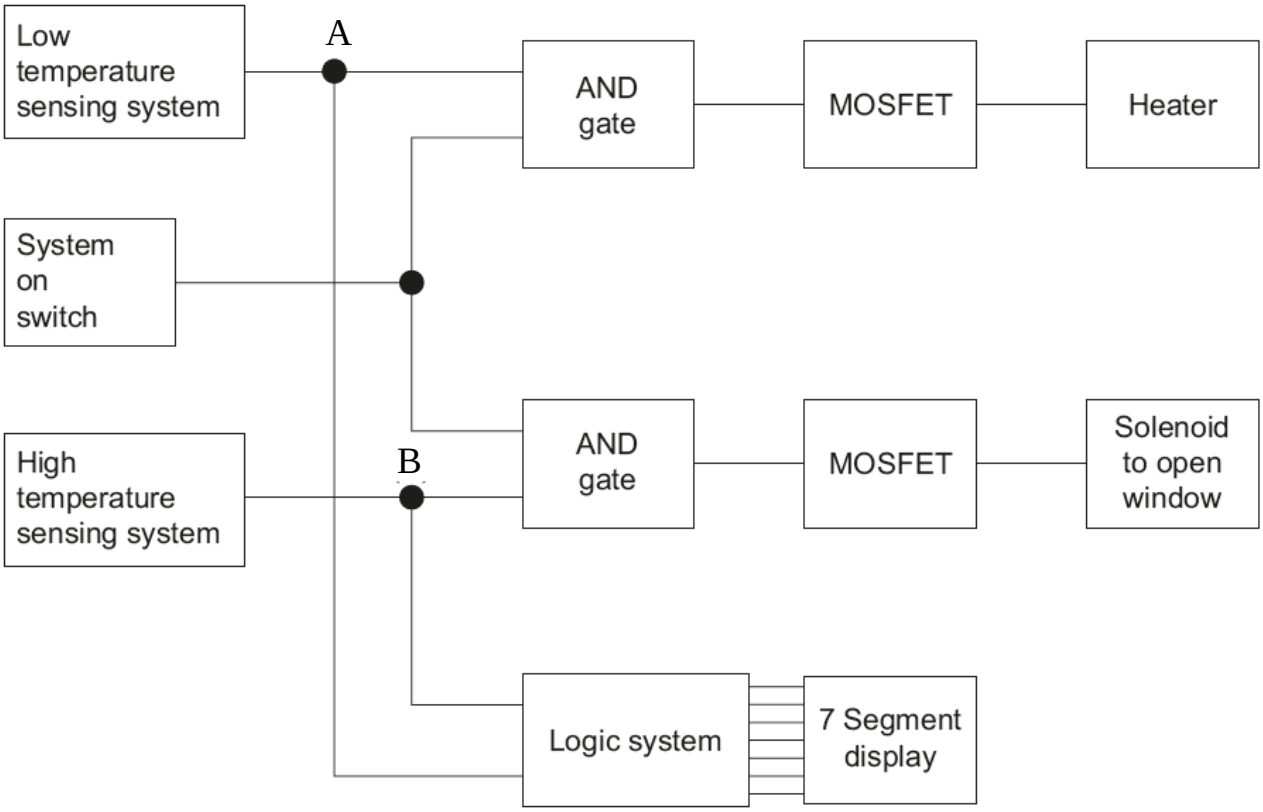




(b) The following block diagram shows the control system for the greenhouse.
The system monitors the temperature of the greenhouse with two temperature sensing sub-systems.
One checks if the temperature is too low, and one checks if it is too high.

The heater switches on when the temperature is too low.
A window opens when the temperature is too high.
The heater switches off and the window closes when the temperature is normal.

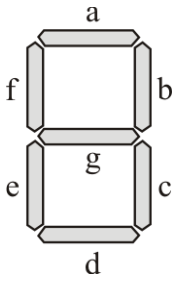
A master switch controls the system and outputs a logic 1 when the system is switched on.

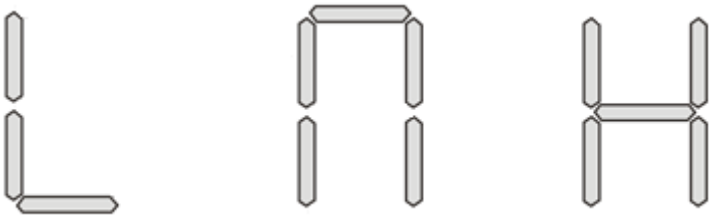


The low temperature sensing sub-system outputs a logic 1 at **A** when the temperature is too low.

The high temperature sensing sub-system outputs a logic 1 at **B** when the temperature is too high.

The 7-segment display indicates the temperature in the greenhouse. The display needs to show the following display for low, normal and high temperatures respectively.





A Logic 1 applied to the segment causes it to light up.

(i) State which output combination of sensors A and B will never occur. [1]

.....

(ii) Complete the relevant rows in the table to show the signals that need to be produced by the logic system to display the required letters L N and H. [3]

Inputs		**Outputs**						
B	**A**	**a**	**b**	**c**	**d**	**e**	**f**	**g**
0	0							
0	1							
1	0							
1	1							

(iii) State which outputs do not need to be controlled by the logic system and how they should be connected. [2]

.....

.....

.....

