Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4162/01

ELECTRONICS

UNIT E2 – Paper replacement test

P.M. MONDAY, 9 June 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**1**	
2.	**2**	
3.	**3**	
4.	**3**	
5.	**1**	
6.	**3**	
7.	**1**	
8.	**2**	
9.	**3**	
10.	**3**	
11.	**3**	
12.	**3**	
13.	**4**	
14.	**4**	
15.	**3**	
16.	**4**	
17.	**2**	
18.	**3**	
19.	**2**	
20.	**3**	
21.	**5**	
22.	**2**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

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

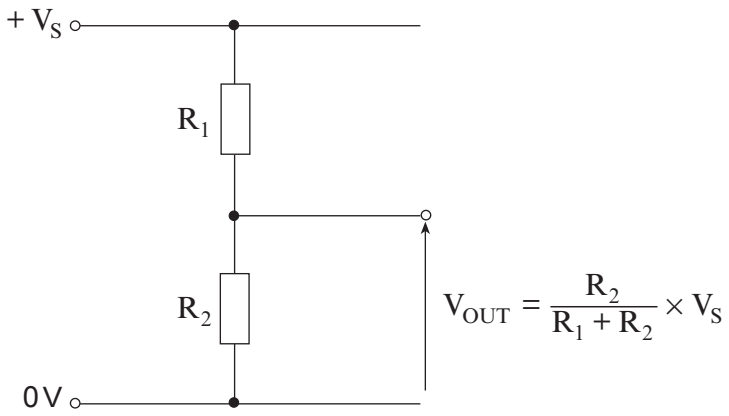
10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

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

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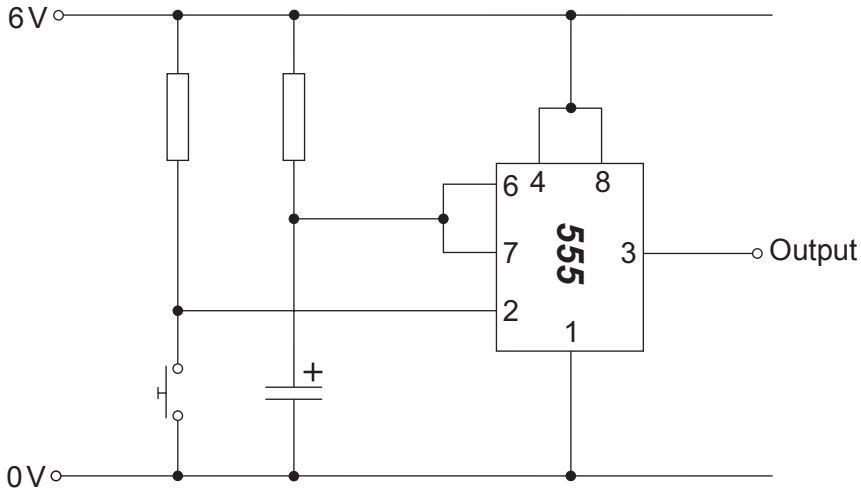
Answer **all** *questions.*

1. The circuit contains a 555 timer. What is the function of this circuit? (Tick (✓) the correct answer.) [1]

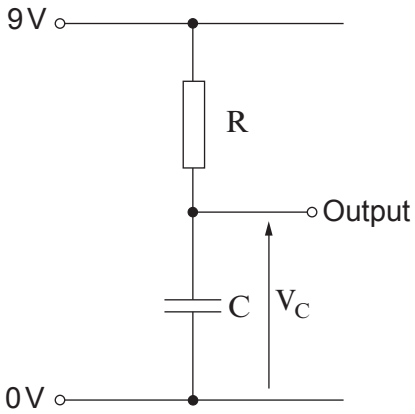
- ☐ Monostable
- ☐ Flip-flop
- ☐ Astable
- ☐ Counter



2. The circuit diagram shows a simple RC network used to produce a time delay.

When first connected the voltage V_C across capacitor C rises slowly over time.

Which **two** of the following would increase the time delay (make V_C rise more slowly)? (Tick (✓) the correct answers.) [2]



- ☐ Increase the resistance of R and keep the capacitance of C unchanged.
- ☐ Decrease the resistance of R and keep the capacitance of C unchanged.
- ☐ Increase the capacitance of C and keep the resistance of R unchanged.
- ☐ Decrease the capacitance of C and keep the resistance of R unchanged.

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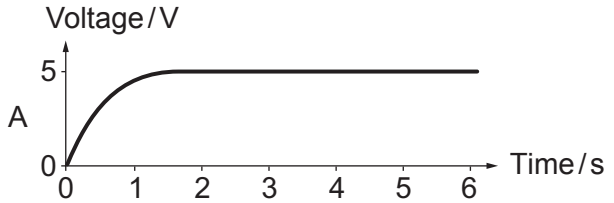
3. *(a)* Which graph shows the output signal of an astable circuit? (Tick (✓) the correct answer.) [1]

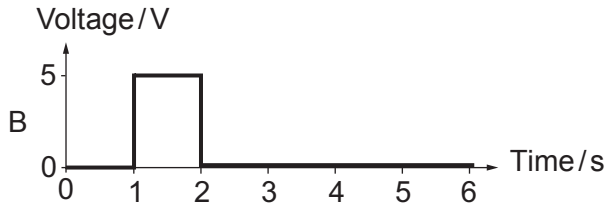
☐ A

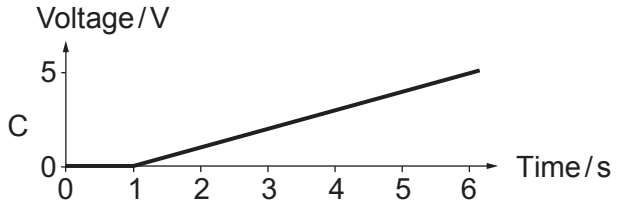
☐ B

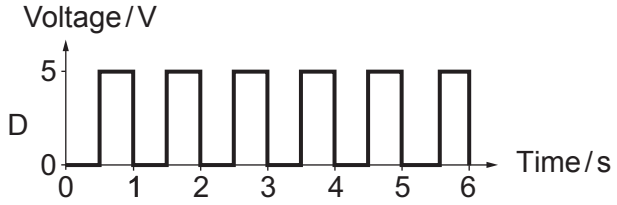
☐ C

☐ D









(b) What is the amplitude of the signal shown in graph **B**? [1]

Amplitude = ... V

(c) What is the period of the signal shown in graph **D**? [1]

Period = ... s

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4. The boxes on the left give the names of three sub-systems.

