Candidate Name	Centre Number	Candidate Number
		0

GCSE

298/02

ELECTRONICS
TERMINAL EXAMINATION
HIGHER TIER

A.M. TUESDAY, 10 June 2008

1¼ hours

For Examiner's use only	
Total Mark	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

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

Answer **all** questions.

Write **all** the answers 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

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

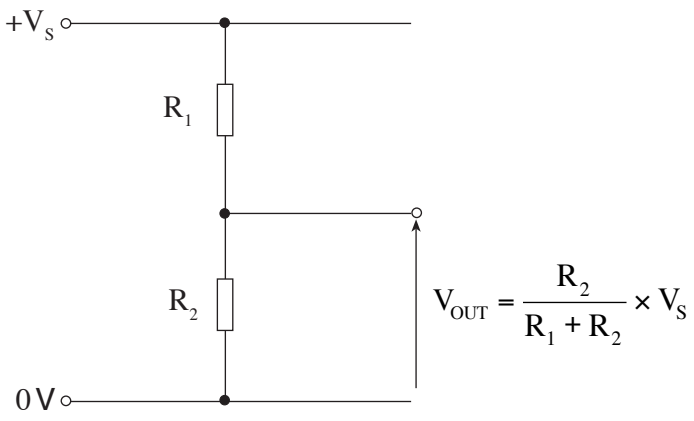
E 12 SERIES OF PREFERRED VALUES
10; 12; 15; 18; 22; 27; 33; 39; 47; 56; 68; 82 and multiples thereafter

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

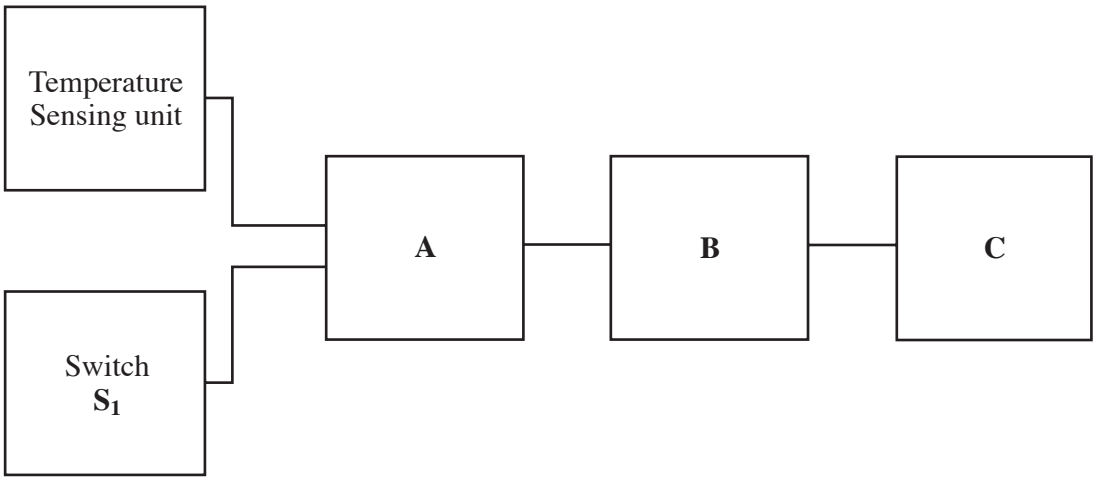
Summing amplifier: $V_{OUT} = -R_F\left(\frac{V_A}{R_A} + \frac{V_B}{R_B} + \ldots\right)$.

Examiner only

*Answer **all** questions in the spaces provided.*

1. Here is a system to warn someone that their freezer is too warm.

The output should only come on when switch $\mathbf{S_1}$ is pressed (high) and the output of the temperature sensing unit is high.



