Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

C490U20-1

Z22-C490U20-1

FRIDAY, 10 JUNE 2022 – AFTERNOON

ELECTRONICS – Component 2
Application of Electronics

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**17**	
3.	**11**	
4.	**9**	
5.	**20**	
6.	**9**	
7.	**6**	
Total	**80**	

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ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

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 **7**.

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INFORMATION SHEET

This information may be of use in answering the questions.

Resistor Colour Codes

Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Grey	8
Yellow	4	White	9

The fourth band colour gives the tolerance as follows:

GOLD ± 5%

SILVER ± 10%

Resistors 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

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

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

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

$$I_C = h_{FE} I_B$$

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

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

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

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

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

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

$$T = 1.1RC$$

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

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

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

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Answer **all** questions.

1. A washing machine has several programs for washing different types of clothes.

A 50 °C wash program is selected. The incomplete flow chart on the next page shows part of the control system program.

The specification for this part of the program is as follows:

- Check door is closed and lock it
- Fill with correct amount of water
- Heat water to 50 °C
- Continue the rest of the wash program

(a) Add these instructions to the correct boxes in the flowchart opposite: [5]

Close water valve

Lock door

Is water level correct?

Is door closed?

Is water at 50 °C?

Switch off heater

(b) **Complete** the 'NO' paths from the decision boxes. [3]

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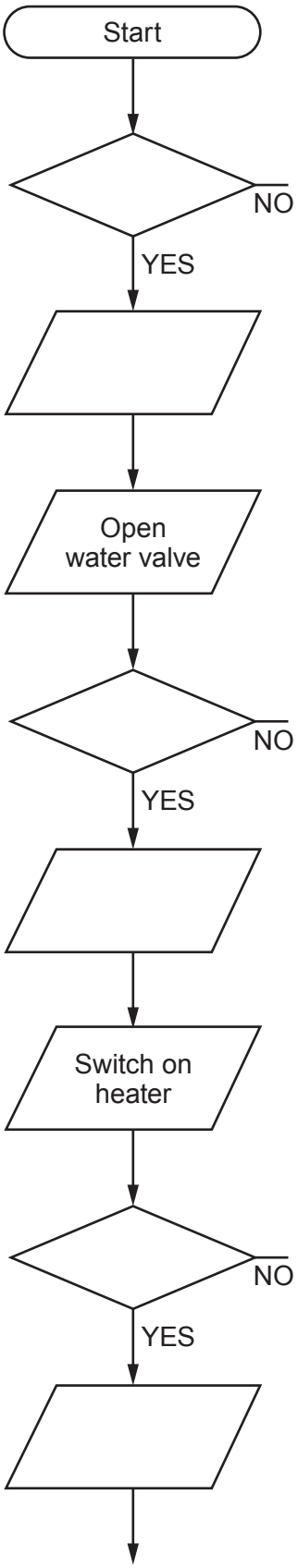

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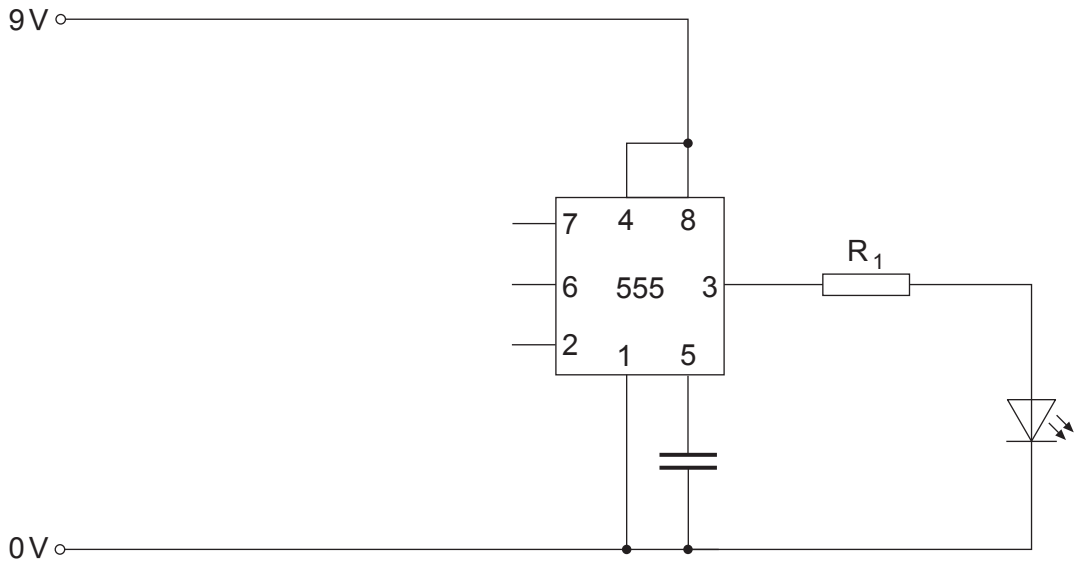
2. A 555 timer is used as a monostable timer to switch on a LED for 20 seconds. A partly completed circuit is shown below.