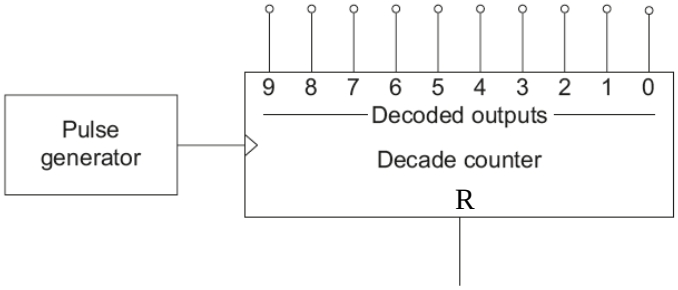
.....

.....

.....

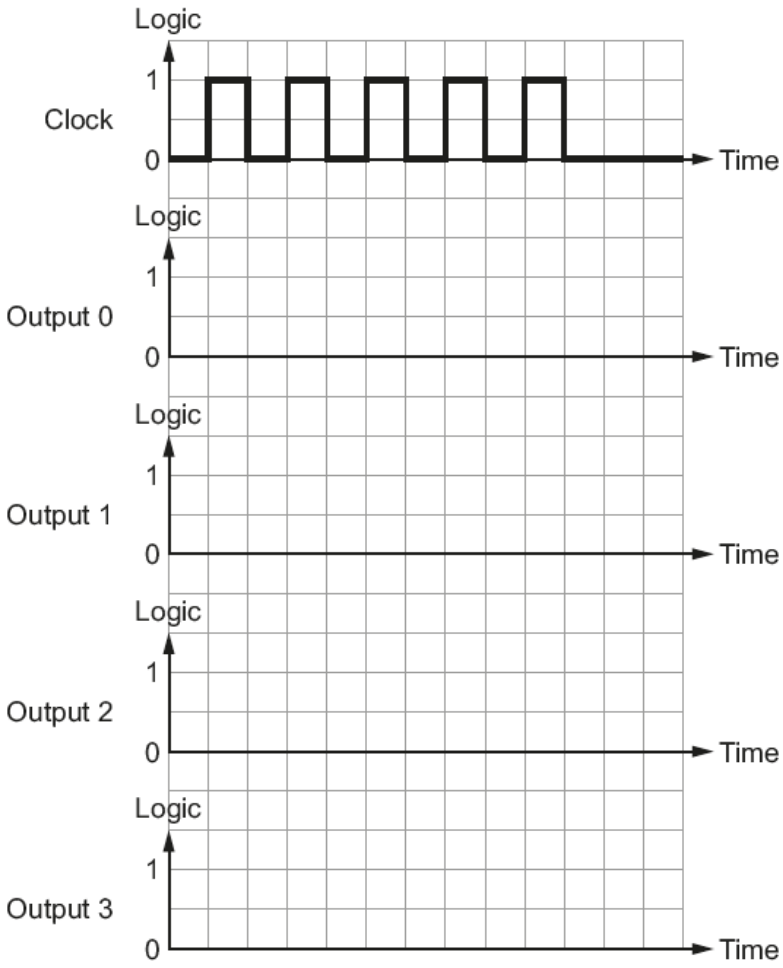
10

7. The diagram shows a pulse generator connected to the clock input of a decade counter.

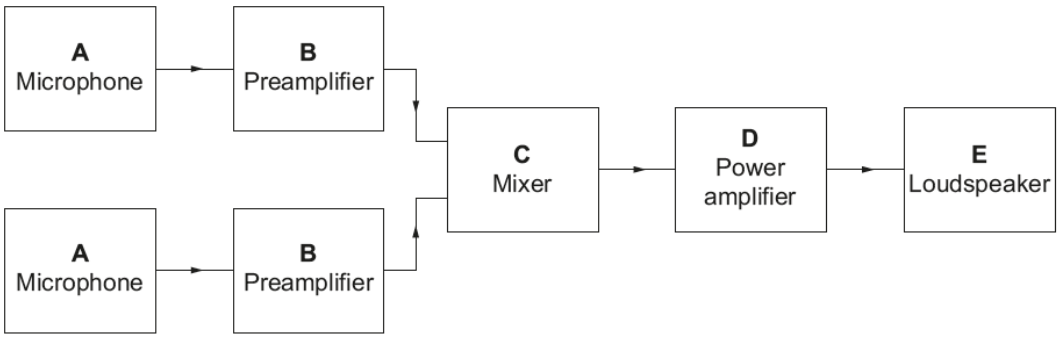


(a) **Add to the diagram** the connections and any components needed to reset the counter after outputs 0, 1, 2 and 3 have gone high so that the pattern repeats. [1]

(b) The counter operates on the rising edge of the clock pulses and the initial state of the outputs is shown in the graph below.
Complete the graph. [5]



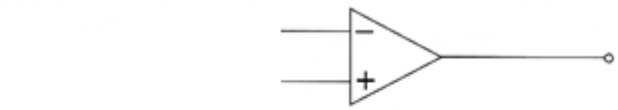
8. The block diagram represents a typical amplifier system.



(a) State which of the blocks is designed to boost the current delivered to the sub-system that follows it. [1]

Answer .....