(a) In each of the following tables place a tick ✓ next to the correct answer:

(i) Which one of the following is the **best** sub-system to use as block **A**? [1]

AND gate	
OR gate	
Time delay	

(ii) Which one of the following is the **best** sub-system to use as block **B**? [1]

switch	
Transistor switch / transducer driver	
comparator	

(b) Name a suitable sub-system for block **C**. [1]

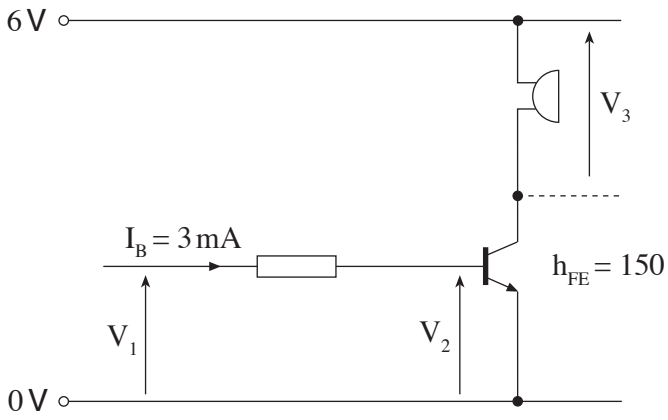
.....

(c) (i) Name an additional sub-system which is needed to keep the output on even if the temperature goes down again. [1]

.....

(ii) Put an "X" on the diagram to show where you would place this sub-system. [1]

2. The following circuit diagram shows part of a system used to switch on a buzzer .



The transistor is **just** saturated when the input voltage V_1 is 2·2 V.

(a) Complete the following table to show the voltages V_2 and V_3 for the input voltages V_1 given. [4]

V_1	V_2	V_3
0·3 V		
2·8 V		

(b) Calculate the collector current when I_B = 3 mA and the transistor is just saturated. [2]

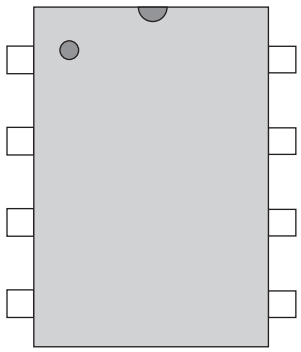
.....

.....

(c) A MOSFET could be used rather than the transistor shown in the diagram.
Draw the circuit symbol for a MOSFET in the space below.

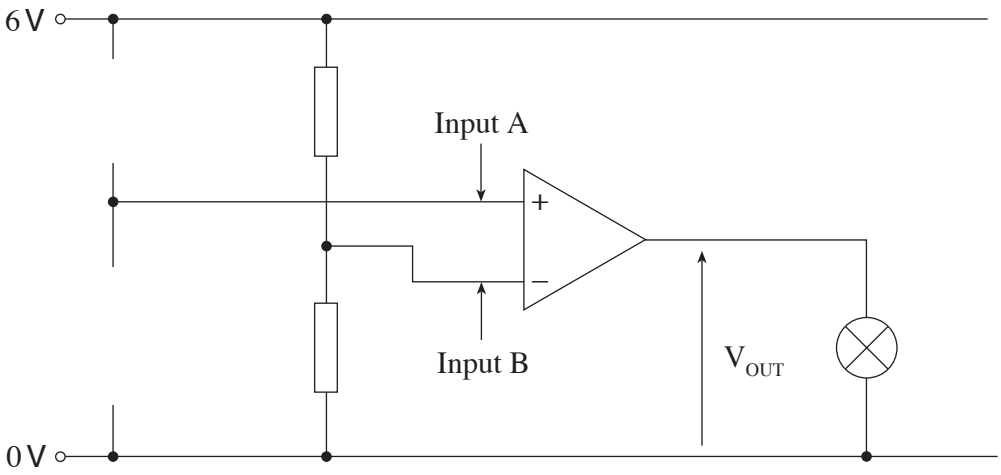
[1]

3. *(a)* The diagram shows a comparator IC seen from above.



Label pin 5. [1]

(b) This comparator circuit uses an LDR to switch on a nightlight when it becomes **dark**. The incomplete circuit diagram is shown below.



(i) The output V_{OUT} of the comparator saturates at +6 V and 0 V.

Complete the table for the given values of the input voltages. [1]

Input A (V)	Input B (V)	Output V_{OUT} (V)
4·2	3·9	
4·5	5·1	

(ii) Complete the circuit diagram above to make:

- The voltage at input A high only when it is **dark**.
- The light level at which the comparator switches on adjustable. [3]

4. *(a)* Which of the following is another name for an astable circuit?

