

Surname	Centre Number	Candidate Number
First name(s)		0



GCSE

C490U20-1



S25-C490U20-1



FRIDAY, 16 MAY 2025 – AFTERNOON

ELECTRONICS – Component 2

Application of Electronics

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	7	
2.	8	
3.	13	
4.	6	
5.	19	
6.	12	
7.	9	
8.	6	
Total	80	

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ADDITIONAL MATERIALS

You will require 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 8.



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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 $\pm$ 5%

SILVER $\pm$ 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

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

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

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

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

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

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

$$I_C = h_{FE} I_B$$

$$T = 1.1RC$$

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

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

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

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

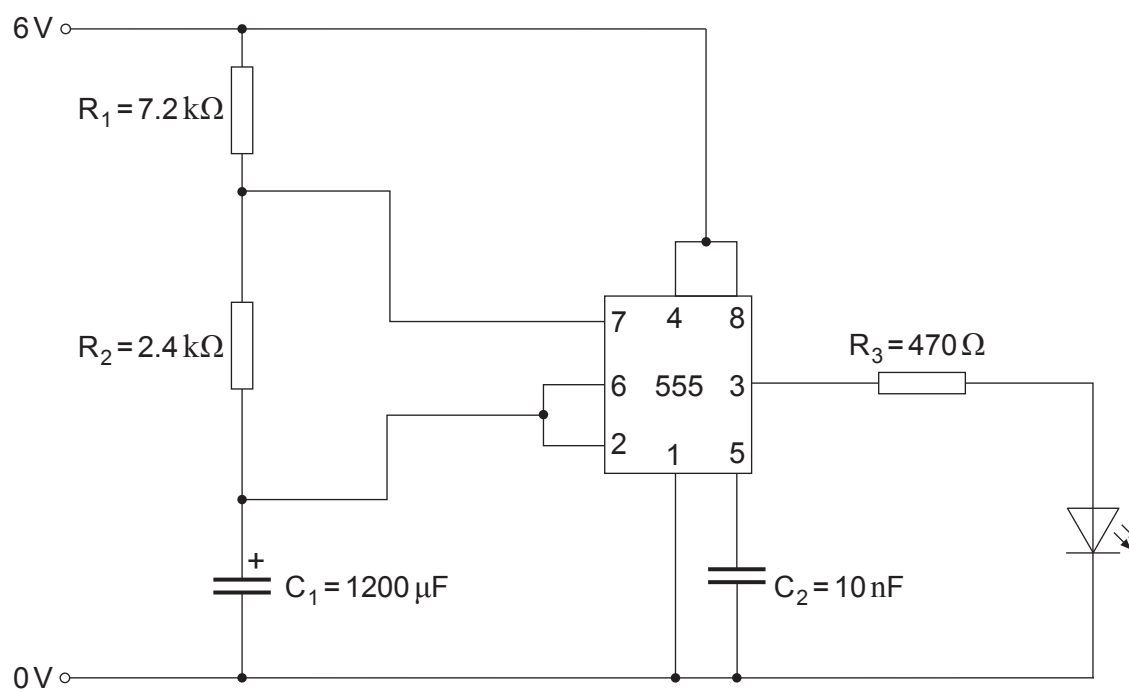
$$G = \frac{V_{OUT}}{V_{IN}}$$

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



Answer **all** questions.

1. The following circuit shows an astable based on a 555 timer IC.



- (a) Calculate the frequency of the astable.

[4]

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- (b) Calculate the mark-space ratio for the astable.

[3]

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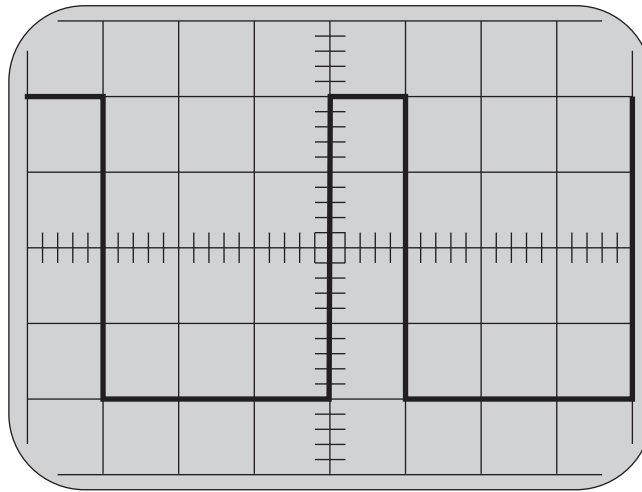
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2. An astable signal is displayed on an oscilloscope screen.
The time base is set to 5 ms/cm and the voltage gain is set at 2 V/cm .



