Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4162/01

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

A.M. TUESDAY, 14 June 2011

1 hour

Examiner only

Total Marks	

4162 010001

ADDITIONAL MATERIALS

Information sheet.
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

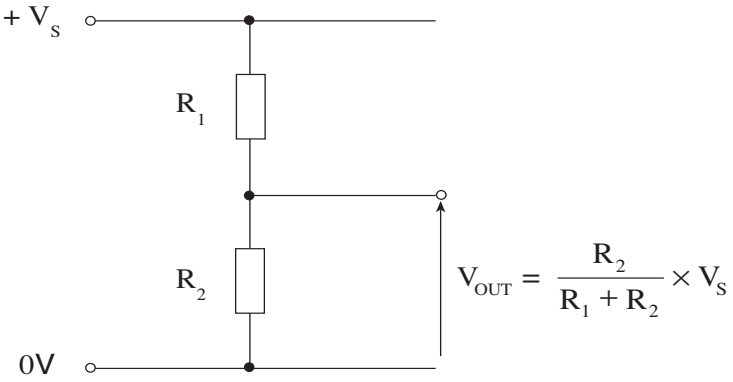
10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

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 2V.

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 0·7V.

10. Amplifiers

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

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

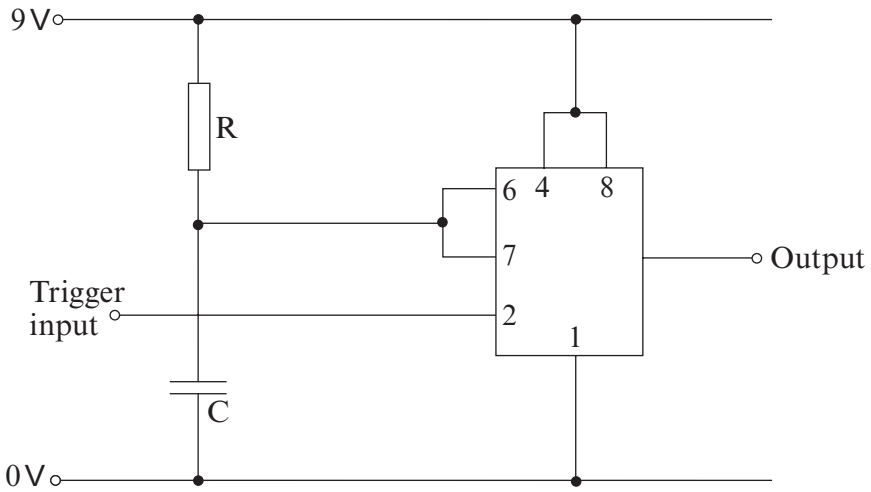
Inverting amplifier: $A = -\frac{R_F}{R_{IN}}$

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

Turn over.

Answer **all** *questions.*

1. Monostable circuits use a capacitor and a resistor to produce a time delay.
The circuit diagram shows a resistor and a capacitor used with a 555 timer IC in a monostable circuit.



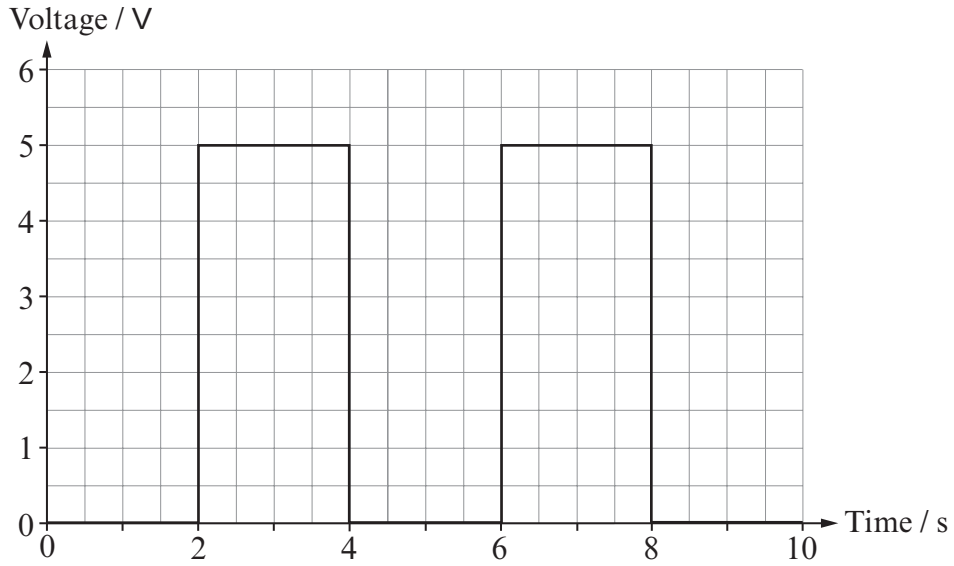
Here are four resistor/capacitor sets.

Set	Resistor	Capacitor
A	10 kΩ	330 μF
B	100 kΩ	330 μF
C	10 kΩ	33 μF
D	100 kΩ	33 μF

Which one, A, B, C or D, will produce the longest time delay? [1]

Answer .....

2. The graph shows a signal produced by an electronic sub-system.



What is:

(a) the amplitude of the signal; ..... [1]

(b) the period of the signal? ..... [1]

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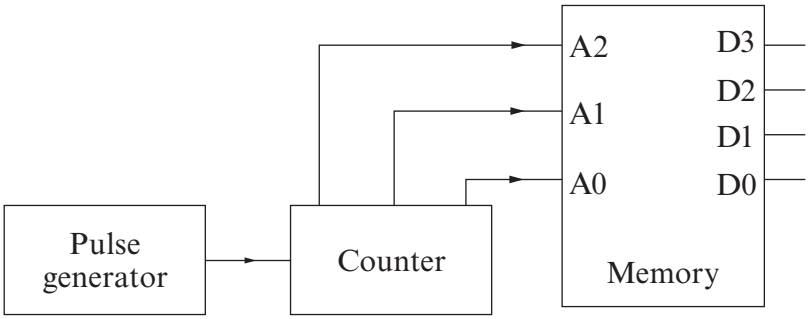
3. The block diagram shows how a sequence can be generated using a memory IC.



The memory stores the following data:

A2	A1	A0	D3	D2	D1	D0
0	0	0	0	0	0	1
0	0	1	0	0	1	1
0	1	0	0	1	1	1
0	1	1	1	1	1	1
1	0	0	0	1	1	1
1	0	1	0	0	1	1
1	1	0	Reset			

(a) How many lights can be controlled separately by this system? [1]

.....