A Inverter

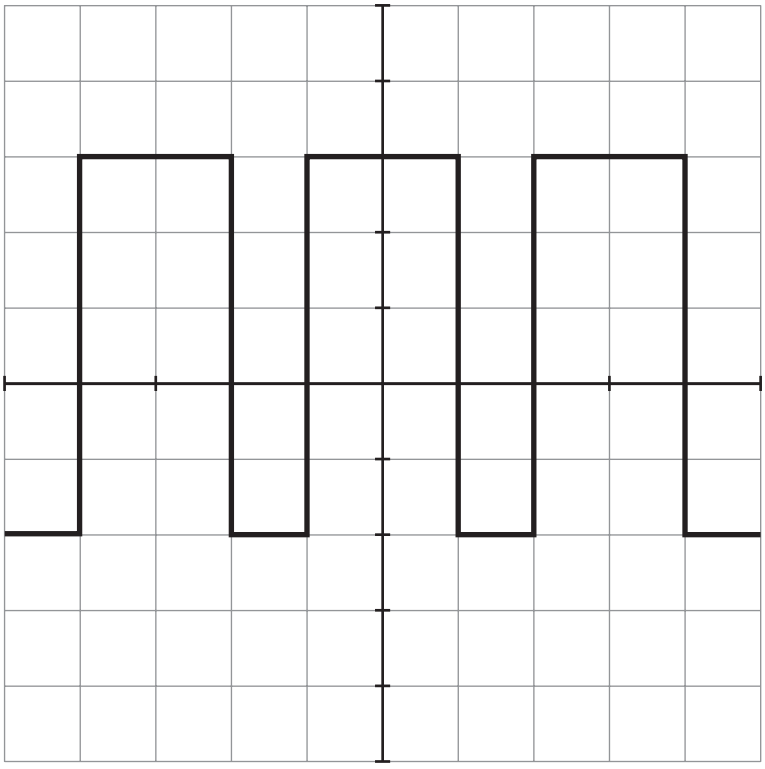
B Time delay

C Pulse generator

D Latch

Answer ..... [1]

(b) The output of an astable circuit is connected to an oscilloscope.
The following trace is produced.



The oscilloscope controls are set as follows:

- sensitivity (voltage gain) = 100 mV/cm
- time base(speed) = 5 ms/cm

Use the trace to find:

(i) the **amplitude** of the signal; [1]

.....

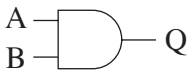
(ii) the **period** of the output signal. [1]

.....

(c) Give one use of an astable circuit. [1]

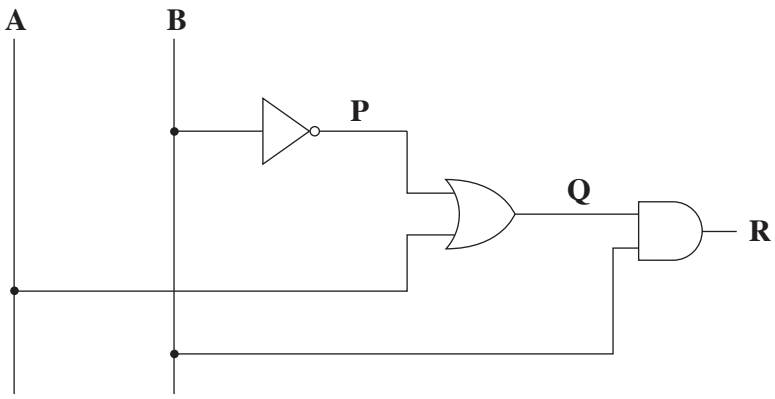
.....

5. *(a)* Complete the truth tables for the following logic gate. [1]



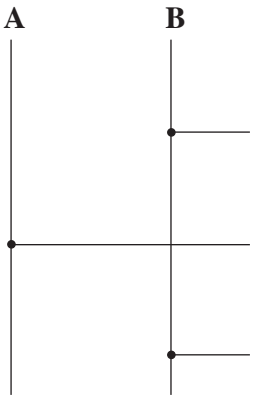
Input		Output
A	**B**	**Q**
0	0	
0	1	
1	0	
1	1	

(b) Complete the truth table for the following logic system. [3]