- (a) What is the amplitude of this signal? [2]

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- (b) (i) What are the **mark** and **space** times for this signal? [3]

Mark time

Space time

- (ii) Calculate the frequency of this signal. [3]

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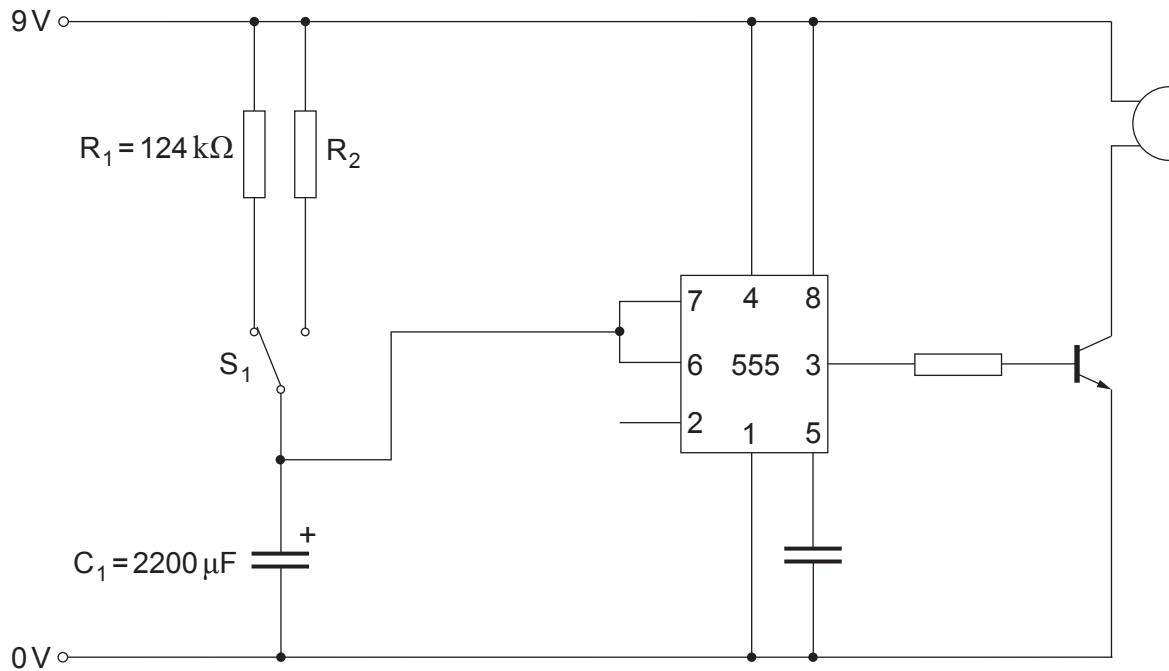


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3. A 555 timer is used in an egg timer with two settings, one for soft-boiled eggs and another for hard-boiled eggs. A partly completed monostable circuit is shown below.



- (a) **Complete the circuit** by adding the triggering sub-system. Use a push-to-make switch and resistor to create a falling-edge trigger pulse at pin 2. [3]
- (b) The $124\text{ k}\Omega$ resistor is not part of the E24 series. **Draw a labelled** diagram to show how a combination of **two** resistors from the E24 series can be used to produce the total resistance of $124\text{ k}\Omega$. [2]

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- (c) (i) Calculate the time period to cook a soft-boiled egg when the switch S_1 is in the position shown in the circuit diagram. [4]

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- (ii) Calculate the ideal value for resistor R_2 to change the time period to 7 minutes for a hard-boiled egg. [3]

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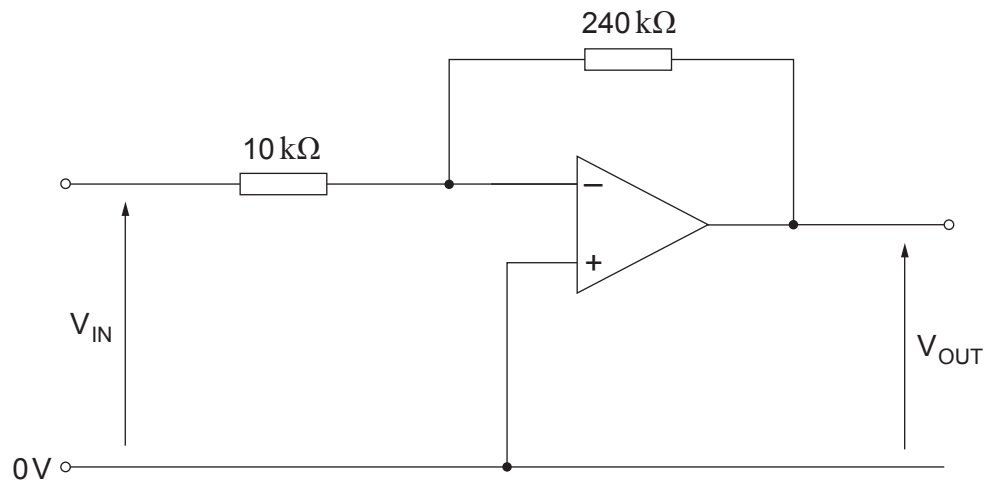
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- (iii) Select the resistor from the E24 series to give a time period closest to 7 minutes. [1]