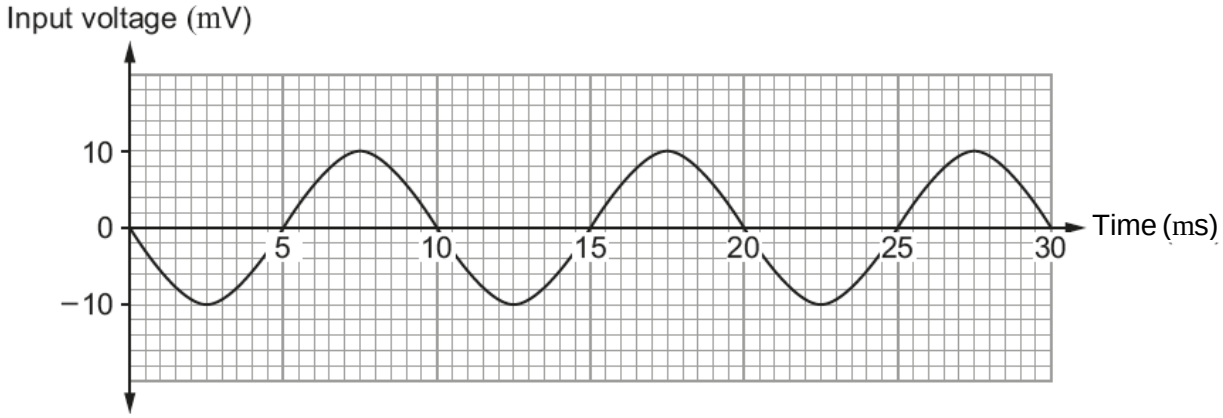
(b) Draw the circuit diagram for one of the preamplifiers which uses a non-inverting amplifier. [3]



(c) Determine the resistor values required for the preamplifier to produce a gain of 40. [3]

Resistor values .....

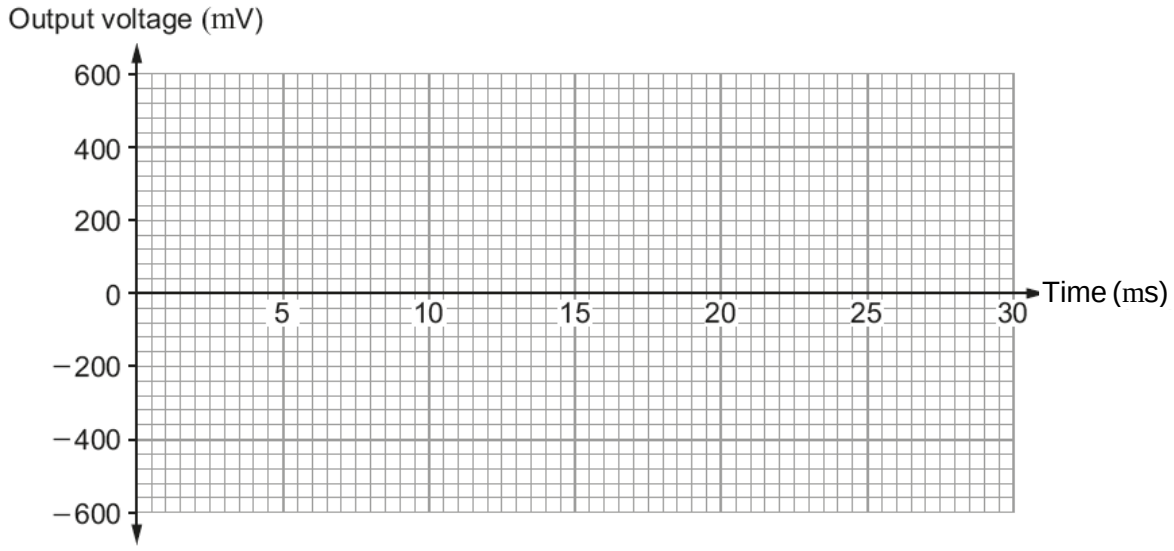
(d) Each preamplifier has a gain of **40**.
The input voltage signal from the microphone is shown below.



(i) Calculate the peak value (amplitude) of the **output voltage of the preamplifier** in mV. [2]

peak value.....mV

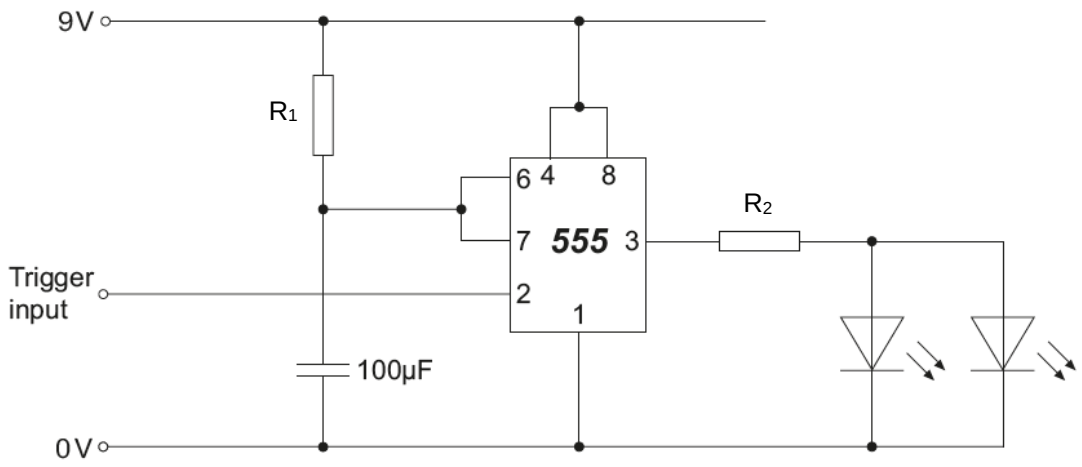
(ii) Draw a graph of this output voltage on the grid below. [2]



(e) The gain-bandwidth product of the amplifier is 1.6 MHz. Calculate the bandwidth of the amplifier. [2]

bandwidth = ... Hz

9. A 555 timer can be used to produce a simple delay circuit.
The circuit diagram shows a monostable circuit using a 555 timer.



