Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4162/01

S17-4162-01

ELECTRONICS

UNIT E2: Paper replacement test

MONDAY, 19 JUNE 2017 – AFTERNOON

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**2**	
2.	**4**	
3.	**2**	
4.	**2**	
5.	**5**	
6.	**3**	
7.	**6**	
8.	**5**	
9.	**3**	
10.	**2**	
11.	**5**	
12.	**3**	
13.	**6**	
14.	**6**	
15.	**6**	
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

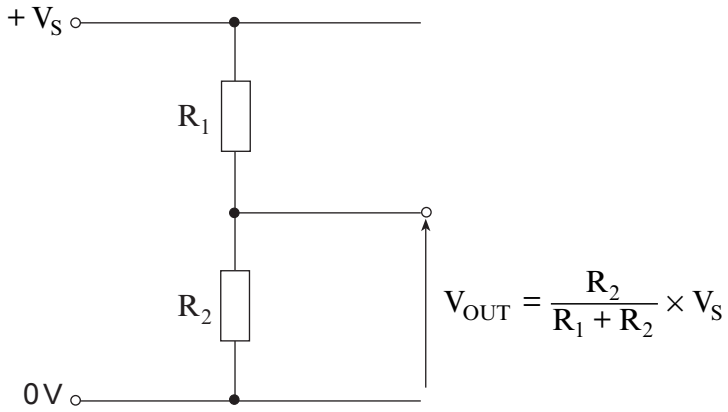
10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

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: $$A = 1 + \frac{R_F}{R_1}$$

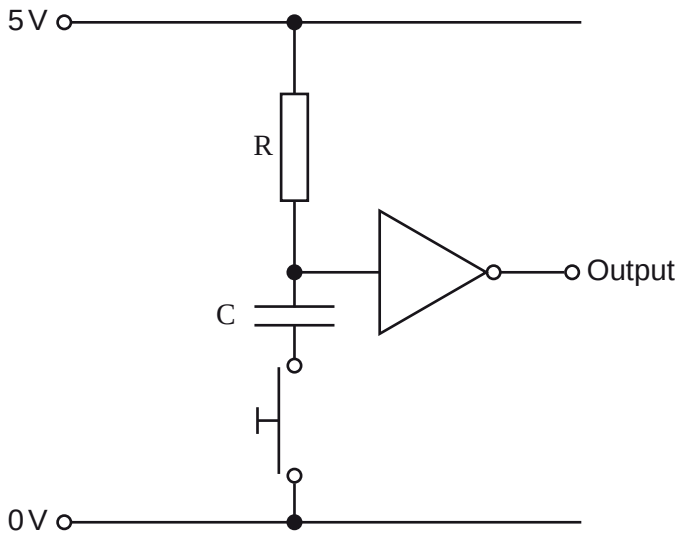
Inverting amplifier: $$A = -\frac{R_F}{R_{IN}}$$

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

Examiner only

Answer **all** *questions.*

1. The diagram shows a capacitor-resistor network, which can be used to produce a time delay.



(a) Which **one** of the following would **increase** this time delay? [1]
(Tick (✓) the correct answer.)

☐ Double the value of R and keep the value of C unchanged

☐ Double the value of R and halve the value of C

☐ Double the value of C and halve the value of R

☐ Halve the value of R and keep the value of C unchanged

☐ Halve the value of C and keep the value of R unchanged

(b) Why is a NOT gate included in this circuit? [1]
(Tick (✓) the correct answer.)

☐ It reduces the time delay

☐ It increases the current taken from the capacitor-resistor network

☐ It keeps the time delay unchanged when current flows from the output

☐ It produces a low voltage at the output when the switch is pressed

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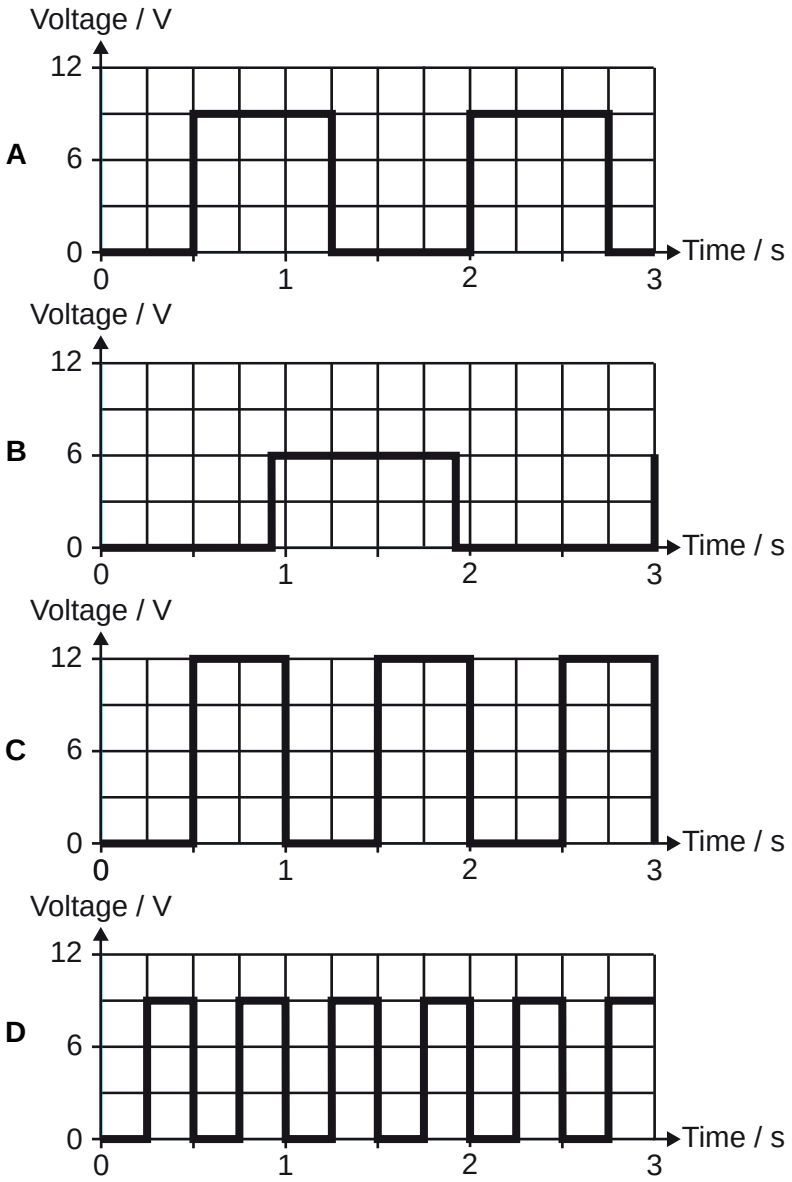
2. *(a)* Here are four signals produced by astable circuits.