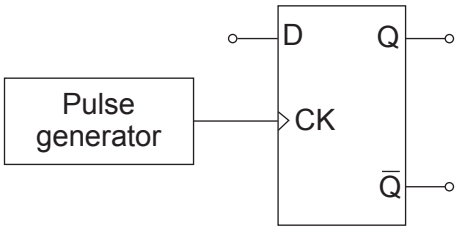
The boxes on the right give descriptions of four lighting applications.

Draw lines to link each sub-system to one correct application. [3]

Monostable	The light inside a fridge comes on as soon as the door opens and goes off as soon as the door shuts.
Astable	The hazard warning lights on a car flash on and off as long as the warning switch is pressed.
Latch	A security light stays on for 30 seconds after a switch is pressed and released.
	The light in a burglar alarm comes on when the alarm is triggered and stays on until a reset switch is pressed.

5. A D-type flip-flop is set up to produce a 'divide-by-two' function for pulses from a pulse generator. Which connection is needed to complete the circuit? (Tick (✓) the correct answer.) [1]

- ☐ Clock input is connected to Q output.
- ☐ Clock input is connected to $\overline{Q}$ output.
- ☐ Data input is connected to Q output.
- ☐ Data input is connected to $\overline{Q}$ output.



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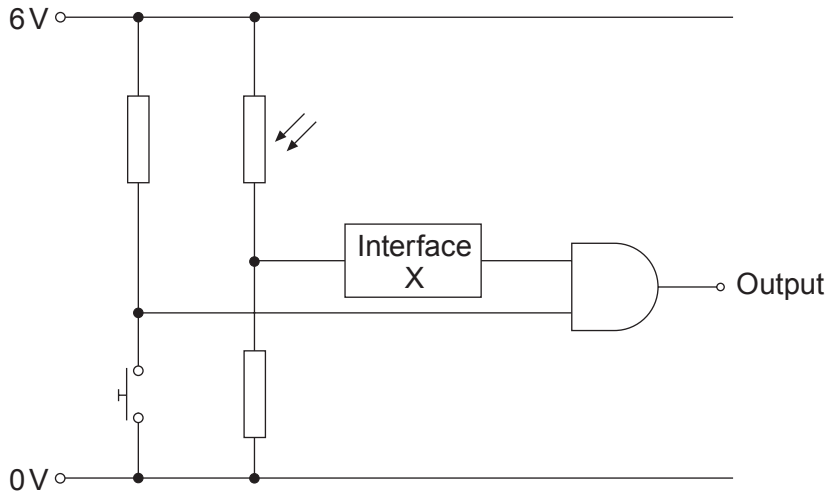
6. The diagram shows part of a control system.
The output of a light sensing unit is connected to an interface, X.

Complete the table by adding either 'Analogue' or 'Digital' to each box, to describe the signals listed. [3]



Signal	Analogue or Digital?
Output of light sensing unit	
Output of switch unit	
Output of interface X	

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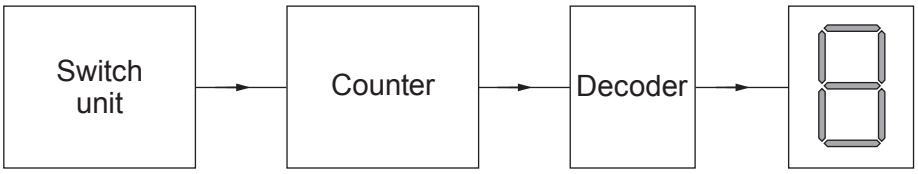
7. Here is the block diagram for a **decimal** counting system.



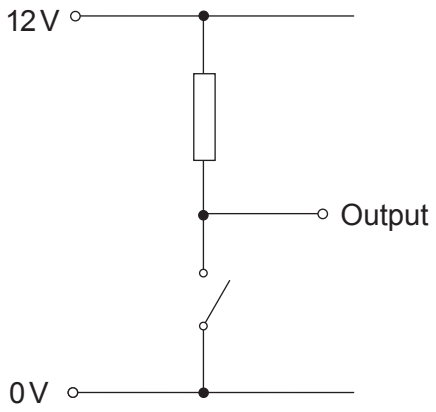
Which type of counter would you use, and for what reason? (Tick (✓) the correct answer.) [1]

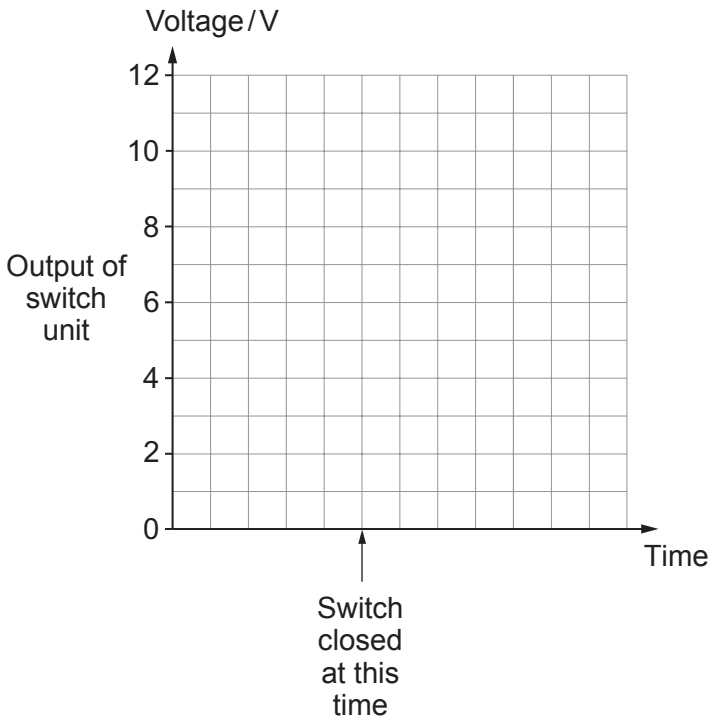
- ☐ A binary counter because it is the simplest as it just uses logic 0's and logic 1's.
- ☐ A BCD counter because it resets automatically on the tenth pulse.
- ☐ A one-bit counter because the system only displays one digit.
- ☐ A decade counter because the system is based on the decimal numbering system.

8. The switch in the circuit is initially open.

At the time shown on the graph, the switch is then closed.

Complete the graph to show the signal from the switch unit. [2]



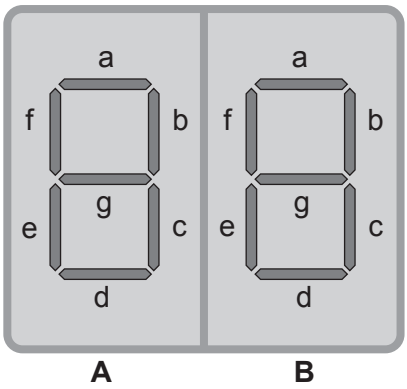


Examiner only

9. A room temperature controller uses the display shown below.

A segment lights when it receives a logic 1 signal.

