Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE

General Certificate of Secondary Education

CYD-BWYLLGOR ADDYSG CYMRU

Tystysgrif Gyffredinol Addysg Uwchradd

298/02

ELECTRONICS

TERMINAL EXAMINATION

HIGHER TIER

P.M. TUESDAY, 13 June 2006

(1 hour 15 minutes)

For Examiner's use only.	
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.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

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

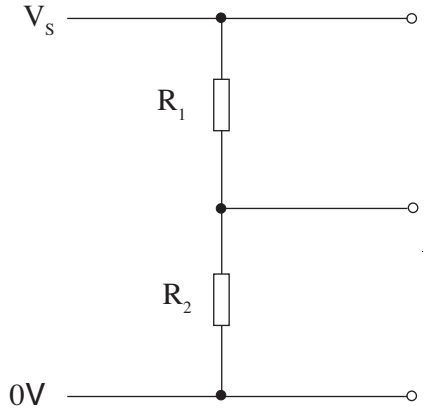
E 12 SERIES OF PREFERRED VALUES
10; 12; 15; 18; 22; 27; 33; 39; 47; 56; 68; 82 and multiples thereafter

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



$V_{OUT} = \frac{R_2}{R_1 + R_2} \times V_S$

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

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

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 0·7V.

10. Amplifiers

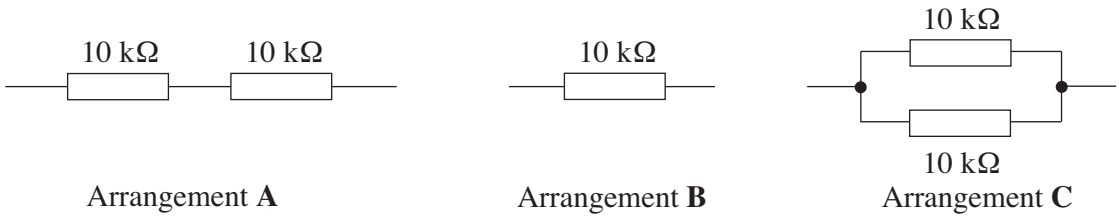
Voltage gain $A = \frac{V_{OUT}}{V_{IN}}$.

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

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

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

1. *(a)* Some 10 kΩ resistors are arranged as follows.



Arrangement **A** Arrangement **B** Arrangement **C**

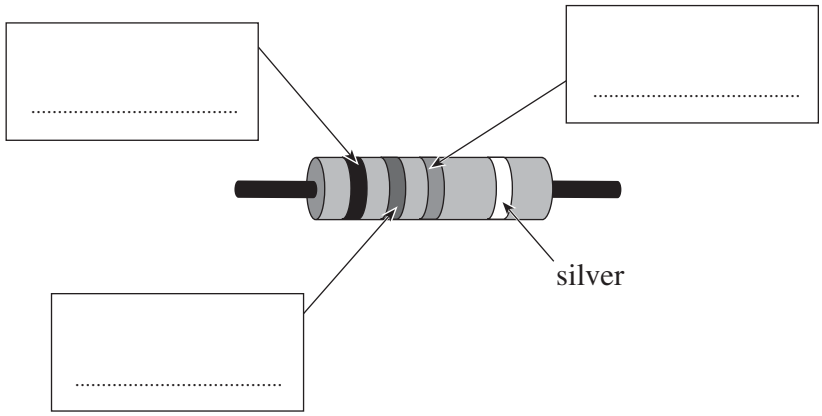
(i) Which arrangement **A**, **B** or **C** has the *lowest* resistance? .....

(ii) Which arrangement **A**, **B** or **C** has the *highest* resistance? .....

[2]

(b) Use the information sheet on page 2 to answer parts (i) and (ii).