Input		Output		
A	**B**	**P**	**Q**	**R**
0	0			
0	1			
1	0			
1	1			

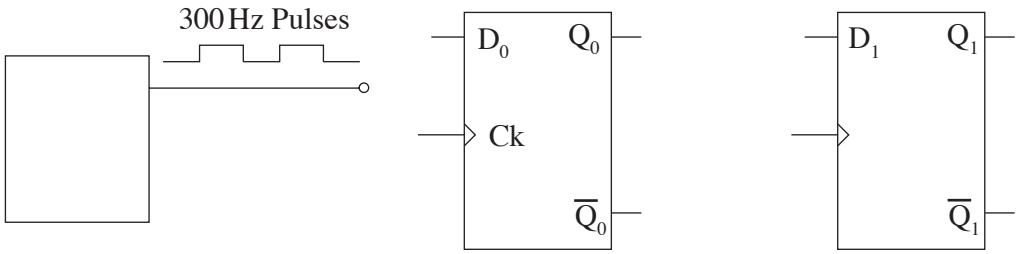
(c) Re draw the system using the NAND gate equivalent of each of the three gates. [3]



(d) Remove any double inversions. [1]

6. The diagram shows a D-type flip flop.

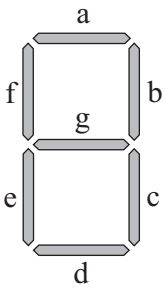
(a) Complete the diagram to show how you would make the D-type flip flop into a 2-bit binary counter. [2]



(b) The frequency of the pulses at the clock input is 300 Hz. What is the frequency of the signal produced at the Q_1 output? [1]

.....

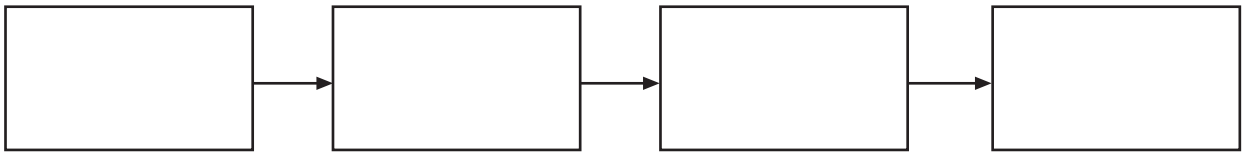
7. Here is a diagram of a seven segment display. It can be used to display numbers or letters.



Complete the following table to show which segments are lit and which number or letter is displayed. [3]

Number or letter	Segment						
	a	b	c	d	e	f	g
4	0	1	1				
H							
	1	0	0	0	1	1	1

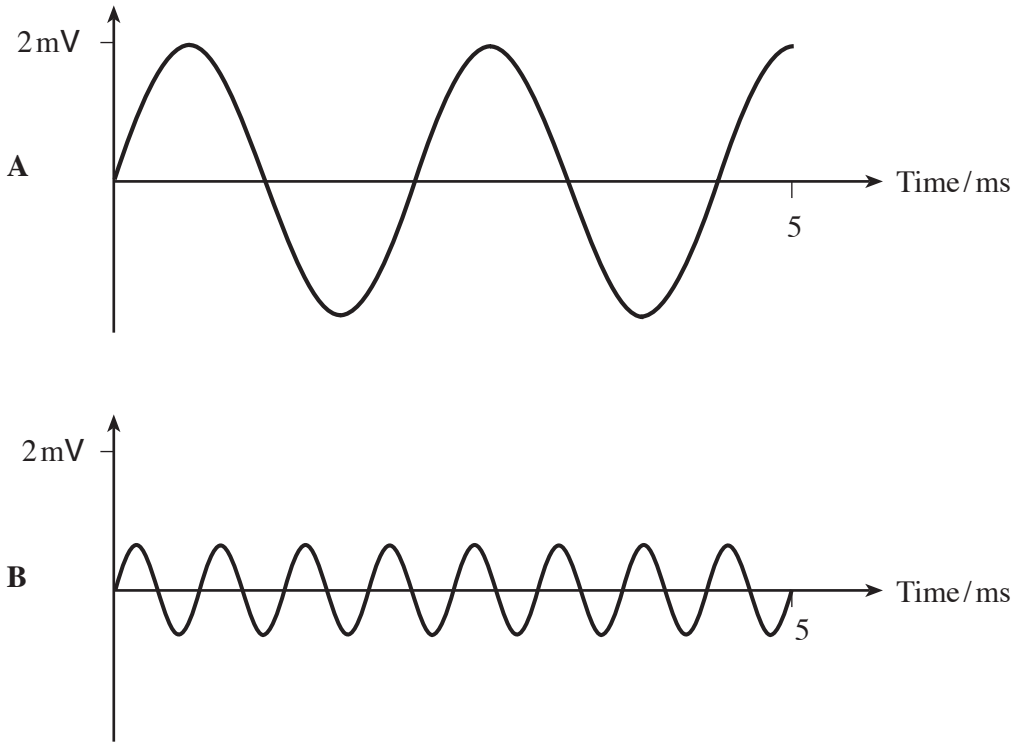
8. The block diagram for a public address system used in a school hall is shown below.