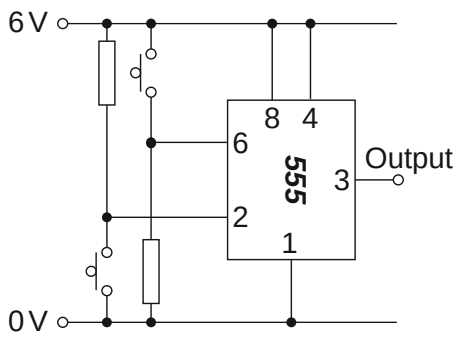
(i) Which has the longest period? ..... [1]

(ii) Which has a period of 1 s? ..... [1]

(iii) Which has an amplitude of 6 V? ..... [1]

Examiner only

(b) Which of the following is the circuit diagram for a 555 monostable circuit? (Tick (✓) the correct answer.) [1]



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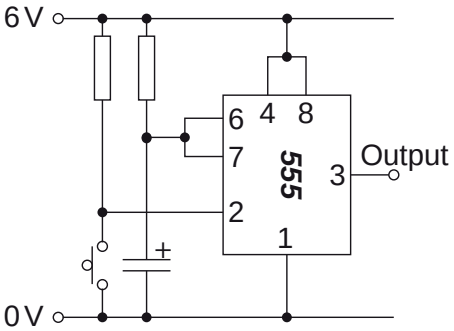

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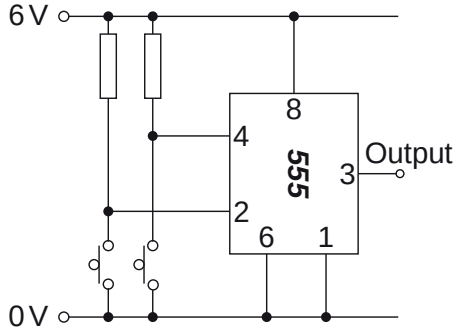

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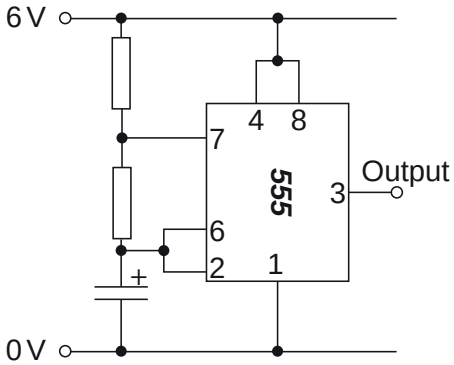

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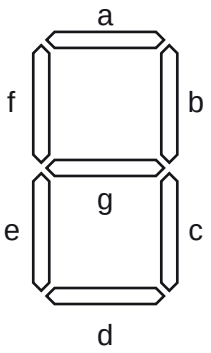
3. *(a)* The segments of a 7-segment display light when they receive logic 1 signals.
By adding a '0' or '1' in each box complete the truth table so that the 7-segment display shows the letter 'F'. [1]

Segments							Character
a	**b**	**c**	**d**	**e**	**f**	**g**	
							F



(b) The display changes to show the number '3'.
Which truth table shows the signals controlling it? (Tick (✓) the correct answer.) [1]

☐

a	**b**	**c**	**d**	**e**	**f**	**g**
1	0	0	1	1	1	1

☐

a	**b**	**c**	**d**	**e**	**f**	**g**
0	0	0	0	1	1	0

☐

a	**b**	**c**	**d**	**e**	**f**	**g**
0	1	1	0	0	0	0

☐

a	**b**	**c**	**d**	**e**	**f**	**g**
1	1	1	1	0	0	1

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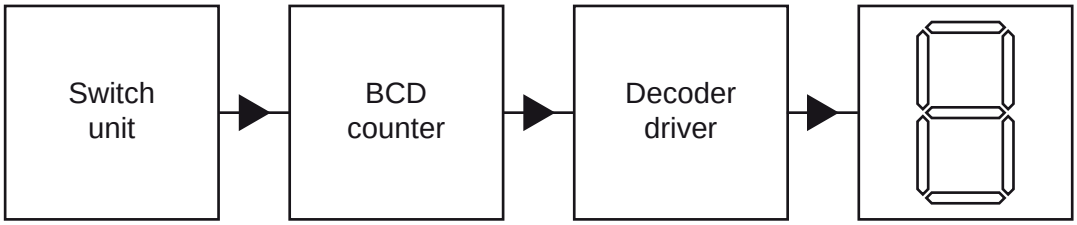
Examiner only

4. This is the block diagram for a single digit decimal counting system.



(a) Why is it better to use a BCD (binary-coded decimal) counter than a binary counter? (Tick (✓) the correct answer.) [1]

☐ It counts up faster

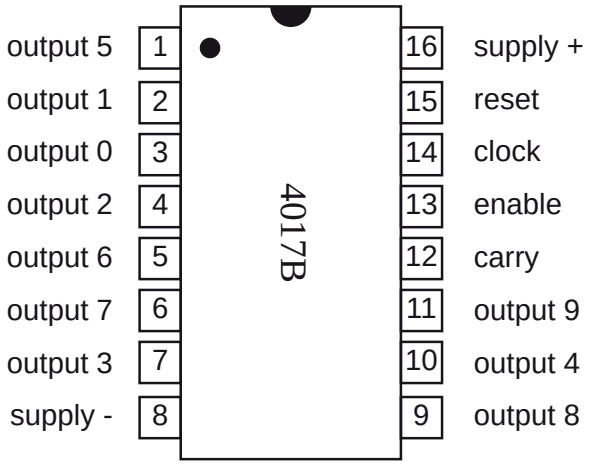
☐ It resets automatically on the tenth pulse

☐ It outputs letters and numbers to the 7-segment display

☐ Binary is easier for humans to understand

Examiner only

(b) The pinout for a decade counter is shown below.



Why is this type of counter unsuitable for the single digit decimal counting system? (Tick (✓) the correct answer.) [1]

☐ A decade counter counts up in tens, not in units

☐ A decade counter cannot reset automatically

☐ Each output of the counter goes high in turn

☐ Every tenth count, it outputs a pulse from its clock pin

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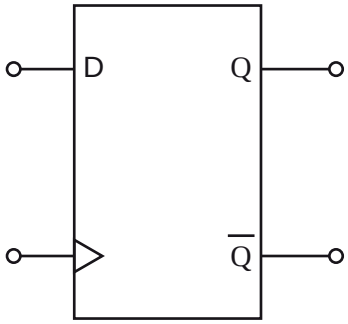
Turn over.