(i) Work out the colour code for a **10 kΩ** resistor.
Write the colours in the correct spaces on the diagram below. [3]

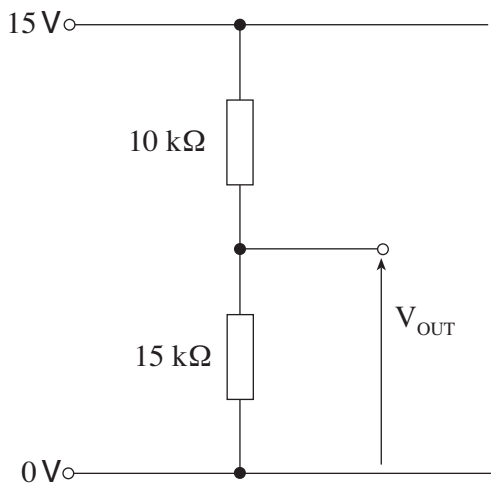


(ii) Use the tolerance band to calculate the **highest** and **lowest** values the resistor should have.

Highest value **in ohms =** .....

Lowest value **in ohms =** ..... [2]

(iii) The 10 kΩ resistor is used in a voltage divider circuit as follows.

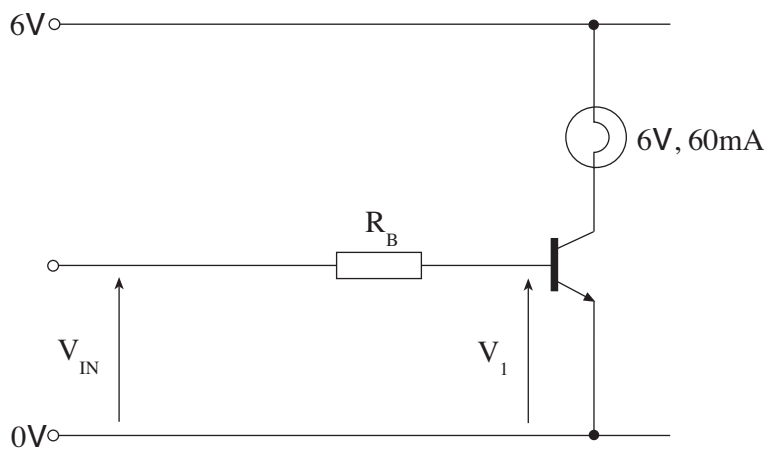


Calculate the output voltage V_{OUT}. [2]

.....

.....

2. Here is a transistor circuit used to switch a 6V, 60mA bulb on and off.



(a) The transistor is **just** saturated when the input voltage V_{IN} is 2·5V.

Complete the following table to show the voltage V_1 and whether the bulb will be on or off. [3]

V_{IN} (V)	V_1 (V)	Bulb On/Off?
0·4		
2·5		

(b) (i) V_{IN} is set to 2·5 V so that the transistor is just saturated. The current gain h_{FE} of the transistor is **150**.

Calculate the base current. [2]

.....

.....

(ii) Calculate the voltage drop across R_B. [1]

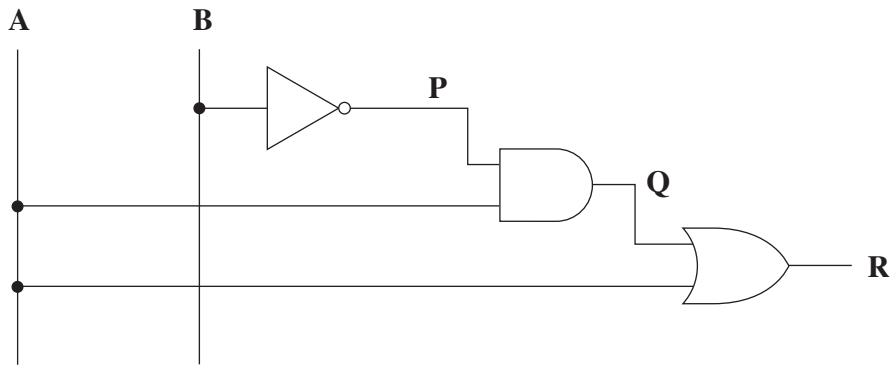
.....