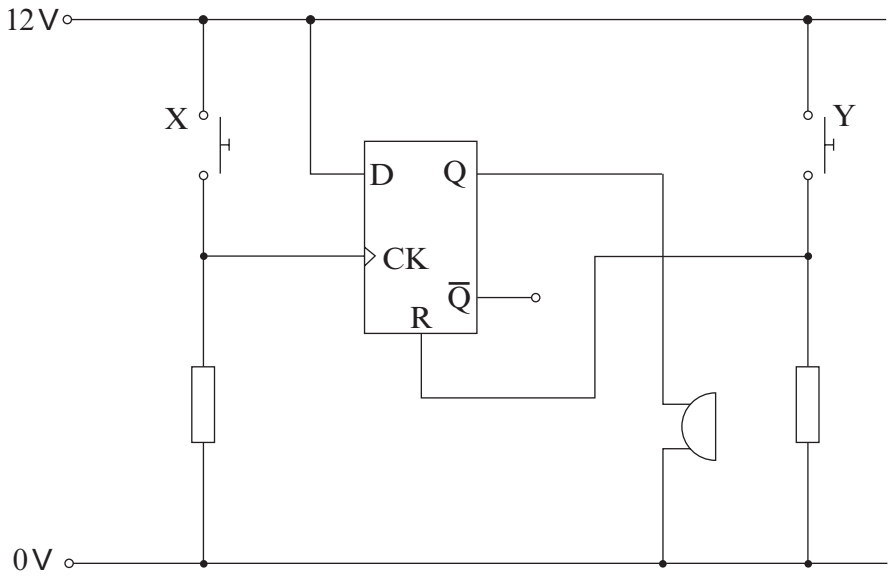
(b) How many separate steps (patterns) are stored in this sequence? [1]

.....

(c) This memory IC has 3 address pins, **A2**, **A1** and **A0**.
What is the maximum number of steps that can be stored in this IC? [1]

.....

4. The latch circuit uses a rising-edge triggered D-type flip-flop. To begin with, the Q output is logic 0.
When switch X is pressed, the clock input changes from logic 0 to logic 1.
When switch Y is pressed, the reset input changes from logic 0 to logic 1.



Here are four possible answers to use in the questions which follow:

A. It goes to logic 1 and stays there.
B. It goes to logic 1 but then drops back to logic 0 when the switch is released.
C. It goes to logic 0 and stays there.
D. It goes to logic 0 but then drops back to logic 1 when the switch is released.

(a) Switch X is pressed and then released.
As a result:

(i) what happens to the Q output? (Choose answer A, B, C or D.) [1]

Answer .....

(ii) what happens to the $\overline{Q}$ output? (Choose answer A, B, C or D.) [1]

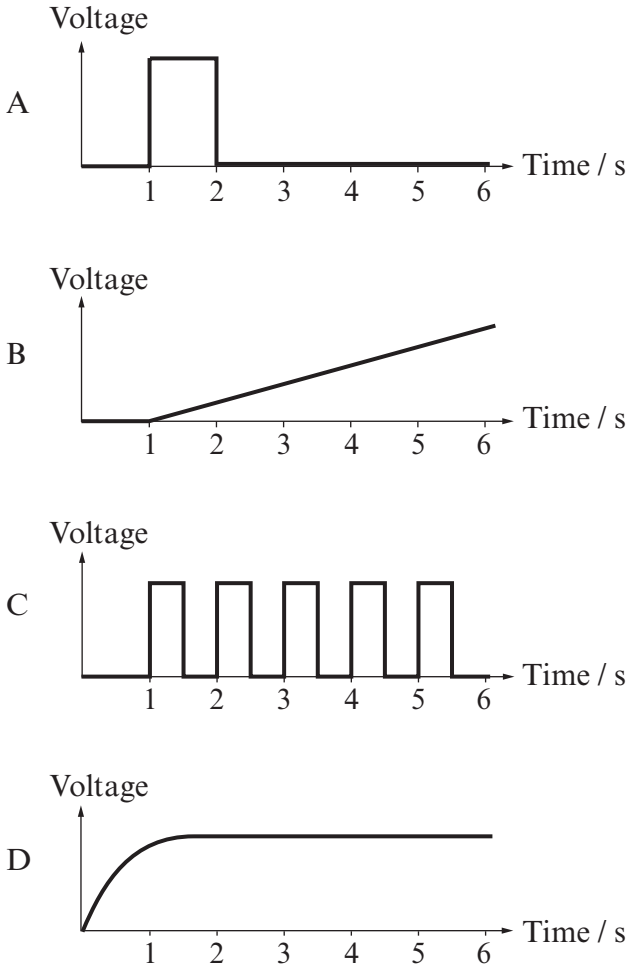
Answer .....

(b) Switch Y is now pressed and released.
What happens to the Q output? (Choose answer A, B, C or D.) [1]

Answer .....

Examiner only

5. The graphs show four different signals.



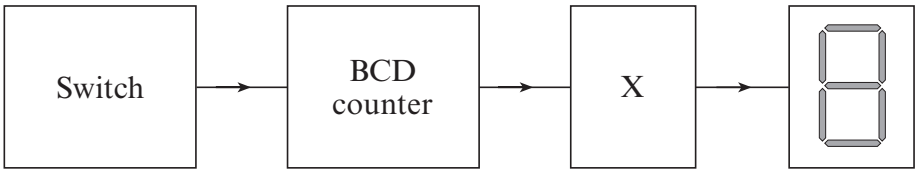
(a) Which signal, A, B, C or D, is the output of an astable circuit? [1]

Answer .....

(b) Which signal, A, B, C or D, is the output of a monostable circuit? [1]

Answer .....

6. Here is the block diagram for a counting system. It shows how many times the switch has been pressed.

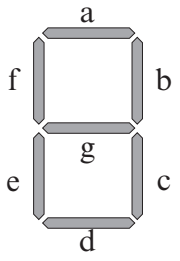


Subsystem X converts the output of the counter to light the correct LEDs in the seven-segment display.
Choose the best subsystem to do this from the following list: [1]

A. monostable
B. decoder / driver
C. AND gate
D. transducer driver

Answer .....

