Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Secondary Education
June 2008

ELECTRONICS
Written Paper
Higher Tier

3432/H

H

Friday 23 May 2008 1.30 pm to 3.30 pm

For this paper you must have:
- a pencil and a ruler
- a calculator.

Time allowed: 2 hours

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

Information
- The maximum mark for this paper is 150.
- The marks for questions are shown in brackets.
- A list of formulae and other information, which you may wish to use in your answers, is provided on page 2.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3		7	
4		8	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Information Sheet

The following information may be useful in answering some of the questions in this examination paper.

1. **Power**

   Power = voltage × current; $P = VI$

2. **Amplifiers**

   Voltage gain $G_v = \frac{V_{out}}{V_{in}}$

3. **Resistor colour code**

   The colours in the resistor colour code correspond to the following values.

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.

   GOLD ±5% SILVER ±10% No fourth band ±20%

4. **Resistor printed code** (BS 1852)

   R means × 1
   K means × 1000
   M means × 1 000 000
   Position of letter gives the decimal point.
   Tolerances are indicated by adding a letter at the end.

   J ±5% K ±10% M ±20%

   e.g. 5K6J = 5.6 kΩ ± 5%

5. **Preferred value for resistors** (E24 SERIES)

   1.0 1.1 1.2 1.3 1.5 1.6 1.8 2.0 2.2 2.4 2.7 3.0 3.3 3.6 3.9 4.3 4.7 5.1 5.6 6.2 6.8 7.5 8.2 9.1 and multiples of 10

6. Resistance = $\frac{\text{voltage}}{\text{current}}$; $R = \frac{V}{I}$

7. Effective resistance, R, of resistors in series is given by $R = R_1 + R_2 + R_3$

8. Effective resistance, R, of two resistors R_1 and R_2 in parallel is given by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

9. **A.C. waveforms**

   (a) Frequency of waveform = $\frac{1}{\text{time period}}$; $f = \frac{1}{T}$

   (b) peak value = 1.4 × rms value

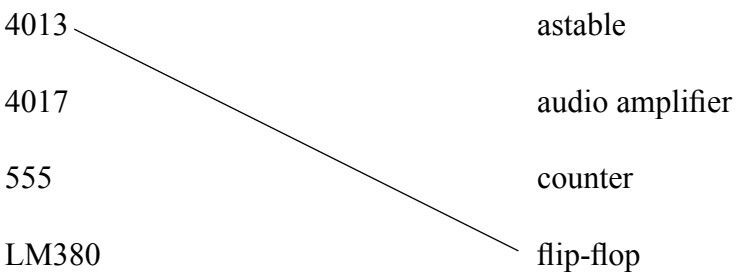
10. **Astable and monostable generators using 555 timers**

    (a) Monostable mode, time period, $T = 1.1\ R_1 \times C_1$

    (b) Astable mode, timer period, $T = \frac{(R_1 + 2R_2)C_1}{1.44}$

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

1 (a) For each integrated circuit in the list below draw a line linking it to the name of the subsystem in which it can be used. (The first line has been drawn already.)



(3 marks)

1 (b) Complete the following statements by filling in the missing words.

1 (b) (i) A capacitor is a device which ..... .

1 (b) (ii) A thin piece of wire designed to melt when too much current flows through it is a ..... .

1 (b) (iii) The wire from a three-pin plug which is connected to the metal case of an appliance is called the ..... .

1 (b) (iv) The colour of the live wire in a mains cable is ..... .

1 (b) (v) A device which converts alternating current into direct current is called a ..... .