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4. The voltage amplifier shown below is connected to a $\pm 12\text{ V}$ power supply. The op-amp saturates at $\pm 10\text{ V}$.



- (a) Calculate the gain of this voltage amplifier.

[3]

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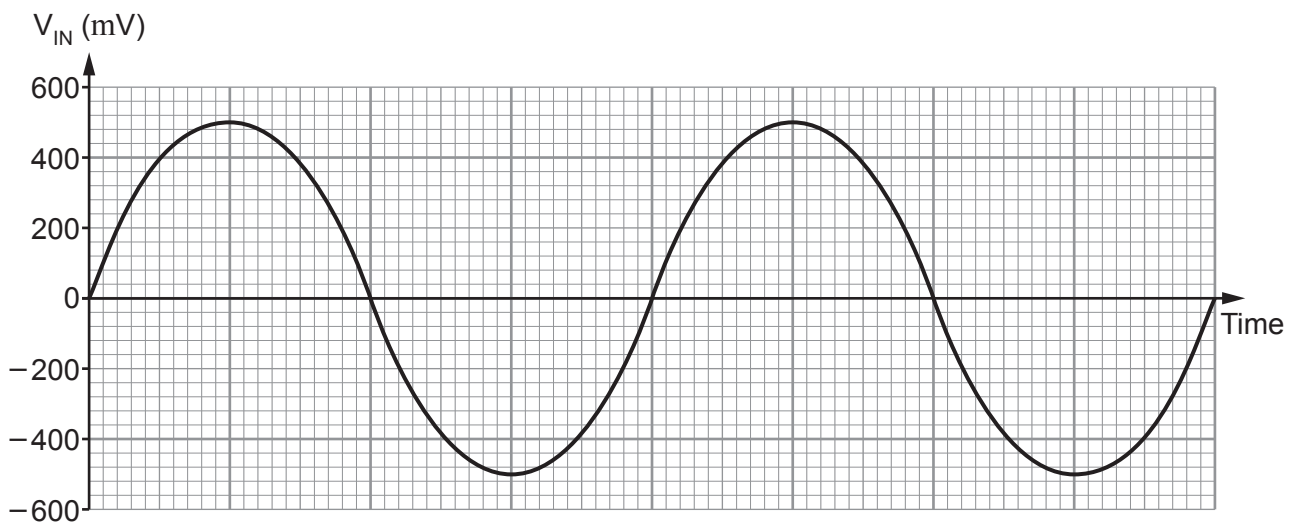
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(b) The following input signal is applied to the amplifier.



Use the axes below to **draw** the corresponding output signal.

[3]