Usually, the display shows the temperature of the room.
When the temperature is outside the set range, the display shows a simple text message.



(a) What is displayed when the following signals are sent to the displays? [2]

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

Display shows

A	**B**

(b) When the room is too cold, the display shows the message “LO”.

Complete the signals for displays A and B. [1]

Display A							Display B						
a	**b**	**c**	**d**	**e**	**f**	**g**	**a**	**b**	**c**	**d**	**e**	**f**	**g**

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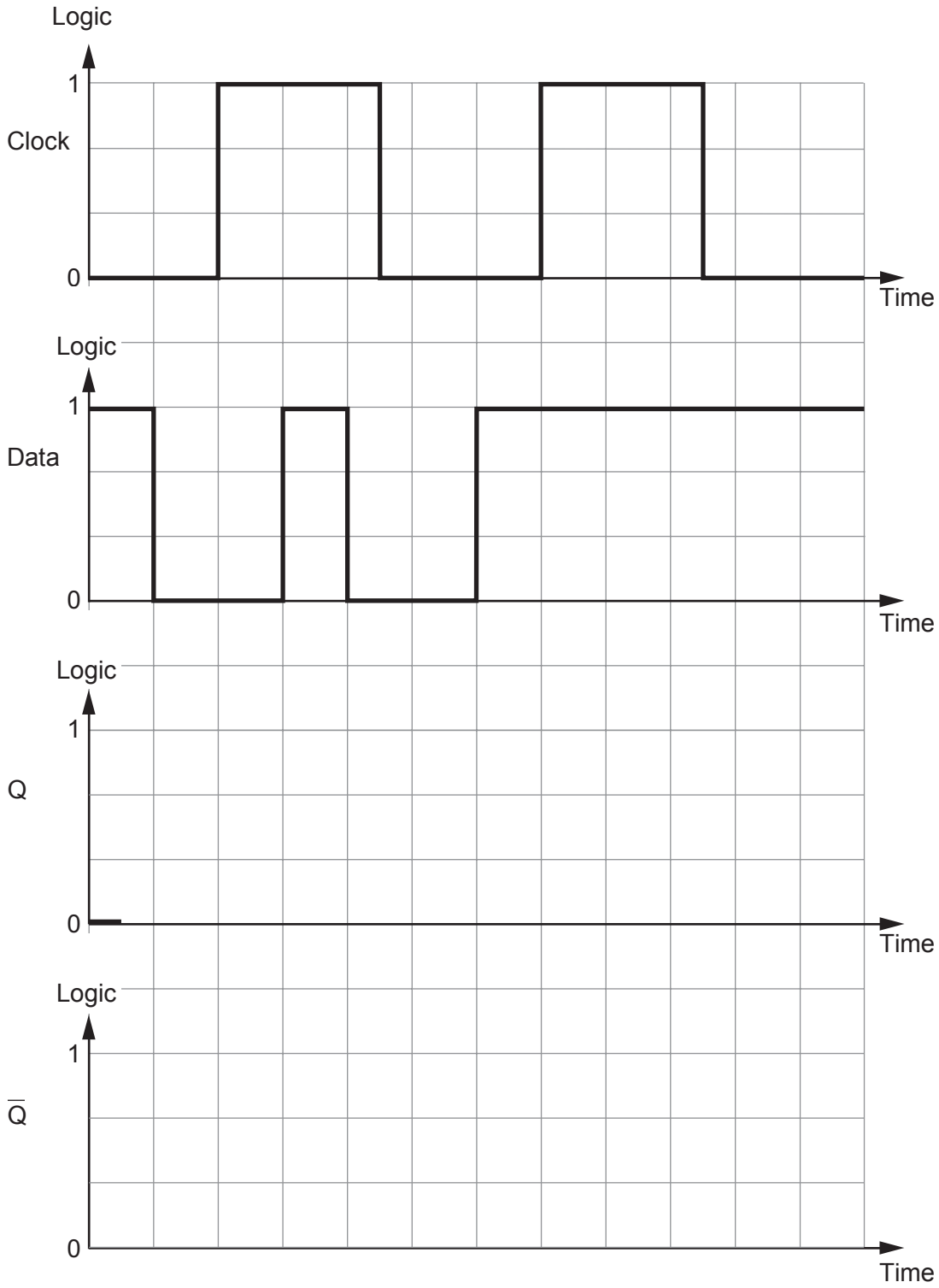
10. A *rising-edge triggered* D-type flip-flop is used for data transfer.

Complete the graphs to show the Q and $\overline{Q}$ outputs. [3]



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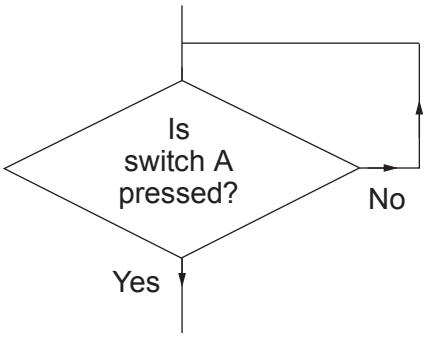
11. The diagrams show two sections of a flowchart designed to monitor the temperature of a room.



(a) Explain what is happening in the section of the flowchart shown above. [1]

.....