Examiner only

5. *(a)* Complete the following statements about the action of the rising-edge D-type flip-flop by inserting either 0 or 1 in the boxes below. [2]



The Q output of a D-type flip-flop is initially at logic 0.
The Data input is set to logic 1.

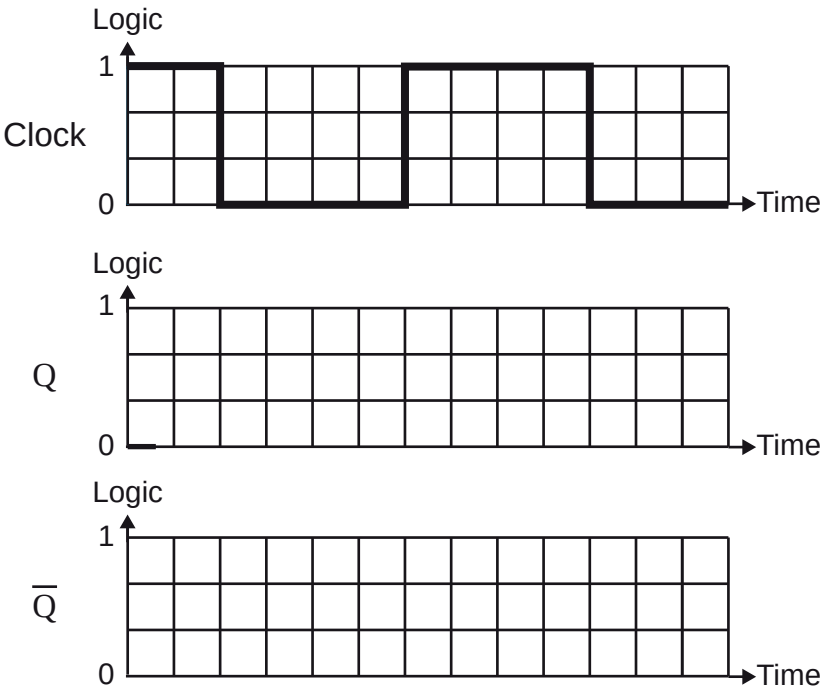
When the clock input changes from ☐ to ☐

the $\overline{Q}$ output changes from ☐ to ☐

(b) A rising-edge triggered D-type flip-flop is set up as a latch. It receives the clock signal shown in the top graph.

Use the axes provided to show the corresponding Q and $\overline{Q}$ outputs. [3]

The Q output starts at logic 0.



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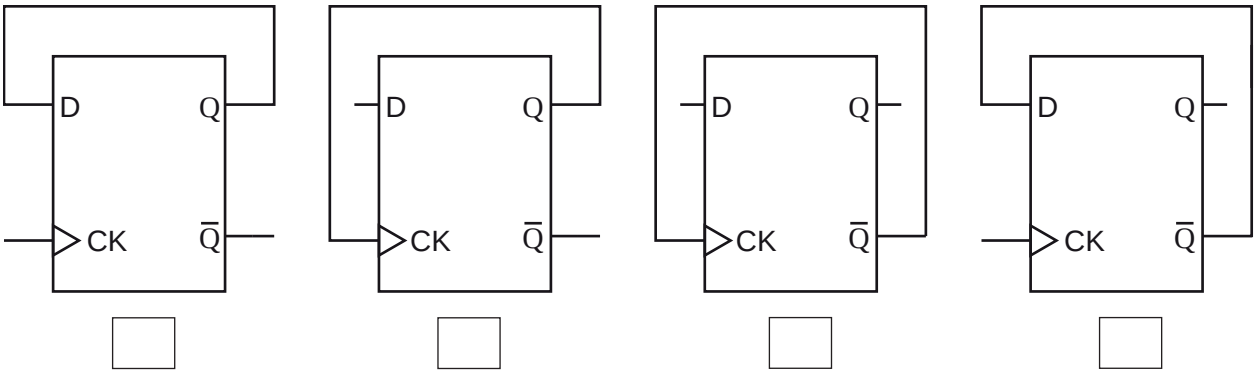
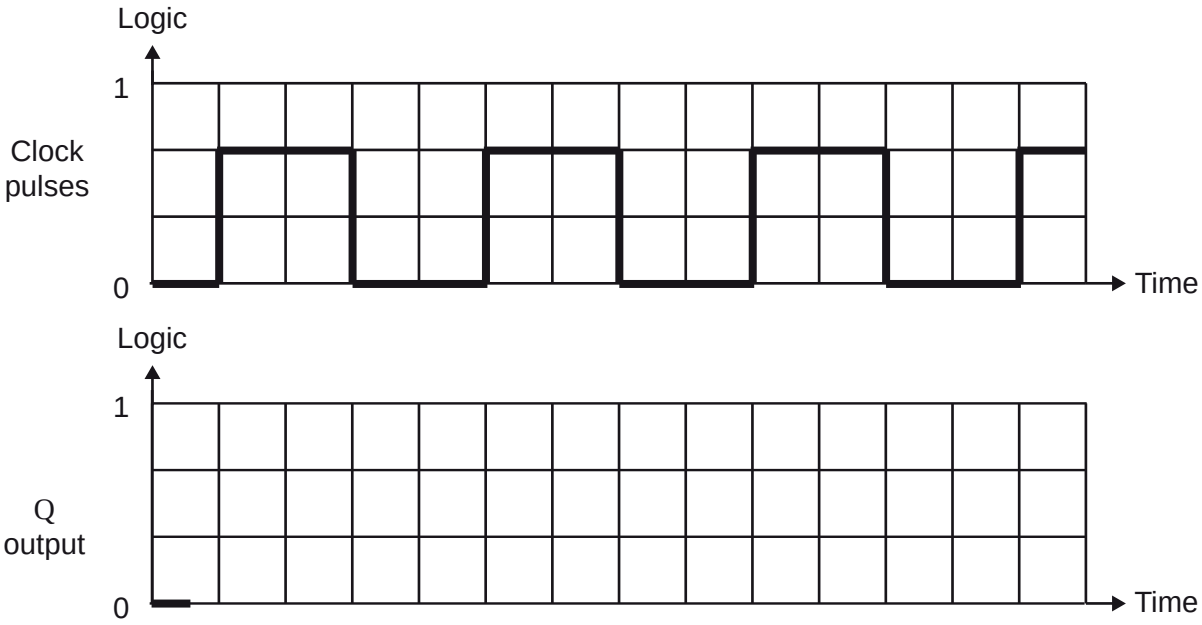
6. A D-type flip-flop can be set up as a 'divide-by-two' subsystem.