(a) **Complete the design** of the monostable circuit by adding:

- The timing sub-system.
- The triggering sub-system, using a **push-to-break** switch and resistor to create a falling-edge trigger pulse at pin 2. [5]

(b) (i) Calculate the ideal value for the resistor required to produce a 20 seconds delay when using a 330 μF capacitor in the timing circuit. [4]

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(ii) Select the resistor from the E24 series to give a delay closest to 20 seconds, using the 330 μF capacitor. [1]

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(c) The resistor R_1 has the following colour bands, Yellow, Orange, Brown, Gold.

(i) What is the resistance of this resistor in **ohms**? [3]

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(ii) The current flowing through the LED is 15 mA. Calculate the power dissipated in the resistor. [4]

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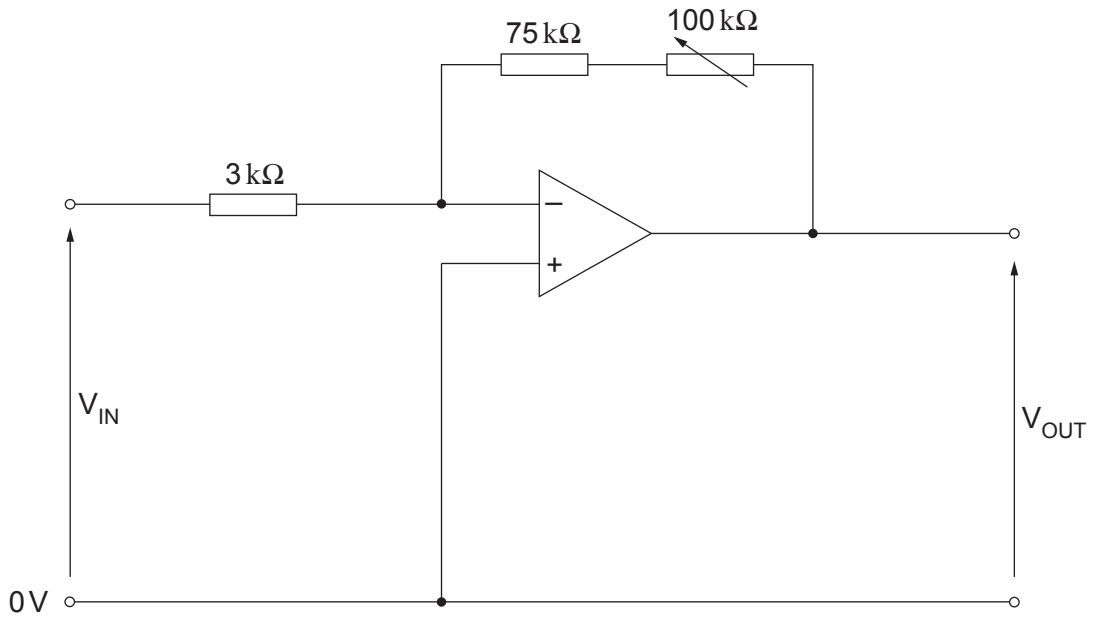
3. The following voltage amplifier is connected to a ±15 V power supply. The amplifier saturates at ±14 V.



(a) Calculate the gain of this voltage amplifier when the variable resistor is set to its:

(i) minimum value; [2]

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(ii) maximum value. [2]