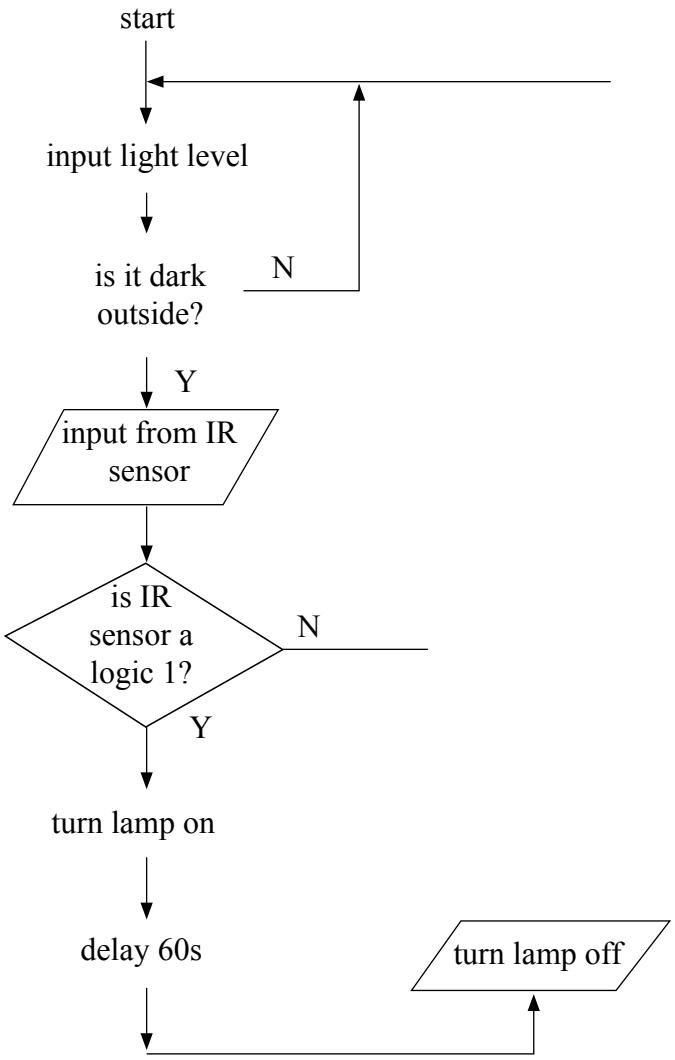
1 (b) (vi) A test instrument which produces an alternating voltage at a frequency which is set by the user is a ..... .

1 (b) (vii) Less noise will be picked up by the cable joining two subsystems if they are connected together using ..... .

(7 marks)

10

2 A student designs a system to save energy by only switching on a light in a room when it is dark outside and when an infrared (IR) sensor detects the presence of a person in the room. The IR sensor gives a logic 1 output when it detects a person.
The flowchart below is not complete and some of the symbols have been omitted.



2 (a) Draw the correct flowchart symbols at **five** places where they are missing above.

(5 marks)

2 (b) (i) Label on the flowchart:

a decision box, an input box, a loop, an output box and a process box

2 (b) (ii) Some of the lines are missing from the flowchart, complete them on the flowchart.

(7 marks)

2 (c) Describe in words the operation of the complete system.

.....

.....

.....

.....

(4 marks)

When the system is working, the student notices that the lamp annoyingly switches off and then quickly back on again every minute.

2 (d) (i) Explain why the lamp switches in this way.

.....

.....

2 (d) (ii) It is suggested that this switching can be avoided by changing the sequence of operations. Which box on the flowchart should be moved to avoid this switching?

.....

2 (d) (iii) Alter the flowchart on **page 4** to show the improved operation.

(4 marks)

20

Turn over for the next question

3 A student decides to construct an energy saving system similar to that described in Question 2.

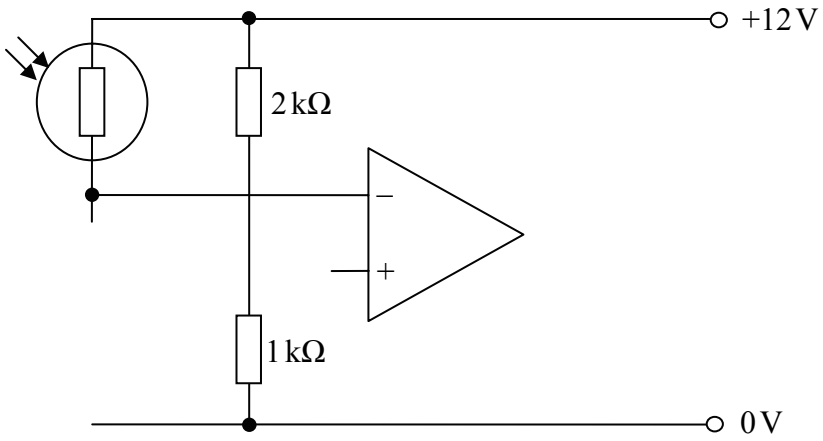
It is not necessary to have completed your answer to Question 2 before attempting this question.