(iii) Use your answers to parts (i) and (ii) to calculate the resistance of R_B. [2]

.....

.....

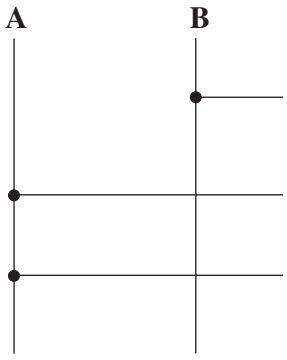
3. *(a)* Three logic gates are arranged as follows.



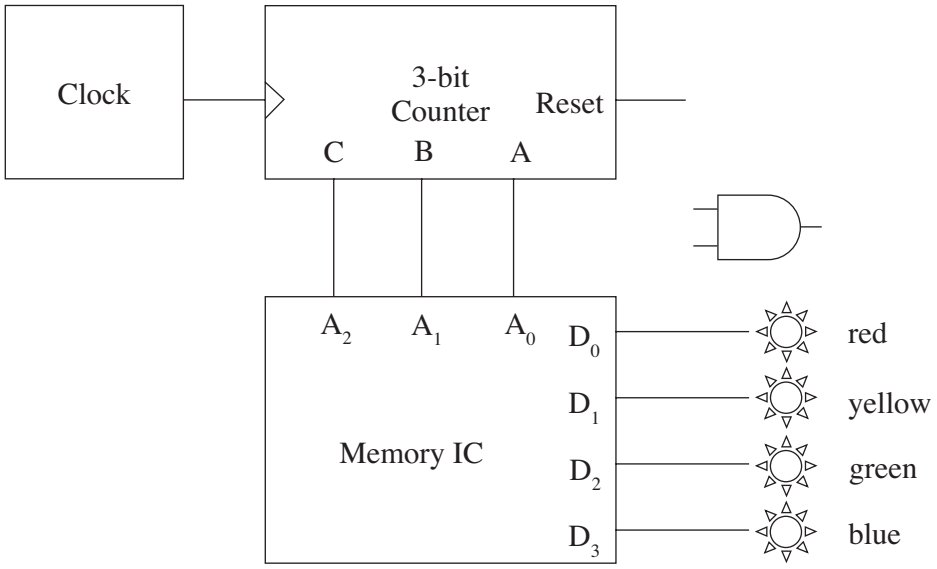
Complete the truth table. [3]

Inputs		Outputs		
A	**B**	**P**	**Q**	**R**
0	0			
0	1			
1	0			
1	1			

(b) Draw the NAND gate equivalent of this circuit. [3]



4. An incomplete circuit diagram for a disco light system is shown below.



- The lamps display a 5 step sequence.
- The steps for the pattern are stored in a memory IC.
- Each memory location is accessed in turn under the control of a clock and 3-bit counter.
- Each lamp is on when its data output is 1.

Memory address			Data (to lamps)			
A_2	A_1	A_0	D_3	D_2	D_1	D_0
0	0	0	0	0	0	0
0	0	1	1	0	0	0
0	1	0	1	1	0	0
0	1	1	1	1	1	0
1	0	0	1	1	1	1
1	0	1	Reset to start			

(a) The 3-bit counter is reset after the correct number of steps to allow the sequence to be repeated.

(i) Write down the memory address, in binary, of the first unused memory location.

.....

(ii) Complete the diagram opposite to show how the counter can be reset.

- C is the most significant bit of the counter.
- The counter is reset when the reset pin is taken to logic 1.