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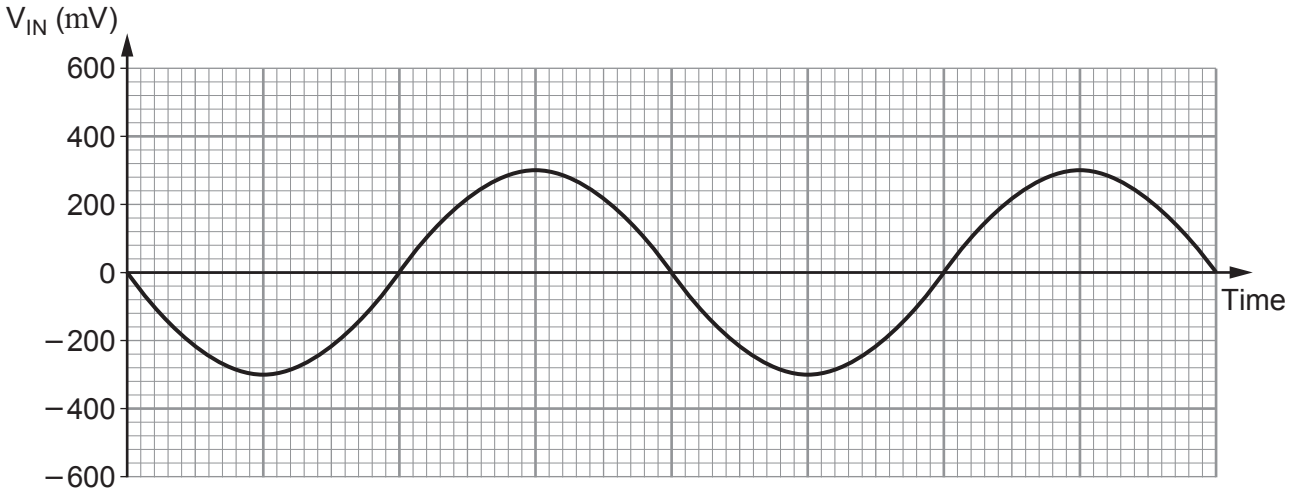
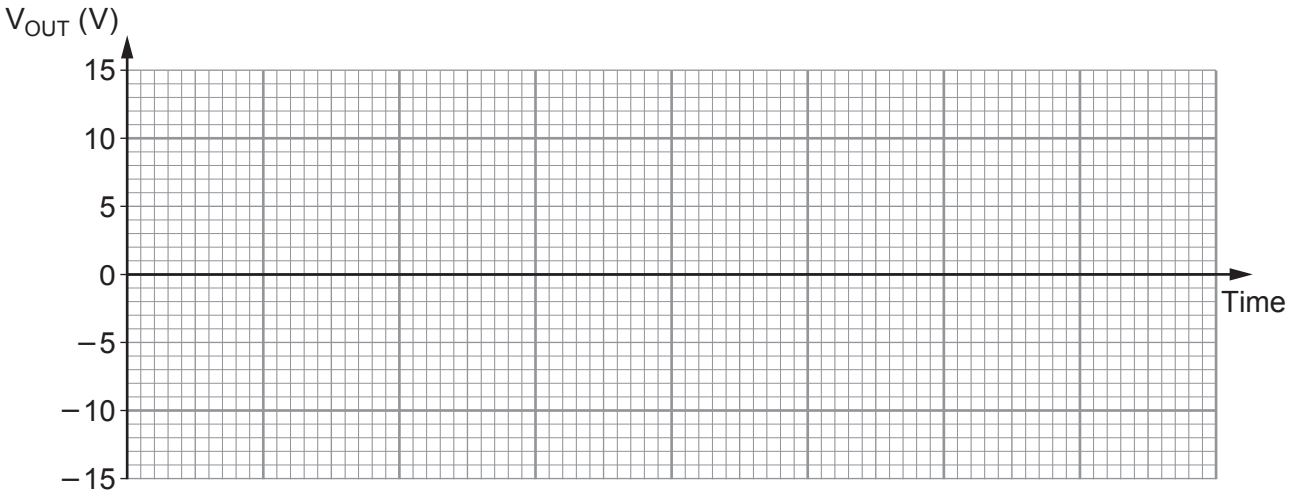
(b) The gain is now set to −30. The following input signal is applied to the amplifier.



Use the axes below to draw the corresponding output signal. [3]



(c) The gain of the amplifier is now set to its maximum value. Calculate the maximum value of the input voltage that avoids distortion of the output. [4]

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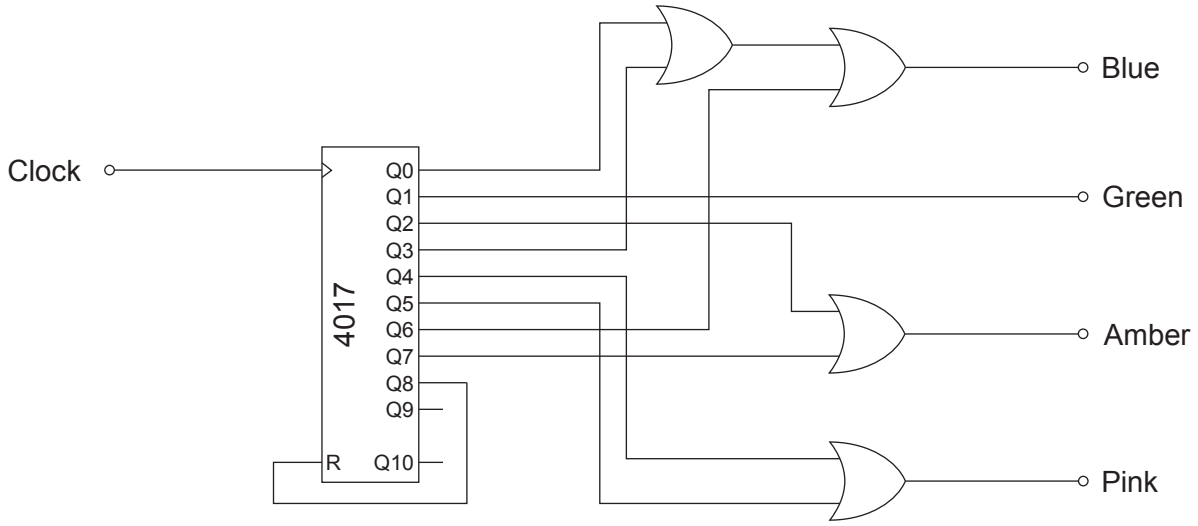
4. (a) The design for a disco light sequence generator is shown below. It uses a 4017 decade counter connected to a 1 Hz clock.