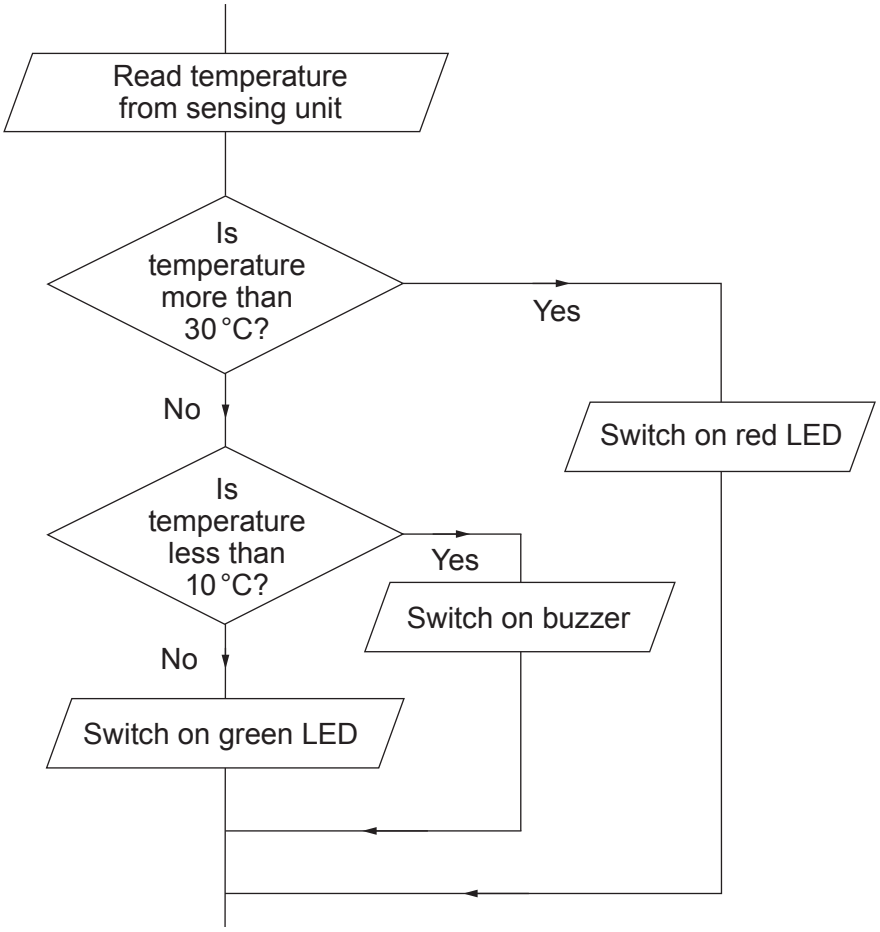
.....

(b) Explain what is happening in the section of the flowchart shown below. [2]

.....

.....

.....



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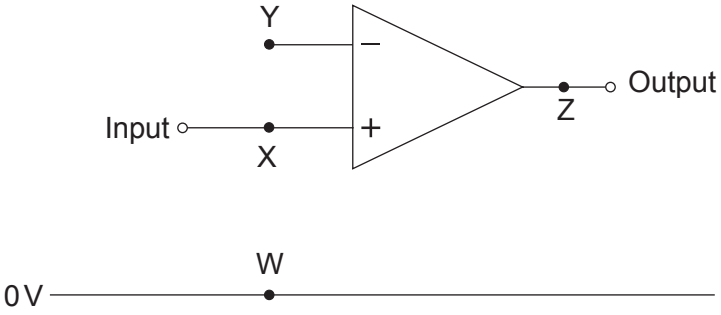
12. A non-inverting amplifier uses two resistors:

R_F = 220 kΩ

R_1 = 22 kΩ

Part of the circuit diagram is shown below:



(a) To complete the circuit diagram, additional connections are needed. **Two** of the following statements are **correct**. (Tick (✓) the correct answers.) [1]

☐ R_F is connected between points Z and Y.

☐ R_F is connected between points Z and X.

☐ R_1 is connected between points Y and W.

☐ R_1 is connected between points X and W.

(b) Calculate the voltage gain of a non-inverting amplifier that uses these resistors by:

(i) selecting the correct equation; (Tick (✓) the correct answer.) [1]

☐ Voltage gain $= 1 + \frac{22}{220}$

☐ Voltage gain $= 1 + \frac{220}{22}$

☐ Voltage gain $= -\frac{22}{220}$

☐ Voltage gain $= -\frac{220}{22}$

(ii) calculating the resulting voltage gain. [1]

Voltage gain = ...

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13. A light sequence controller uses a simple memory IC.

It has four address pins and three data pins.

(a) What is the decimal equivalent of the biggest binary number that can be stored in each location? [1]

Biggest decimal number = ...

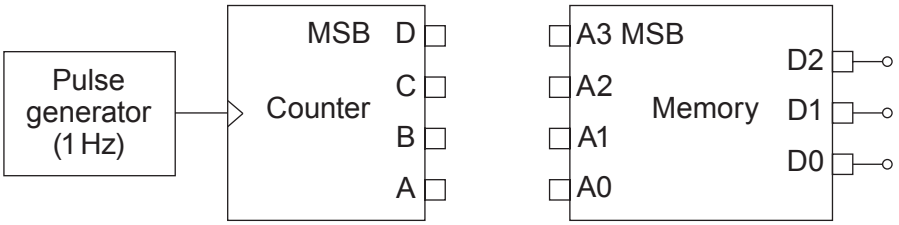
(b) How many address locations are there in the memory IC? [1]

Number of locations = ...

(c) The counter outputs (D C B A) should be connected to the memory and are used to select addresses on the memory IC.

Pin A3 is the most significant bit (MSB) of the address.

Output D is the most significant bit of the counter output.



Draw a line to link the counter output **B** to the correct address pin on the memory IC. [1]

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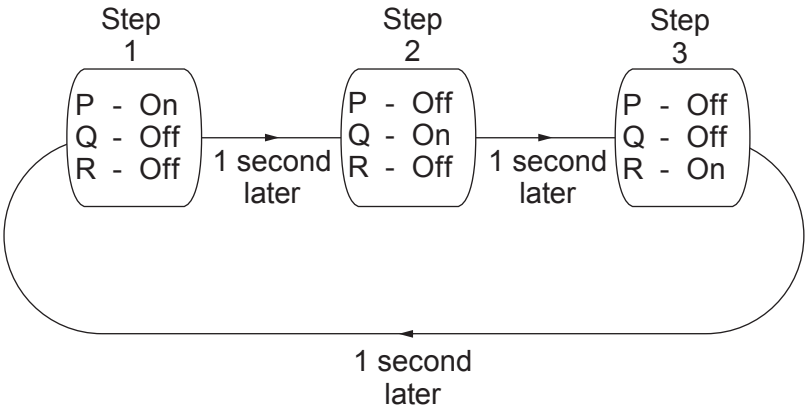
(d) The controller will light three LEDs P, Q and R in the sequence shown.



The memory IC outputs a logic 1 signal to light a LED.

Complete the table to show the contents of the memory IC needed to produce this sequence. [1]

Step	Memory location				LED		
	A3	A2	A1	A0	P	Q	R
1	0	0	0	0			
2	0	0	0	1			
3	0	0	1	0			

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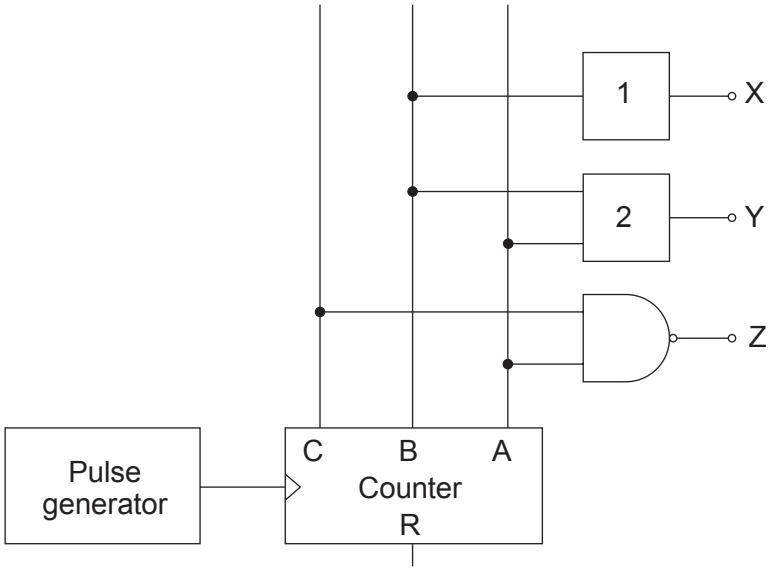
14. The diagram shows part of a sequence controller circuit.



