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, 12 June 2007

(1 hour 15 minutes)

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.

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

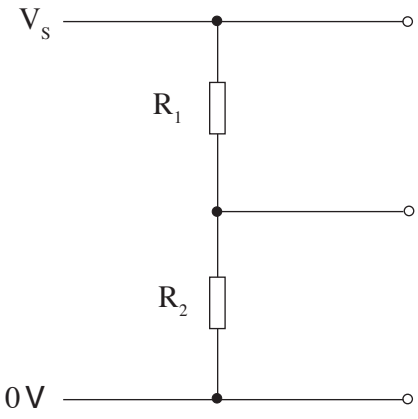
E 12 SERIES OF PREFERRED VALUES
10; 12; 15; 18; 22; 27; 33; 39; 47; 56; 68; 82 and multiples thereafter

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

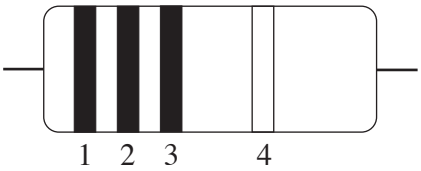
Inverting amplifier: $A = -\frac{R_F}{R_{IN}}$.

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

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

1. The resistor colour code is given in the information sheet on page 2.

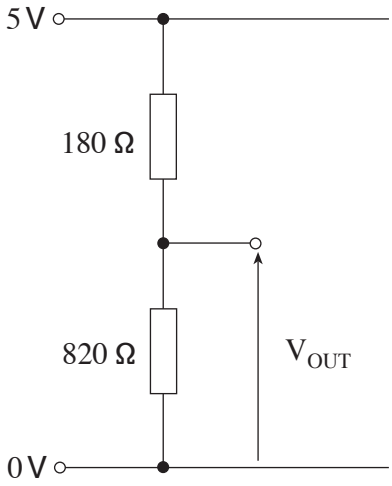
Here is a diagram of an 820 Ω resistor with a 5% tolerance.



(a) Complete the following table. [4]

Resistor value	Colour of Band 1	Colour of Band 2	Colour of Band 3	Colour of Band 4
820 Ω ± 5%				

(b) The 820 Ω resistor is used in a voltage divider circuit as follows.



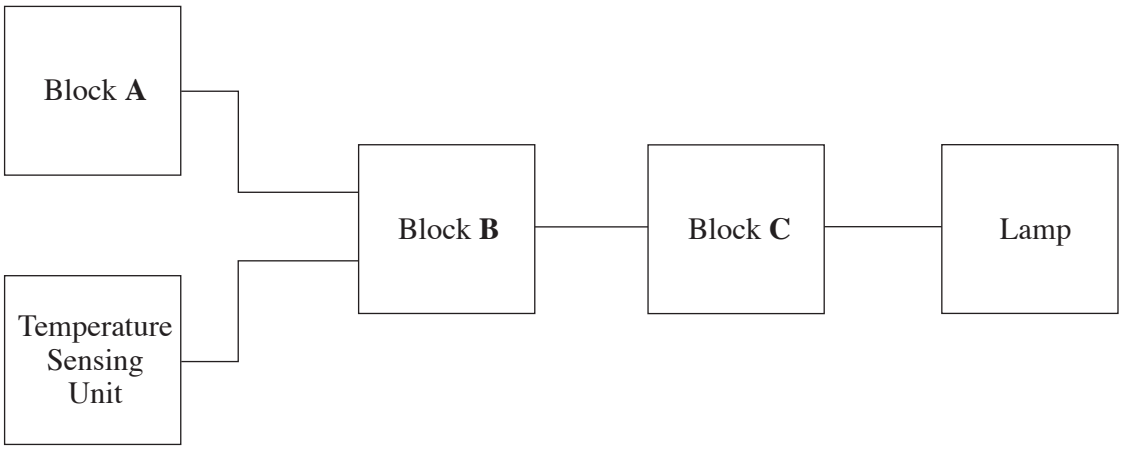
Calculate the output voltage V_{OUT}.

.....

.....

[2]