[3]

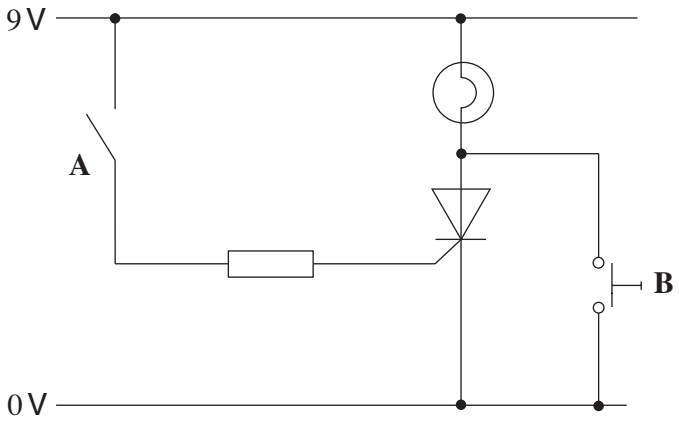
(b) The clock gives 1 pulse every second. For how long is the green lamp on for in each sequence? [1]

.....

(c) How many memory addresses are available on this memory IC? [1]

.....

5. The diagram shows a thyristor switching circuit.



The bulb is **OFF**.

(a) What happens to the bulb when switch **A** is closed? [1]

.....

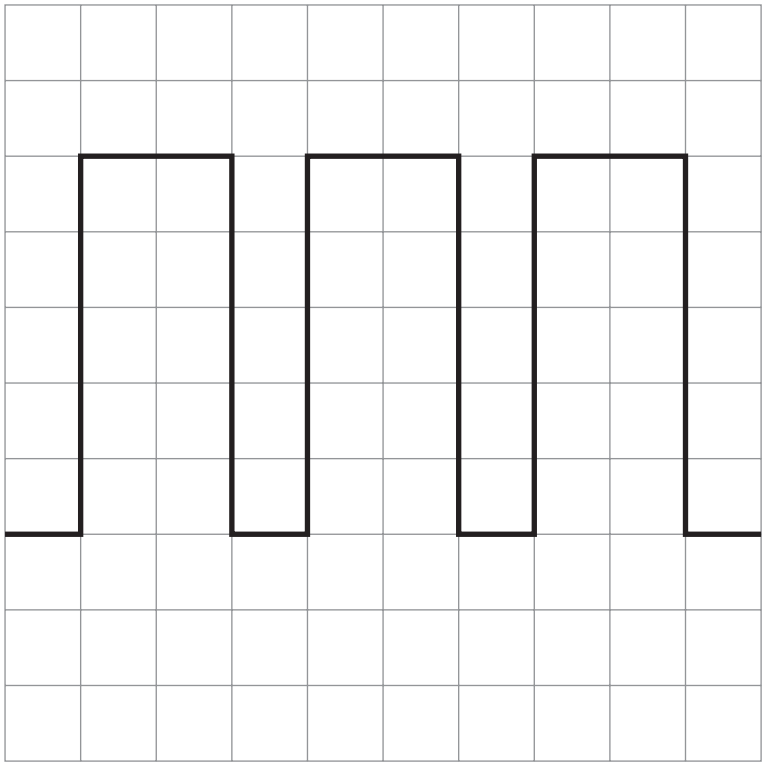
(b) What happens to the bulb when switch **A** is then opened? [1]

.....

(c) Switch **B** is momentarily closed. What happens to the bulb? [1]

.....

6. 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) = 50 mV/cm;
- time base (speed) = 0·5 ms/cm.

Use the trace to find:

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

.....

(b) the period of the signal; [2]

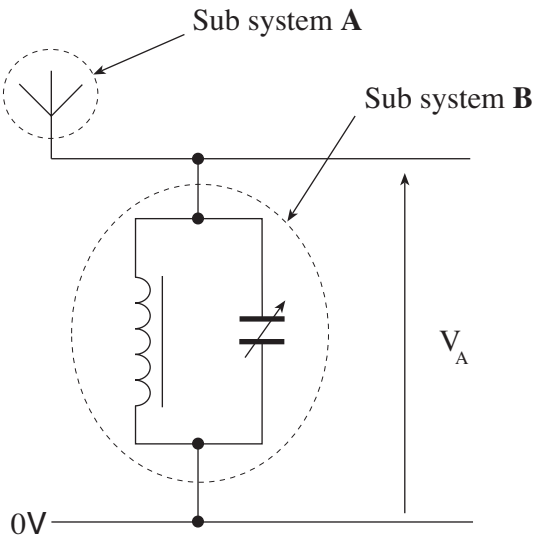
.....