A logic gate has inputs from two subsystems. Subsystem one detects the light level, sending its output signal to another subsystem which produces an output signal logic 1 when it gets dark.
Subsystem two uses an infrared (IR) detector which produces a logic 1 output signal when a person is present in the room.
The two logic signals form the inputs to a logic gate whose output signal triggers a timer which in turn controls a lamp.

3 (a) Draw a system diagram consisting of six subsystems for this complete system. Label **all** the subsystems with their respective functions.

(6 marks)

3 (b) (i) Complete the circuit diagram below to show how an op-amp should be connected as a comparator. Add the power supply connections to the op-amp. Mark and label the output of the comparator.



3 (b) (ii) Calculate the voltage on the non-inverting input of the op-amp.

.....

3 (b) (iii) On the diagram on **page 6** draw a ring around the light sensor voltage divider circuit that provides the input signal to the comparator.

3 (b) (iv) The LDR has a resistance of 200 kΩ when it gets dark. Give a suitable value for the other component you have drawn in the light sensor circuit:

.....

(7 marks)

The logic subsystem must only produce a logic 0 output signal to trigger the timer when the room is dark so that the comparator gives an output signal of logic 1, and the IR module indicates the presence of a person by giving out a logic 1.

3 (c) (i) Complete the truth table for this logic subsystem.

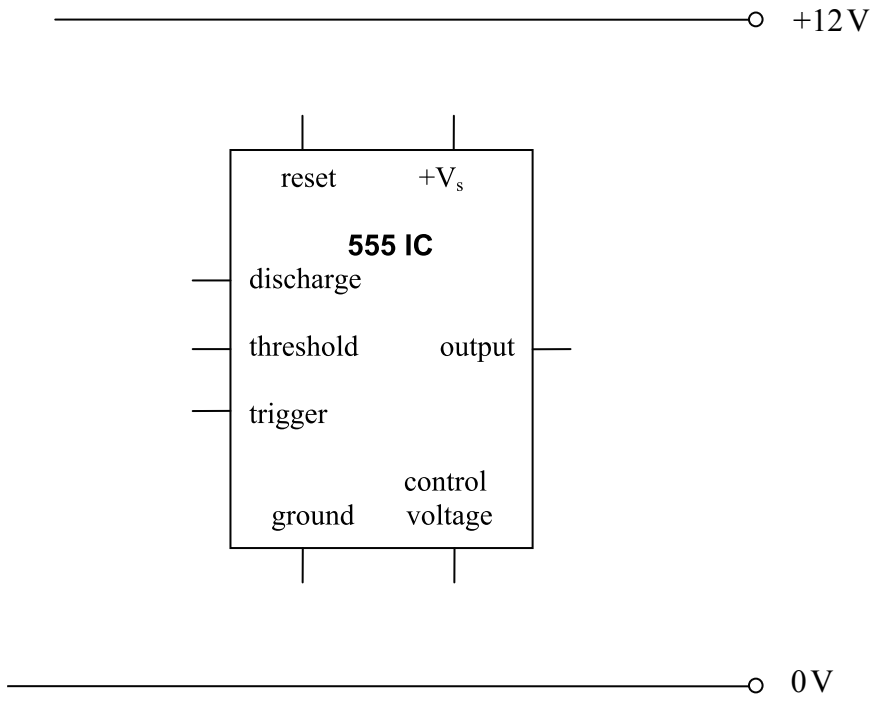
light sensor	**IR module**	**output**
0	0	
0	1	
1	0	
1	1	

3 (c) (ii) What type of logic gate is required? .....

(5 marks)

Question 3 continues on the next page

3 (d) (i) Complete the circuit diagram below to show how a 555 IC should be connected to form a timer subsystem. Include a timing resistor, capacitor and any other components or connections required. Label the connection from the logic gate and the output to control the lamp.



3 (d) (ii) Draw a ring round the two components in the circuit diagram which could be changed to make the lamp stay on longer. *(10 marks)*

The output from the timer cannot directly control the lamp in the room.

3 (e) (i) Name the electromechanical device that has an electrically isolated switching action that could control the lamp.

.....

3 (e) (ii) What component must be added to the timer circuit to protect it as the device in part (e)(i) switches off?