2. Here is a system to warn a gardener if the soil is too cold or too wet.



You can choose any of the following sub-systems to use for blocks A, B and C:

moisture sensing unit *OR gate* *light sensing unit* *latch*

comparator *transistor switch / transducer driver* *AND gate*

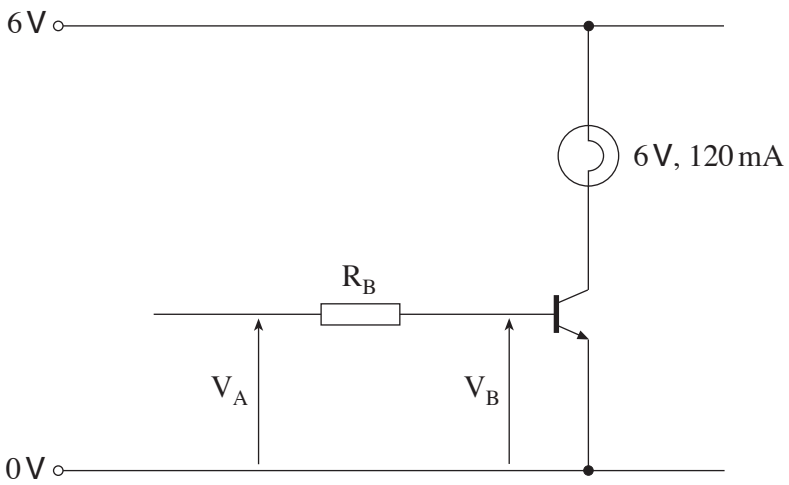
Which subsystem is a suitable unit:

(a) for block **A**? .....

(b) for block **B**? .....

(c) for block **C**? ..... [3]

3. The following circuit diagram shows part of a system used to switch on a lamp.



The transistor is **just** saturated when the input voltage V_A is 3·1 V.

(a) Complete the following table to show:

- the voltage V_B for each of the two values of V_A,
- whether the bulb will be **On** or **Off**.

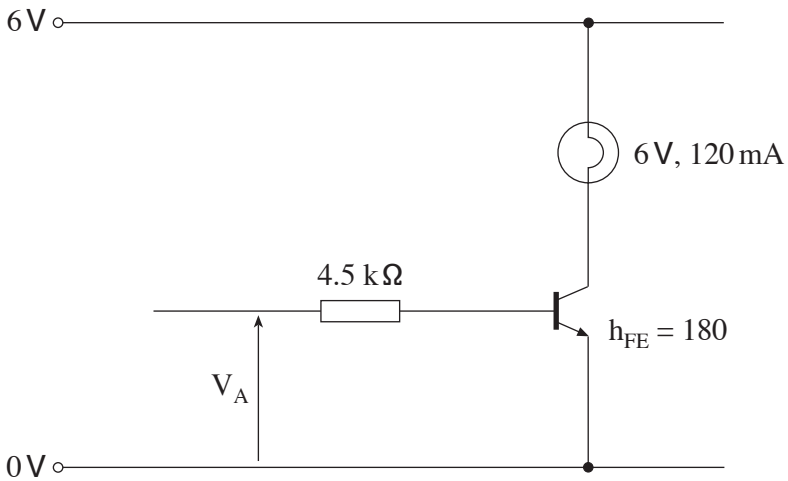
V_A	V_B	Bulb On/Off?
0·3 V		
3·3 V		

[3]

(b) Complete the diagram above to show the sensing circuit that would be used to make the lamp come on when it is dark. [2]

(c) The base resistor R_B is now changed to a new value of **4·5 kΩ**.

The current gain h_{FE} of the transistor is **180**.



The transistor is just saturated.

(i) Calculate the base current.

.....

.....

[2]

(ii) Calculate the voltage drop across the **4·5 kΩ** resistor.

.....

.....

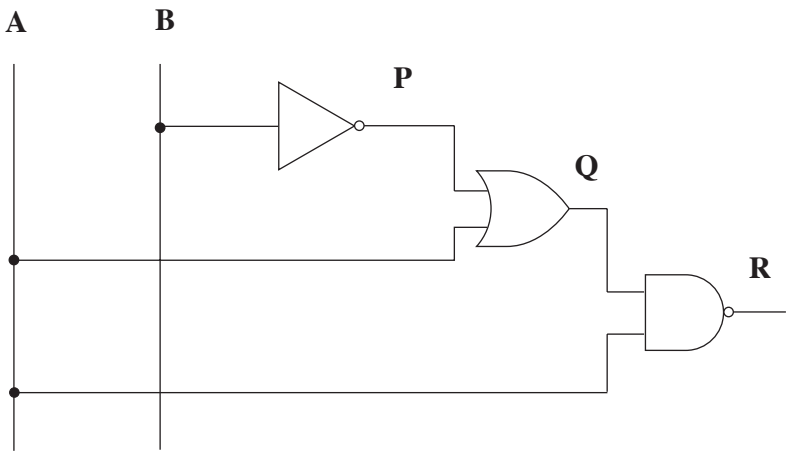
[2]

(iii) Hence calculate the new value of the input voltage V_A.

.....

