Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4162/01

ELECTRONICS
UNIT E2
(Paper version of on-screen assessment)

P.M. THURSDAY, 14 June 2012

1 hour

Examiner only

Total Marks	

4162 010001

ADDITIONAL MATERIALS

In addition to this examination paper you may need a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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

Answer **all** questions 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.

INFORMATION SHEET FOR UNIT E2

This information may be of use in answering the questions.

1. 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%

2. Preferred Values for Resistors – E24 series

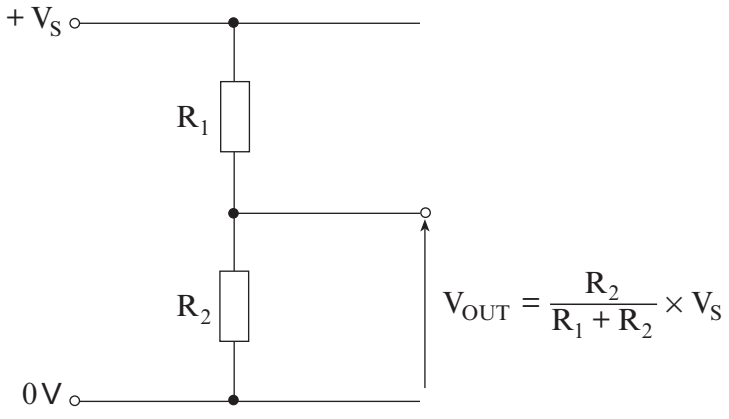
10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

3. Resistance = $\frac{\text{voltage}}{\text{current}}$; $R = \frac{V}{I}$.

4. Effective resistance, R, of two resistors R_1 and R_2 in series is given by $R = R_1 + R_2$.

5. Effective resistance, R, of two resistors R_1 and R_2 in parallel is given by $R = \frac{R_1 R_2}{R_1 + R_2}$.

6. Voltage Divider



7. Power = voltage × current; $P = VI = I^2R = \frac{V^2}{R}$.

8. LED The forward voltage drop across an LED is 2 V.

9. NPN Transistors (i) Current gain = $\frac{\text{Collector current}}{\text{Base current}}$; $h_{FE} = \frac{I_C}{I_B}$.

(ii) The forward voltage drop across the base emitter junction is 0·7 V.

10. Amplifiers

Voltage gain: $A = \frac{V_{OUT}}{V_{IN}}$

Non-inverting amplifier: $A = 1 + \frac{R_F}{R_1}$

Inverting amplifier: $A = -\frac{R_F}{R_{IN}}$

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

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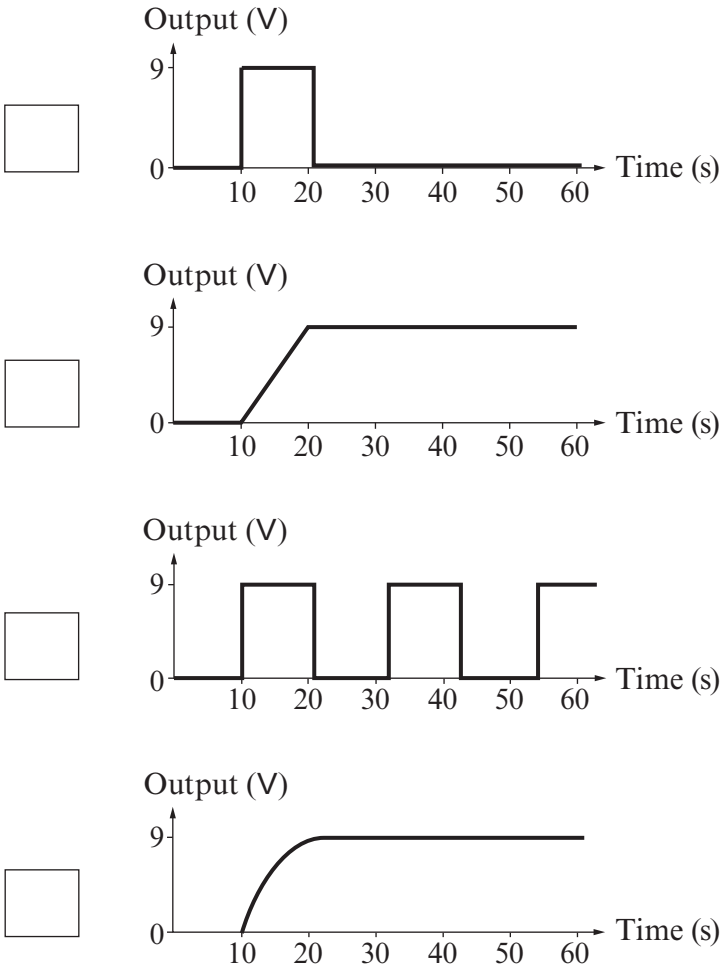
Answer **all** *questions.*

1. Which graph shows the output signal for a monostable set up to produce a delay of 11 s? (Tick (✓) the correct answer.) [1]



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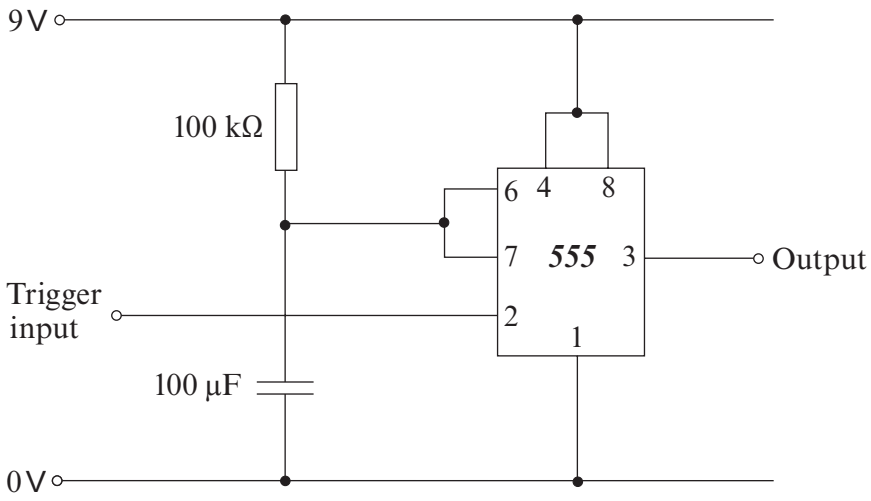
2. The circuit diagram shows a 555 timer set up as a monostable to give a time delay of 11 seconds.



The 100 kΩ resistor is replaced with a 200 kΩ resistor. What is the new time delay? (Tick (✓) the correct answer.) [1]

- ☐ 1.1 s
- ☐ 5.5 s
- ☐ 11 s
- ☐ 22 s
- ☐ 110 s

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Turn over.

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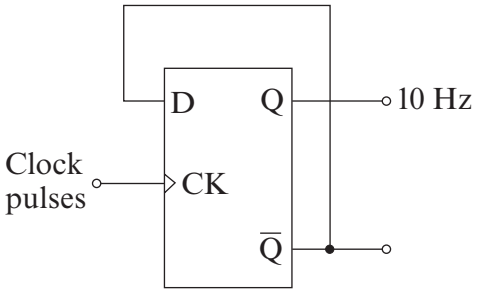
3. The diagram shows a D-type flip-flop used in a divide-by-two circuit.
Pulses from the Q output have a frequency of 10 Hz.