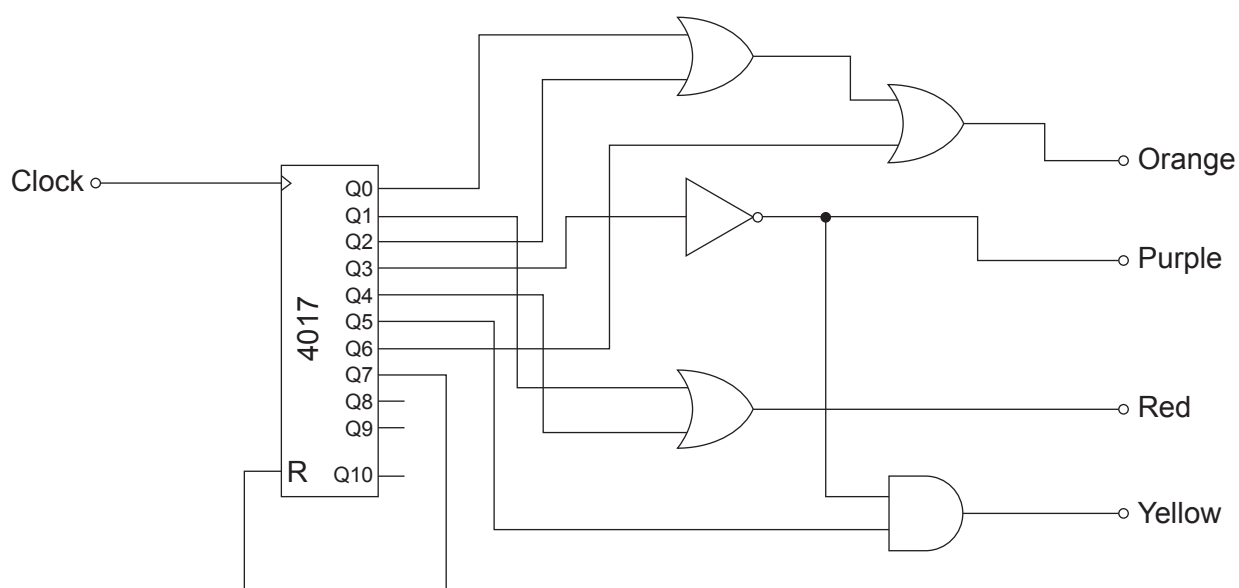


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5. (a) The circuit design for a repeating lighting sequence is shown below. It is based on a 4017 decade counter connected to a 1 Hz clock.



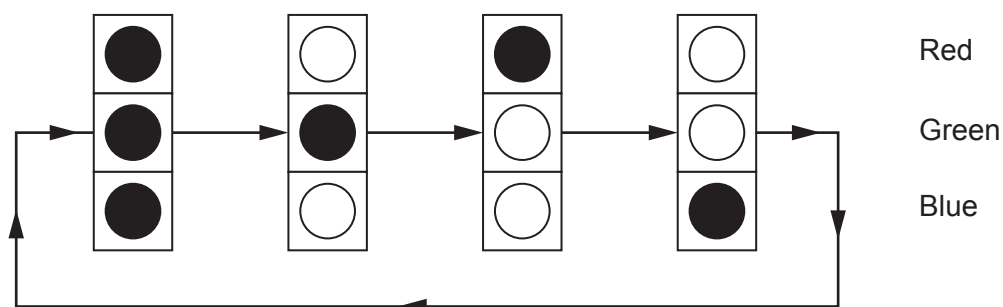
Complete the table to show the state of each light after each clock pulse. Initially, output Q0 is at logic 1.

[6]

Clock pulse	Orange	Purple	Red	Yellow
0	On	On	Off	Off
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



- (b) A different light sequence circuit is used to make a disco lighting system. A solid black circle represents a light that is on. The sequence should change at a frequency of 2 Hz.



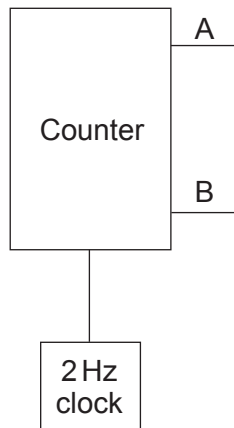
- (i) Complete the following truth table for the lighting sequence. Logic 1 represents a light that is on. [3]

Inputs		Outputs		
B	A	Red	Green	Blue
0	0	1	1	1
0	1			
1	0			
1	1			

- (ii) I. Study the Red output column and name the logic gate required to produce the Red output. [1]
 Type of logic gate:
- II. Study the Green output column and complete the Boolean equation for the Green output. [1]
 Green = ...
- III. Study the Blue output column and complete the Boolean equation for the Blue output. [3]
 Blue = ...



- (iii) Complete the design by adding AND, OR and NOT gates to produce the required outputs. [5]