(a) Which **one** of the following shows the connections needed to do this? [1]
(Tick (✓) the correct answer.)



(b) Complete the graph for the Q output of the 'divide-by-two' sub-system when it receives the clock signals shown. [2]

Initially the Q output is at logic 0.



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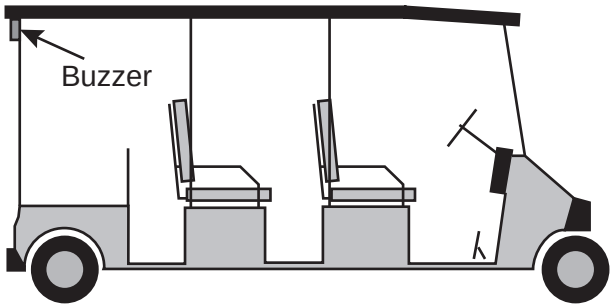
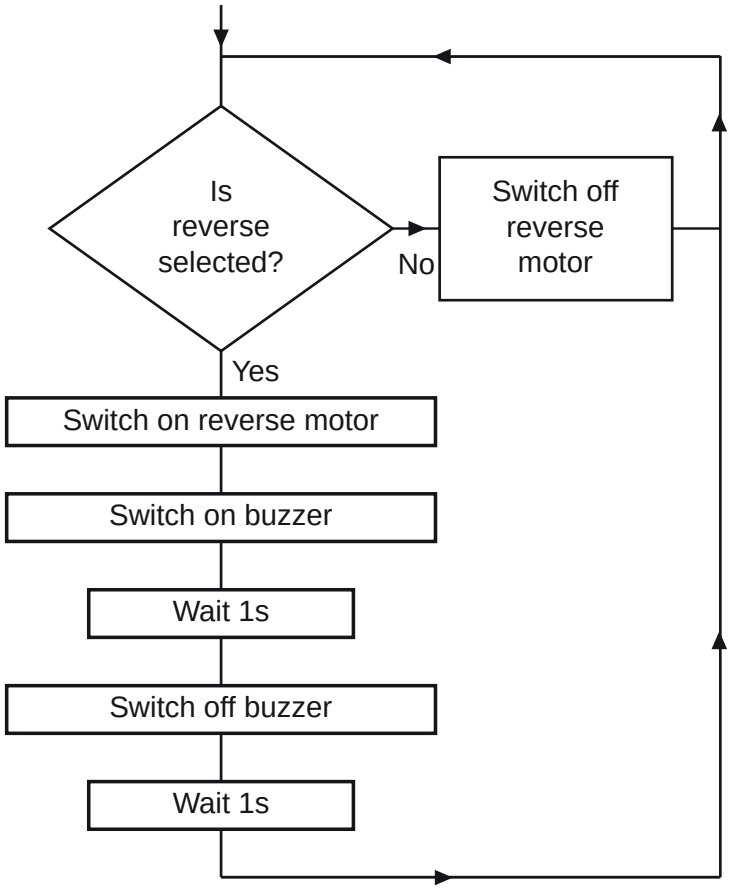
Turn over.

Examiner only

7. At an airport, an electric buggy is used to transport people and their luggage. It has a warning buzzer which sounds when it reverses.



(a) The flowchart that controls reversing is shown below.
Reverse is selected for **three** seconds only.



Describe what happens over the **five** seconds after reverse is selected. [3]

.....

.....

.....

.....

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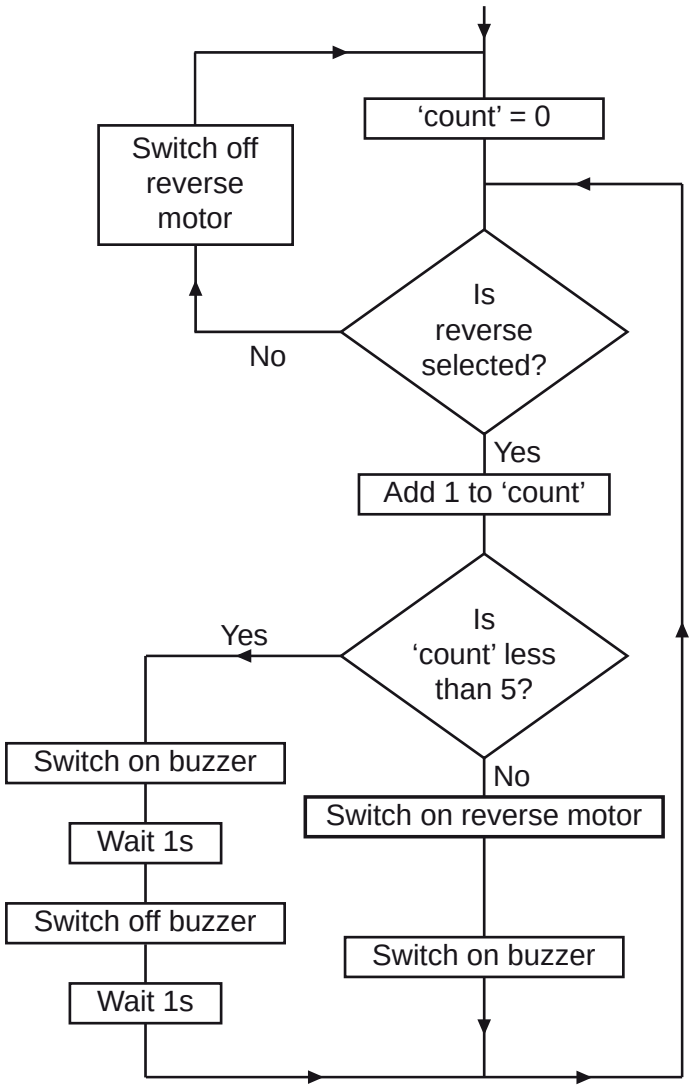
Examiner only

(b) The flowchart program is modified as shown.



(i) Reverse gear is selected. How many times does the buzzer pulse before the buggy moves? [1]

..... times

(ii) During testing, while the buggy is moving backwards, the gear lever is moved out of reverse. The buggy stops moving. Two other things happen. State **one** which is necessary and **one** which is a problem. [2]

Necessary .....

.....

Problem .....

.....

Turn over.

Examiner only

8. A public address system contains two microphones, two preamplifiers, a power amplifier, a mixer and a loudspeaker.

(a) Complete the answers/sentences by drawing a circle around the correct word in the brackets:

(i) In this system, electrical signals are converted into sound by the [1]

(preamplifier / power amplifier / mixer / loudspeaker).