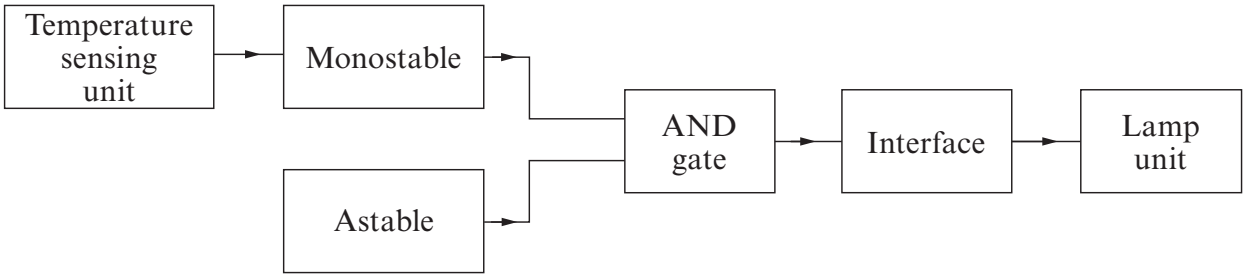
7. The diagram shows a 7-segment display. A logic 1 signal makes a segment light up.
Complete the table by identifying the number shown on the display when the signals given in the table are sent to the 7-segment display. [1]



Segments							Number Displayed
a	**b**	**c**	**d**	**e**	**f**	**g**	
1	1	0	1	1	0	1	

Examiner only

8. Here is the block diagram for a freezer alarm.



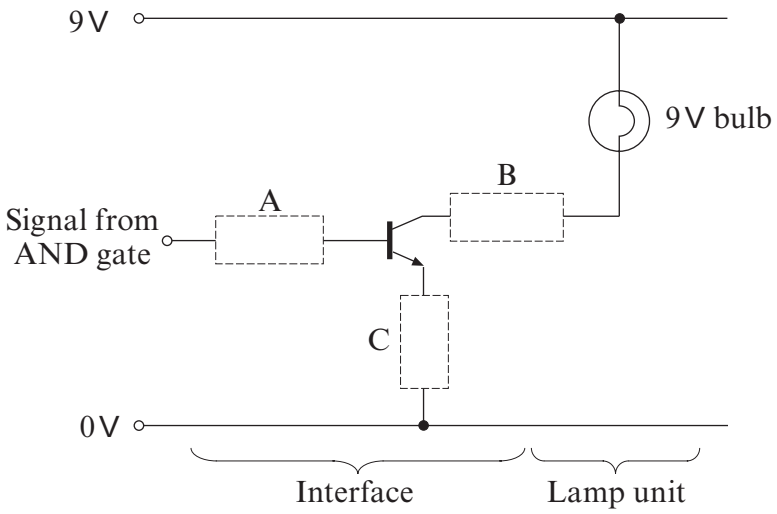
Normally, when the freezer is cold enough, the lamp is not lit.
When the freezer is too hot, the lamp flashes on and off repeatedly.

(a) What is the job of the astable in this system?
Choose your answer from the following list:

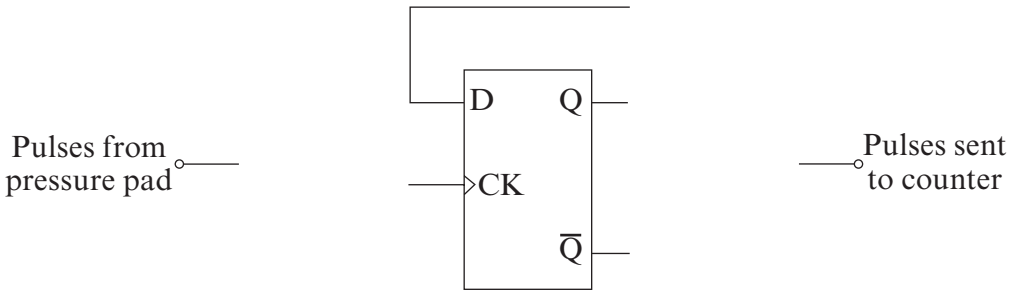
A. It makes the Lamp unit pulse on and off repeatedly when the Monostable output is high.
B. It outputs a steady logic 1 signal when the freezer gets too hot.
C. It keeps the Lamp unit switched on for 30s and then switches it off automatically.
D. It buffers the output of the Monostable, providing enough current to light the lamp. [1]

Answer .....

(b) The circuit diagram shows part of the interface.
Each of the boxes labelled A, B and C needs the addition of a component or a wire link.
Complete the circuit diagram. [3]



9. A D-type flip-flop is used to make a divide-by-two circuit.



Complete the circuit diagram for the divide-by-two circuit. [2]

10. The boxes on the left give the names of three devices which can be used to interface analogue sensors to digital systems.
The boxes on the right give three descriptions of these devices.
Draw lines to link each device to the correct description. [1]

Transistor	Has one switching threshold and it can be easily changed
Comparator	Has two fixed switching thresholds
Schmitt trigger	Has a fixed switching threshold of 0.7 V

11. The boxes on the left give the names of the sub-systems in a typical amplifier system. The boxes on the right give the functions of three of these sub-systems. Draw lines to link each function to the correct sub-system. [3]

Microphone	
Preamplifier	Turns an electrical signal into sound
Mixer	Boosts both current and voltage
Power amplifier	Combines the signals from several sources
Loudspeaker	

12. Which of the following, A, B, C or D, best completes the sentence describing the behaviour of a rising-edge D-type flip-flop? [1]

On the rising-edge of a clock pulse:

A. the Q output copies the logic level present on the clock input.
B. the Q output copies the logic level present on the data input.
C the $\overline{Q}$ output copies the logic level present on the clock input.
D. the $\overline{Q}$ output copies the logic level present on the data input.

Answer .....

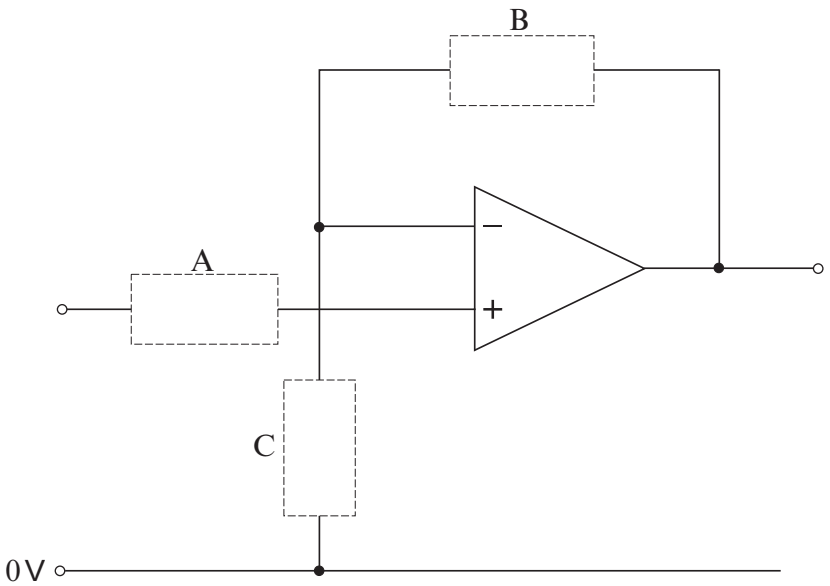
13. An amplifier outputs a signal of amplitude 20 mV when the input signal has an amplitude of 10 mV.

Which one of the following is the voltage gain of the amplifier? [1]

1 2 3 4 5 6 7 8 9 10

Answer .....