Complete the table to show the state of each light for each clock pulse.
Initially output Q0 is at logic 1. [5]

Clock Pulse	Blue	Green	Amber	Pink
0	On	Off	Off	Off
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

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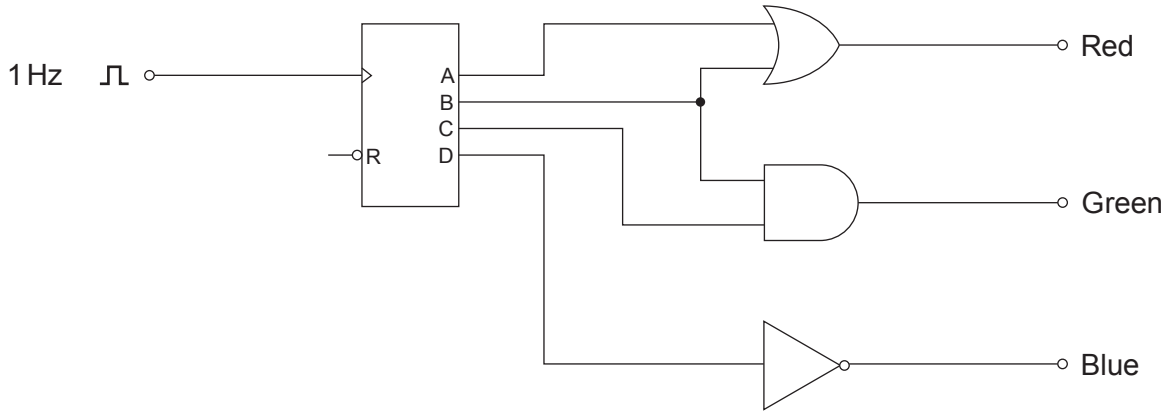
(b) A dedicated binary counter IC which has an active low reset is used to switch on three different coloured lights.

Add a logic gate and connections to reset the counter when it reaches a count of 12. Output A is the least significant bit (LSB). [4]