(ii) Which sub-system is used to combine the signals that start in the microphones? [1]

(preamplifier / power amplifier / mixer / loudspeaker)

(iii) Which boosts the voltage signal from a source such as a microphone? [1]

(preamplifier / power amplifier / mixer / loudspeaker)

(b) Circle the correct answer. The range of frequencies that an amplifier can successfully amplify is known as its: [1]

input voltage / power supply voltage / gain / bandwidth

(c) A public address system uses a voltage amplifier to boost a signal from 20 mV to 240 mV.

What is the voltage gain of this amplifier? [1]

.....

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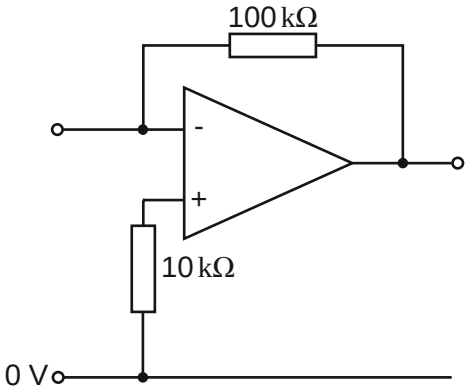
9. *(a)* Which of the following is the circuit diagram for a non-inverting voltage amplifier? (Tick (✓) the correct answer.) [1]



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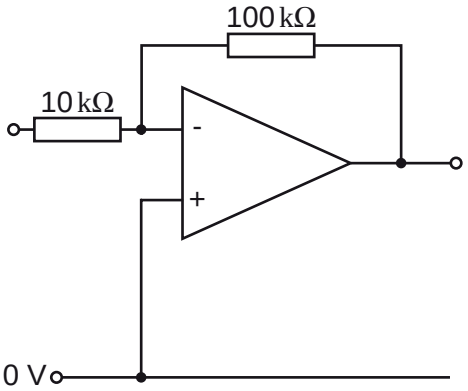

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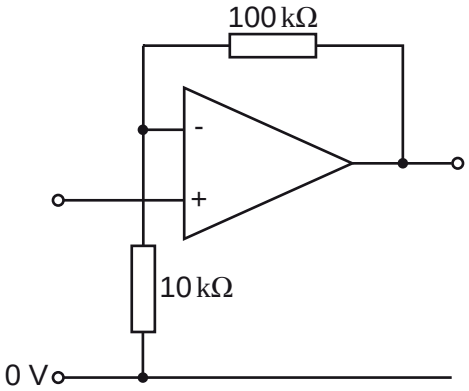

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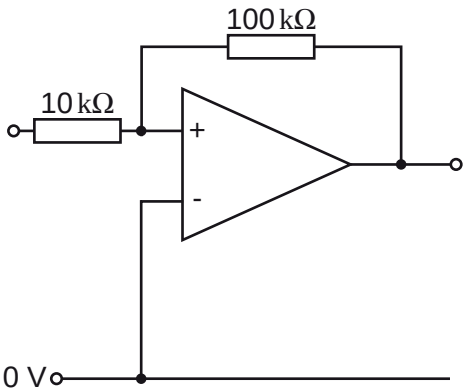

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(b) What is the voltage gain of the non-inverting amplifier? [1]

.....

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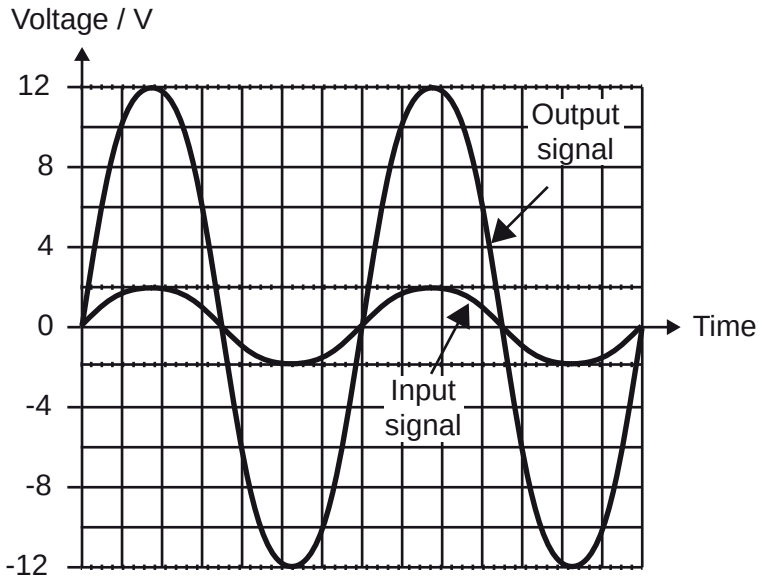
(c) The graphs show the input and output signals for a **different** amplifier.



What is the voltage gain of this amplifier? [1]

.....

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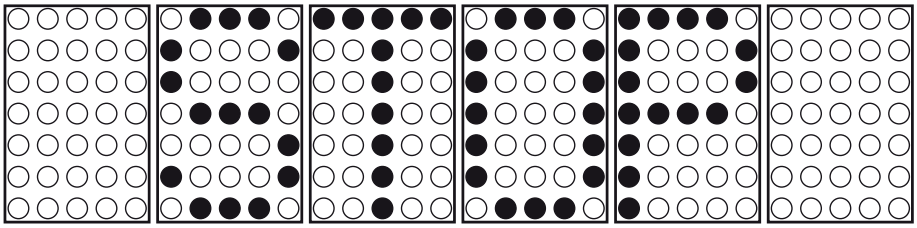
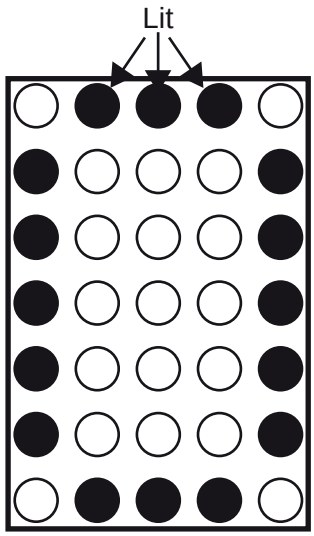
10. A warning sign is made up of a number of sections and is used to display messages such as “STOP”.



Each section has 7 rows each containing 5 LEDs. The LEDs are controlled individually, using a memory IC that stores all 26 letters of the English alphabet. The one below is lighting the LEDs needed to show the letter ‘O’.