[1]

4. Three logic gates are connected to make a logic system.

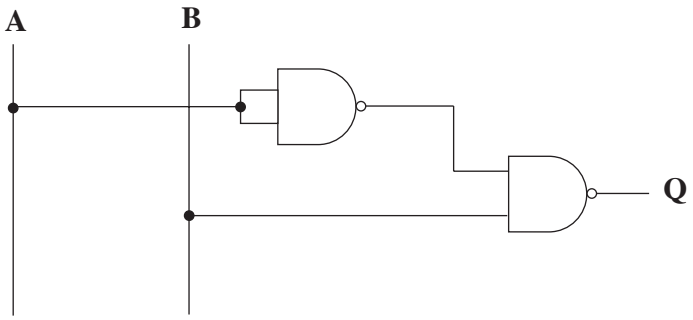


(a) Complete the truth table.

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

[3]

(b) Here is another logic system.

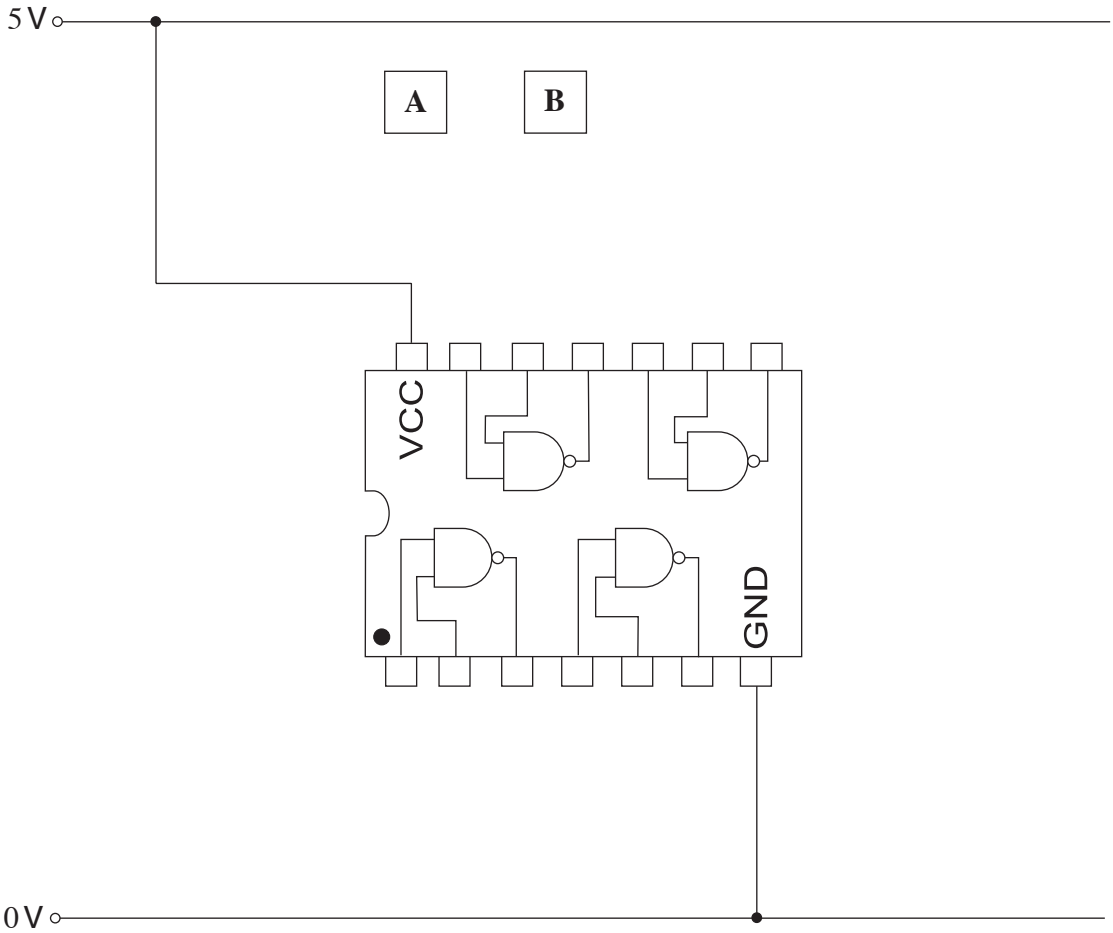


The diagram below shows the pinout layout for the 7400 logic gate IC.
It has four NAND gates.

Complete the diagram below by:

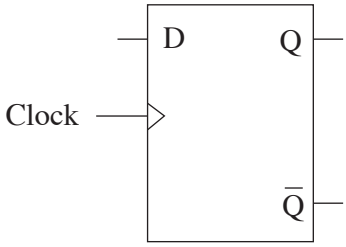
- drawing all the connections to show the above system,
- labelling the output Q.

Some of the connections have been made and the two logic inputs **A** and **B** are labelled.