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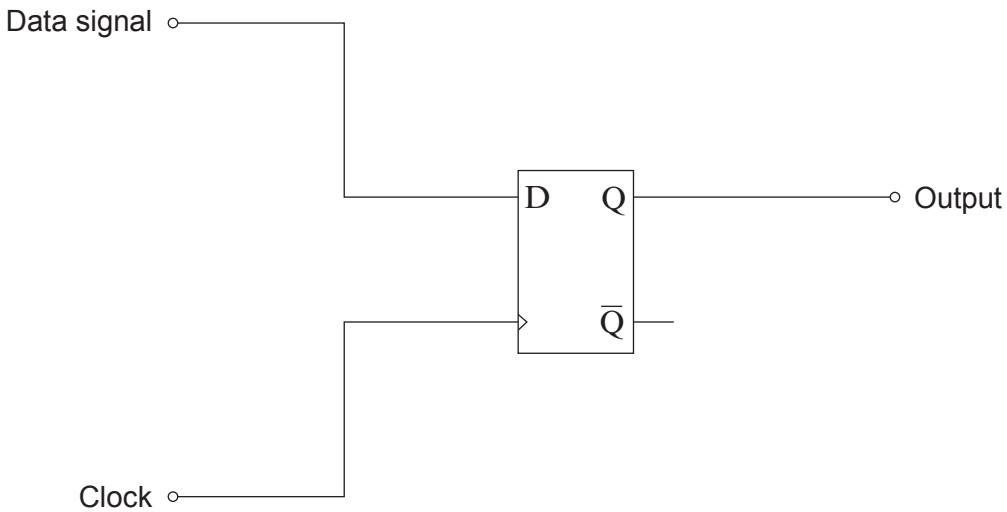
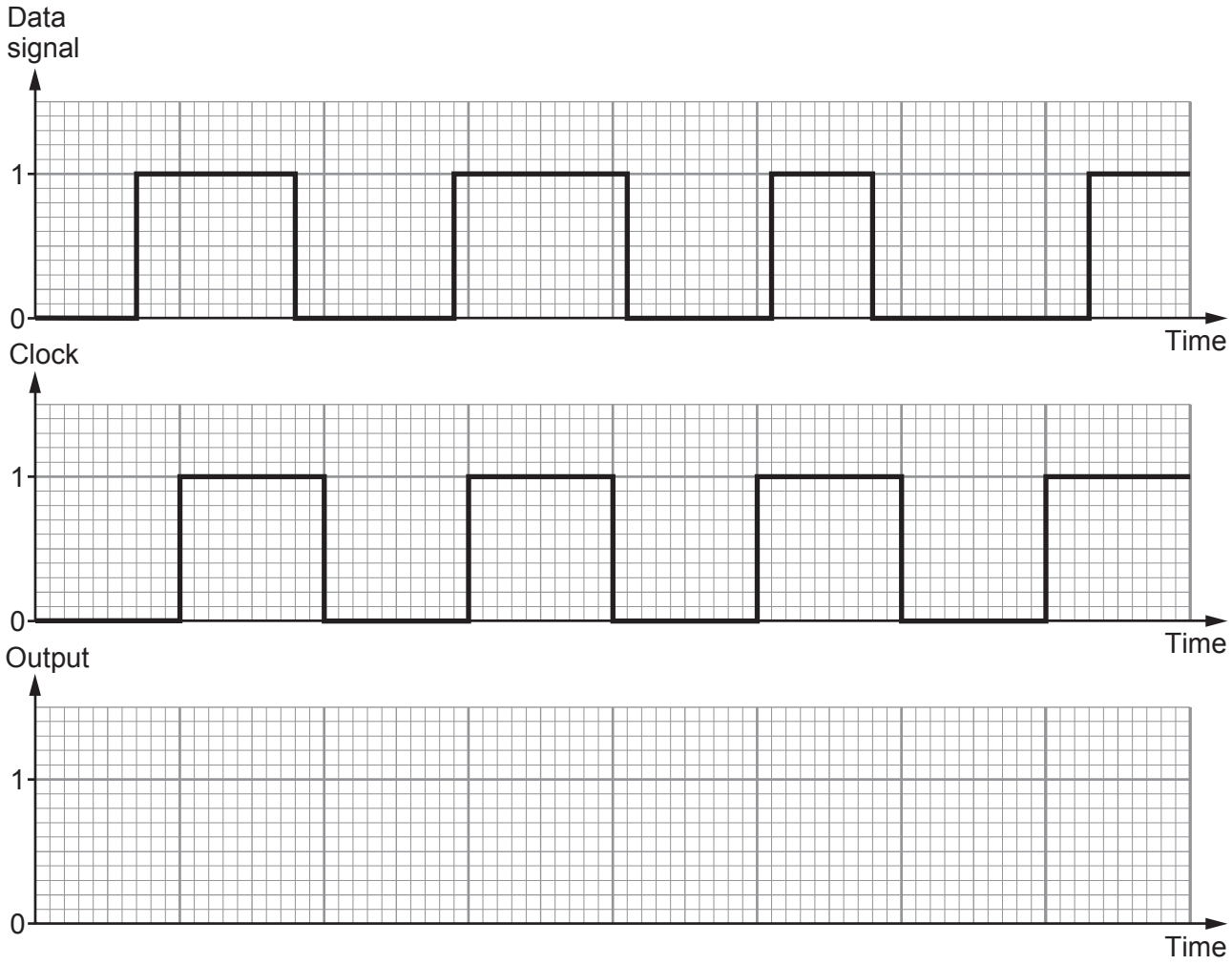
5. The D-type flip-flop can be used in a variety of applications.

(a) The following diagram shows a rising-edge triggered D-type flip-flop connected to a data signal and a clock.



The data signal and clock signal are shown below. Use the axes provided to draw the output signal. The output is initially low. [3]



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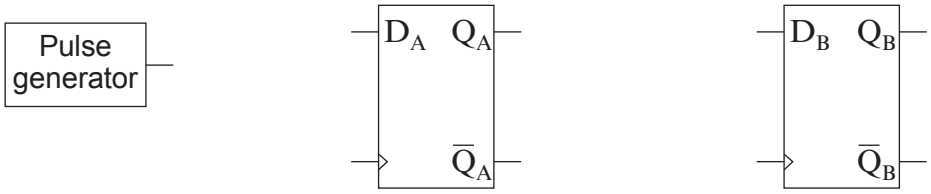
(b) The diagram shows two D-type flip-flops and a pulse generator.