14. The circuit diagram shows part of the circuit of a non-inverting amplifier.
Each of the boxes labelled A, B and C needs the addition of a component or a wire link.
Complete the circuit diagram [3]



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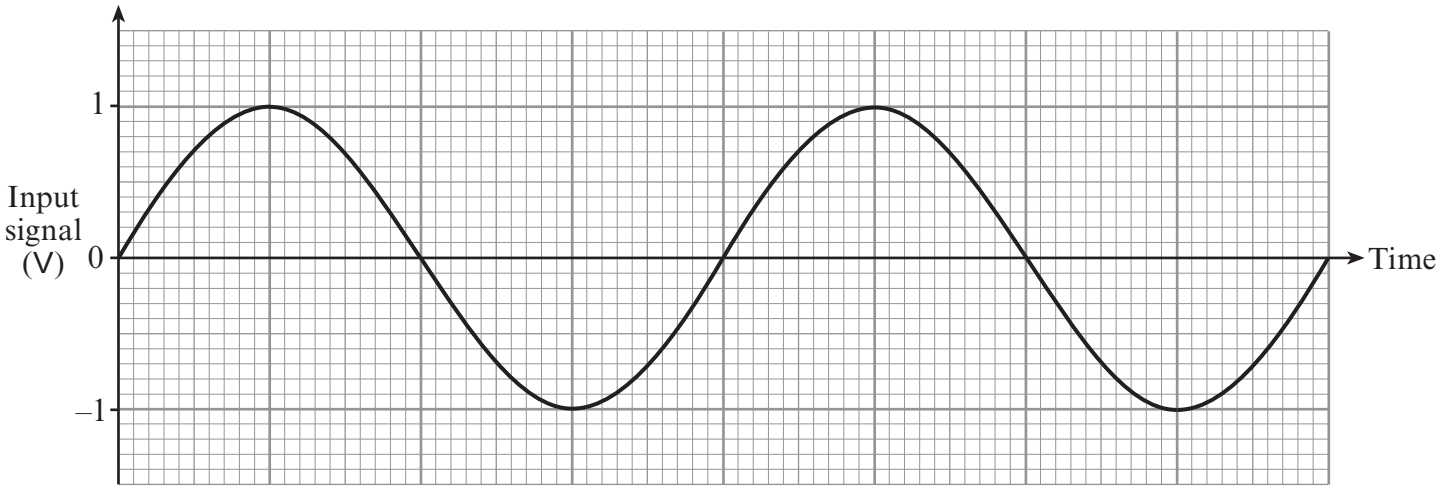
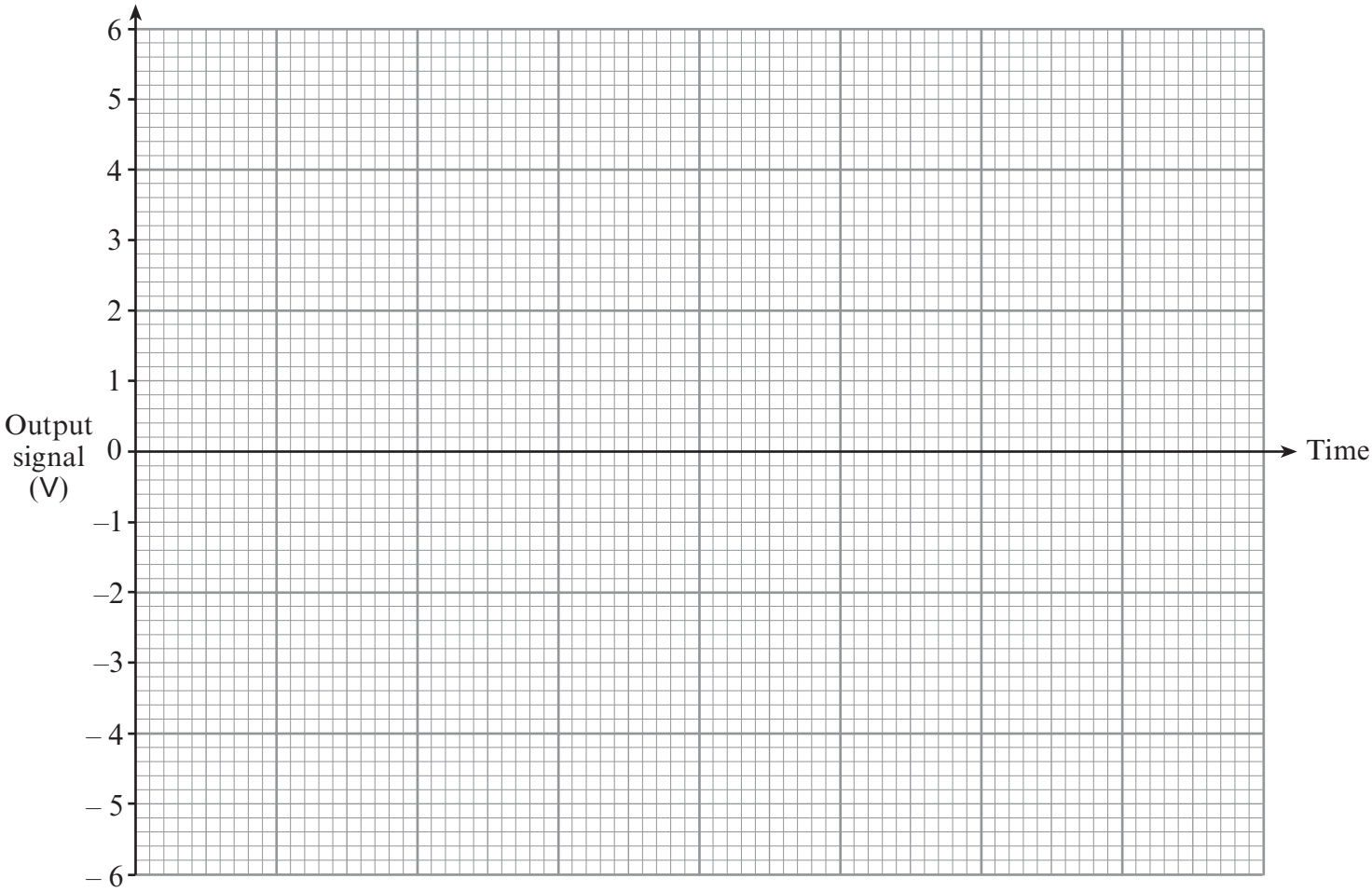
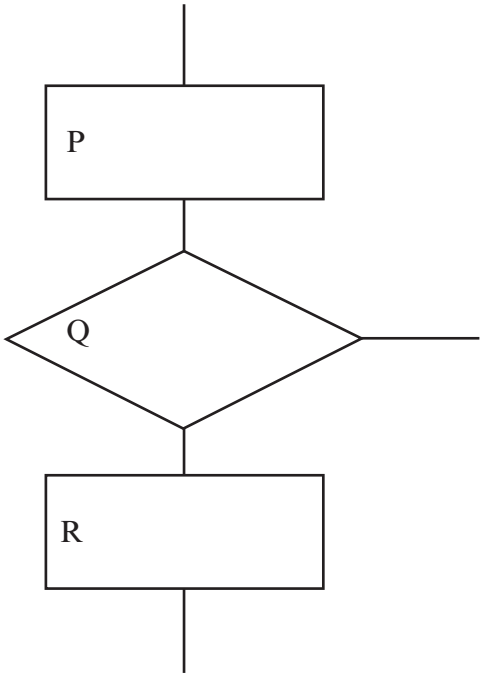
15. A non-inverting amplifier has a voltage gain of 4.
The upper graph shows the signal applied to the input of the amplifier.
Use the axes provided to sketch the corresponding output signal. [2]





16. Here is part of the flowchart for a control system.
The system must:

- set the counter to zero;
- then wait until a switch is pressed;
- then increase the number stored in the counter by 1.