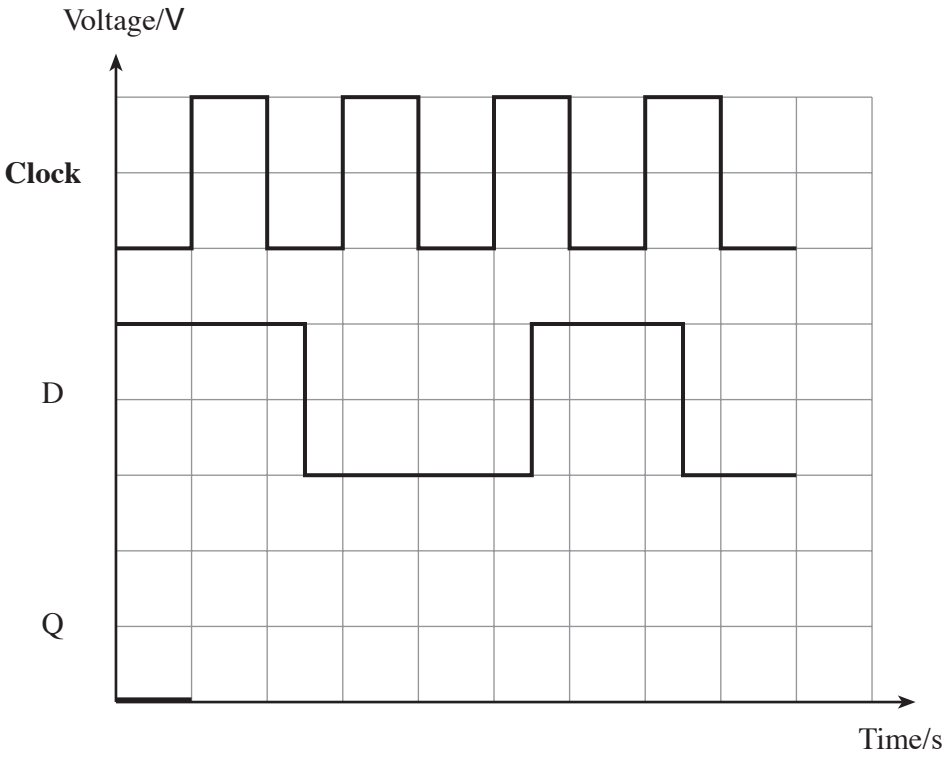


[4]

5. Here is a diagram of a D-type flip-flop.

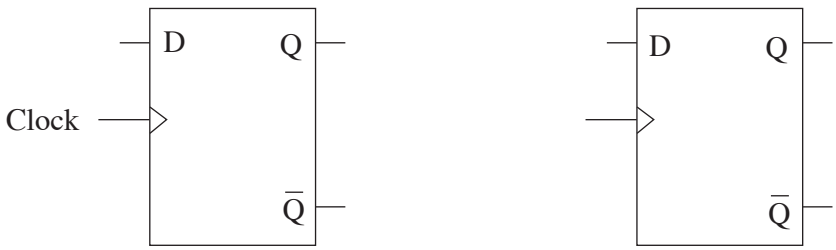


(a) Complete the timing diagram below to show the output Q when the following signals are applied to the clock and D inputs.



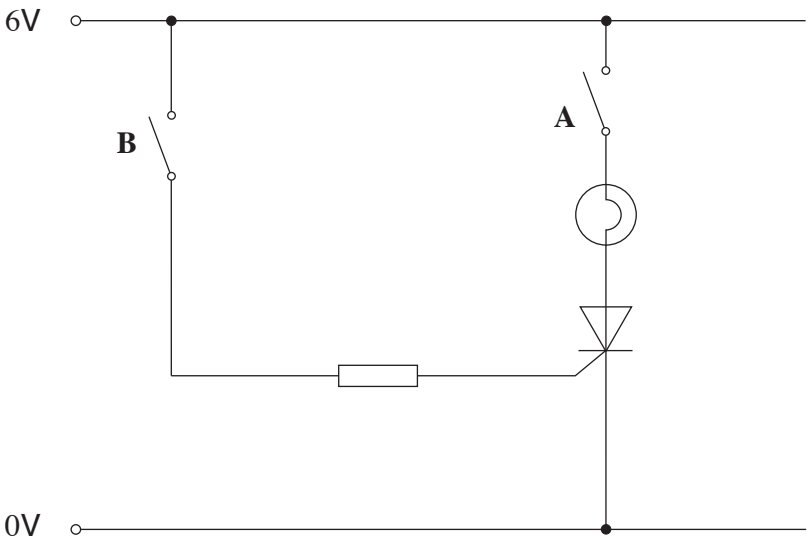
[4]

(b) Complete the following diagram to show how two D-type flip-flops should be connected to produce a **divide-by-four** function.



[2]

6. The diagram below shows a thyristor switching circuit.



- The bulb is **OFF** and both switches are in the **OFF** position to start with.