(a) Write the names of the four blocks in the boxes on the above diagram. Choose from the following list.

Power amplifier *Loudspeaker* *Pre-amplifier* *Comparator* *Microphone* [4]

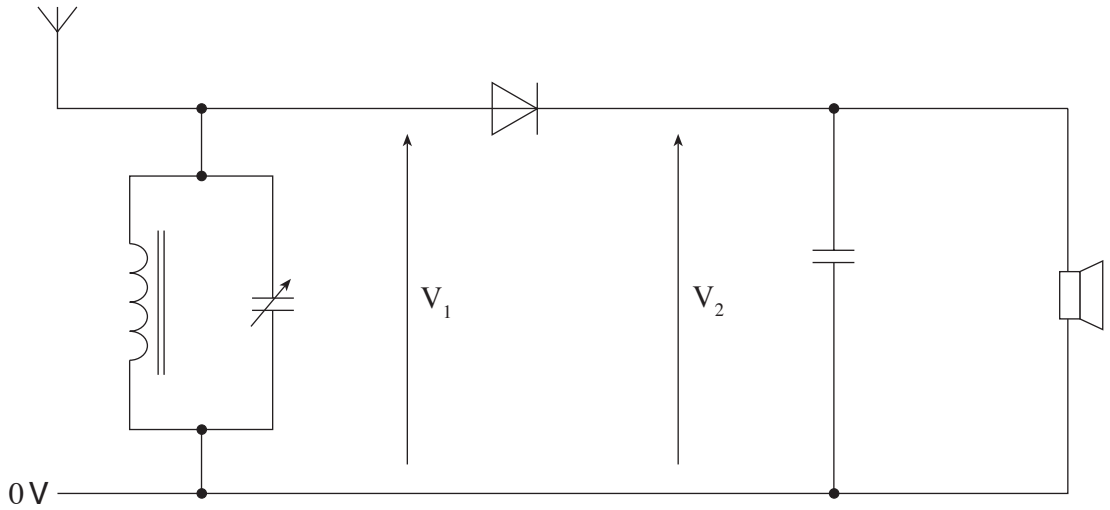
(b) The following waveforms were produced by two microphones A and B.