—○ Red

—○ Green

—○ Blue

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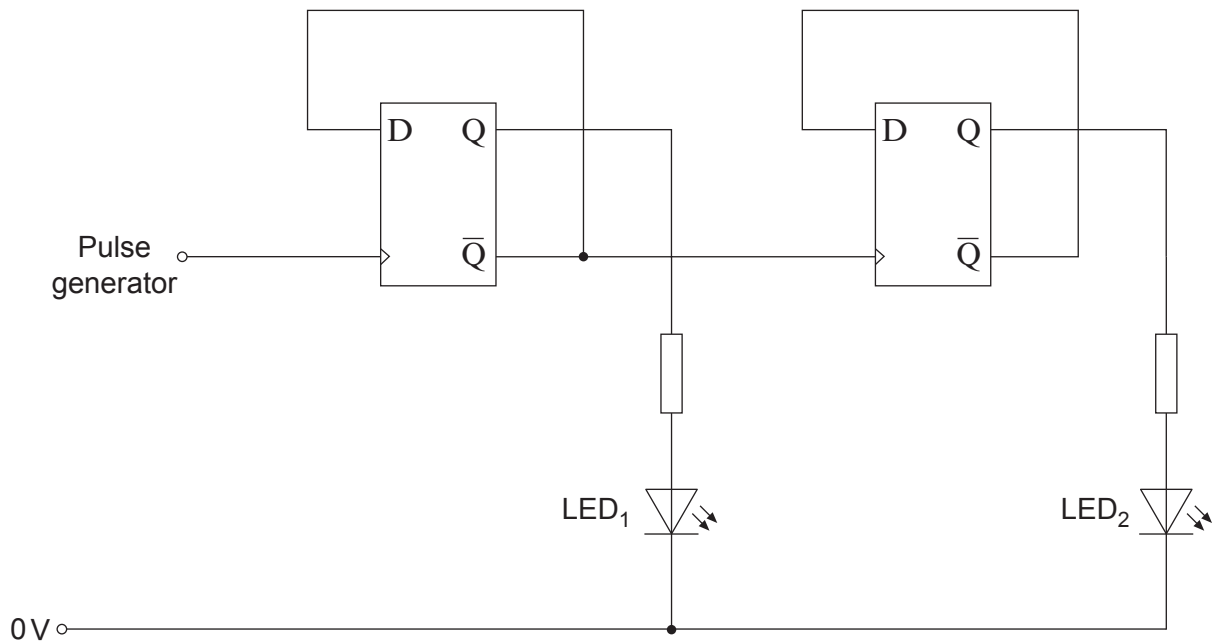
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6. The D-type flip-flop is a very versatile device that has many different applications.

- (a) The diagram below shows two D-type flip-flops and a pulse generator. The pulse generator operates at 20 Hz.



- (i) Complete the following table to show the state of the LEDs after each of the next three clock pulses. [3]

Clock pulse	LED ₁	LED ₂
0	Off	Off
1		
2		
3		

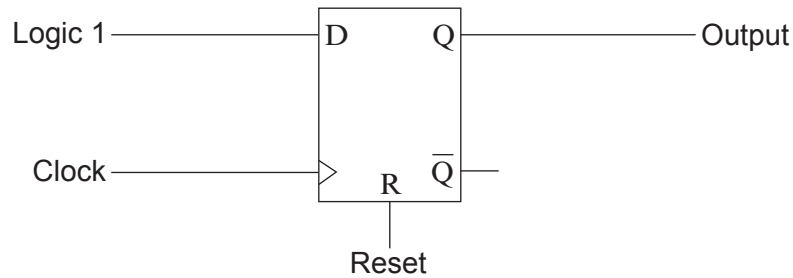
- (ii) At what frequency does each of the LEDs pulse? [2]

LED₁ pulses at

LED₂ pulses at



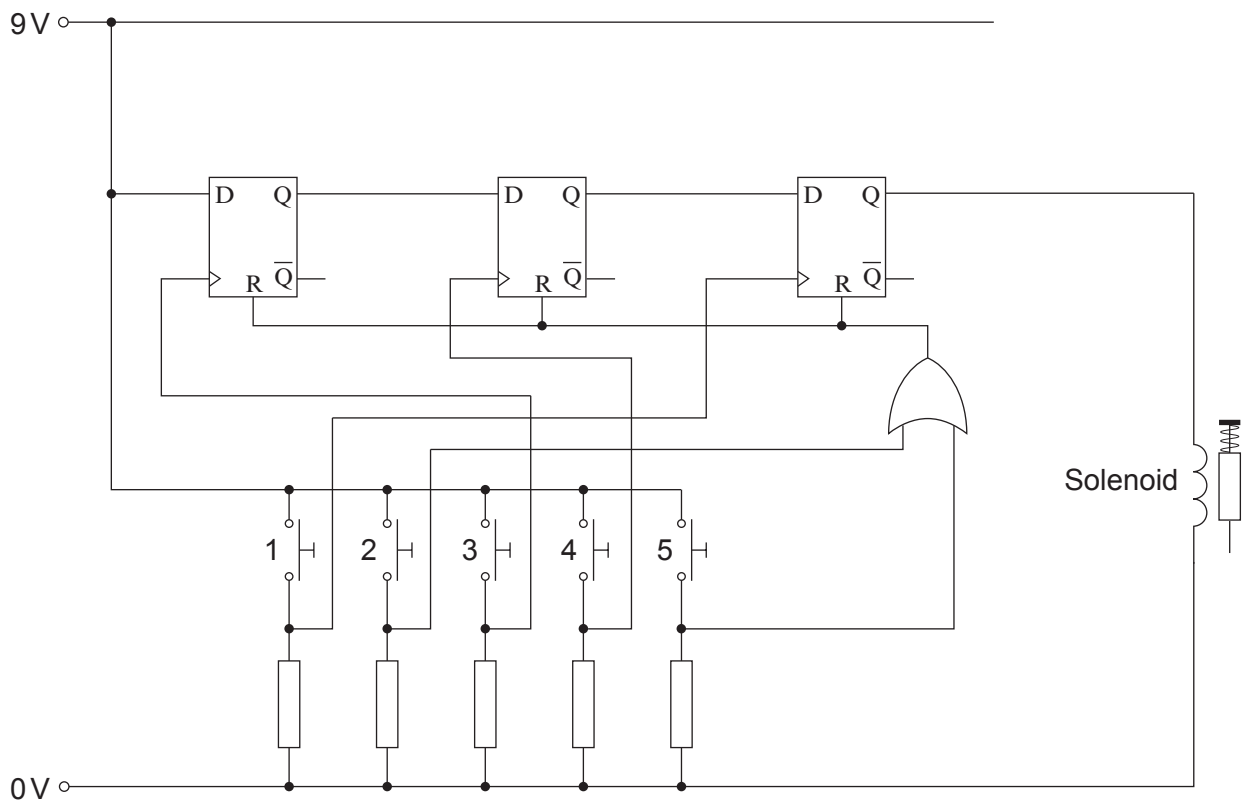
- (b) Another application of a D-type flip-flop is a latch. The basic setup is shown below:



The logic level present on the D input is transferred to the Q output when the clock signal goes from logic 0 to logic 1.

A logic 1 on the reset pin changes Q to logic 0.

The following circuit is a 3-number combination lock, based on D-type latches. There are 5 switches labelled 1–5. Selecting an incorrect number will reset all of the D-types.



- (i) Which input switches will reset the latches?

[1]

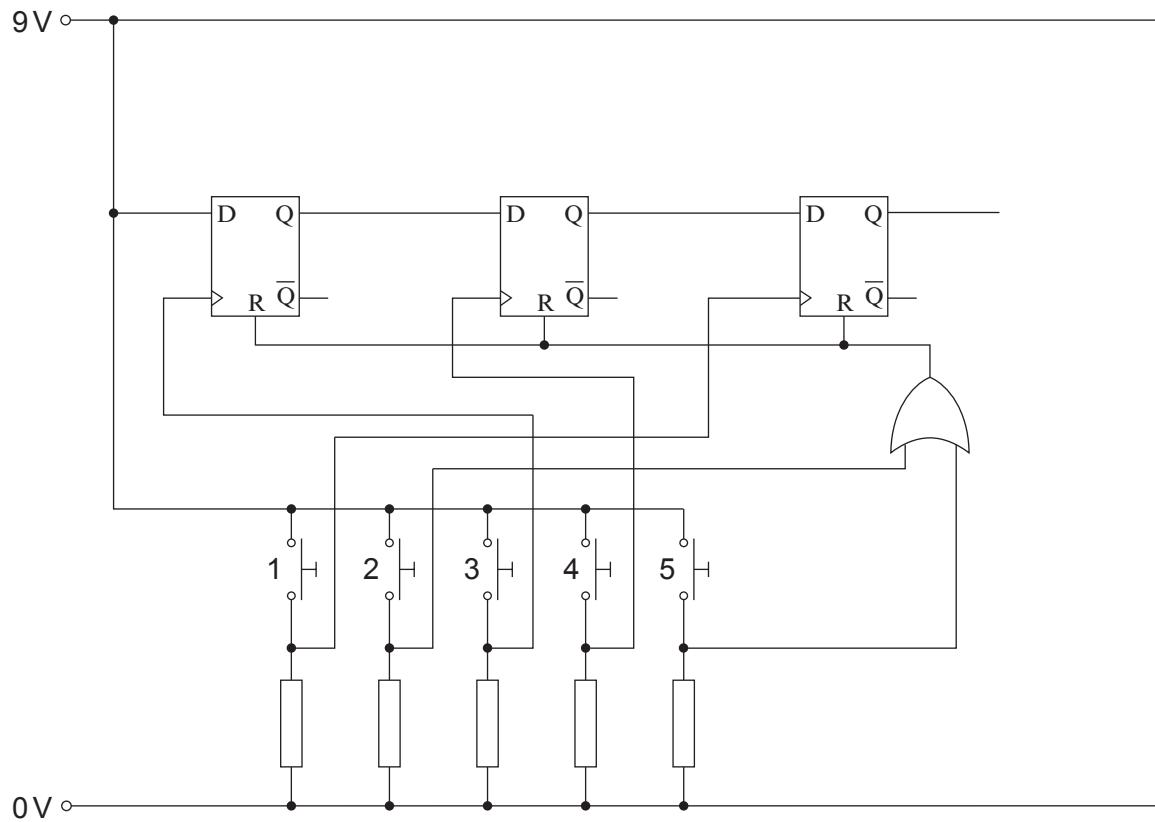
- (ii) In what order do the remaining switches have to be pressed to operate the solenoid?