(a) How many address locations are used to store the alphabet? [1]

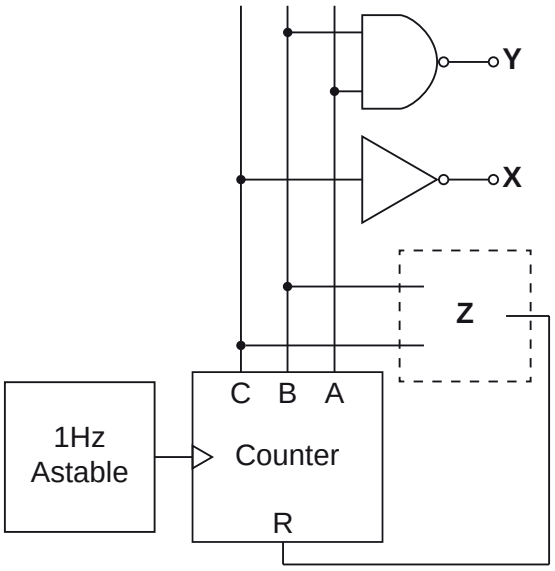
.....

(b) How many data bits must each location have in order to control the LEDs? [1]

.....

Examiner only

11. The circuit diagram shows part of a sequence generator.
The purpose of the table is to summarise the behaviour of the system.



Pulse	Counter outputs			Sequence generator outputs	
	C	B	A	X	Y
0	0	0	0		
1	0	0	1		
2	0	1	0		
3	0	1	1		
4	1	0	0		
5					
6	Reset				

(a) **Complete the 'C', 'B' and 'A' columns** by adding either a '0' or a '1' to show the effect of pulse 5. [1]

(b) **Complete the 'X' and 'Y' columns** by adding either a '0' or a '1'. [2]

(c) For how many seconds after the counter is reset does output C remain at logic 0?
Circle the correct answer. [1]

1 2 4 6

(d) The system resets on pulse 6. What type of logic gate is needed in box 'Z' to do this?
Circle the correct answer. [1]

NOT AND NAND OR NOR

Examiner only

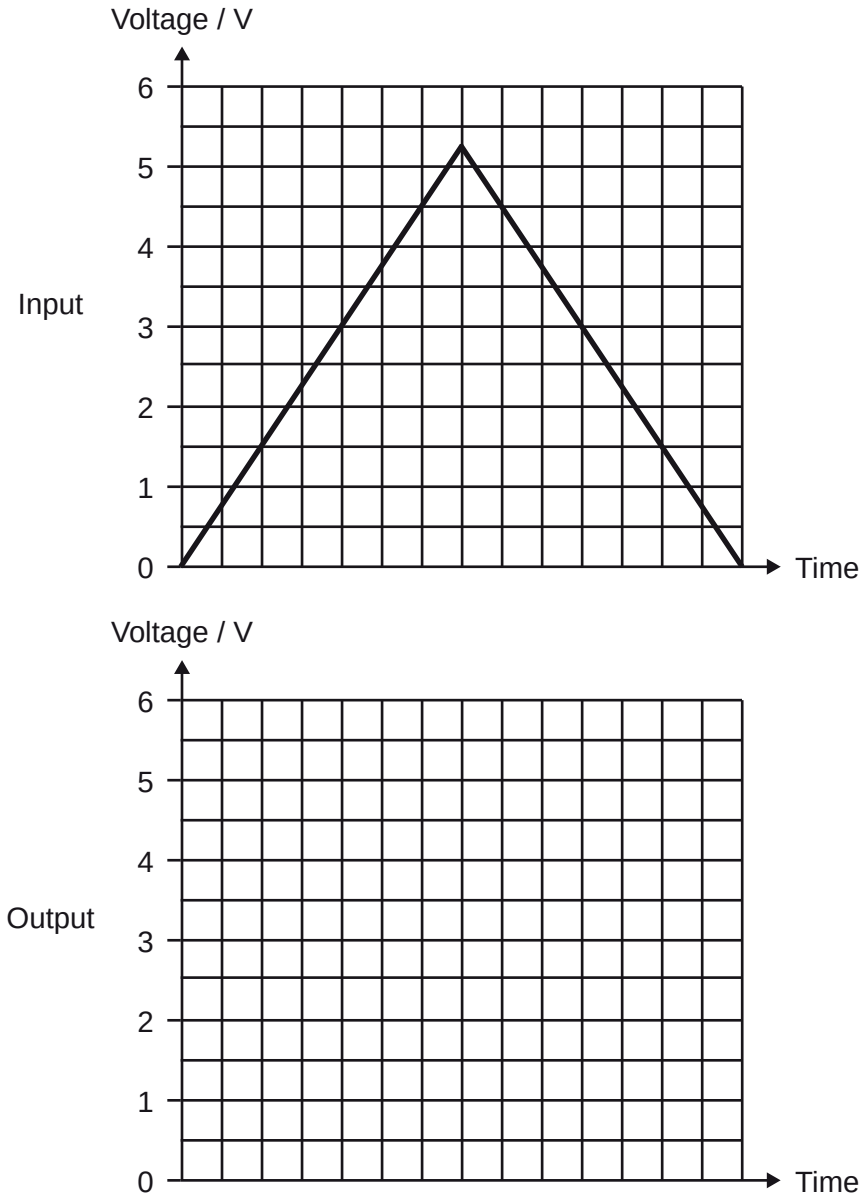
12. When connected to a 5 V power supply, the output of a Schmitt inverter:

- changes from logic 1 to logic 0 when a **rising** input voltage reaches 3 V;
- changes from logic 0 to logic 1 when a **falling** input voltage reaches 1 V.

For this system, a signal at 0.5 V represents logic 0 and a signal at 5 V represents logic 1.

The Schmitt Inverter receives the signal shown in the upper graph.