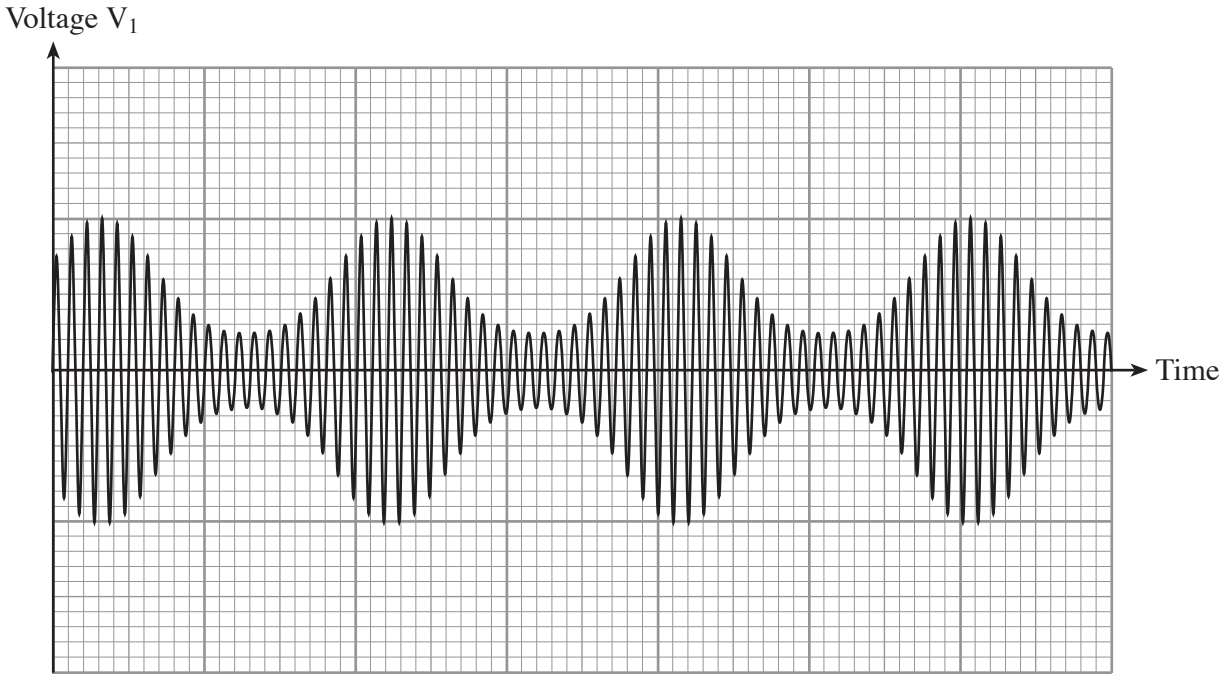
(i) Which signal **A** or **B** is the **quieter**? ..... [1]

(ii) Which signal **A** or **B** has the **lower** pitch? ..... [1]

9. The diagram below shows the circuit for a simple AM radio receiver.
An oscilloscope is used to display two signals V_1 and V_2.



(a) The graph shows the signal V_1.



Use this information to sketch the signal V_2 on the axes provided. [2]

(b) Which sub-system from the diagram: [4]

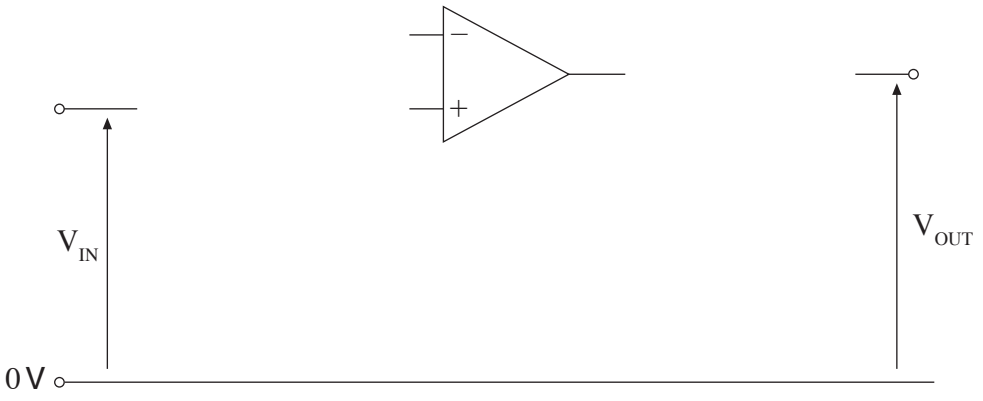
(i) detects the radio waves; .....

(ii) enables the audio signal to be heard; .....

(iii) selects the radio station you want to listen to; .....

(iv) separates the audio signal from the radio signal? .....

10. *(a)* Complete the following diagram to show an inverting amplifier by adding two resistors R_1 and R_2 and any necessary connections. [3]



(b) Use the formula at the beginning of this paper to calculate values for resistors R_1 and R_2 to give a gain of **−80**.