[3]



(iii) It is found that the solenoid does not operate correctly.

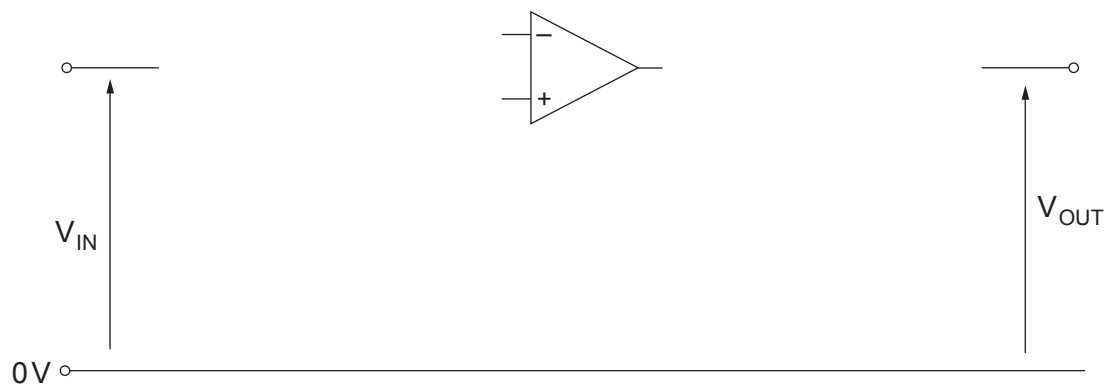
Modify the circuit diagram below to show how a MOSFET can be used to interface the solenoid to the system. [3]



7. An engineer requires a **non-inverting** amplifier with a gain of 40.

(a) Complete the circuit diagram below, adding any components needed.

[3]



(b) Calculate the values of the components you included to provide the gain of 40.

[3]

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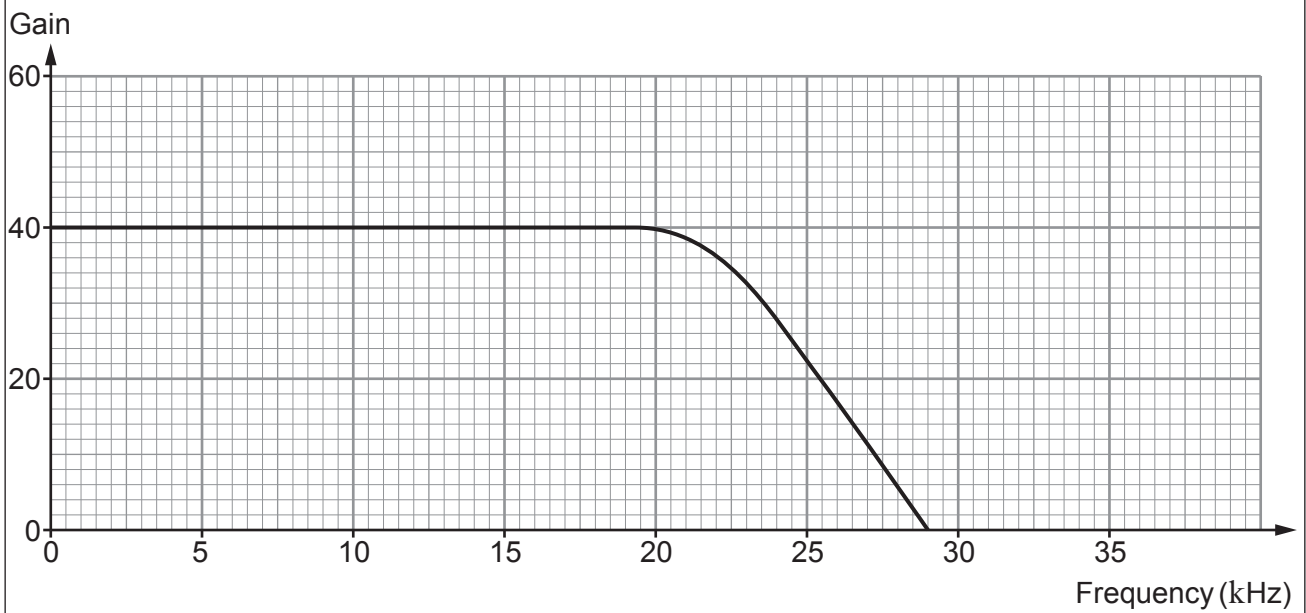
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(c) The amplifier has the following gain-frequency graph.