.....

(c) the frequency of the signal. [2]

.....

7. The diagram below shows an incomplete circuit for a simple AM radio receiver.



(a) Two sub-systems labelled **A** and **B** are shown encircled by dashed lines on the diagram. Give the name of **each** sub-system.

A .....

B ..... [2]

(b) (i) What does sub-system **A** do? [1]

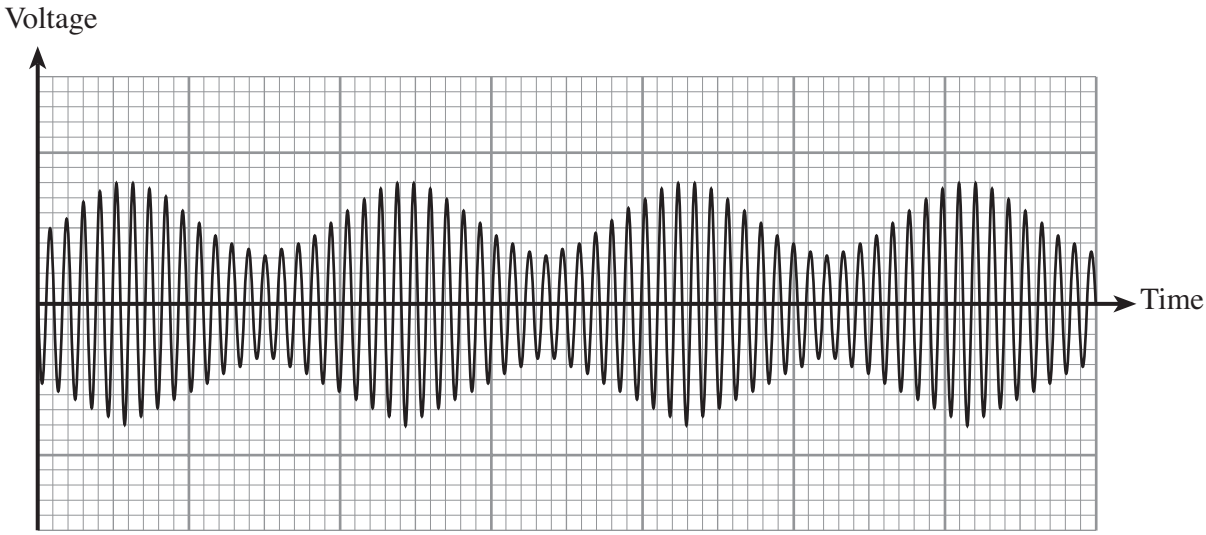
.....

(ii) What does sub-system **B** do? [1]