State what happens to the bulb when:

(a) switch **A** is closed,

.....

[1]

(b) switch **B** is then closed,

.....

[1]

(c) switch **B** is then opened,

.....

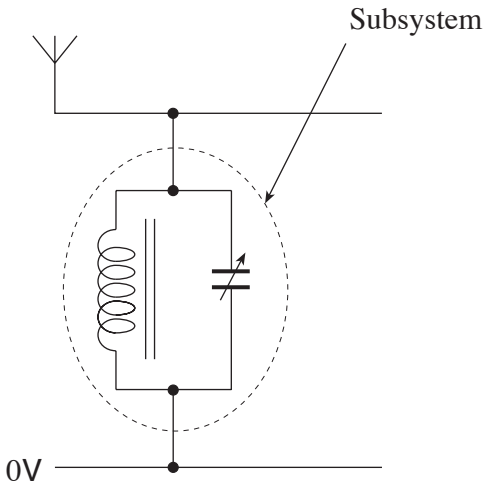
[1]

(d) switch **A** is then opened.

.....

[1]

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



(a) (i) Name the subsystem shown encircled by dashed lines on the diagram.

.....

(ii) What does this subsystem do?

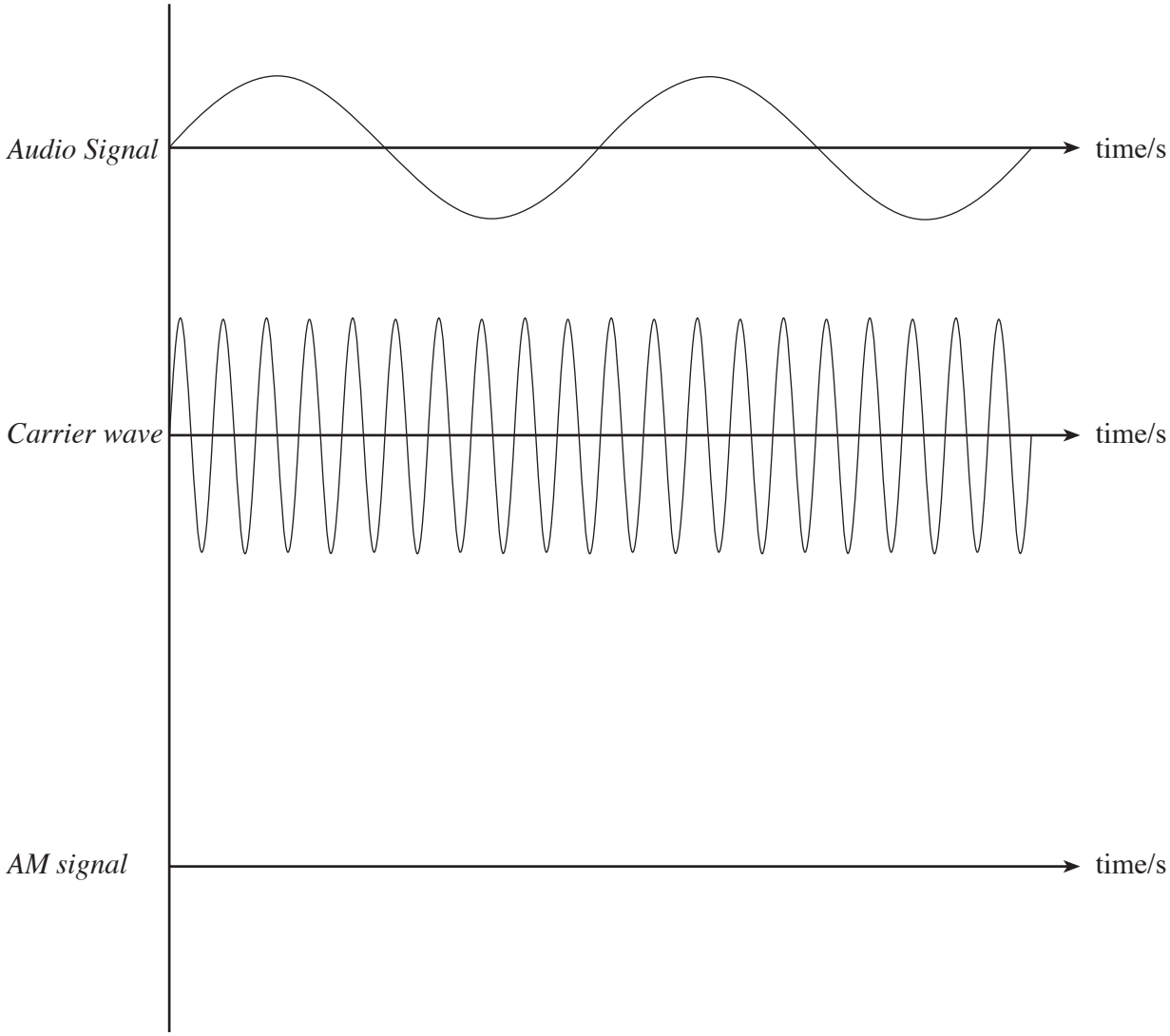
.....