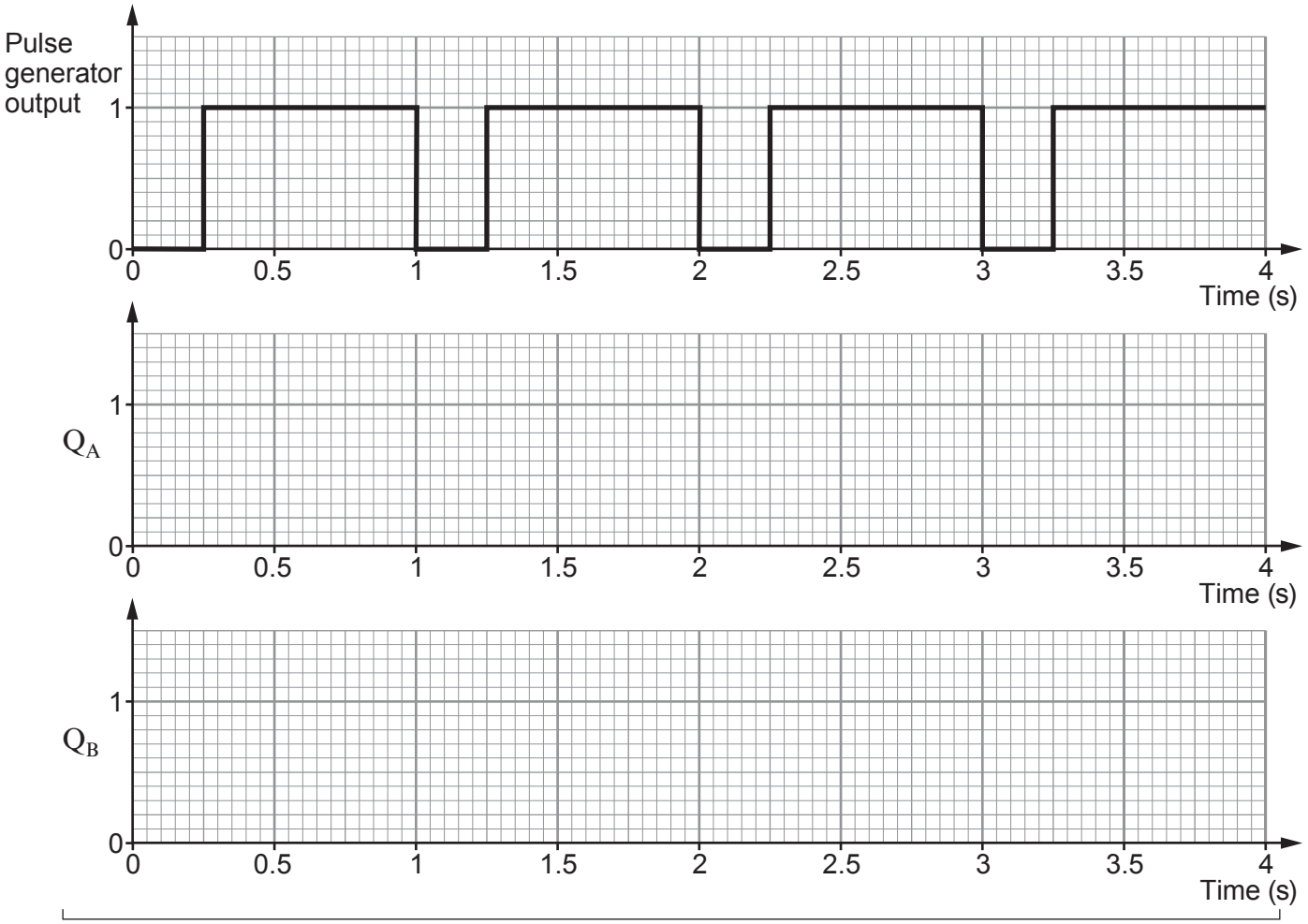


(i) **Draw the connections** needed to make a 2-bit binary up-counter. [4]

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

I. **Label a rising-edge** on the pulse generator output graph. [1]

II. The Q_A and Q_B outputs are initially at logic 0.
On the axes below **draw the signals** at the Q_A and Q_B outputs. [6]



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(c) Using the information on the graphs.