.....

(2 marks)

30

Turn over for the next question

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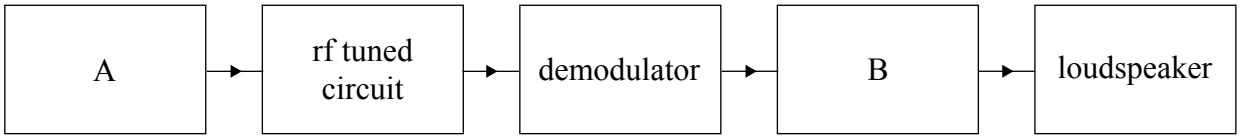
ANSWER IN THE SPACES PROVIDED

4 This diagram shows how subsystems are connected together to make a simple radio receiver.



4 (a) (i) State the name and function of subsystem A.

Name .....

Function .....

.....

4 (a) (ii) State the name and function of subsystem B.

Name.....

Function.....

.....

(6 marks)

4 (b) Explain what is meant by

4 (b) (i) sensitivity.....

.....

4 (b) (ii) selectivity. .....

.....

(4 marks)

The abbreviations AM and FM are often used in radio.

4 (c) (i) What does FM stand for?

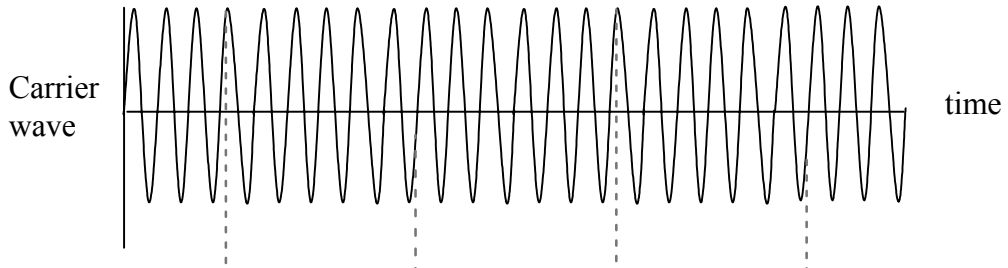
.....

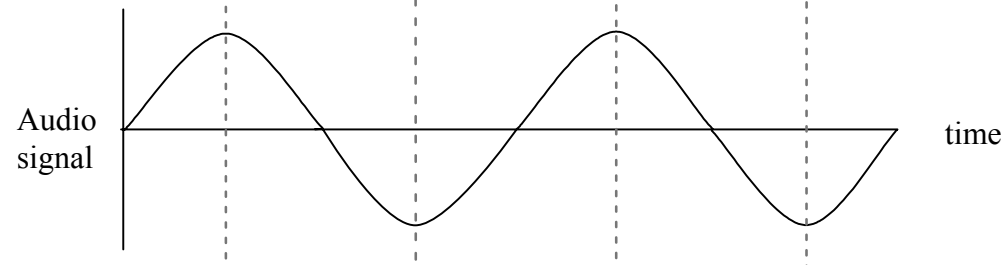
4 (c) (ii) What does AM stand for?

.....

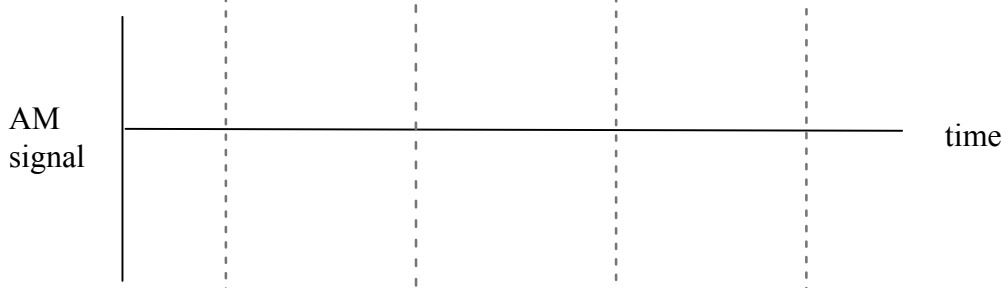
(2 marks)

4 On the blank axes below draw diagrams to show how the audio signal and the carrier wave can be combined to produce an AM and an FM signal. Your diagrams should show the correct relationship to the audio signal.