[2]

(b) **Complete the diagram** above by showing a complete circuit diagram for the simple AM radio receiver. [3]

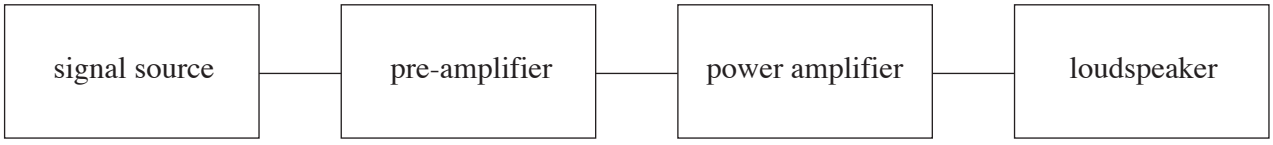
(c) Circle the subsystem that acts as an RF filter. [1]

(d) On the bottom axes below show how the audio frequency wave and the unmodulated radio frequency carrier wave are combined to produce an AM modulated radio wave.



[2]

8. The block diagram for a disco sound system is shown below.



(a) (i) Name one possible signal source.

.....

[1]

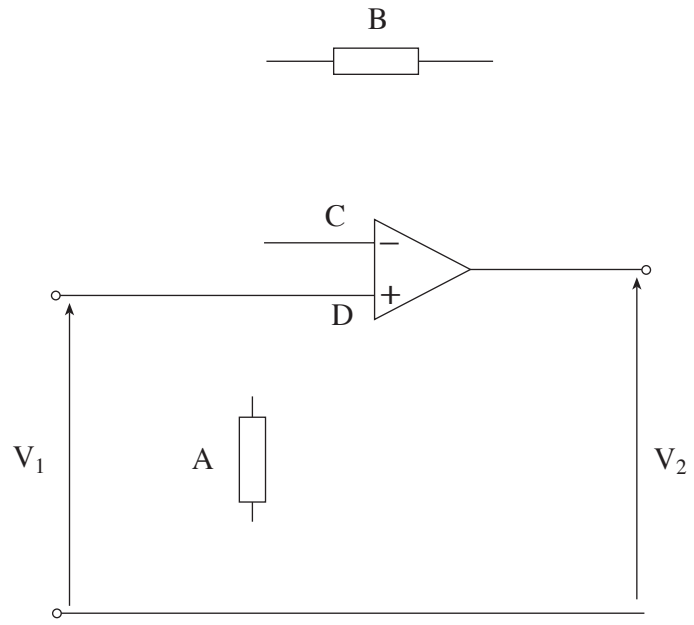
(ii) Why is a pre-amplifier needed?

.....

.....

[1]

(b) A **non-inverting** amplifier is used as the pre-amplifier.



(i) Which input, C or D, on the diagram is the **inverting input**?

.....

[1]

(ii) **Complete the diagram** for the **non-inverting** amplifier. [2]

(iii) Choose suitable values for resistors A and B to give the gain of **40**.
Use the information sheet on pages 2 and 3.

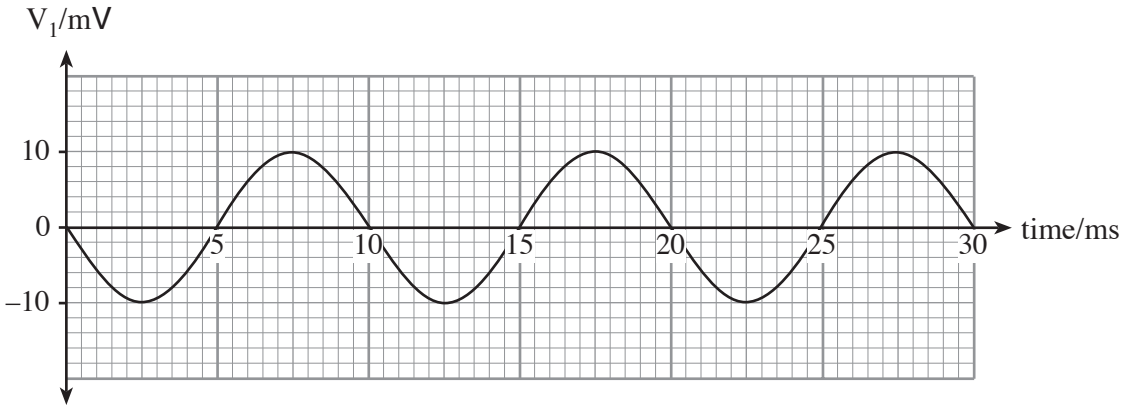
.....