Give the frequency of the signals at:

(a) the clock input; ..... Hz [1]

(b) the $\overline{Q}$ output. ..... Hz [1]

4. Which **one** of the following systems **must** contain an astable circuit?
(Tick (✓) the correct answer.) [1]

☐ A bath alarm flashes an LED on and off when the bath water is too hot.

☐ In a kitchen timer, a buzzer comes on and stays on until a reset switch is pressed.

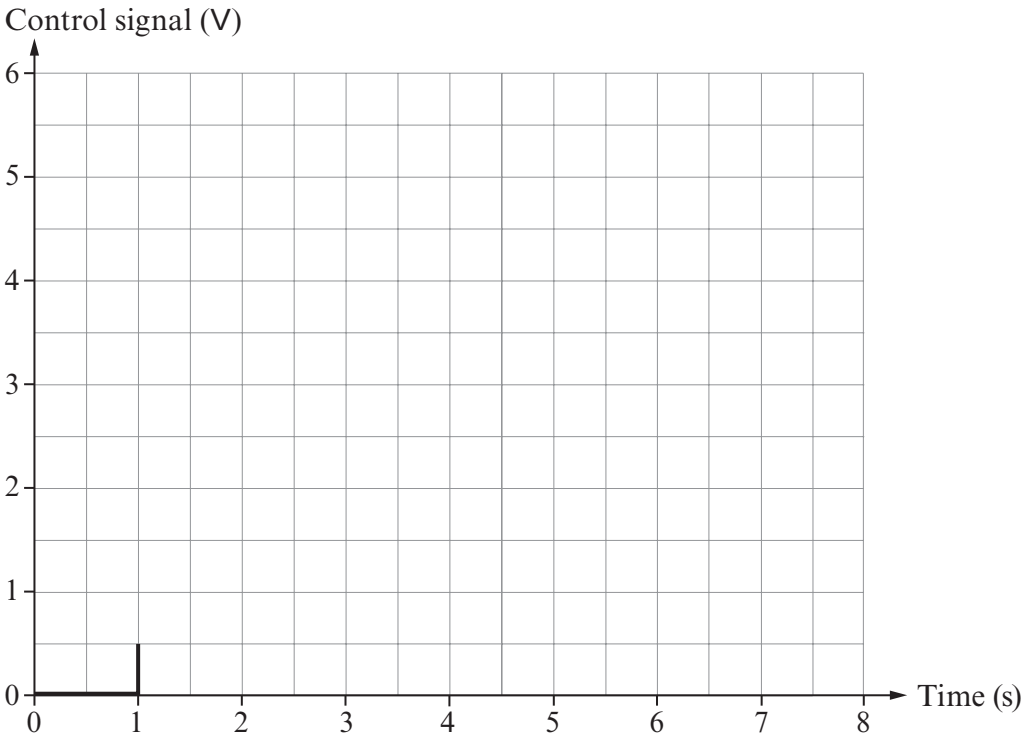
☐ In a game scorer, a lamp lights as soon as one team reaches a score of 5.

☐ A car alarm sounds the horn continuously for 2 minutes when someone rocks the car.

5. An electronic toothbrush warns the user that the battery voltage is too low by sounding a buzzer for three seconds.

The control system does this by generating a single square pulse with an amplitude of 5 V and a period of 3 s.

Complete the graph by drawing this pulse. *The trace is started for you.* [2]



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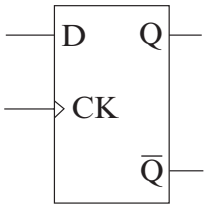
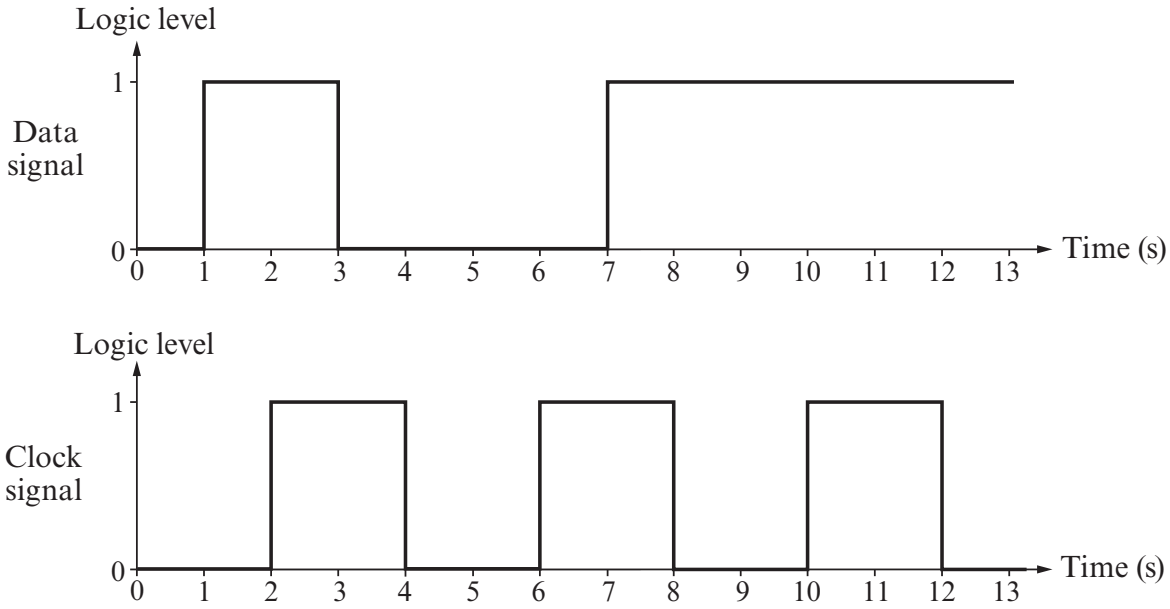
6. This D-type flip-flop is rising-edge triggered.



The graphs show the data and clock signals.