(a) The time delay is 10 seconds. Select and use an equation to calculate a suitable value for resistor R_1. [3]

Resistor R_1 = ...kΩ

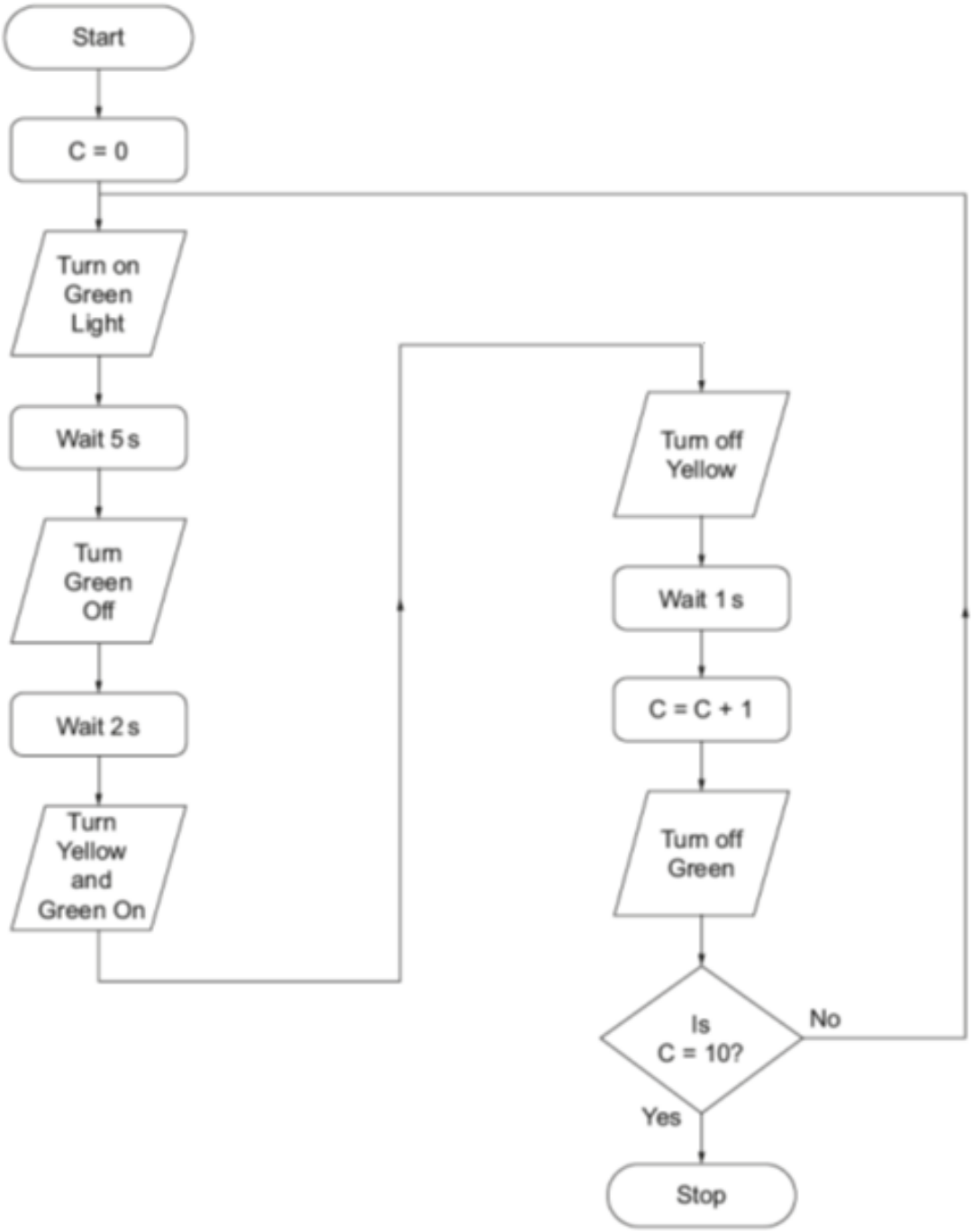
(b) The output voltage of the 555 timer is 8.8 V when high. The voltage across each LED is 2 V.

The E24 series colour code of the resistor R_2 is Orange Black Brown.
Calculate the current flowing in each LED. [4]

current = ... A

7

10. The following flowchart represents the function of a control system.



The specification for the system is:

- The light sequence starts when limit switch A is pressed
- The light sequence must operate as follows:
    - The green light is switched on for 5 seconds before being switched off
    - 2 seconds later the yellow and green lights are switched on
    - After 3 seconds the yellow light is switched off
    - 1 second later the green light is switched off
- The light sequence must repeat 12 times

Evaluate the function of the system shown in the flowchart against the specification and suggest any improvements required to fully meet the specification. [6 QER]

END OF PAPER

6

GCSE ELECTRONICS

COMPONENT 2 – Application of Electronics – SAMPLE ASSESSMENT MATERIAL

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.