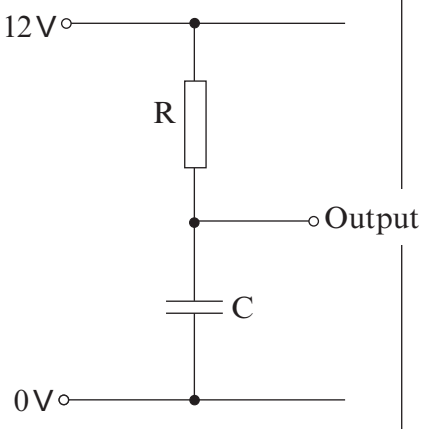


(a) Add the following instructions to the correct box:

Is the switch pressed?
Increment the counter
Reset the counter

(b) Complete this section of the flowchart by drawing the link from block Q to the correct point in the flowchart. [3]

17. The RC network shown in the diagram can be used to produce a time delay.



Which one of the following can be a problem with this arrangement?

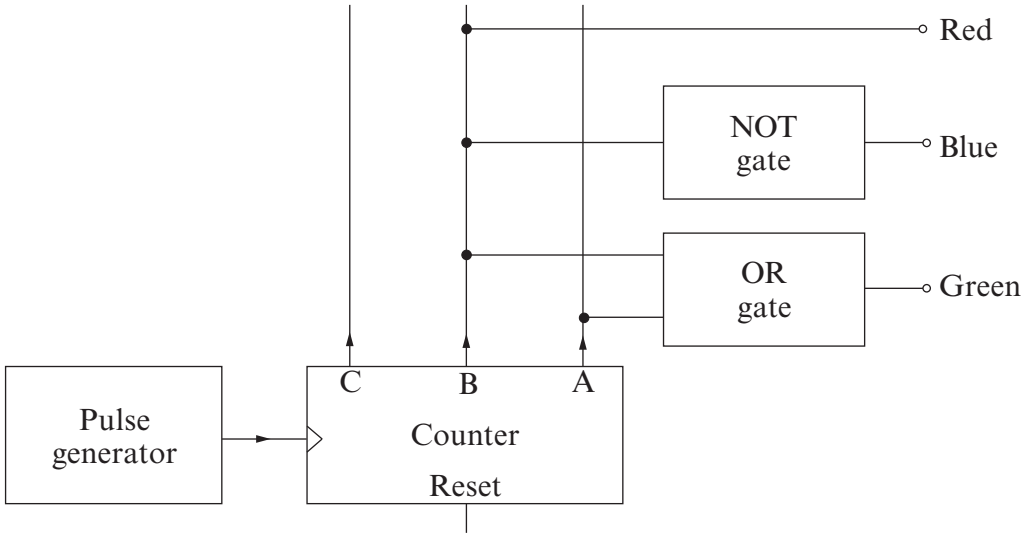
P. The time delay cannot be greater than a few microseconds.
Q. The time delay changes when current is drawn from the output.
R. The time delay changes each time the network is used.
S. The time delay does not depend on the capacitance of component C.

[1]

Answer .....

Examiner only

18. The circuit diagram shows part of the control system for a set of coloured lights.



Each of the lights is switched on when it receives a logic 1 signal.

(a) Complete the table by adding either 'Off' or 'On' in each cell to show the state of the lights for each set of counter outputs. [3]

Pulses from pulse generator	Counter outputs			Lights		
	C	B	A	Red	Blue	Green
0	0	0	0			
1	0	0	1			
2	0	1	0			
3	0	1	1			

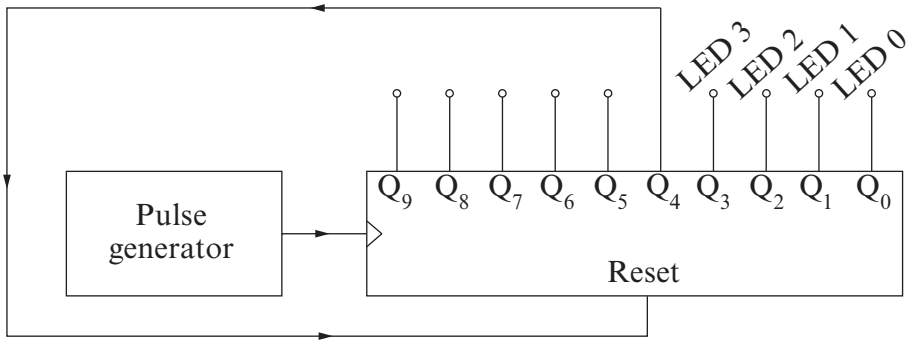
(b) Which one of the following, P, Q, R, S or T, would make the counter reset on the 4th pulse from the pulse generator? [1]

P. Connect counter output A directly to the Reset input.
Q. Connect counter output B directly to the Reset input.
R. Connect counter output C directly to the Reset input.
S. Connect counter outputs B and C to the inputs of a 2-input AND gate, and then connect the output of the AND gate to the Reset input.
T. Connect counter outputs A and C to the inputs of a 2-input AND gate, and then connect the output of the AND gate to the Reset input.

Answer .....

Examiner only

19. The diagram shows part of a light-chaser system.



The four LEDs light up when they receive a logic 1 signal.
They light up in the following sequence:

Step	LED 3	LED 2	LED 1	LED 0
1	Off	Off	Off	On
2	Off	Off	On	Off
3	Off	On	Off	Off
4	On	Off	Off	Off

The sequence then repeats.

Which of the following types of counter, A, B, C or D, will produce the necessary output signals? [1]

A. binary counter
B. BCD counter
C. decade counter
D. up/down counter

Answer .....

Examiner only

20. Here are four electronic systems:

A. Car hazard warning lights – all the indicators flash on and off when the switch is closed.
B. Egg timer – a buzzer sounds continuously four minutes after a switch is pressed.
C. Decorative lighting display – the ten lights in the system switch on, one after another, in a sequence that repeats over and over again.
D. Electronic game scorer – a siren sounds as soon as one team reaches a score of 5, and stays on until a reset switch is pressed.