Pulses	Counter outputs			Signals		
	C	B	A	X	Y	Z
0	0	0	0	1	0	
1	0	0	1	1	1	
2	0	1	0	0	1	
3	0	1	1	0	1	
4	1	0	0	1	0	
5	1	0	1	1	1	
6	1	1	0	0	1	
7	1	1	1	0	1	

(a) Complete the final column for signal Z. [1]

(b) Which logic gate, in box 1, would produce the signal X shown in the table? [1]

.....

(c) Which logic gate, in box 2, would produce the signal Y shown in the table? [1]

.....

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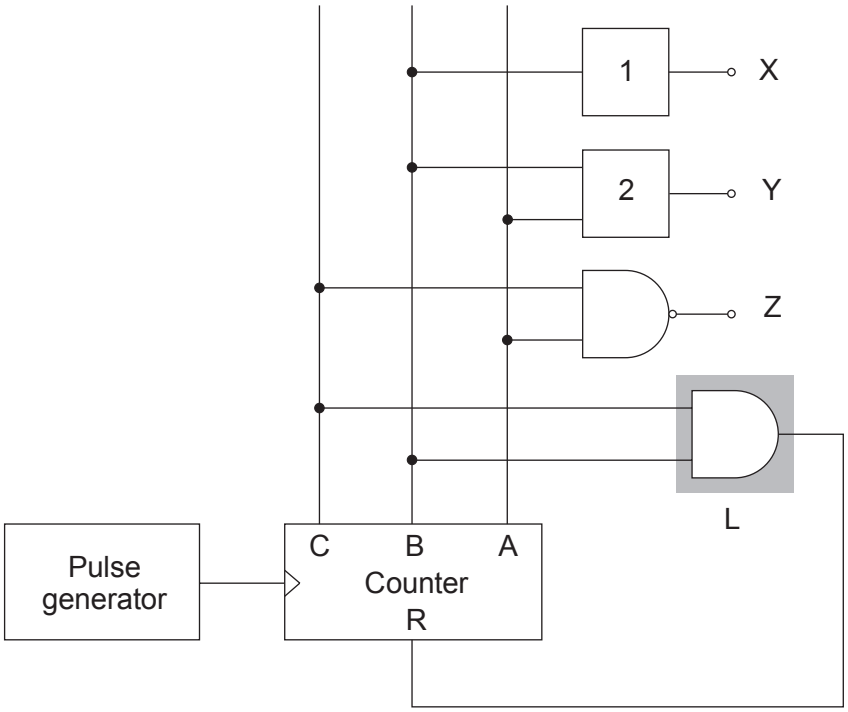
(d) The system is then modified.



The logic gate shown in box L is connected to reset the counter.

The counter resets when input R receives a logic 1 signal.

What is the lowest counter output CBA that resets the counter?

C	B	A
☐	☐	☐

[1]

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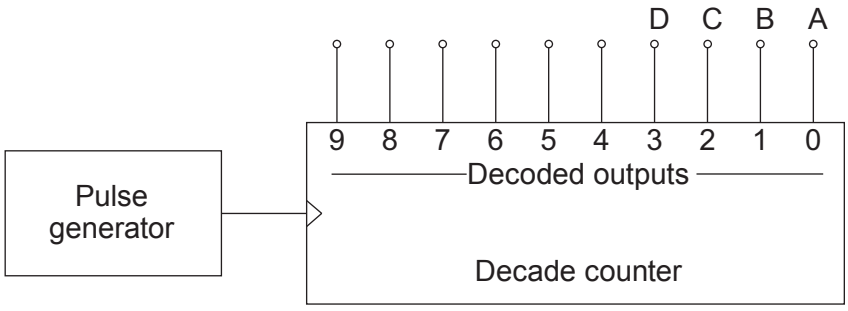
15. The diagram shows a pulse generator connected to a decade counter.



The counter operates on the rising-edge of the clock pulses and is initially reset.

Four pulses are sent from the pulse generator to the counter.

Use the axes opposite to show the effect on the counter outputs labelled A, B, C and D. [3]