Determine the bandwidth of the amplifier. Show clearly on the graph how you have reached your answer.

[3]

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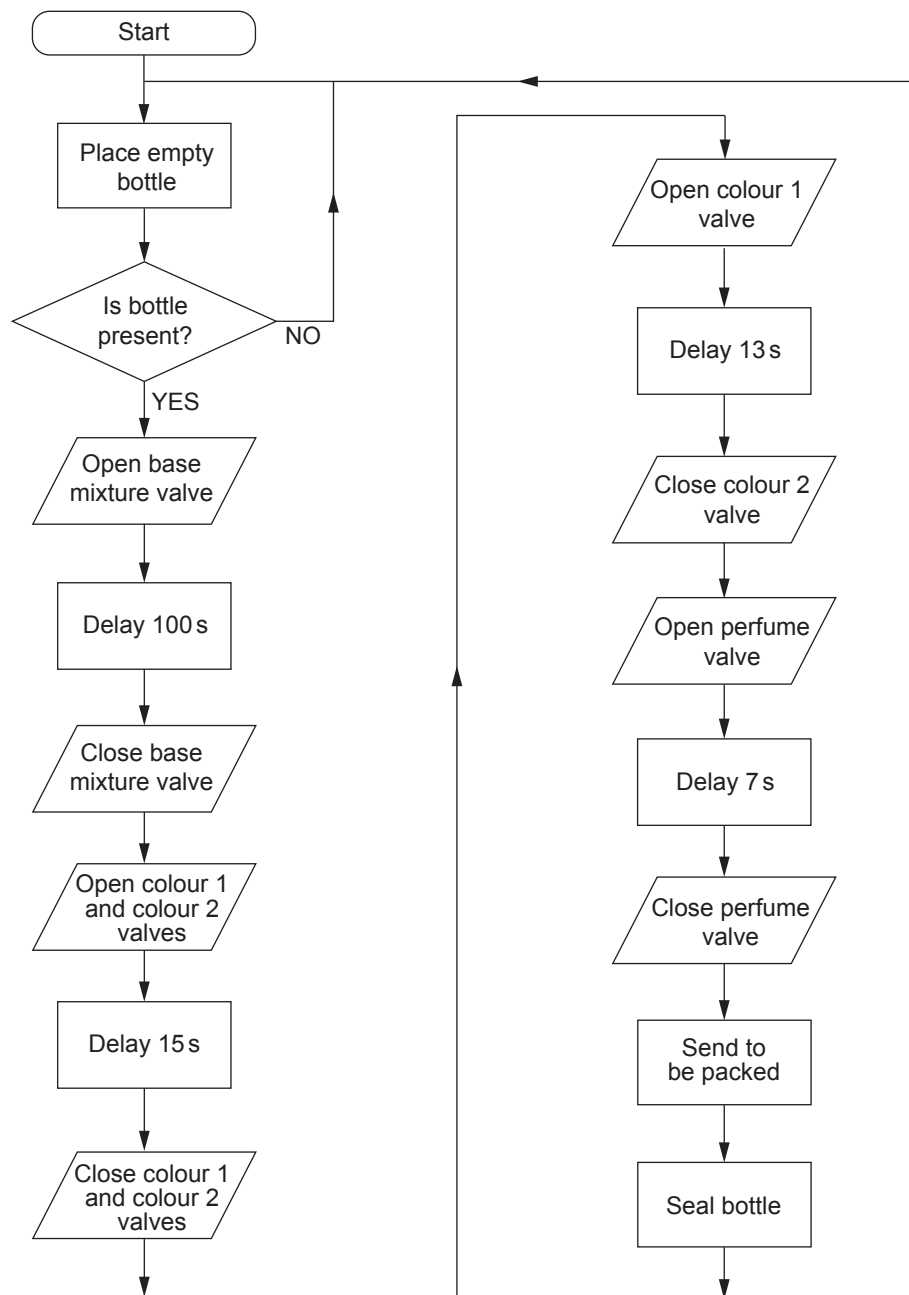
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8. The following flowchart shows a student's solution to the process of filling a 250 ml shampoo bottle with all of the ingredients of the shampoo. This consists of mixing a base mixture, two colour pigments and a perfume additive to make the finished shampoo. These are dispensed by a series of valves that deliver 1 ml of ingredient per second. The bottle is sealed before being sent to be packed.

To complete the mixture, the following amount of each ingredient is required:

- 200ml of shampoo base mixture
- 28ml of colour pigment 1
- 15ml of colour pigment 2
- 7 ml of perfume



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[6 QER]

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