Draw the expected output signal. [3]



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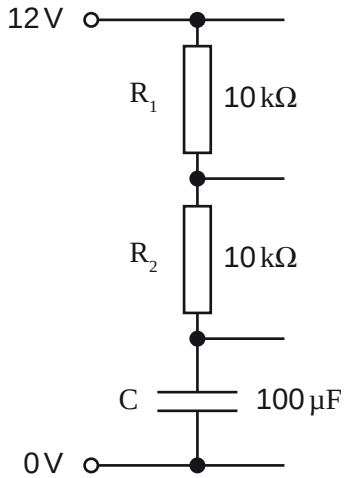
13. *(a)* An astable circuit includes the following R-C network:



(i) Convert 10 kΩ to ohms. [1]

..... ohms

(ii) Convert 100 μF to farads. Circle the correct answer. [1]

0.000001 / 0.00001 / 0.0001 / 100 / 100 000 000

(iii) The pulse frequency, f, produced by the astable is given by the formula:

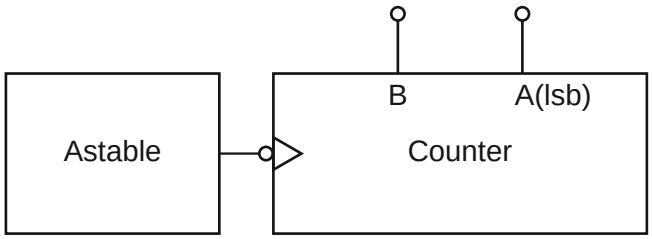
$$f = \frac{1.4}{(R_1 + 2R_2) \times C}$$

Calculate the pulse frequency produced by the astable. [1]

Pulse frequency = ... Hz

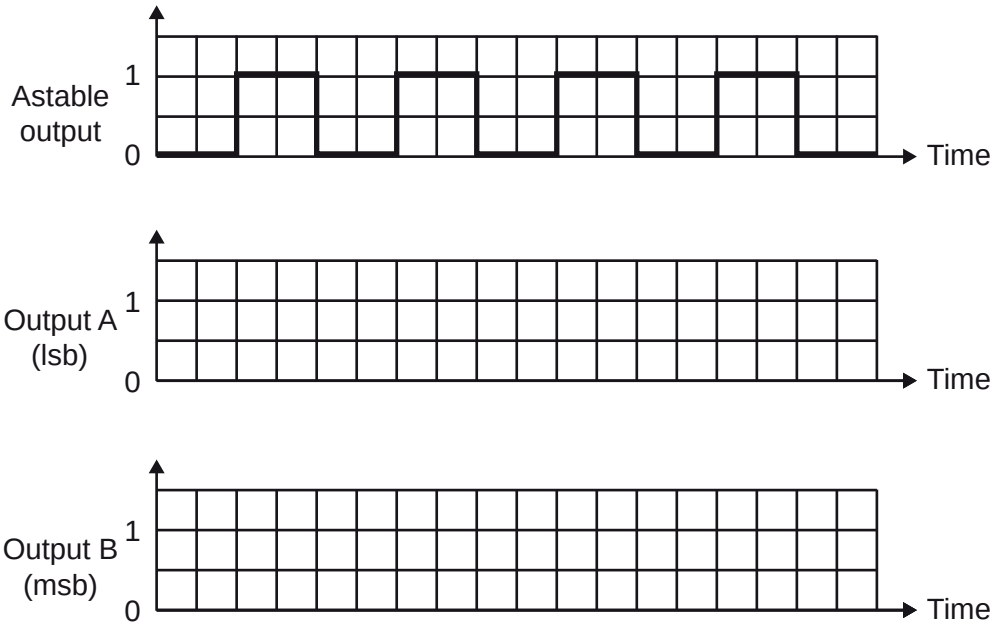
Examiner only

(b) A 2-bit counting system uses an astable circuit.



The counter is initially reset and is falling-edge triggered.
Output A is the least-significant bit (lsb).

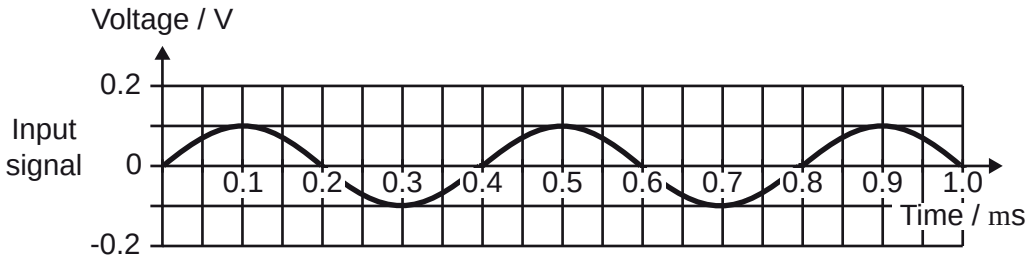
The upper graph shows pulses arriving at the input of the counter.
Draw the resulting signals at outputs A and B. [3]



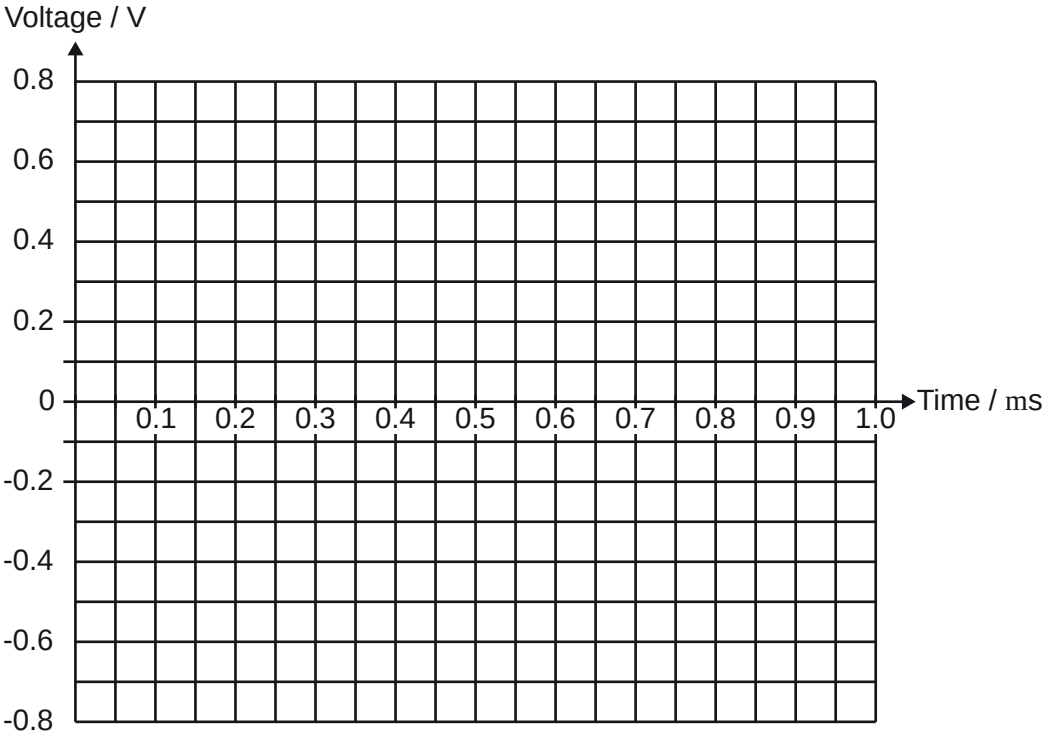
Examiner only

14. An **inverting** amplifier has a voltage gain of **-5**.

(a) The graph shows the signal applied to the input of this amplifier.