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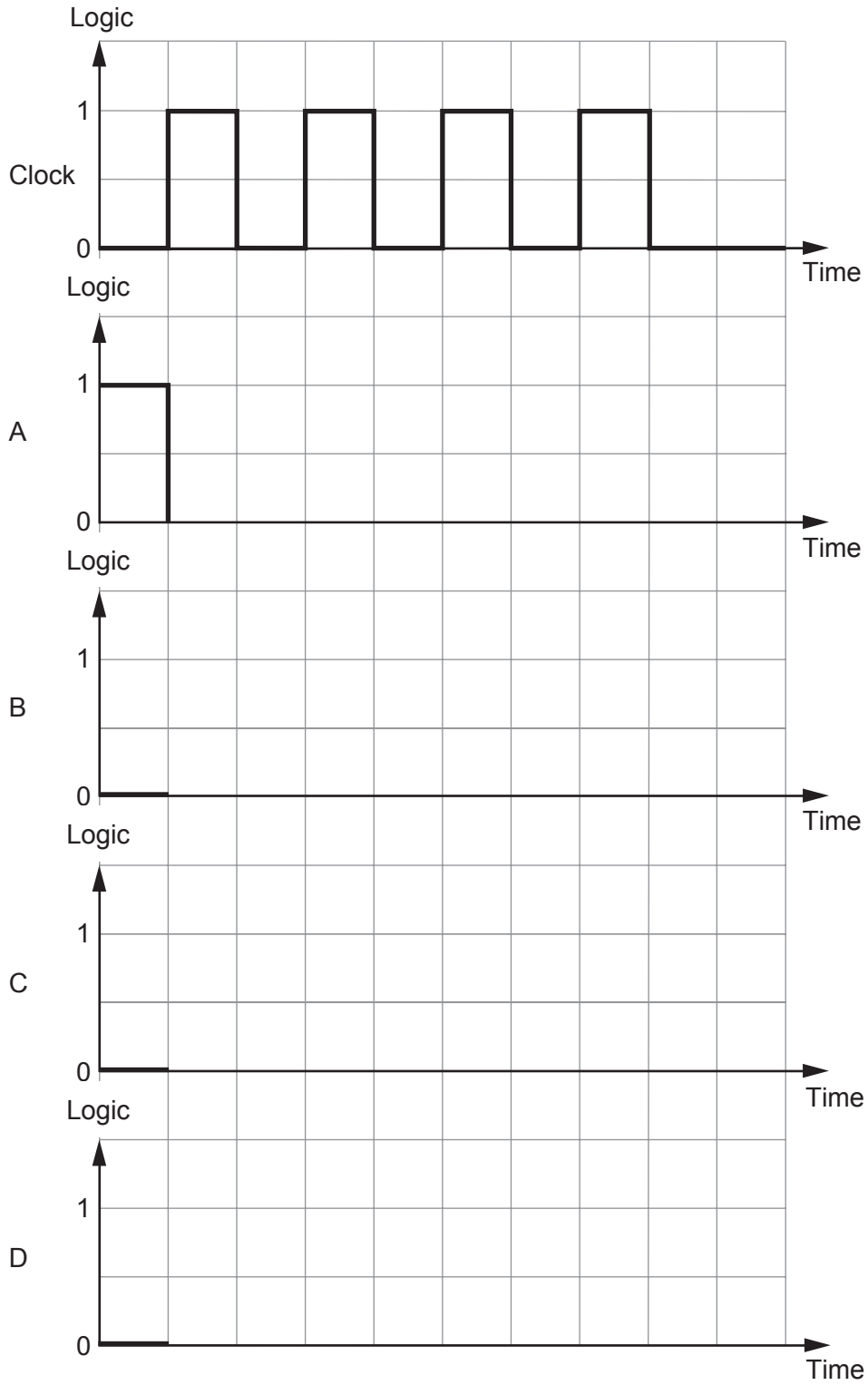

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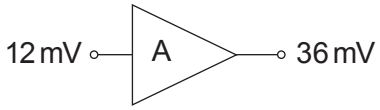
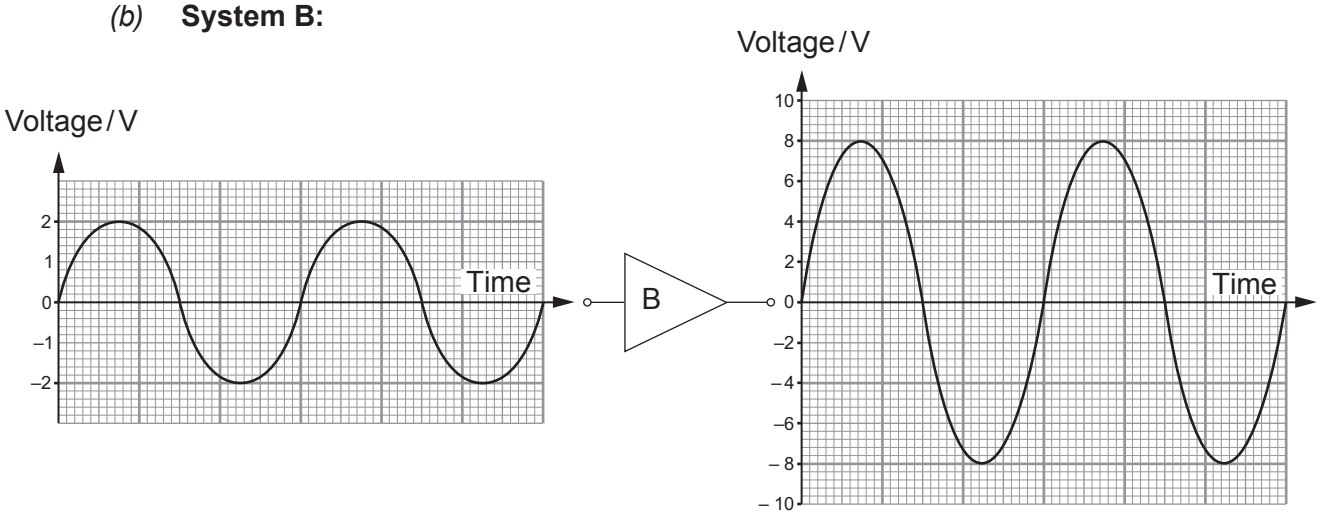
16. Calculate the voltage gain for each of the following amplifier systems. [4]

(a) **System A:**



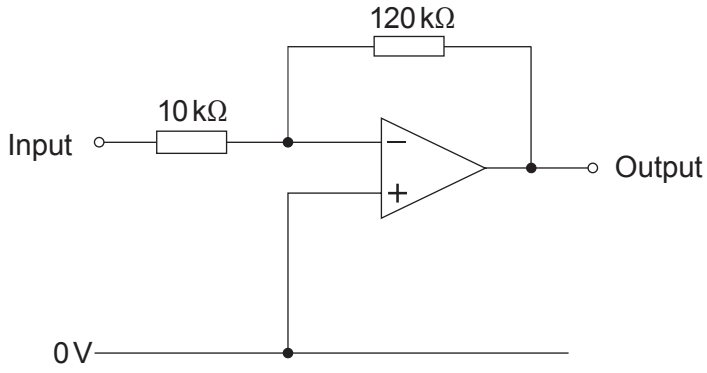
Voltage gain = ...

(b) **System B:**



Voltage gain = ...

(c) **System C:**



Voltage gain = ...

Turn over.

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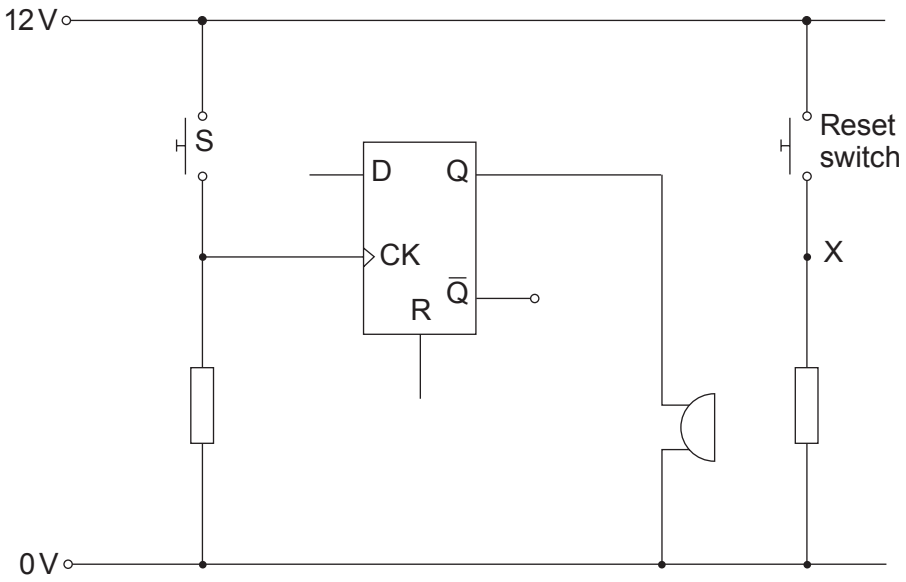
17. A D-type flip-flop is used as part of a latch circuit.