.....

.....

[3]

(c) The following signal is the input voltage V_1.



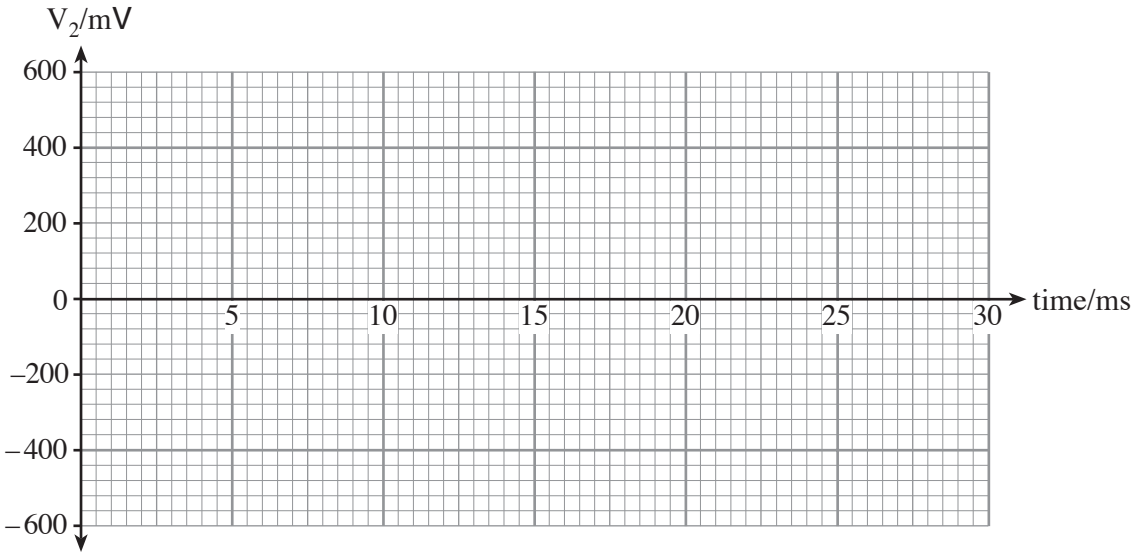
(i) Calculate the highest value of the **output voltage V_2** in mV.

.....

.....

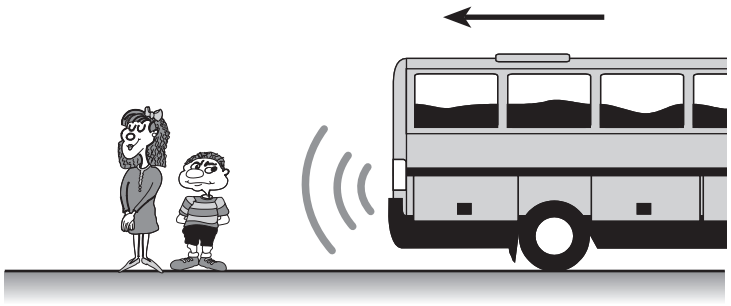
[2]

(ii) Draw a graph of this output voltage V_2.



[3]

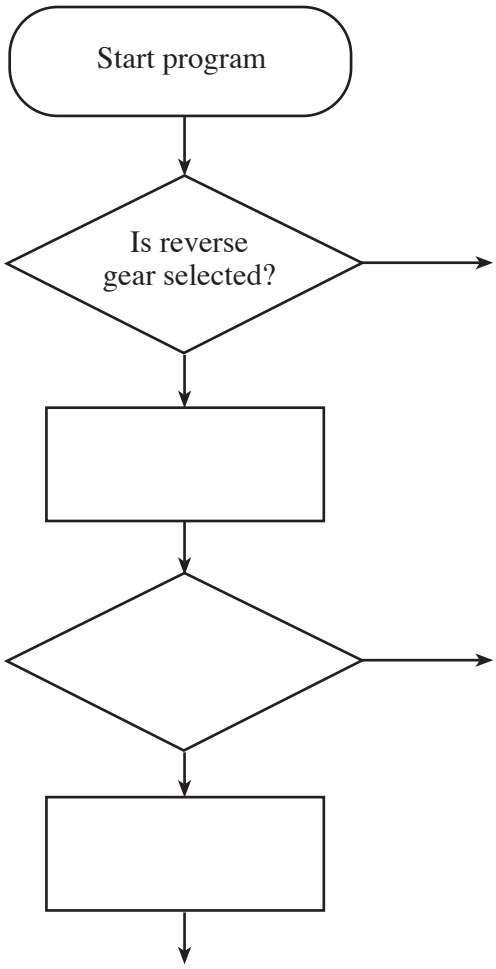
9.