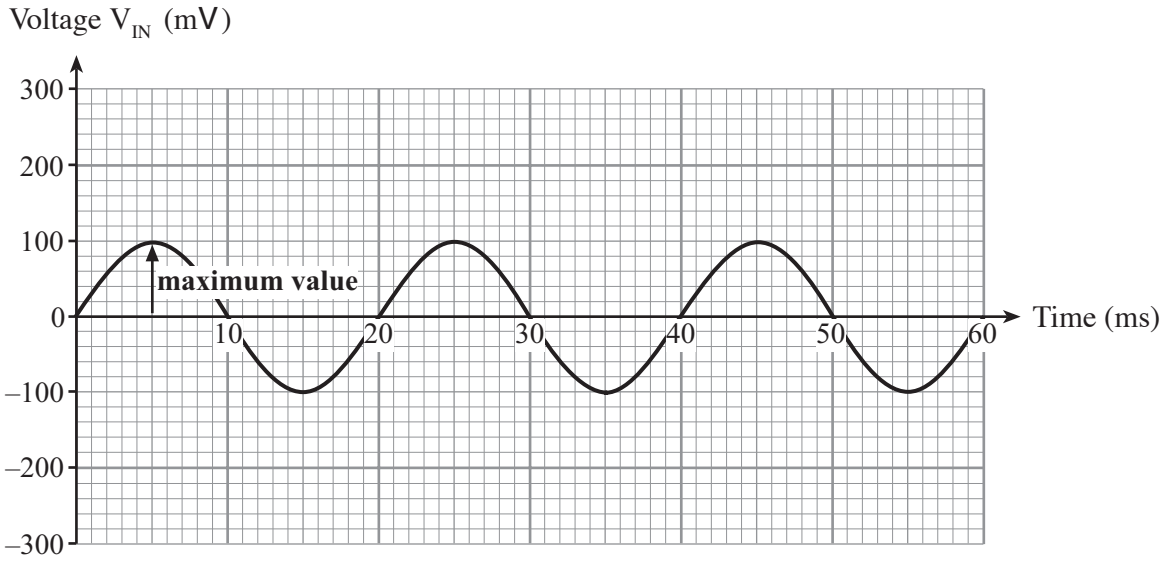
.....

.....

R_1 = ...

R_2 = ... [3]

(c) The following signal is then applied to the input.
The amplifier output saturates at ± **9 V**.



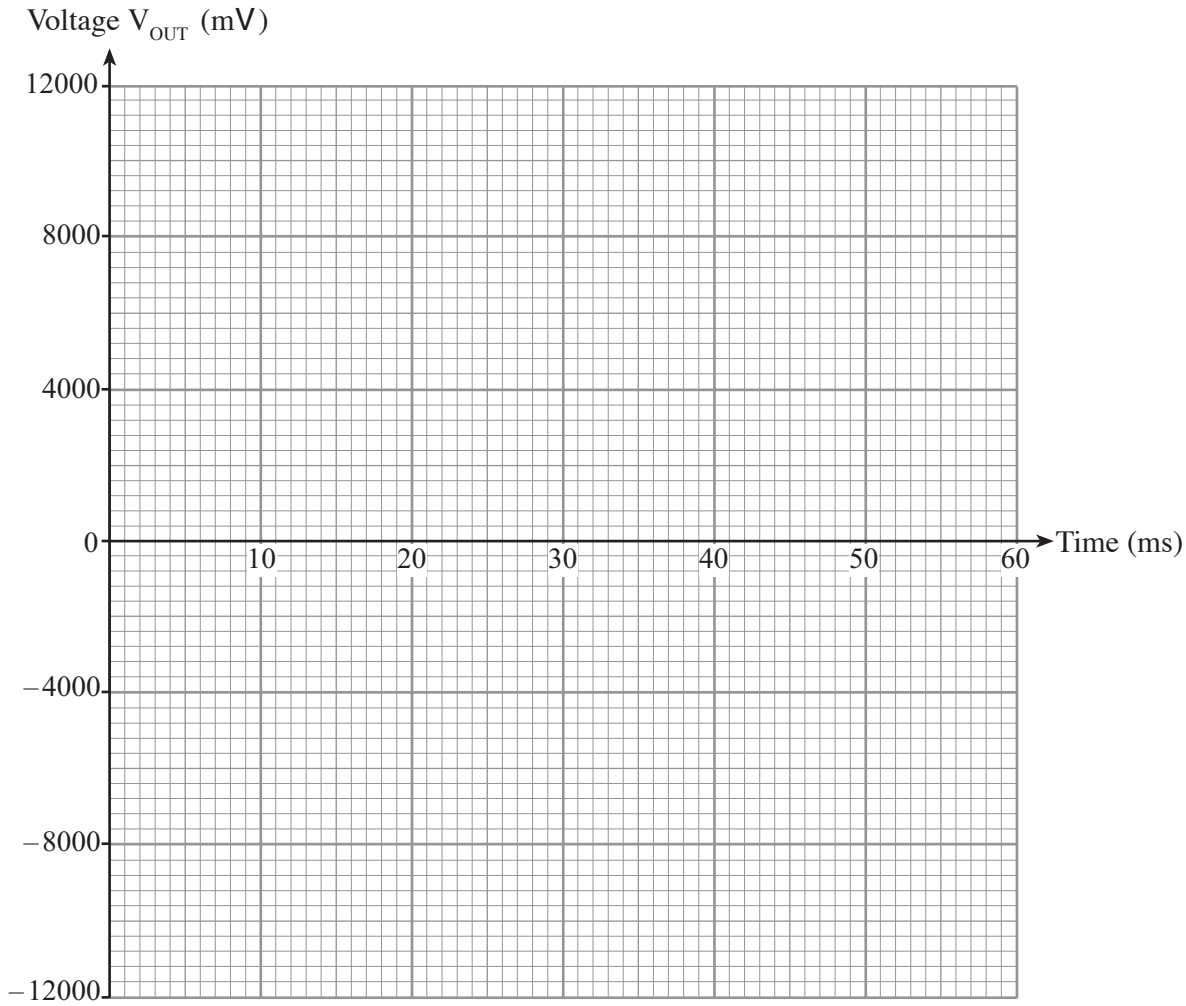
(i) Use the graph to find the maximum value of the input voltage V_{IN} in mV. [1]