What logic level is present on the Q output:

(a) at time 5 s; ..... [1]

(b) at time 9 s; ..... [1]

(c) at time 13 s? ..... [1]

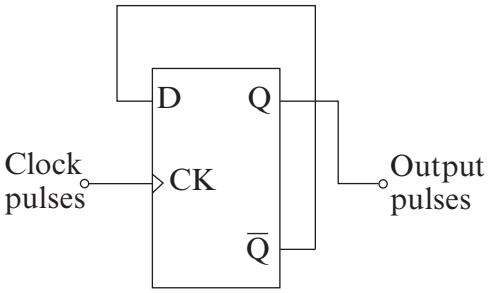
(d) Which line of the table gives the signals on the $\overline{Q}$ output at the times shown? (Tick (✓) the correct answer.) [1]

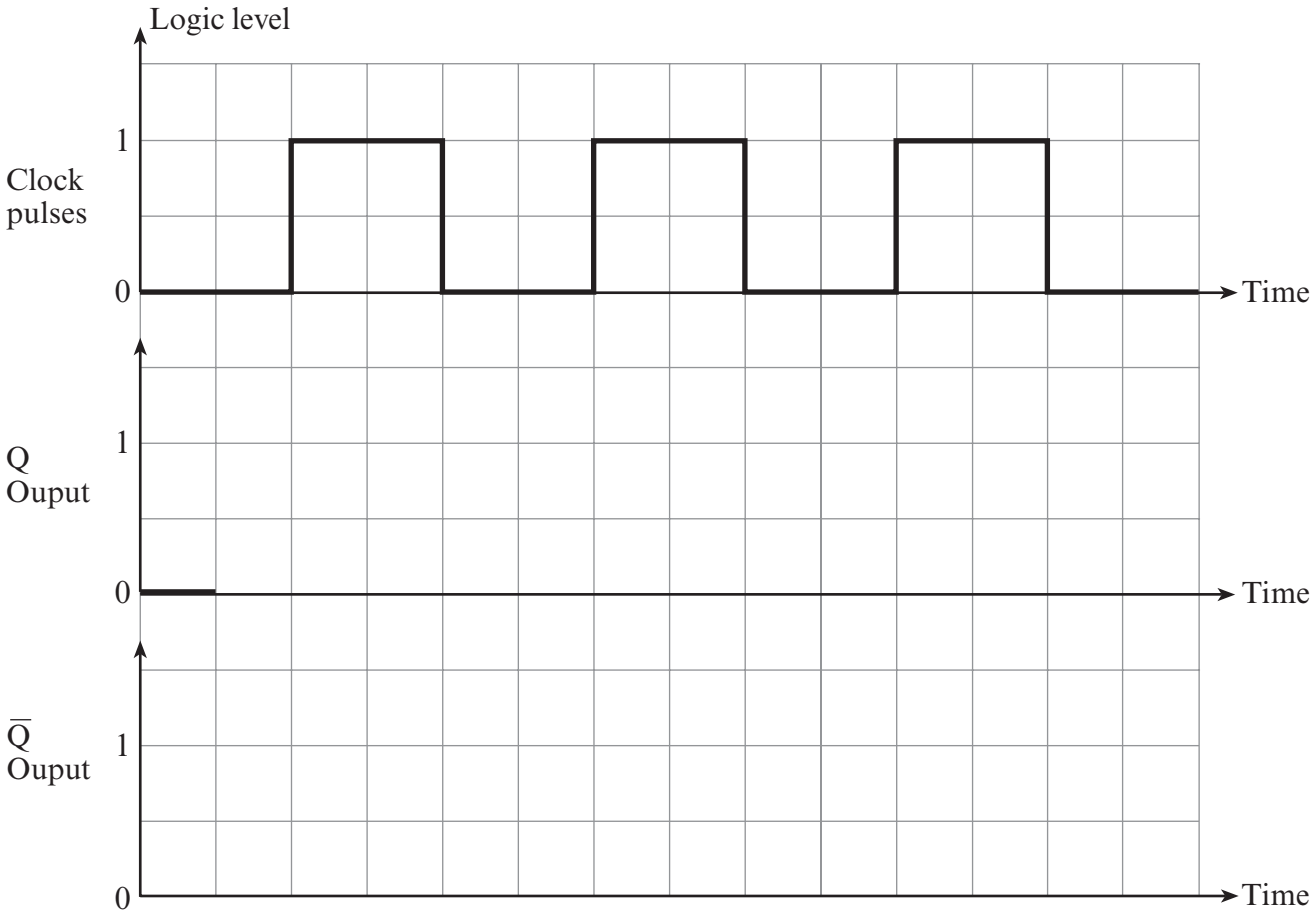
	time = 5 s	time = 9 s	time = 13 s
☐	0	1	0
☐	0	1	1
☐	1	0	0
☐	1	0	1

7. The diagram shows a D-type flip-flop set up as a one-bit counter. The Q output starts at logic 0.

The upper graph shows the clock pulses applied to the counter.

Complete the corresponding output signals at the Q and $\overline{Q}$ terminals. [3]





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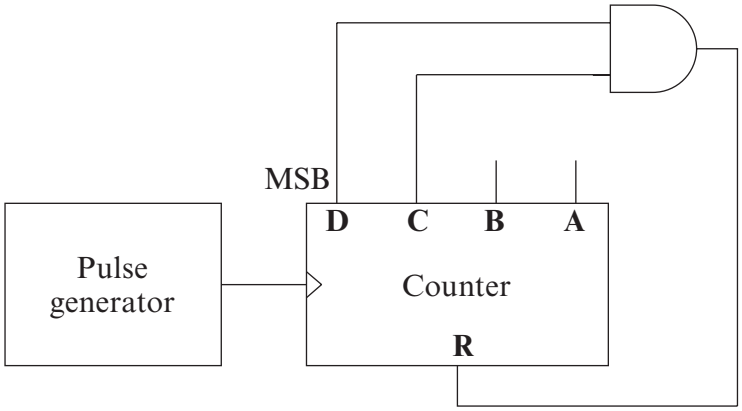
8. The diagram shows a four-bit up counter. Output **D** is the most significant bit (MSB).



The table shows the initial sequence of output signals caused by clock pulses from the pulse generator.

Clock pulses received	Outputs			
	D	**C**	**B**	**A**
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0

(a) Which line shows the signals at the outputs after four clock pulses have been received? (Tick (✓) the correct answer.) [1]

	Clock pulses received	Outputs			
		D	**C**	**B**	**A**
☐	4	0	0	1	1
☐	4	0	1	0	0
☐	4	0	1	0	1
☐	4	0	1	1	0

(b) How many clock pulses are needed to make the **D** output produce a logic 1 signal? (Tick (✓) the correct answer.) [1]

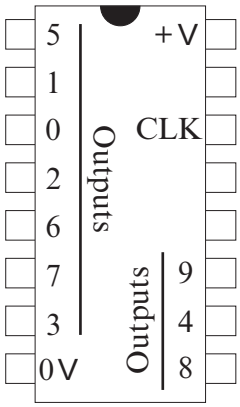
☐ 5 ☐ 6 ☐ 7 ☐ 8

(c) The counter resets when the Reset input receives a logic 1 signal. Which output combination will reset the counter? (Tick (✓) the correct answer.) [1]

	Outputs			
	D	**C**	**B**	**A**
☐	0	1	0	1
☐	0	1	1	0
☐	1	0	0	1
☐	1	1	0	0

Examiner only

9. In one type of counter, each output is activated in turn when the clock pulses arrive.

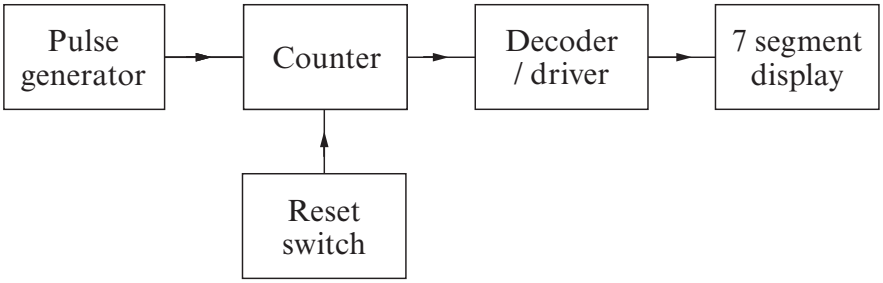


A typical pinout is shown in the diagram.