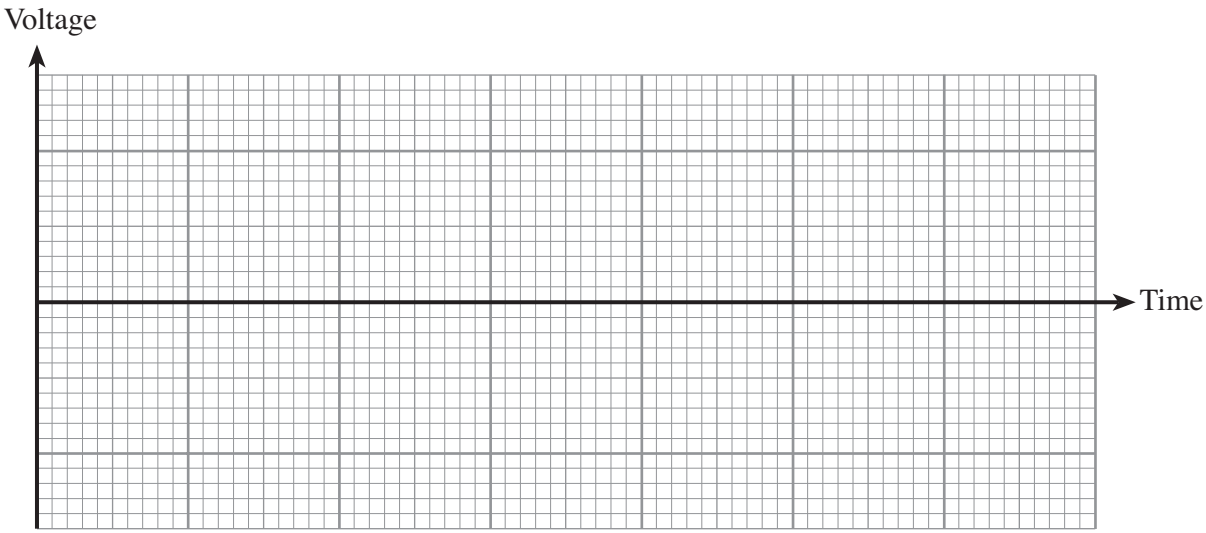
.....

(c) Complete the diagram above to show a complete circuit diagram for the simple AM radio receiver. [3]

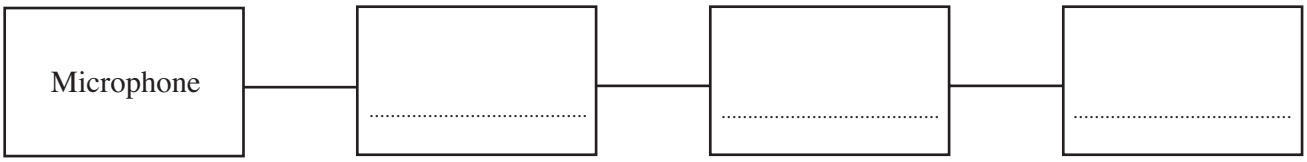
(d) The graph below shows the modulated carrier wave shown by signal V_A in the diagram opposite.



Use this information to sketch the audio signal which is being carried. [2]



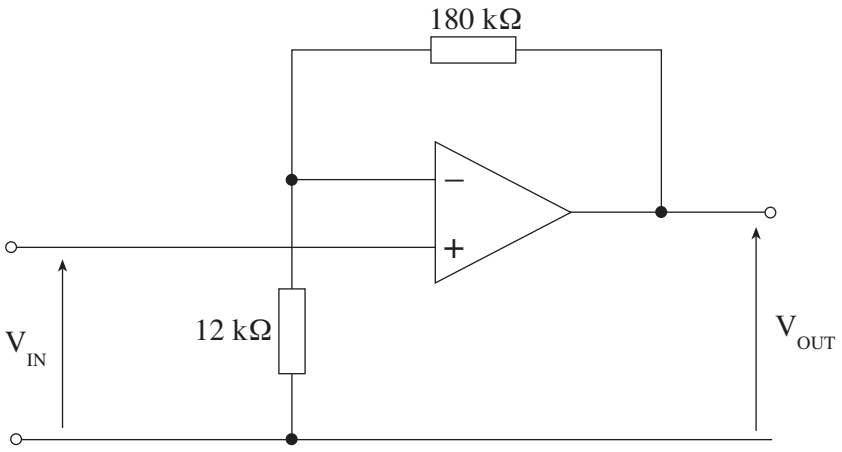
8. The block diagram for a public address system used in a school hall is shown below.



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

Power amplifier *Loudspeaker* *Comparator* *Pre-amplifier* [3]

(b) The following diagram shows a **non-inverting** amplifier.



(i) Calculate the voltage gain of this amplifier. [2]

.....

.....