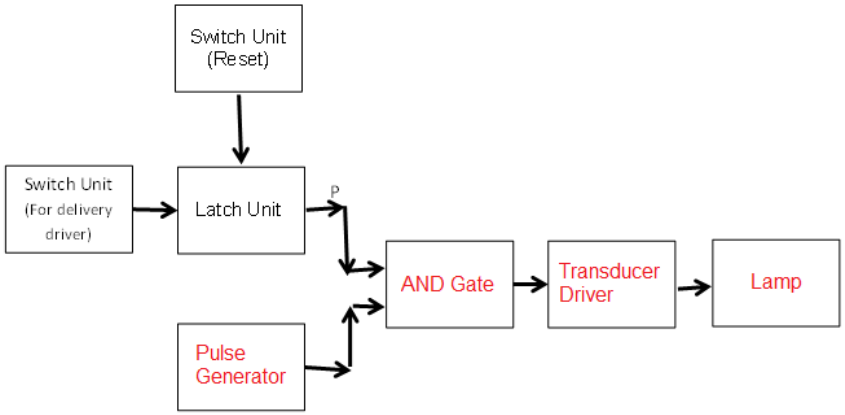
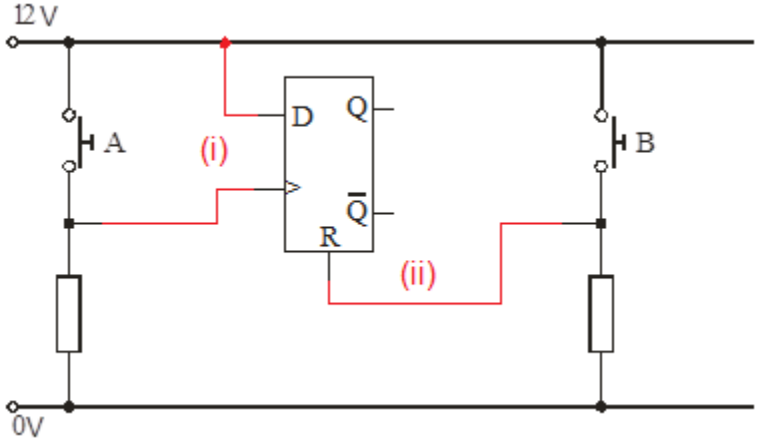
Extended response question

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.

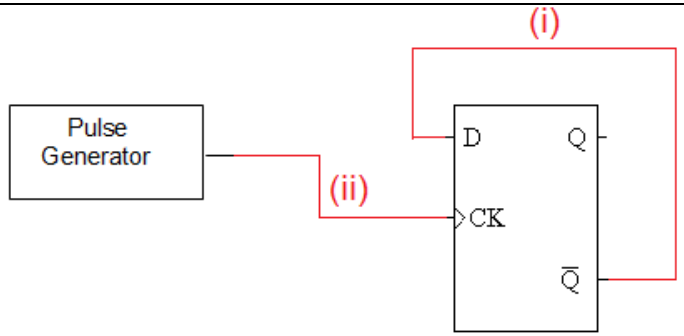
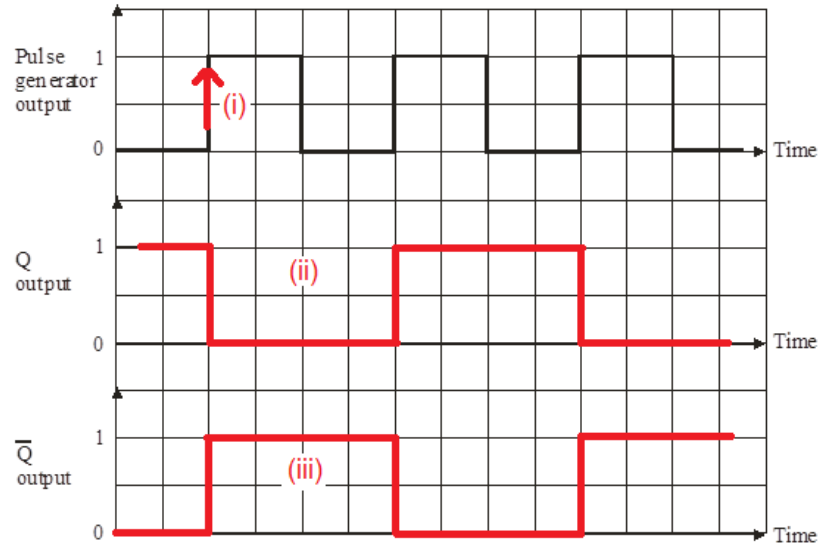
Marking abbreviations