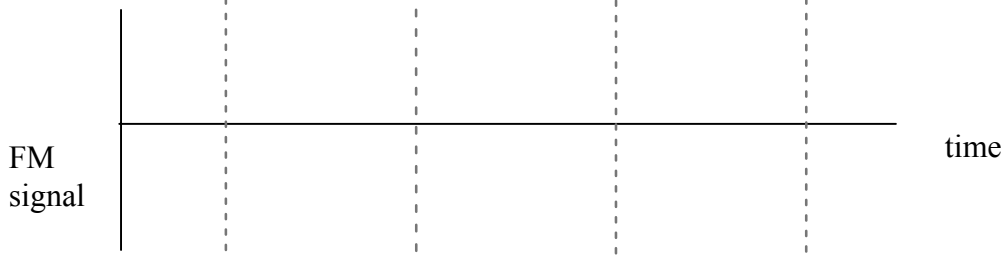




4 (d) (i)



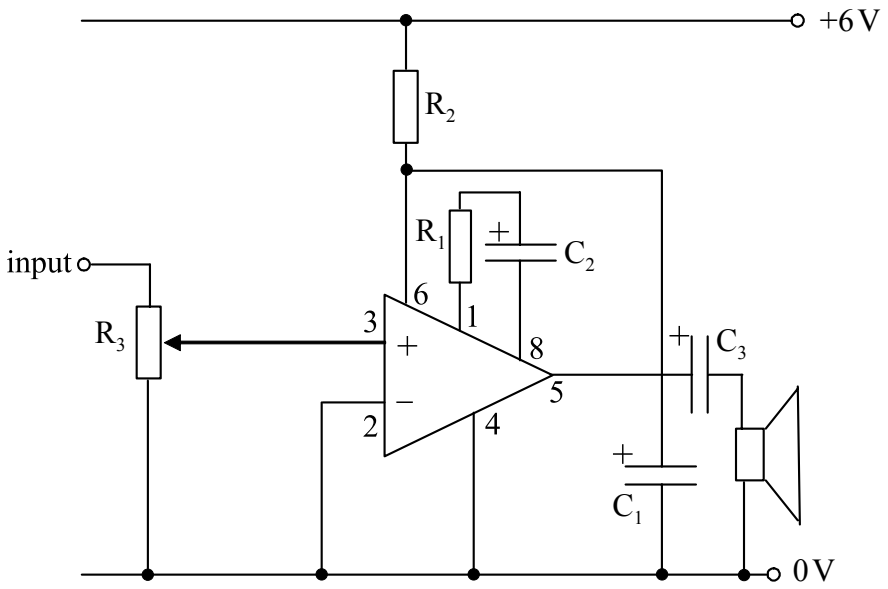
4 (d) (ii)



(4 marks)

16

5 A student decides to build an audio amplifier using an integrated circuit (IC) which he has not seen before. He uses the circuit diagram below, which shows the pin numbers of the integrated circuit, to construct the amplifier on prototyping board.



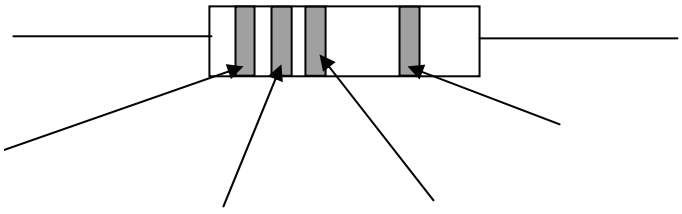
5 (a) (i) What is the name of the type of component which is labelled R_3?

.....

5 (a) (ii) What is the function of R_3 in this amplifier circuit?

.....

5 (a) (iii) R_2 has a value of 10 Ω and a tolerance of 5%. Label the colour of the bands on this diagram of R_2.