(ii) If the input voltage V_{IN} is 10 mV, calculate the output voltage V_{OUT}. [2]

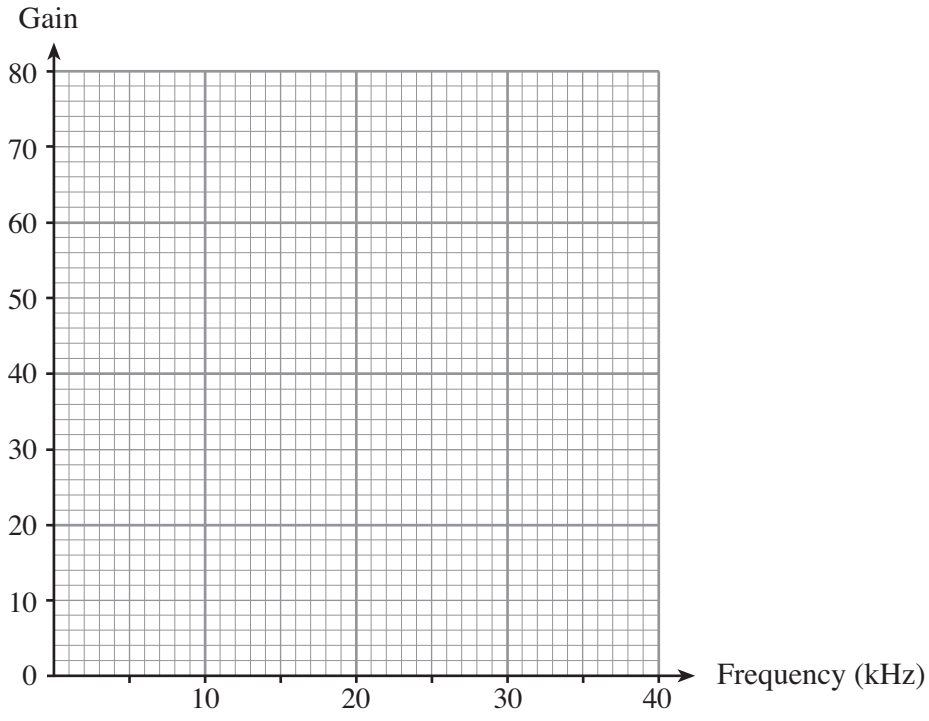
.....

.....

(c) The gain of a pre-amplifier is measured as the frequency of a signal source is varied. The results are shown in the following table.

frequency (kHz)	Gain
0	70
5	70
10	70
15	50
20	30
25	10
30	5

(i) On the grid below, draw a graph of frequency against gain. [2]



(ii) Mark carefully on the graph, the points at which the bandwidth of the amplifier would be measured. [2]

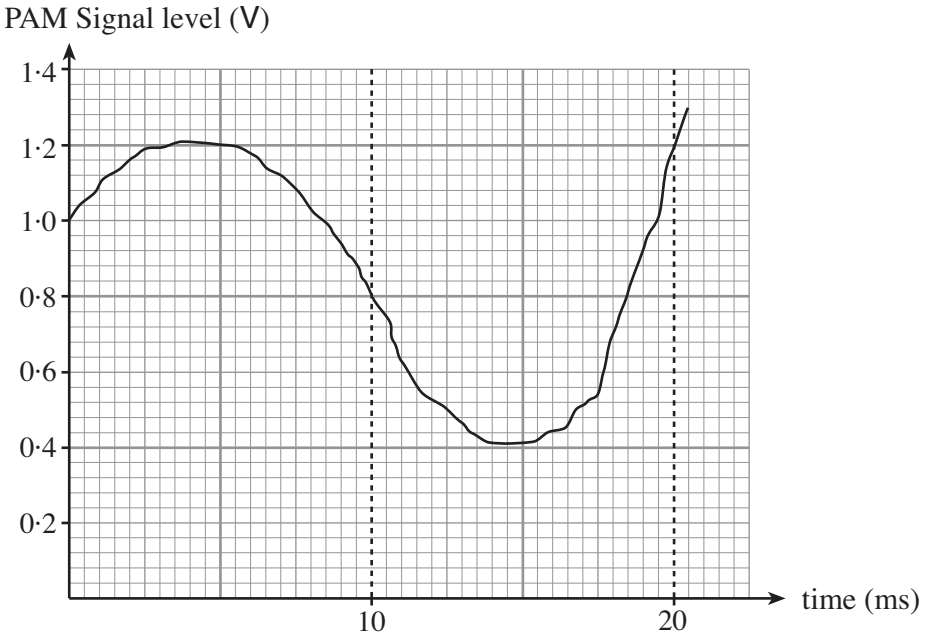
(iii) Hence estimate the bandwidth of this pre-amplifier.