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

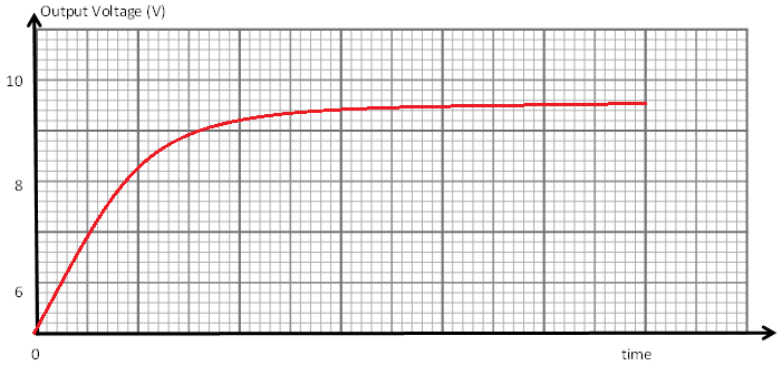
cao = correct answer only
ecf = error carried forward

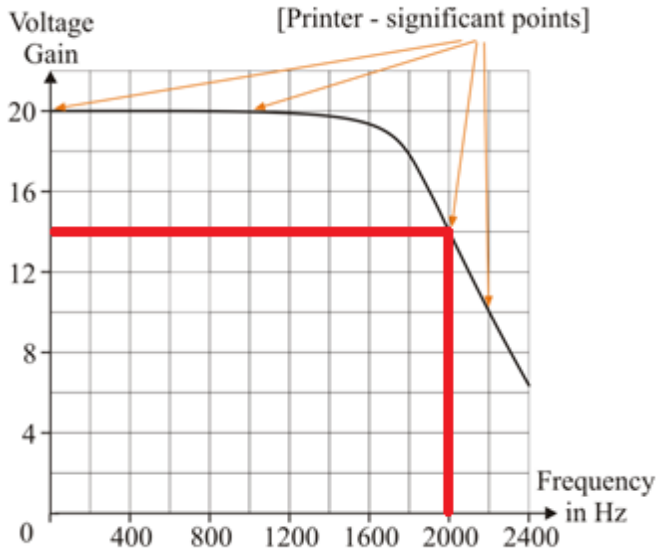
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
1	*a*		 For each correct sub-system (1)			4	4	
	b		 Switch A connected to clock (1) Switch B connected to reset (1) D connected to 12 V(1)	3			3	
			Question 1 Total	**3**	**0**	**4**	**7**	**0**

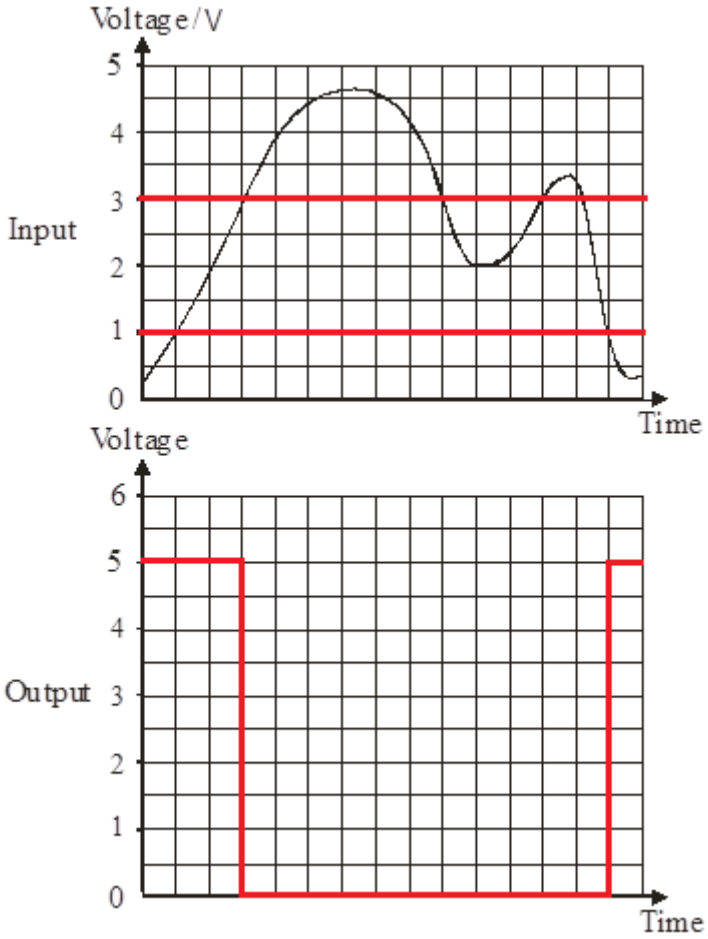
<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="4">Marks available</th><th></th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th></tr>
<tr><td>2</td><td>a</td><td></td><td>G = $\overline{A}.\overline{B}$ or $\overline{A+B}$</td><td></td><td>1</td><td></td><td>1</td><td>1</td></tr>
<tr><td></td><td>b</td><td></td><td>
<table>
<tr><th rowspan="2">Pulse number</th><th colspan="3">Counter outputs</th><th colspan="3">Traffic lights</th></tr>
<tr><th>C</th><th>B</th><th>A</th><th>Red light</th><th>Yellow light</th><th>Green light</th></tr>
<tr><td>0</td><td>0</td><td>0</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>0</td><td>1</td><td>0</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>4</td><td>1</td><td>0</td><td>0</td><td colspan="3">Reset</td></tr>
</table>
For each correct row in the table (1)</td><td></td><td>3</td><td></td><td>3</td><td></td></tr>
<tr><td colspan="3"></td><td>Question 2 Total</td><td>0</td><td>4</td><td>0</td><td>4</td><td>1</td></tr>
</table>