Which one of these systems, A, B, C or D, must contain a monostable sub-system? [1]

Answer .....

21. A computer-controlled system is used to count sweets and pack them in a bag. The sweets pass a sensor and then fall into a bag.

When the bag contains 50 sweets a solenoid switches on and seals the bag.

Give one **advantage** of using this system rather than humans to pack the sweets. [1]

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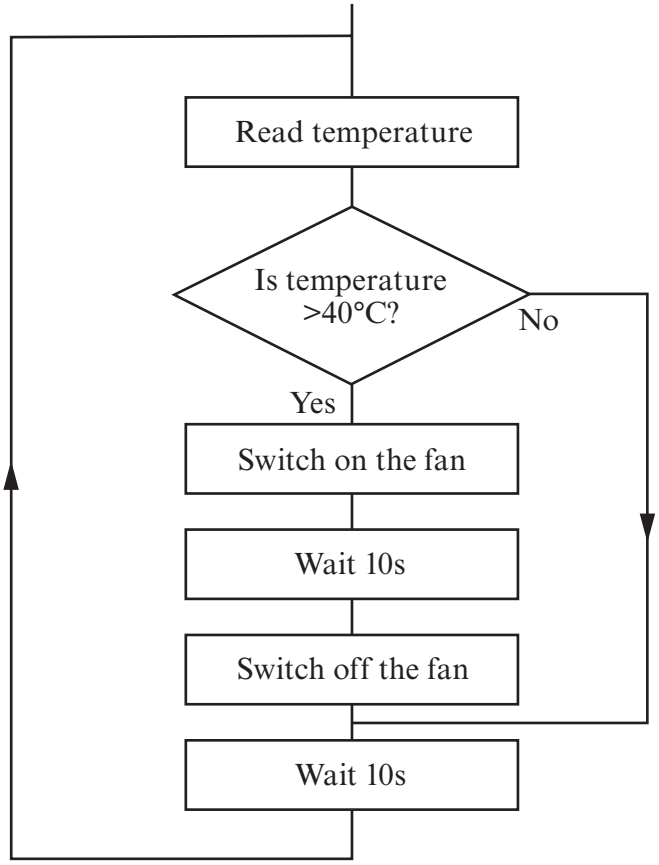
Examiner only

22. The diagram shows part of the flowchart for a system that is designed to prevent an enclosure from overheating. If the temperature goes above 40°C the system blows in cool air.

Describe the sequence of events that takes place over a period of 25 seconds after the temperature goes above 40°C. [2]



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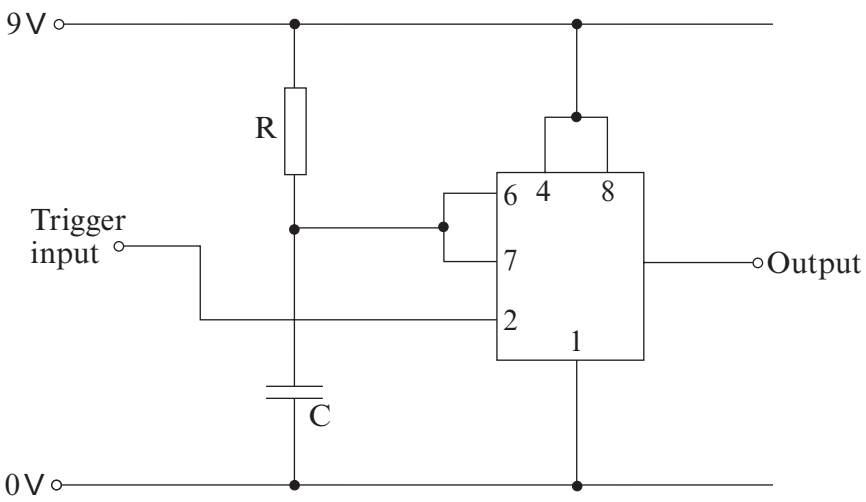
23. The circuit diagram shows a 555 timer used in a monostable circuit.



(a) Complete the trigger circuit for the monostable by adding a pull-up resistor and a push switch. [2]

(b) Use the component values below in the formula T = 1.1 RC to calculate the time delay produced by this circuit.

R = 47kΩ;
C = 120μF. [2]

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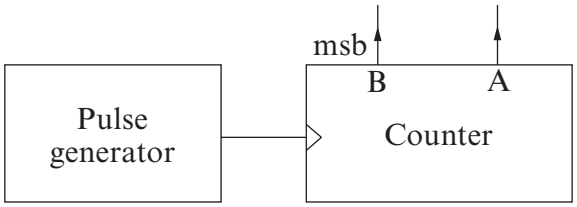
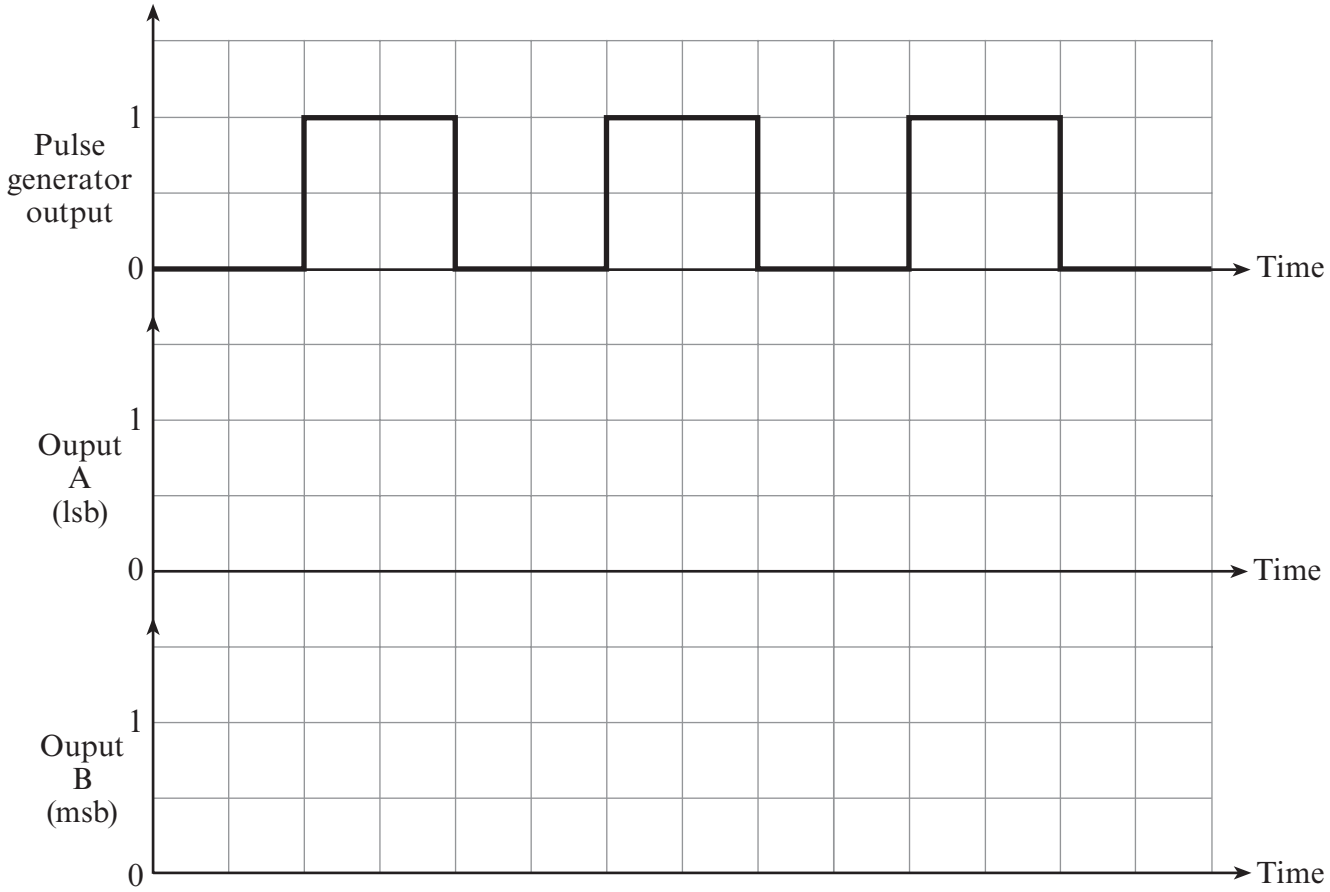
.....