When switch S is pressed, the buzzer should sound and keep on sounding until the reset switch is pressed.



Select **all** connections needed to complete the latch. (Tick (✓) the correct answers.) [2]

- ☐ The data input, D is connected to the 12 V power rail.
- ☐ The data input, D is connected to the 0 V power rail.
- ☐ The data input, D is connected to point X.
- ☐ The reset input, R is connected to the 12 V power rail.
- ☐ The reset input, R is connected to the 0 V power rail.
- ☐ The reset input, R is connected to point X.

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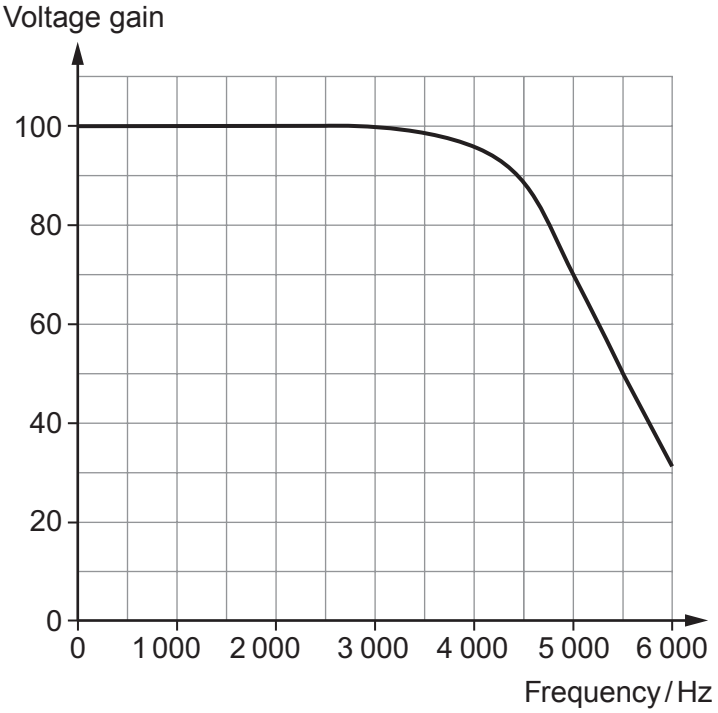
18. *(a)* Which **one** of the following is the best description of the term *bandwidth*? (Tick (✓) the correct answer.) [1]

☐ The maximum frequency of the input signal.

☐ The input voltage range that can be amplified successfully.

☐ The range of frequencies that produces more than a specified voltage gain.

☐ The power supply voltage that produces optimum output voltage for a given signal.



(b) Use the graph to find: [2]

(i) the voltage gain at which the bandwidth should be measured;

Voltage gain = ...

(ii) the bandwidth.

Bandwidth = ... Hz

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19. A monostable circuit uses a 555 timer IC, a resistor R of value 100 kΩ and a capacitor C, of value 68 μF.

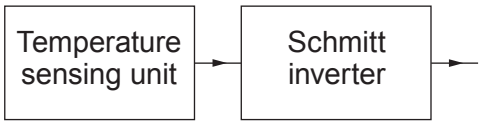
The time delay produced is given by the formula: $T = 1.1\ RC$

Calculate the time delay for this monostable, and give the correct unit for your answer. [2]

Time delay = ...

Unit = ...

20. A Schmitt inverter is connected to a temperature sensing unit.



The circuit runs on a 15 V power supply.

Part of the data sheet for the Schmitt inverter is shown below.

When connected to a 15 V supply:

- Logic 0 output = 0 V;
- Logic 1 output = 15 V;
- The output changes from logic 1 to logic 0 when a **rising** input voltage reaches 10 V;
- The output changes from logic 0 to logic 1 when a **falling** input voltage reaches 5 V.

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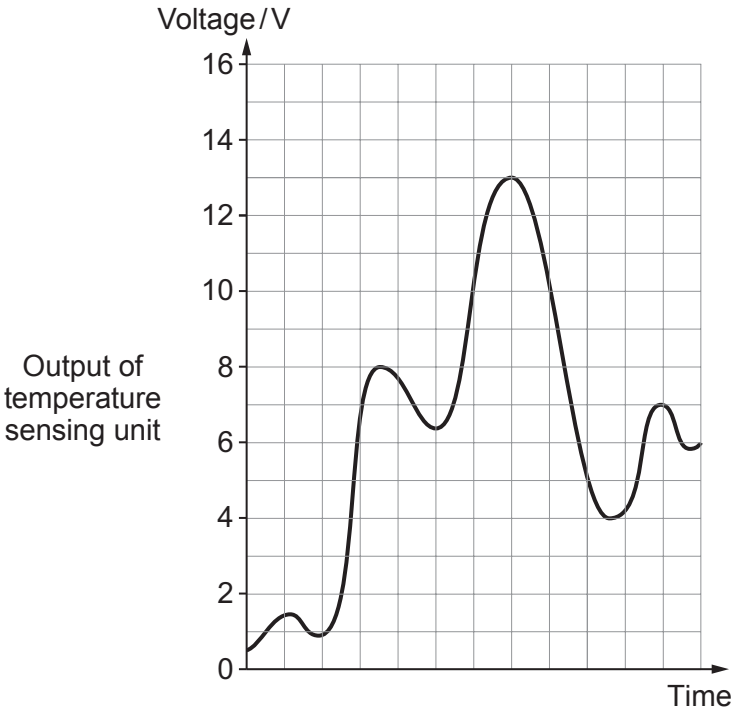
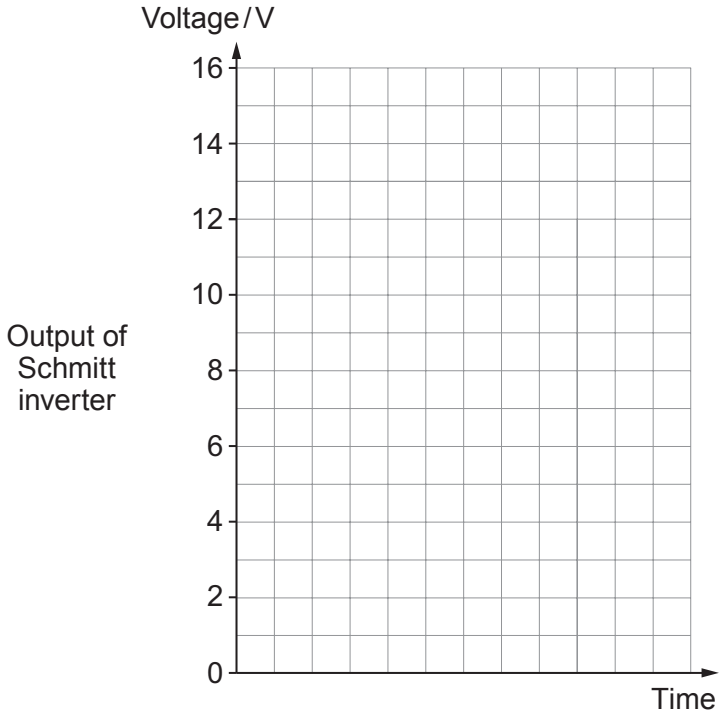
The output of the temperature sensing unit is shown in the top graph.