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3	*a*							
		i	Connection required from D to $\overline{Q}$ (1)					
		ii	Connection from pulse generator to CK (1)	2			2	
	b	i ii iii						
			Notes: i) Allow a mark for any correct rising edge identified (1)	1				
			ii) Falling edge on first rising edge (1)		1			
			Transitions on remaining two rising edges (1)		1			
			iii) $\overline{Q}$ output as the inverse of Q, allow e.c.f. for incorrect Q (1)	1			4	

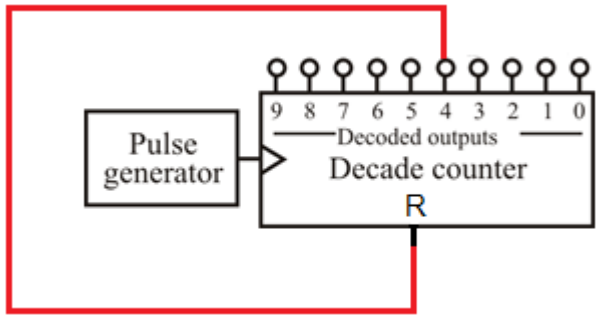
Question			Marking details		Marks available			
				AO1	AO2	AO3	Total	Maths
3	*c*		Selection of $f = \frac{1.44}{(R_1+2R_2)C}$ (1) Substitution of $f = \frac{1.44}{(1000+44000)\times10\times10^{-9}}$ (1) f = 3 200Hz (1)	1	 1 1		 3	 2
			Question 3 Total	**5**	**4**	**0**	**9**	**2**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4	*a*	i	Astable	1			1	
		ii	Signal Amplitude = 3.2 cm from oscilloscope (1) Actual amplitude = 3.2 × 5 = 16 V (1)	2			2	1
		iii	I 1 Cycle = 3cm from oscilloscope (1) Time of 1 cycle = 3 × 20 ms = 60 ms (1) II Frequency = $\frac{1}{T} = \frac{1}{60\ ms}$ (1) = 16.67 Hz (1)	1 1	1 1		4	3
	b		 Increase in voltage when switch closed at time zero (1) Decrease in gradient to zero (1) Max voltage of 9 V (1)	1 1	1		3	1
			Question 4 Total	**7**	**3**	**0**	**10**	**5**

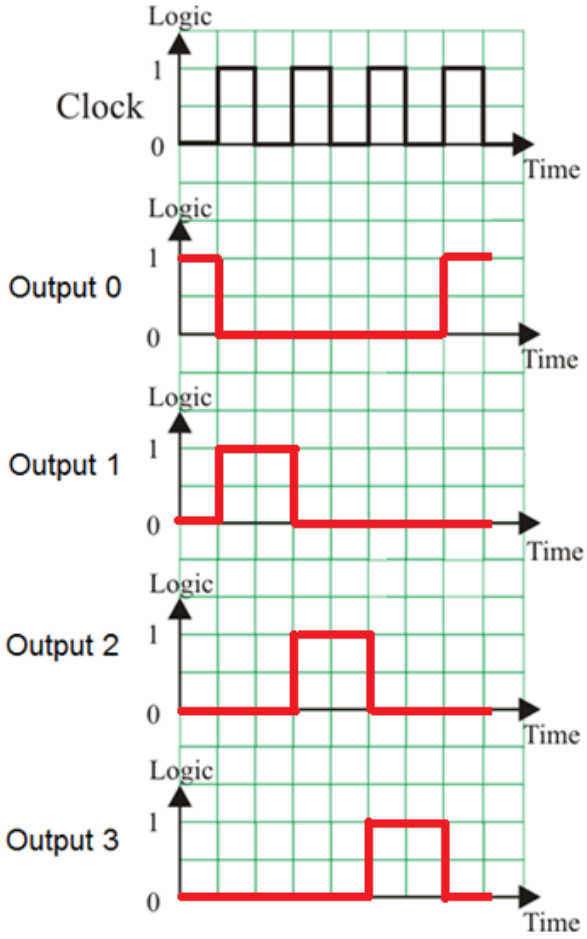
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
5	*a*	i	Selection and use of $\text{Gain} = -\frac{R_F}{R_{IN}}$ $R_F = R_{IN} \times \text{Gain}$ $R_F = R_{IN} \times 20$ $R_F = 20R_{IN}$ (1) Choice of R_{IN} > 1k (1) $R_F = 20 \times R_{IN}$ (1)	1 1	1		3	2
		ii	Sine wave with amplitude ± 8 V (0.4 × 20) (1) Same frequency (1) Inverted (1)	1 1	1		3	1
	b		 Line on graph at 14 (0.7 × Max gain) (1) Correct reading of frequency 2 000 Hz (1)	1	1		2	2
			Question 5 Total	**5**	**3**	**0**	**8**	**5**