Which type of counter IC does this describe? ..... [1]

10. The diagram shows a system that displays the number of pulses received from a pulse generator.

A reset switch is used to restart the count.



Which counter could be used in this system without requiring extra connections to reset it when the count passes 9? (Tick (✓) the correct answer.) [1]

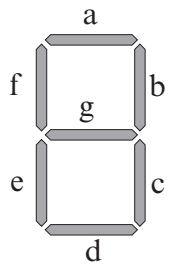
☐ up/down counter

☐ a binary counter

☐ a BCD counter

☐ a decade counter

11. The diagram shows a 7-segment display.
A logic 1 signal makes a segment light up.



(a) Identify the character displayed by the signals shown. [1]

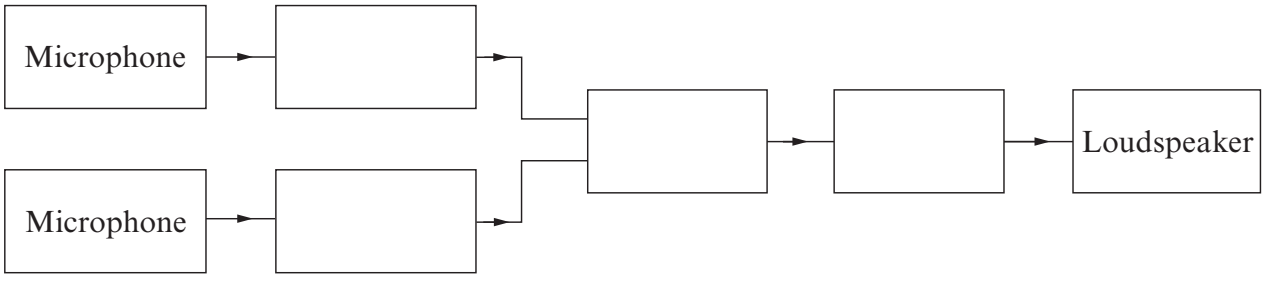
Segments							Character displayed
a	**b**	**c**	**d**	**e**	**f**	**g**	
1	1	1	0	0	0	0	

(b) Complete the signals needed to display the letter 'H'. [1]

Segments							Character displayed
a	**b**	**c**	**d**	**e**	**f**	**g**	
							H

12. Complete the diagram for an amplifier system using some of the sub-systems given. You can use each sub-system **once**, **more than once** or **not at all**. [3]

Power amplifier	Astable	AND gate	Preamplifier	Mixer



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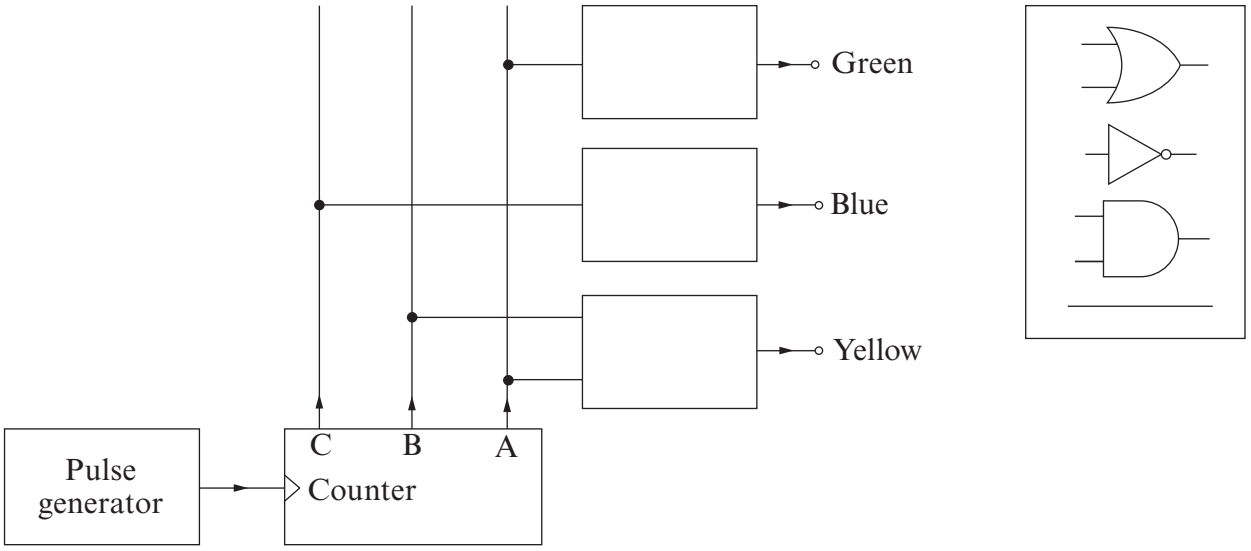
13. The diagram shows part of the control system for a set of coloured lights.
Each light is switched on when it receives a logic 1 signal.



Complete the diagram by adding three of the components provided. [3]
The required sequence of lights is shown in the table.

Pulses from pulse generator	Counter outputs			Lights		
	C	B	A	Yellow	Blue	Green
0	0	0	0	0	1	0
1	0	0	1	1	1	1
2	0	1	0	1	1	0
3	0	1	1	1	1	1
4	1	0	0	0	0	0
5	1	0	1	1	0	1
6	1	1	0	1	0	0
7	1	1	1	1	0	1