Some school buses have a reversing system controlled by a microcontroller.

- The system pulses a bleeper when reverse gear is selected.
- The system also switches on a warning lamp inside the bus if it senses something near the back of the bus.

The flowchart shows **part** of the operation of this reversing system.
Some parts of the flowchart have been left out.



(a) Name a suitable device to sense when reverse gear is selected.

.....

[1]

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

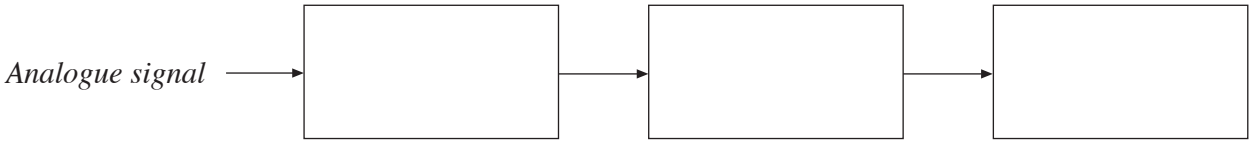
- writing the instructions in the empty boxes,
- adding correct branches to the decision boxes,
- writing yes/no on the decision boxes. [6]

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

(a) The following lists the steps involved:

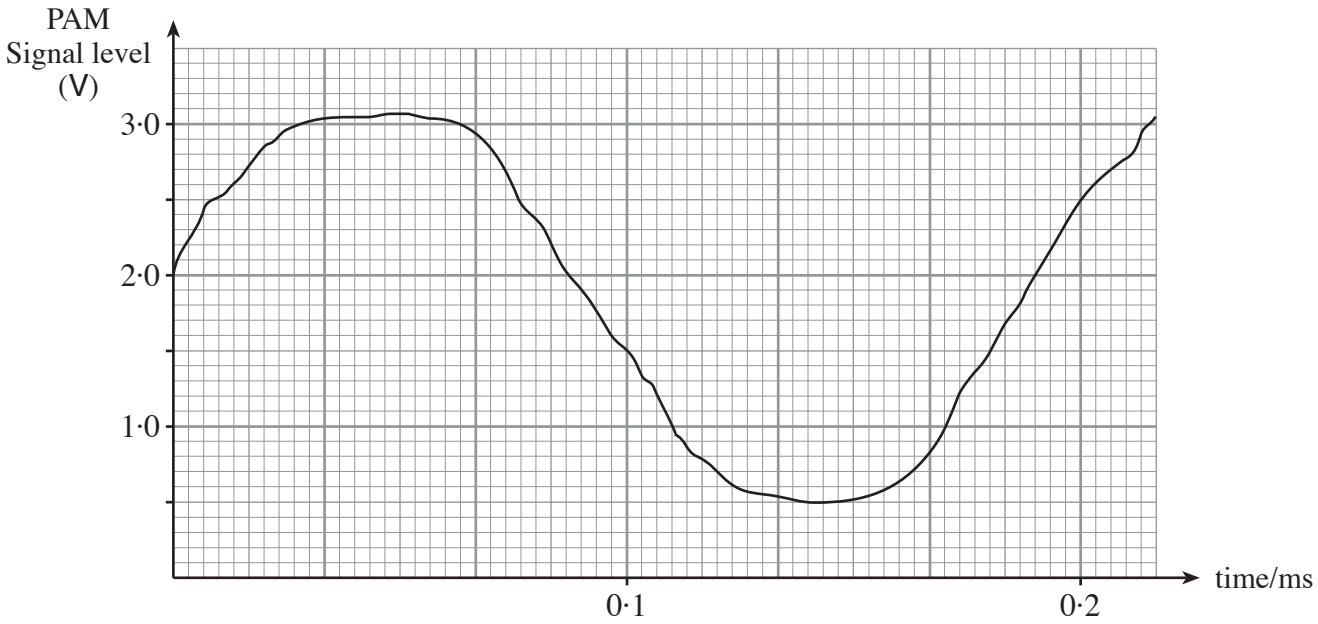
ADC (Analogue to digital conversion) *sampling* *PAM signal*

Write these steps in their correct order in the following boxes.



[2]

(b) The following graph shows an analogue signal being sampled at the times shown.



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

time of sampling pulse (ms)	PAM voltage (V)
0·1	
0·2	

[2]

(ii) The following table shows some of the binary outputs from the ADC for various values of PAM voltage. Complete the table. [3]

PAM voltage (V)	ADC binary output
0·3	0 0 0 1
0·6	0 0 1 0
0·9	0 0 1 1
1·2	
2·1	
	1 1 1 1