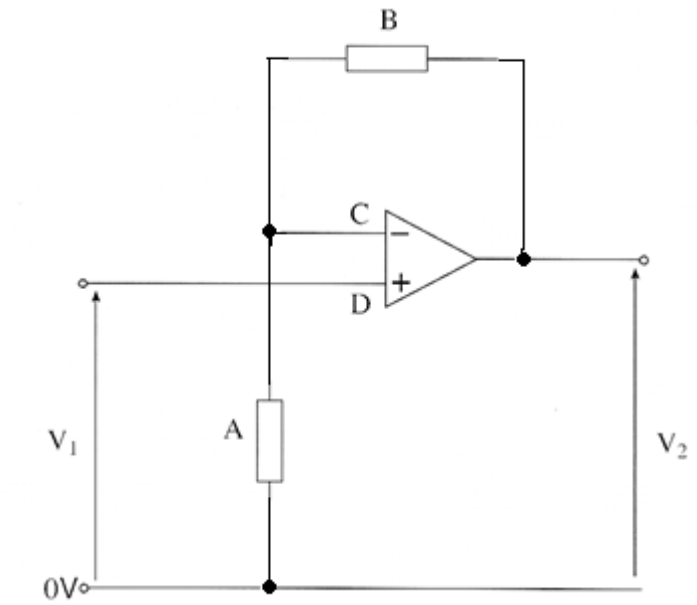
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6	*a*							
			Output initially at 5 V (1)	1				
			Output drops to 0 V at instant input reaches 3 V (1)		1			
			Output remains at 0 V until input falls below 1 V (1)	1				
			Output rises to 5 V when input falls below 1 V (1)		1		4	

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="4">Marks available</th><th></th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th></tr>
<tr><td>6</td><td>b</td><td>i</td><td>A = 1, B = 1</td><td></td><td>1</td><td></td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>
<table>
<tr><th colspan="2">Inputs</th><th colspan="7">Outputs</th></tr>
<tr><th>B</th><th>A</th><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th>f</th><th>g</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
Each correct row (1)</td><td></td><td>3</td><td></td><td>3</td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td>Outputs ‘e’ and ‘f’ (1)
Need to be connected directly to logic 1 as they are always on (1)</td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td colspan="3"></td><td>Question 6 Totals</td><td>4</td><td>6</td><td>0</td><td>10</td><td>0</td></tr>
</table>

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="4">Marks available</th><th></th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th></tr>
<tr><td>7</td><td>a</td><td></td><td>


Link from output 4 to Reset</td><td>1</td><td></td><td></td><td>1</td><td></td></tr>
</table>

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
7	*b*		 (1) (1) (1) (1) Award the 5th mark if notice taken of reset taking place **and** Output 0 responding to following pulse. (1)		5		5	
			Question 7 Total	**1**	**5**	**0**	**6**	**0**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8	*a*		D – Power Amplifier	1			1	
	b		 Feedback resistor connected between output and inverting input (1) Inverting input connected to 0 V via resistor (1) Input connected to non-inverting input (1)	3			3	
	c		Selection and use of $\text{Gain} = 1 + \frac{R_F}{R_1}$ (1) Manipulation to give $R_F = 39 \times R_{IN}$ (1) Both resistors over 1k and correct ratio (1)	1	1 1		3	2
	d	i	$V_{PEAK} = 40 \times 10\,\text{mV}$ (1) $= 400\,\text{mV}$ (1)	1	1		2	
		ii	Sine wave output in phase with input (1) Peak consistent with d(i) (1)	1	1		2	1

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8	*e*		Use of Gain-Bandwidth Product = Gain × Bandwidth 1.6MHz = 40 × Bandwidth Bandwidth = $\frac{1600000}{40}$ (1) = 40 000 Hz accept 40 kHz (1)	1	1		2	2
			Question 8 total	**8**	**5**	**0**	**13**	**5**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9	*a*		Substitution and use of $T = 1.1 \times R \times C$ $10 = 1.1 \times R \times 100 \times 10^{-6}$ (1) Manipulation $R = \frac{10}{1.1 \times 100 \times 10^{-6}}$ (1) R = 90.9 kΩ accept 91 kΩ (1)	1	1 1		3	2
	b	i	Voltage across resistor = 8.8-2 = 6.8V (1) Determination or R = 300 Ω (1) Recall and manipulate V=IR to I = $\frac{V}{R}$ Substitute = $\frac{6.8}{300}$ (1) = 0.02 A accept 23 mA (1)	1	1 1 1		4	2
			Question 9 Total	**2**	**5**	**0**	**7**	**4**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
10			Indicative content: Evaluation identifies the three functions which do not meet the requirements of the specification: • there is no reference to limit switch A to initiate the sequence • the system does not wait for 3 seconds before switching the yellow light off • the light sequence repeats 10 times rather than 12 times as required The candidate has provided suggestions for improvement: • decision command to check switch A • to include a 3 second delay after the yellow light is switched on • to change the number in the count from 10 to 12					
			5-6 marks The candidate's evaluation identifies all three shortfalls of the system and details how those can be successfully overcome, including the amendments needed and their position in the flowchart. *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.*					

Question	Marking details	Marks available				
		AO1	AO2	AO3	Total	Maths
	3-4 marks The candidate's evaluation identifies two shortfalls of the system and details how those can be successfully overcome, specifying the location of those amendments in the flowchart. *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** The candidate's evaluation identifies one shortfall of the system and details how that can be successfully overcome, specifying the location of the amendment in the flowchart. *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 complete misunderstanding of the program. *Response not creditworthy or not attempted.*			6		
	Question 10 total	**0**	**0**	**6**	**0**	**0**
	TOTAL	**35**	**35**	**10**	**80**	**22**