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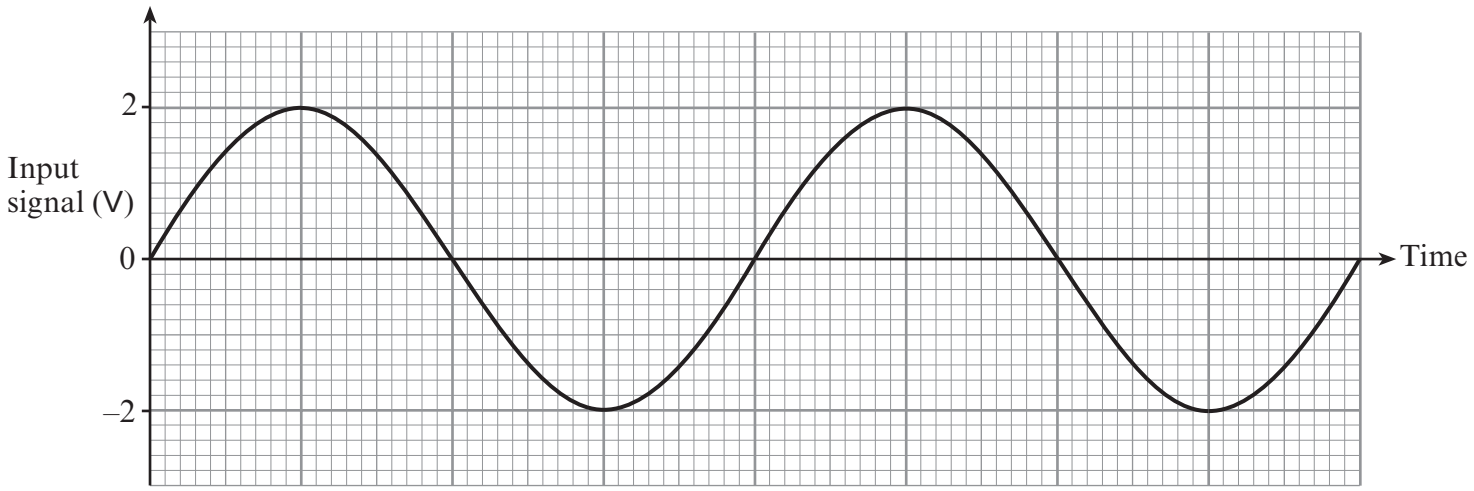
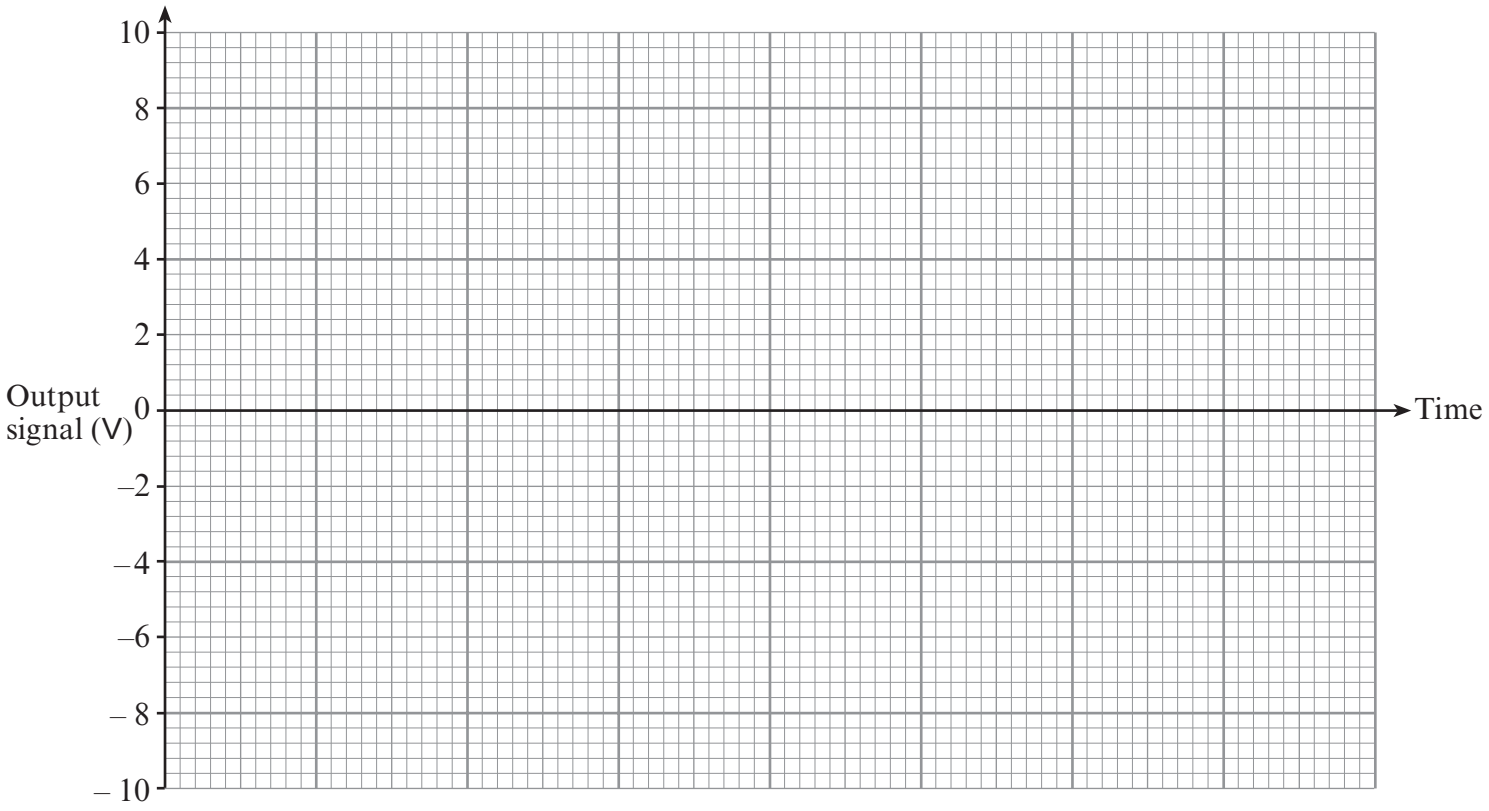
14. A non-inverting amplifier has a voltage gain of 4.
The upper graph shows the signal applied to the input of the amplifier.
Use the axes provided to draw the corresponding output signal. [3]

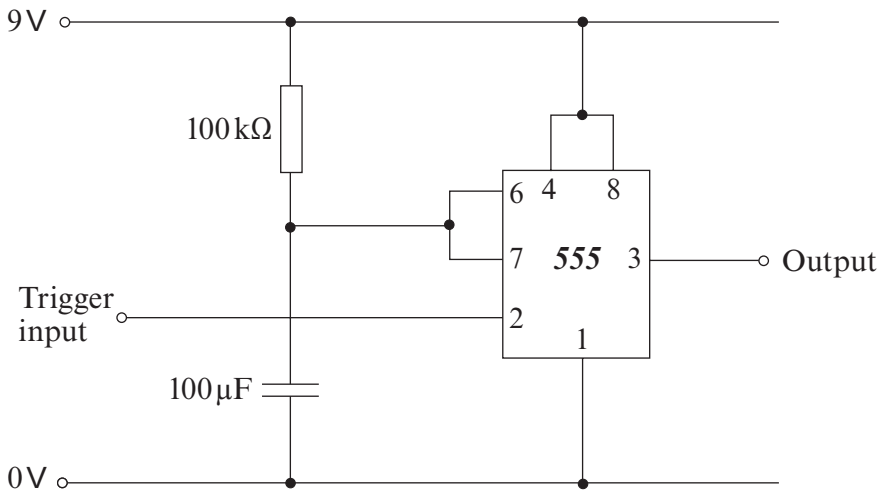




Turn over.