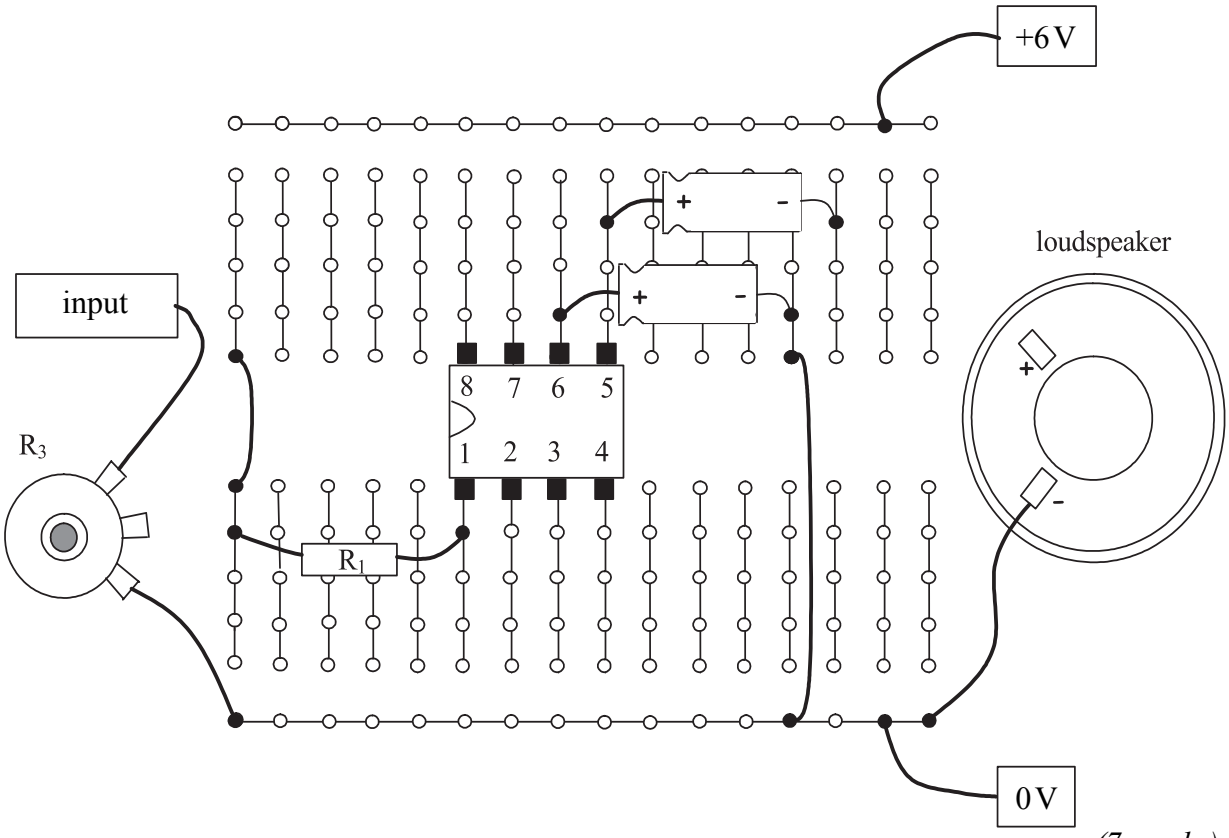
....

....

(6 marks)

5 (b) Complete this diagram of the layout of the components of the amplifier by adding another resistor —▭— , another capacitor —|+ –|— and **four** connecting wires.

The pin numbers for the IC are shown on the diagram on **page 12**.



(7 marks)

5 (c) The loudspeaker has a resistance of 8 Ω. Calculate the peak power delivered at a time when the peak current through it is 0.2 A.

.....