.....

(ii) Calculate the maximum value of the corresponding output voltage V_{OUT} in mV. [1]

.....

(iii) Draw a graph of this output voltage V_{OUT} on the following grid. [3]



(d) Because of a change in the power supply voltage, the amplifier output now saturates at ± **7 V**. What effect will this have on the output signal for the same input? [1]

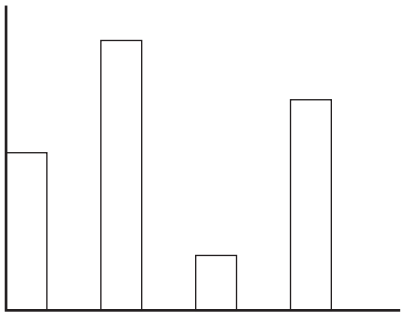
.....

.....

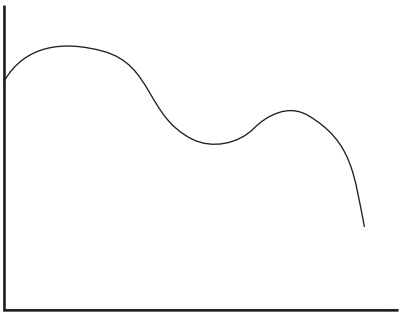
11. An analogue signal can be converted to a digital signal and transmitted as a series of binary numbers.

This is done by sampling the analogue signal to make a PAM signal. This is then passed through an ADC to produce a digital signal.

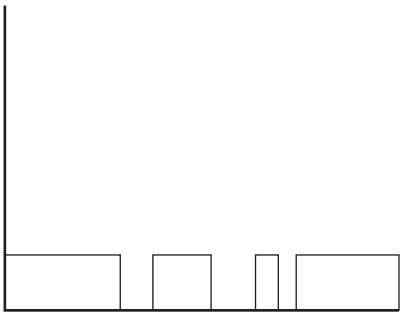
Here are 3 signals:



Signal A



Signal B



Signal C

Which signal A, B or C is:

(i) the analogue input signal, ...

(ii) the PAM signal, ...

(iii) the digital output signal? ..... [3]

12. A maximum of 100 cars can enter a car park. A computer program is used to count the number of cars and close a barrier if 100 cars have entered.

(a) Name a suitable sensor to be used at the entrance. [1]

.....

(b) Complete the following flow chart for the program required by :

- writing the instructions in the empty boxes
- adding correct loops to the decision boxes
- Writing Yes/No on the decision boxes. [7]