T = ...

24. The circuit diagram shows a dedicated 2-bit up counter IC. It counts pulses produced by a pulse generator.
The counter is rising-edge triggered.

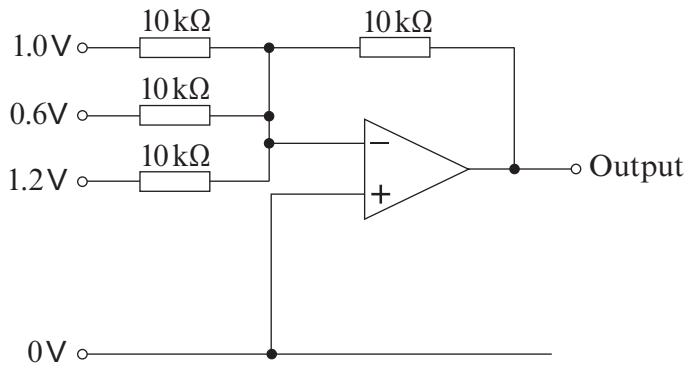


The top graph shows the pulses received from the pulse generator.
Initially, the counter is reset.
Use the axes provided to construct the signals at the A (least significant bit) and B (most significant bit) outputs of the counter. [3]



Examiner only

25. The circuit diagram shows a summing amplifier, with voltages of 1.0 V, 0.6 V and 1.2 V applied to its inputs.



Use the formula: $V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$

to calculate the output voltage produced by the summing amplifier. [2]

.....

.....

.....

.....

V_{OUT} = ...

26. An inverting amplifier uses a 120 kΩ resistor as the feedback resistor, and a 10 kΩ resistor as the input resistor.

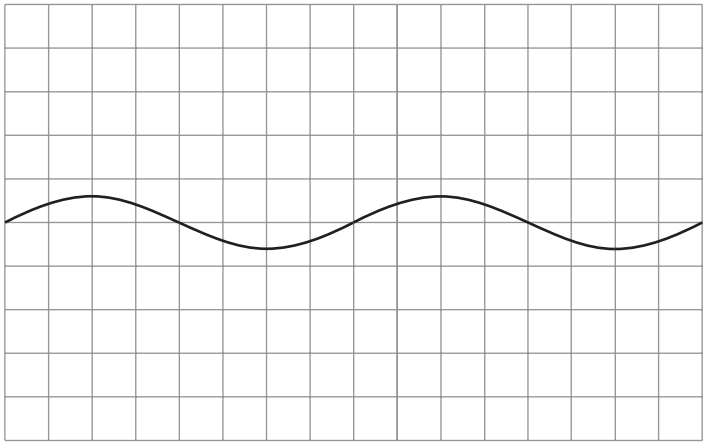
(a) Calculate the voltage gain of this inverting amplifier. [1]

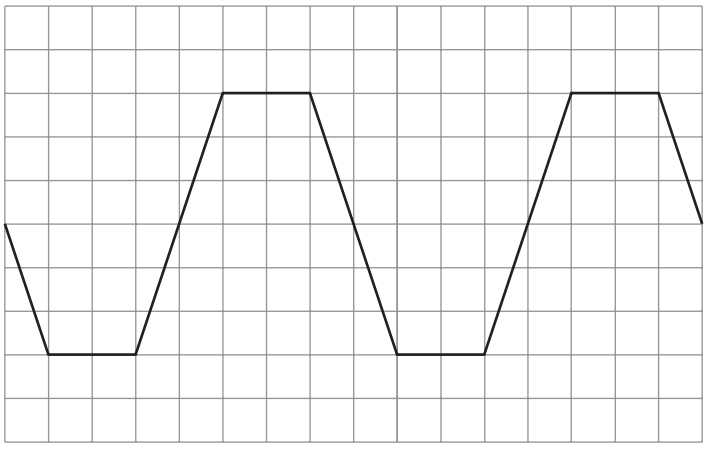
.....

.....

Voltage gain = ...

(b) The upper graph shows the signal applied to the input of this amplifier.
The lower graph shows the signal produced at the output.
Explain what has happened. [1]