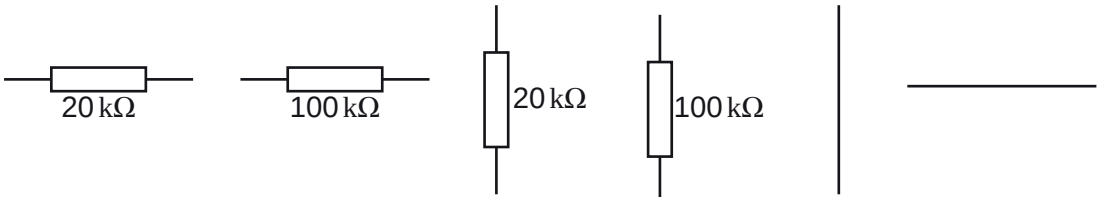


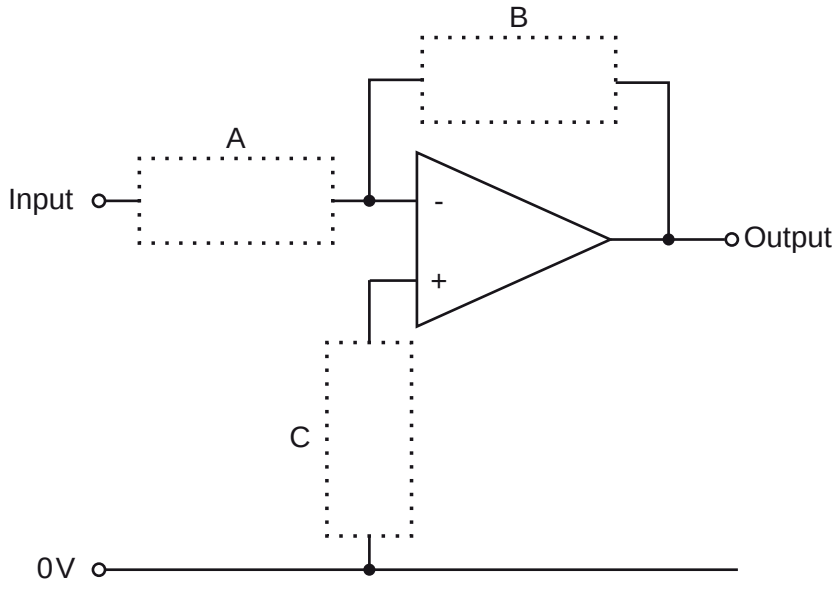
On the axes below draw a wave that shows the corresponding **output** signal. [3]



Examiner only

(b) Draw the correct components into the circuit diagram for this inverting amplifier with a voltage gain of -5. [3]





Examiner only

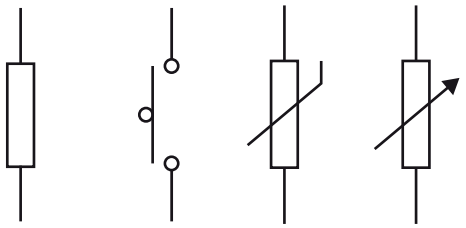
15. *(a)* A transistor switches on a fan motor automatically when the room gets too hot.

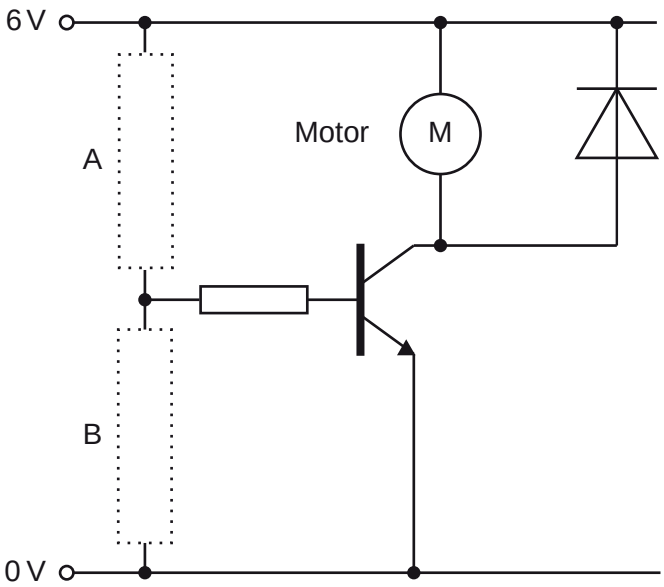
Part of the circuit for this system is shown below.

Complete it by drawing suitable components. [3]

The system must:

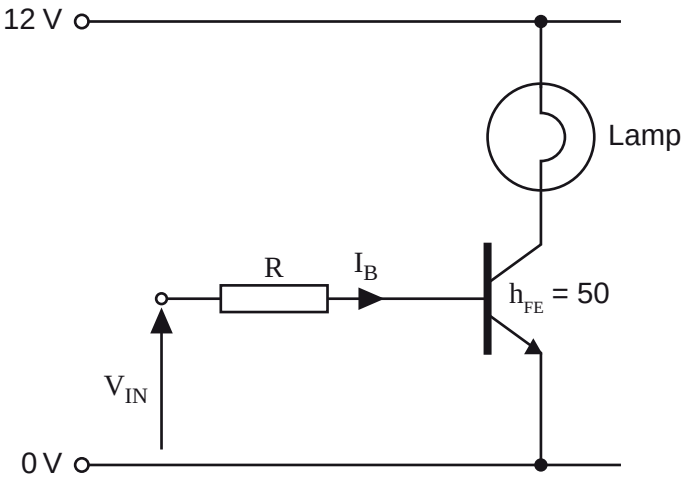
- switch on the motor when the temperature gets too hot;
- allow the user to adjust the switch-on temperature.





Examiner only

(b) A **different** transistor switch is used to interface a logic system to a lamp unit. Assume that the transistor is just saturated.



(i) When the logic system outputs logic 1, V_{IN} = 10.7 V.
This produces a base current, I_B, of 2 mA.

What is the voltage across resistor R? [1]

Voltage = ... V

(ii) What is the resistance of the base resistor, R? [1]

Resistance = ... kΩ

(iii) The transistor has a current gain (h_{FE}) of 50.
Calculate the collector current when the base current, I_B, is 2 mA. [1]

Current = ... mA

END OF PAPER