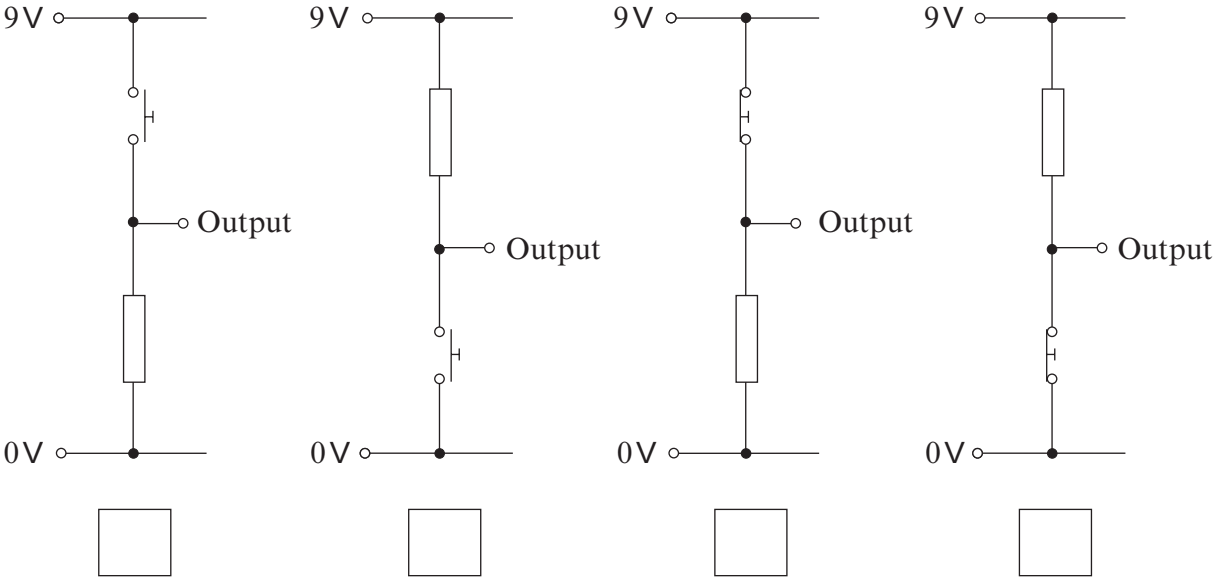
Examiner only

15. The monostable circuit shown in the diagram is triggered by the falling-edge of a signal applied to the trigger input.



This can be achieved by using push-to-make or push-to-break switches.

Which **two** of the following produce a falling-edge signal at the output when the switch is pressed? (Tick (✓) the correct answers.) [2]



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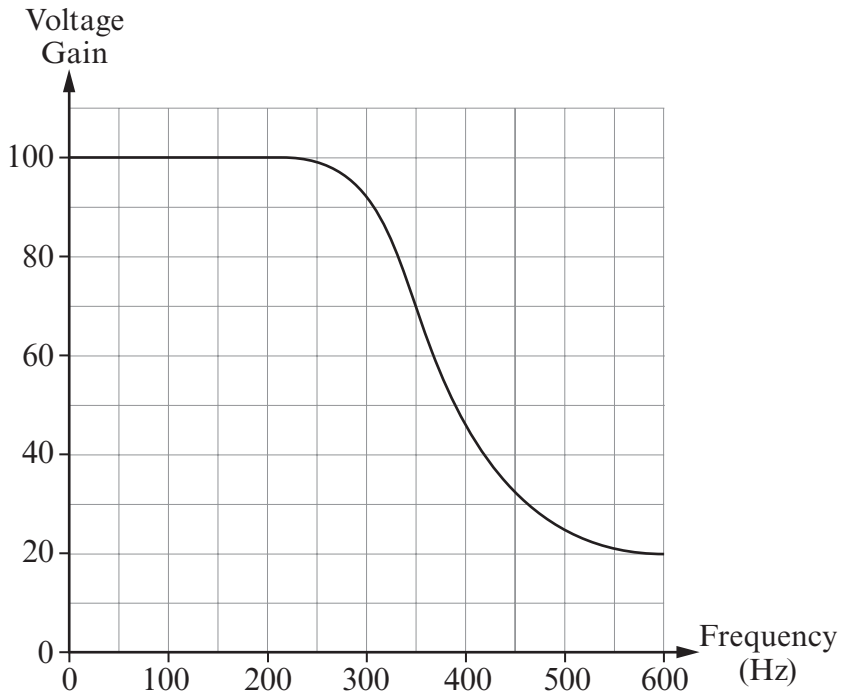
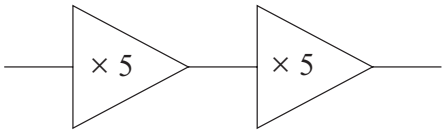
16. The graph shows the frequency response of a voltage amplifier.

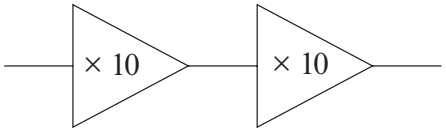


What is the bandwidth of this amplifier in Hz? ..... [1]

17. Two multistage amplifiers are shown.
They use identical op-amps, which are configured to give the gains shown.



System **A**



System **B**

Which system, **A** or **B**, has the bigger gain? .....

Which system, **A** or **B**, has the bigger bandwidth? ..... [1]

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18. The output signal from a voltage amplifier is 'clipped'.

Which is the best solution to remove the clipping? (Tick (✓) the correct answer.) [1]

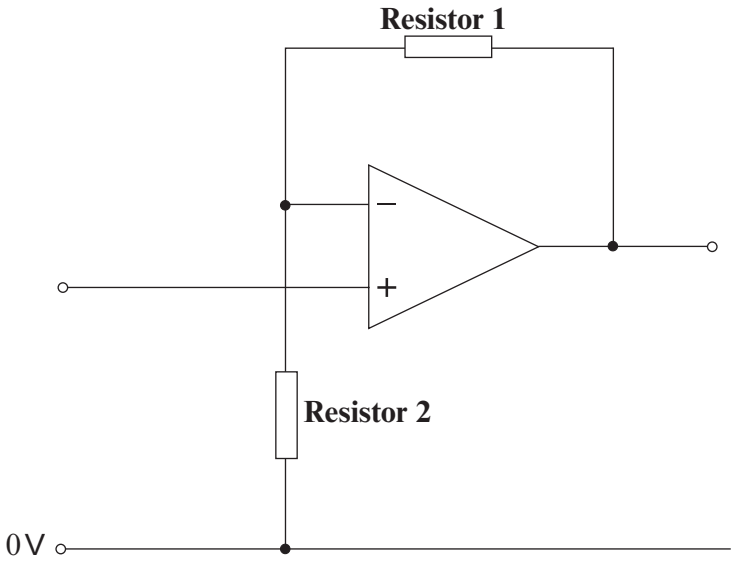
☐ Increase the power supply voltage to the amplifier.

☐ Reduce the power supply voltage to the amplifier.

☐ Increase the bandwidth of the amplifier.

☐ Reduce the bandwidth of the amplifier.