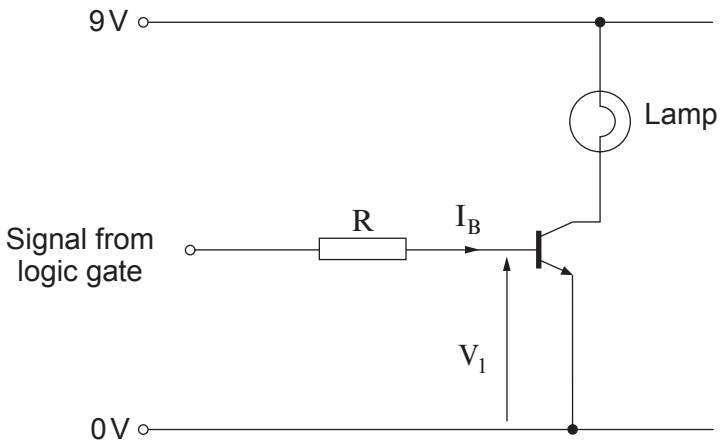
Use the axes provided to draw the corresponding output signal of the Schmitt inverter, when the signal from the temperature sensing unit is applied to its input. [3]





Examiner only

21. The diagram shows a transistor used to interface a logic gate to a lamp.



(a) The logic gate outputs 0.3 V for logic 0, and 7.5 V for logic 1.

Complete the table below to show the effect of these signals on the transistor and lamp by:

(i) adding the correct voltages to the V_1 column; [1]

(ii) writing either 'Off' or 'On' to show the state of the lamp. [1]

Logic gate output	V_1	State of lamp
0.3 V	 V	
7.5 V	 V	

When fully lit, the lamp passes a current of 200 mA.

The transistor has a current gain, h_{FE} of 40.

(b) Calculate the base current, I_B. [1]

Base current, I_B = ... mA

(c) When the logic gate outputs 7.5 V, what is the voltage drop across resistor R? [1]

Voltage drop = ... V

(d) Calculate the value of resistor R. [1]

Resistor R = ... Ω

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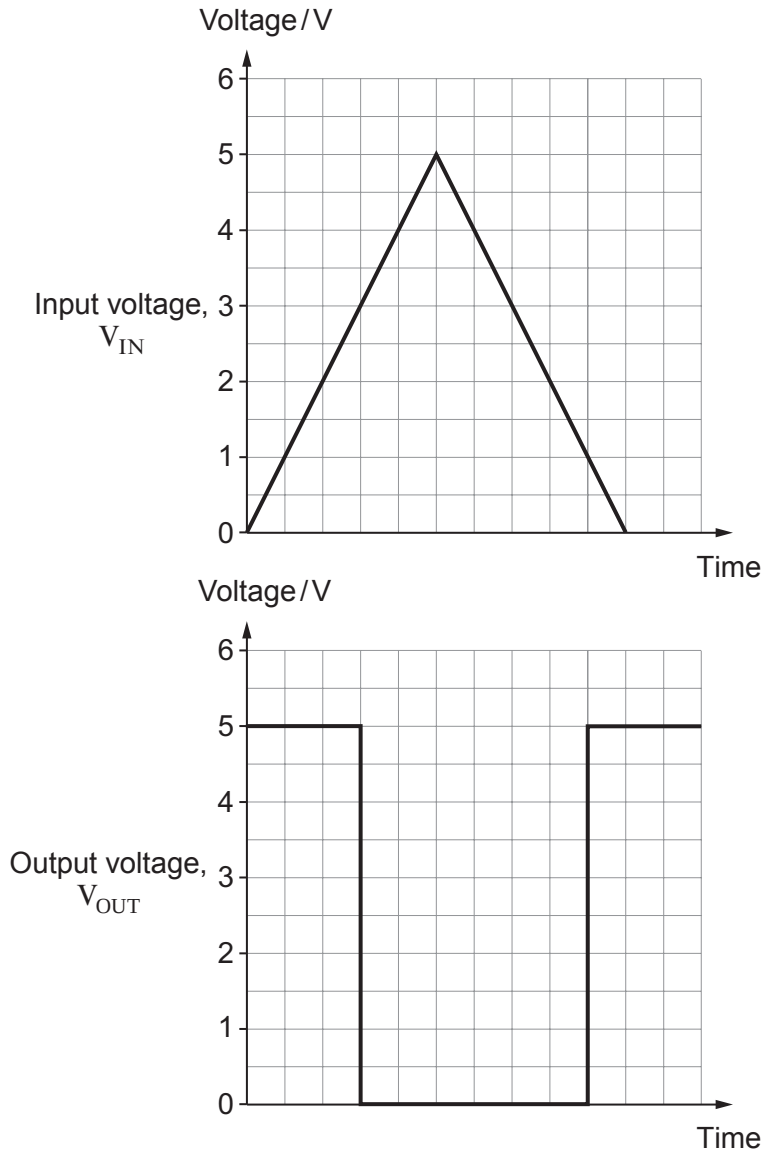
22. The performance of a Schmitt inverter is shown in the graphs below.
The top graph shows the input voltage V_{IN} applied to it.
The bottom graph shows the corresponding output voltage V_{OUT}.

Complete the following sentences:

(a) The output of the Schmitt inverter changes
from logic 1 to logic 0 when a **rising** input voltage reaches ..... V. [1]

(b) The output of the Schmitt inverter changes
from logic 0 to logic 1 when a **falling** input voltage reaches ..... V. [1]



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