Bandwidth is ..... kHz [1]

9. Two steps are needed to digitise an analogue signal.

- The signal must first be sampled to produce a PAM (pulse amplitude modulated) signal.
- The PAM signal is then converted to a binary signal by an ADC (analogue to digital converter).

The following graph shows the analogue signal being sampled at the times shown to produce the PAM voltage signal.



(a) Complete the table to show the PAM voltages.

Time of sampling pulse(ms)	PAM voltage(V)
0	1·0
10	
20	

[2]

(b) The following table shows some of the binary outputs from the ADC for various values of PAM voltage. Complete the table.

PAM voltage(V)	ADC binary output
0·2	0 0 0 1
0·4	0 0 1 0
0·6	0 0 1 1
0·8	
1·2	

[2]

(c) Give **one** advantage of converting the analogue information into digital form before transmission. [1]

.....

BLANK PAGE

10. The heating system in a new school is controlled by a computer program.

If the temperature is **below 17°C**, the heating is switched **ON**.
If the temperature is **above 21°C**, the heating is switched **OFF**.

(a) Older systems use a timer to switch the heating on for the same time every day. The new system uses feedback. Give **one** advantage of using feedback apart from cost. [1]

.....

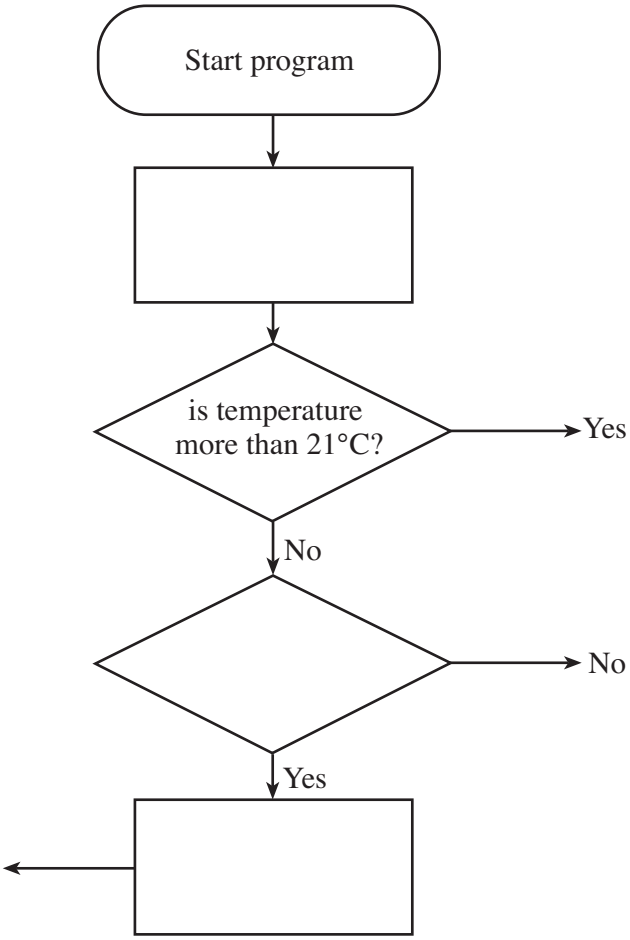
(b) Why is it better to have two switching levels rather than switch the system ON and OFF at one temperature? [1]

.....

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

(i) writing the correct instruction in the empty boxes;

(ii) adding correct branches to the decision boxes.



[6]