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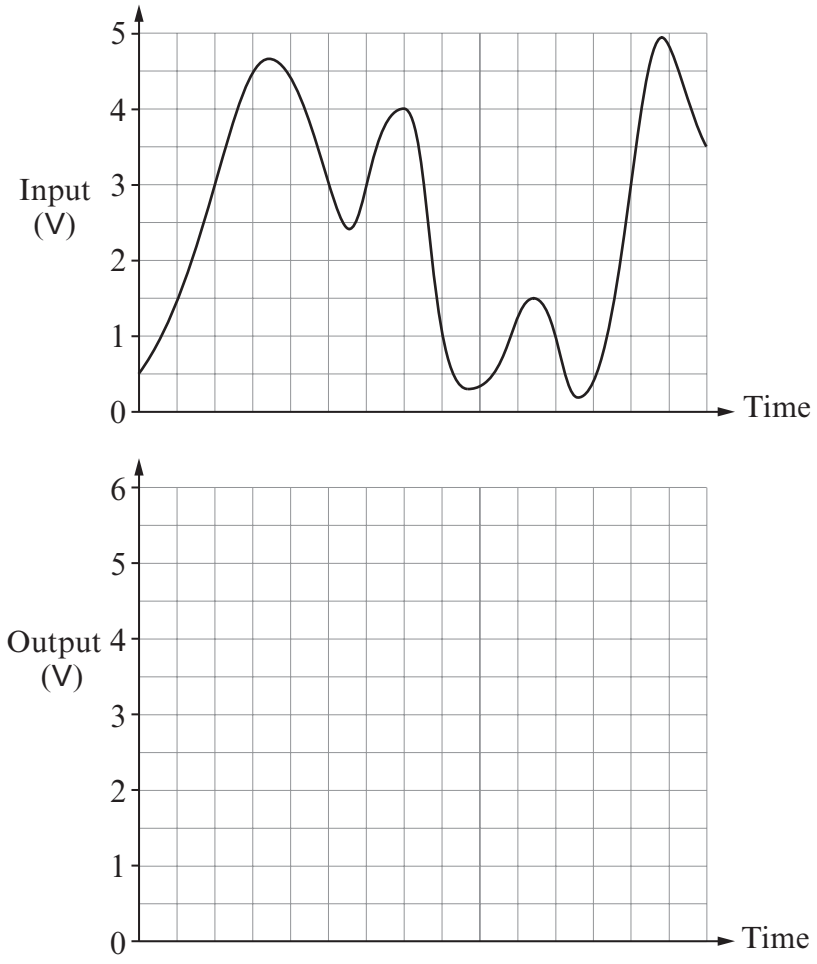
27. Here is part of a data sheet for a Schmitt Inverter:

When connected to 5 V supply:

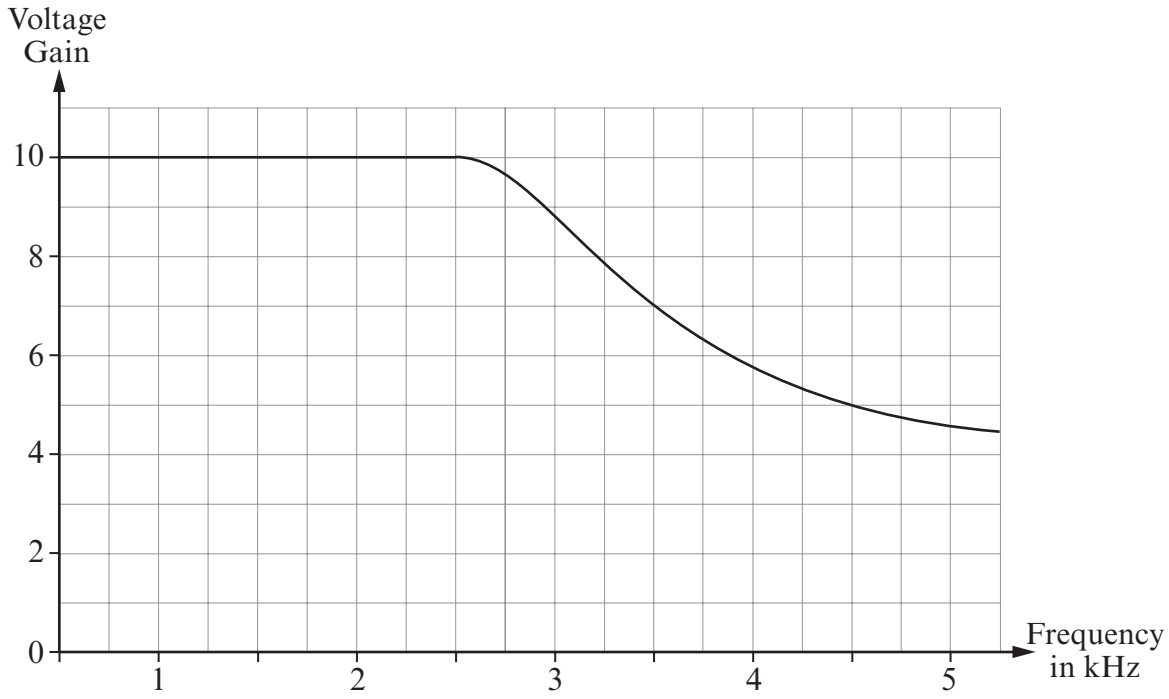
- Logic 0 = 0 V
- Logic 1 = 5 V
- The output changes from logic 1 to logic 0 when a **rising** input voltage reaches 3 V
- The output changes from logic 0 to logic 1 when a **falling** input voltage reaches 1 V

The input signal for the Schmitt Inverter is shown below.

Use the axes provided to draw the resulting output signal produced by the Schmitt trigger. [4]



28. The graph shows the way in which the voltage gain of an amplifier changes as the frequency of the signal changes.



(a) Use the graph to measure the bandwidth of the amplifier. [1]

(b) Which one of the following techniques, A, B, C or D, could be used to increase the bandwidth while maintaining the voltage gain? [1]

A. Use a higher power supply voltage.

B. Increase the amplitude of the input signal.

C. Combine several amplifiers in a multi-stage amplifier.

D. Monitor the output signal with a cathode-ray oscilloscope (CRO).

Answer: .....

GCSE

4162/01-A

ELECTRONICS
CANDIDATE INFORMATION SHEET FOR UNIT E2

A.M. TUESDAY, 14 June 2011

This information may be of use in answering the questions.

1. Resistor Colour Codes

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YELLOW	**4**	**WHITE**	**9**

The fourth band colour gives the tolerance as follows:

GOLD ± 5%

SILVER ± 10%

2. Preferred Values for Resistors – E24 series

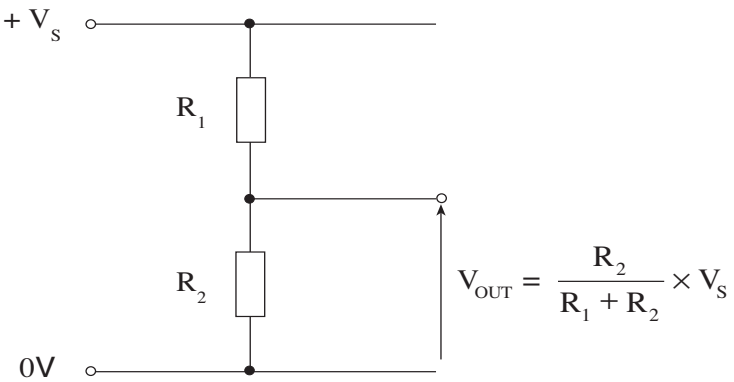
10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

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

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 $R = \dfrac{R_1R_2}{R_1 + R_2}$.

6. **Voltage Divider**



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

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

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

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

10. Amplifiers

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

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

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

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