(i) Determine the **space** time for the pulse generator. [1]

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(ii) Determine the **mark** time for the pulse generator. [1]

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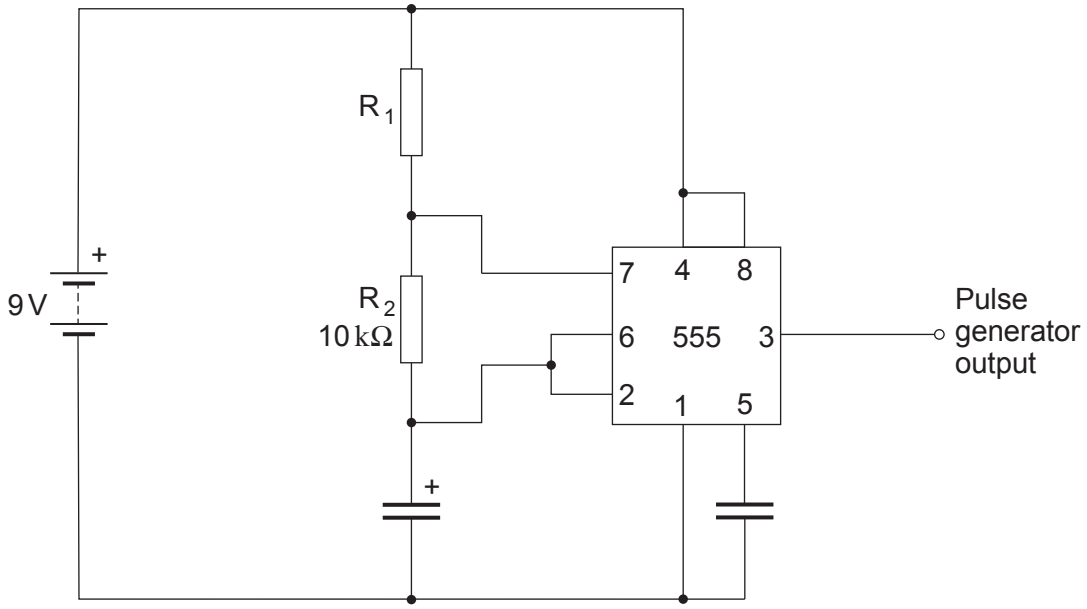
(iii) The pulse generator is constructed from a 555 astable as shown below:



Calculate the value of R_1 that provides the mark / space ratio for this pulse generator. [4]

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R_1 = ...

20

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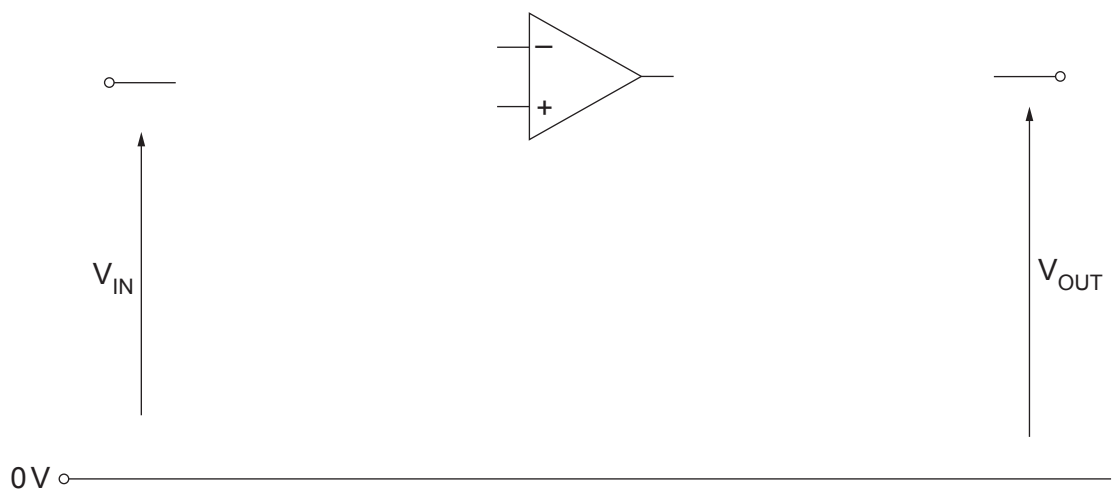
6. A non-inverting amplifier has a gain of 48.

(a) **Complete the circuit diagram below**, adding any components required. [3]



(b) Calculate the values of the components needed to provide the gain of 48. [3]