19. Which combination of resistors would give the following non-inverting amplifier a voltage gain of 10? (Tick (✓) the correct answer.) [1]

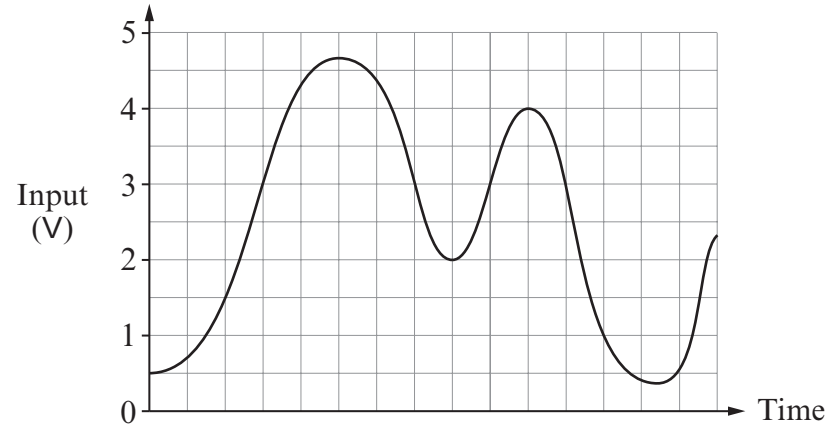


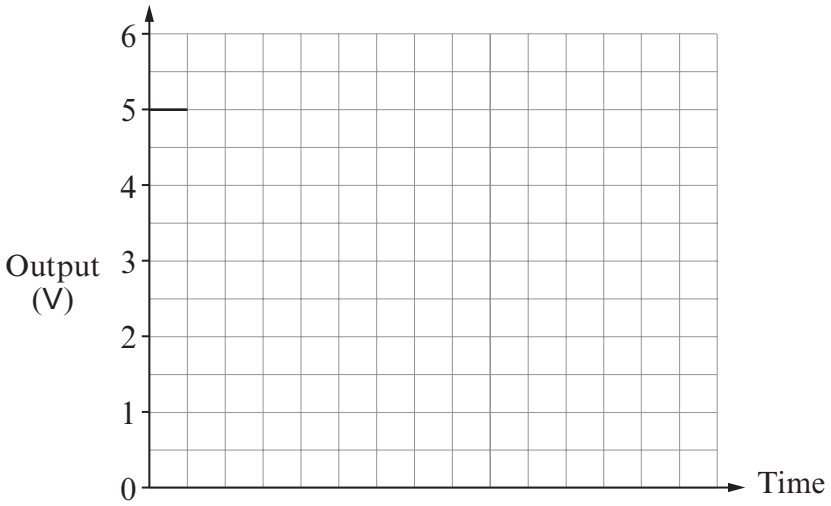
	Resistor 1	Resistor 2
☐	9 kΩ	1 kΩ
☐	1 kΩ	9 kΩ
☐	1 kΩ	10 kΩ
☐	10 kΩ	1 kΩ

20. Here is part of a data sheet for a 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 input signal for the Schmitt Inverter is shown below.





Use the axes provided to complete the corresponding output signal. [3]

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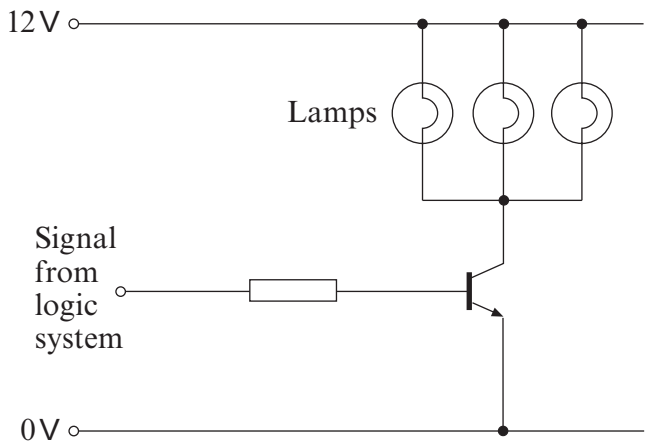
21. The transistor switch in the diagram acts as an interface between a logic system and three lamps.

Each lamp is rated at 12 V, 100 mA.



(a) What is the collector current when the three lamps are fully lit?

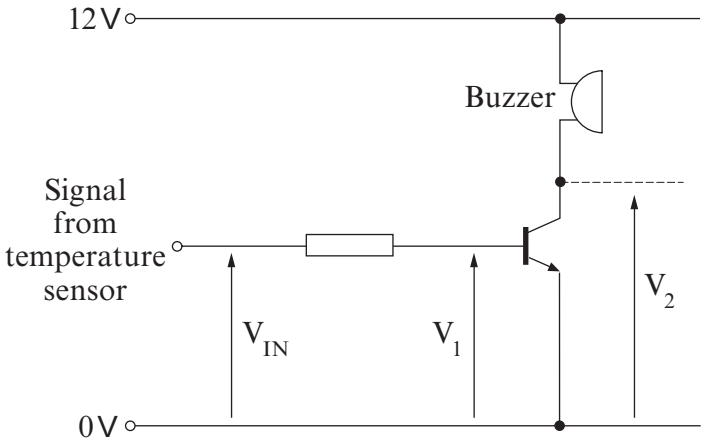
Collector current = ... mA [1]

(b) Using the following table, which transistor is capable of driving the three lamps, whilst drawing the smallest current from the logic system?
(Tick (✓) the correct answer.) [1]

	Transistor	Current gain, h_{FE}	Collector current, I_C max
☐	A	50	120
☐	B	100	120
☐	C	50	500
☐	D	150	500

Examiner only

22. A simple fire alarm uses a transistor switch.

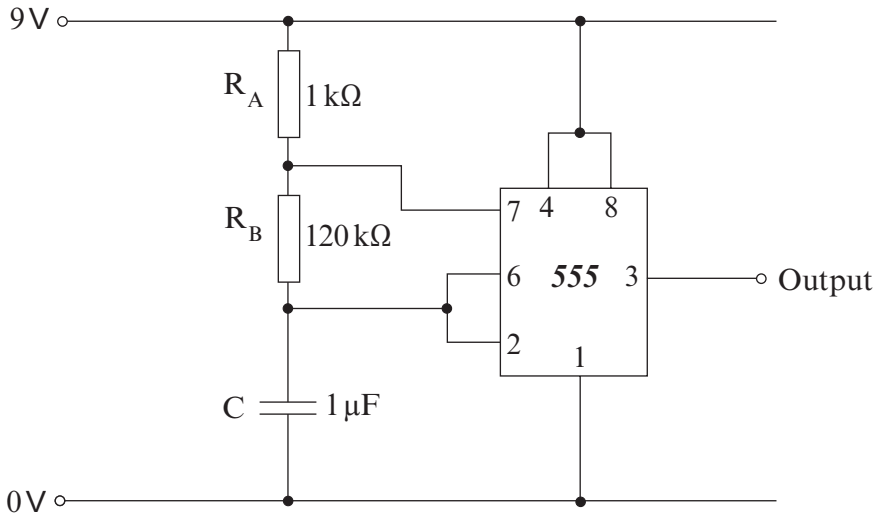


Complete the table to show the voltages V_1 and V_2 for the input voltages V_{IN} given. [4]

	V_{IN}	V_1	V_2
(a)	0.2V		
(b)	1.2V		

Examiner only

23. The circuit diagram shows an astable circuit.



The output frequency can be calculated using the formula:

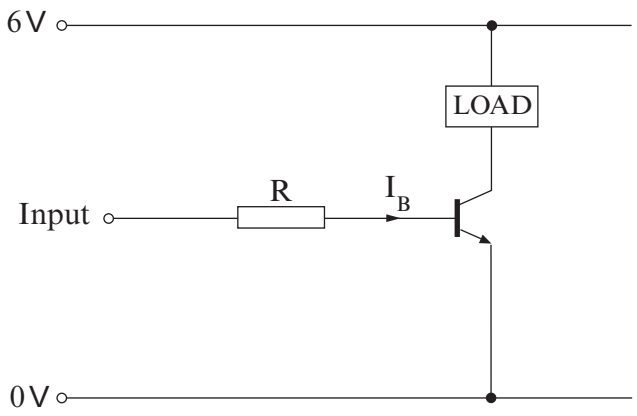
$$f = \frac{0.72}{R_B \times C}$$

Calculate the output frequency.