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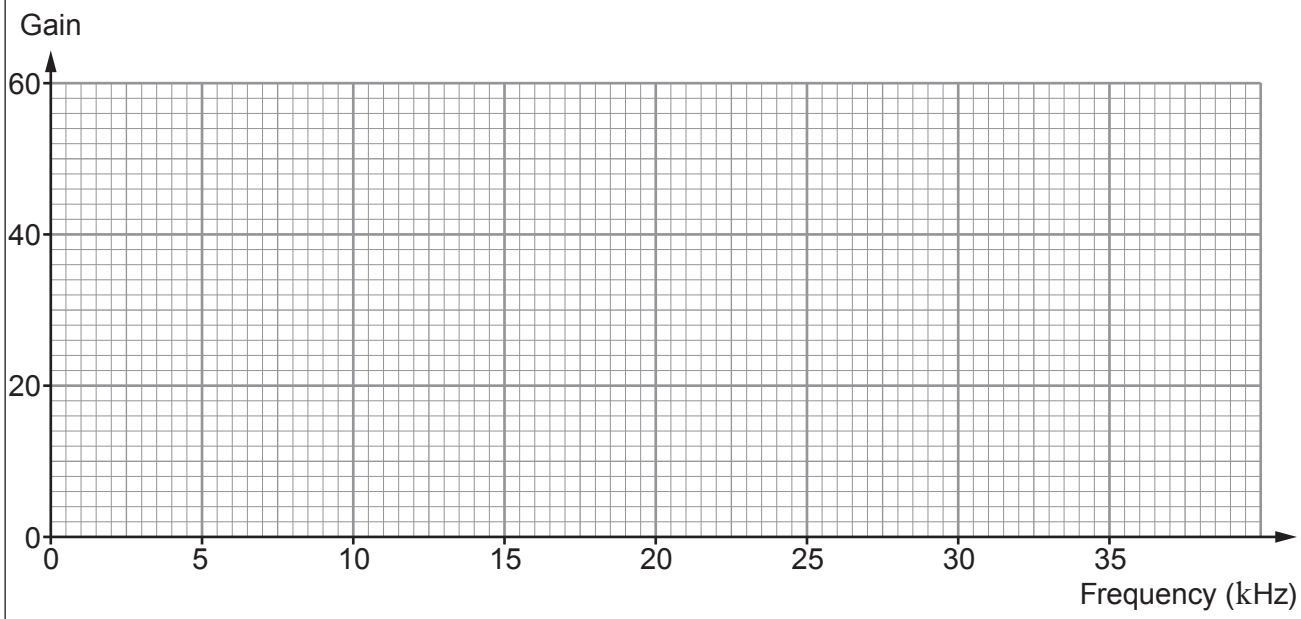
(c) The op-amp has a bandwidth of 25 kHz when the gain is 48. **Draw** the gain-frequency graph below for this amplifier. [3]



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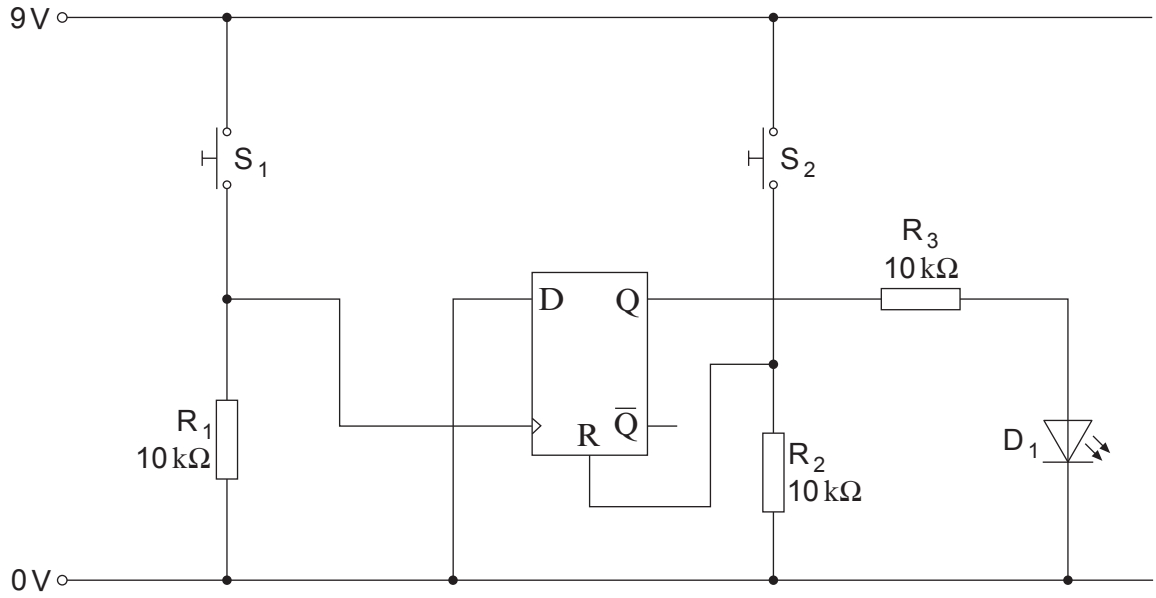
7. The D-type flip-flop can be configured to act as a latch. A student has made the following circuit from a rising-edge triggered D-type flip-flop.

The student's specification states that the circuit should operate as follows:

- pressing switch S_1 makes an LED come on and stay on
- pressing switch S_2 resets the latch so that the LED goes off



Evaluate the design against the specification and if required suggest any changes or modifications required. [6 QER]

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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