Output frequency = ... Hz [1]

Examiner only

24. The diagram shows a transistor switch circuit.
The input voltage V_{IN} = 5.2 V and V_{BE} = 0.7 V.



(a) Calculate the voltage drop across resistor R.

Voltage drop = ... V [1]

(b) Calculate the ideal value of resistor R, in kΩ that gives a base current, I_B of 2 mA. [1]

.....

.....

.....

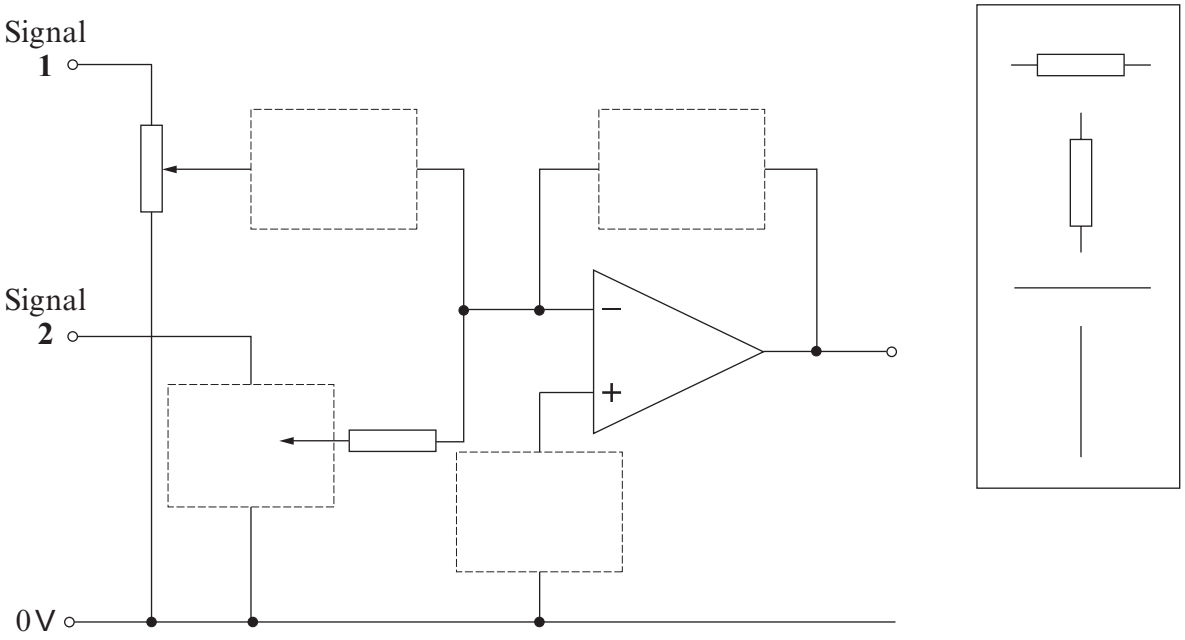
Examiner only

25. Amplifier systems often contain a mixer to combine signals.

The diagram shows part of the circuit of a mixer, used to combine signals **1** and **2**.

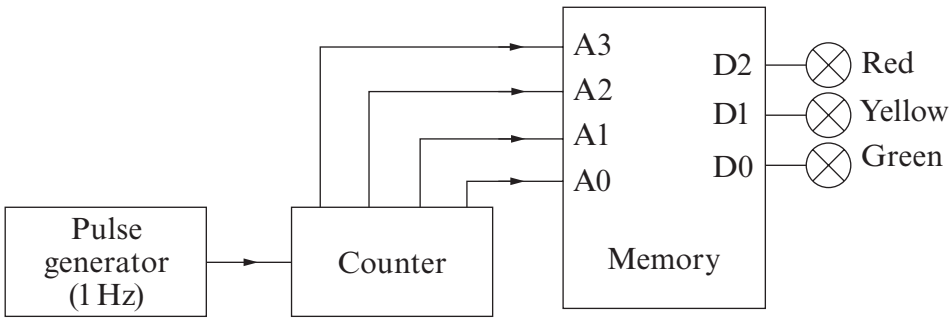
The box on the right contains the available components.

Draw the correct component in each of the dotted boxes. [4]



Examiner only

26. The block diagram shows a simple traffic light system controlled by a memory IC.



The data stored in the memory IC is shown in the following table:

A3	A2	A1	A0	D2	D1	D0
0	0	0	0	1	0	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	1	1	0
0	1	0	0	1	1	0
0	1	0	1	0	0	1
0	1	1	0	0	0	1
0	1	1	1	0	1	0
1	0	0	0	0	1	0
1	0	0	1	Reset		

(a) For how many seconds does the red light stay on after the counter is reset?

..... s [1]

(b) How long does the whole sequence take before it is reset?

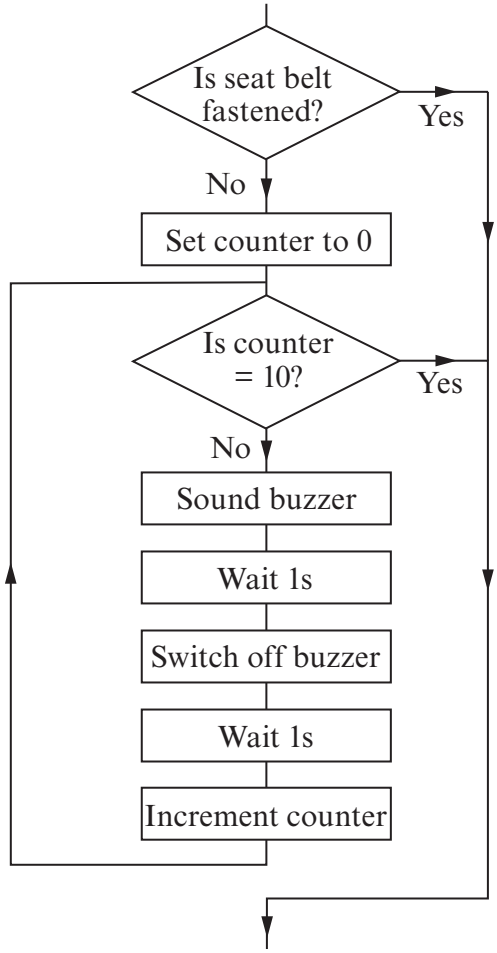
..... s [1]

(c) This memory IC has 4 address pins, **A3**, **A2**, **A1** and **A0**.
What is the maximum number of steps that can be stored in this memory IC?

..... [1]

Examiner only

27. Here is part of the flowchart for a car safety system. It warns the driver that the seat belt is not fastened.



(a) What is the effect of the first two boxes? [2]

.....

.....

.....

.....

(b) The seat belt is not fastened. Explain in detail what the buzzer does. [3]

.....

.....

.....

.....

.....

.....

THERE ARE NO MORE QUESTIONS IN THE EXAMINATION