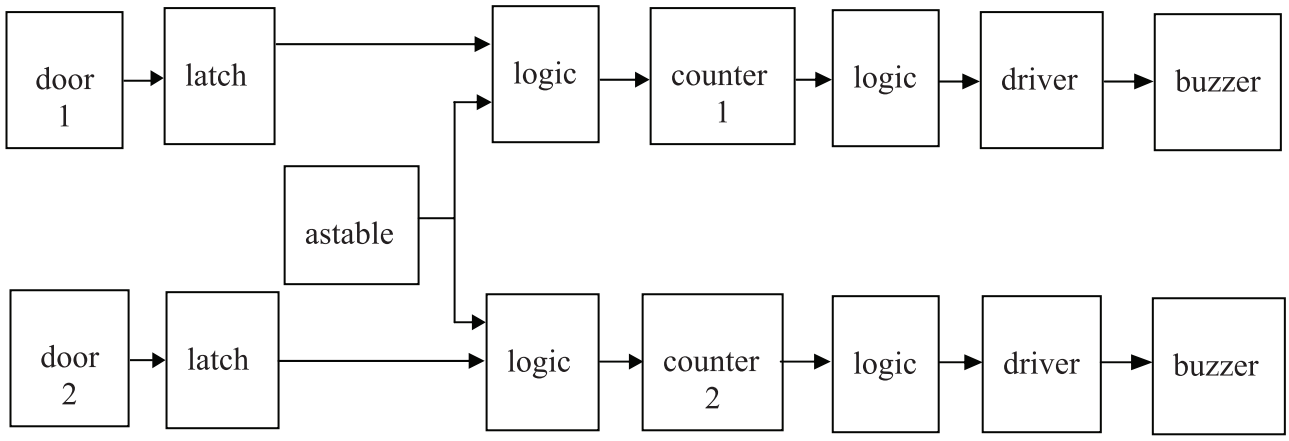
.....

(2 marks)

15

6 A large D.I.Y. store has two fire exits which can be opened by pushing bars. If they are opened a buzzer sounds in the manager's office. A work placement student modifies the system so that a different pattern of sounds is produced for each door so that it is easy to tell which one has been opened.

This is the diagram for the student's system:



6 (a) Name a type of circuit or component which could be used in the latch subsystem.

.....

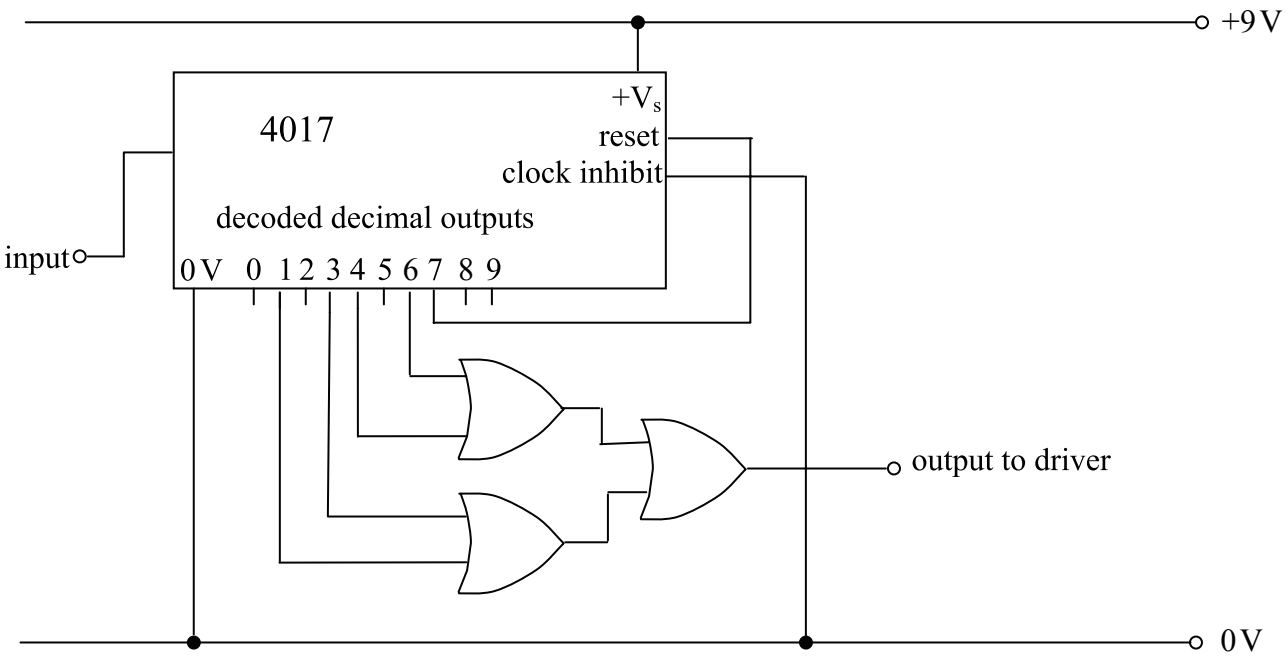
(1 mark)

6 (b) Name a type of logic gate which would transfer the astable pulses to the counter if its input from the latch is high.

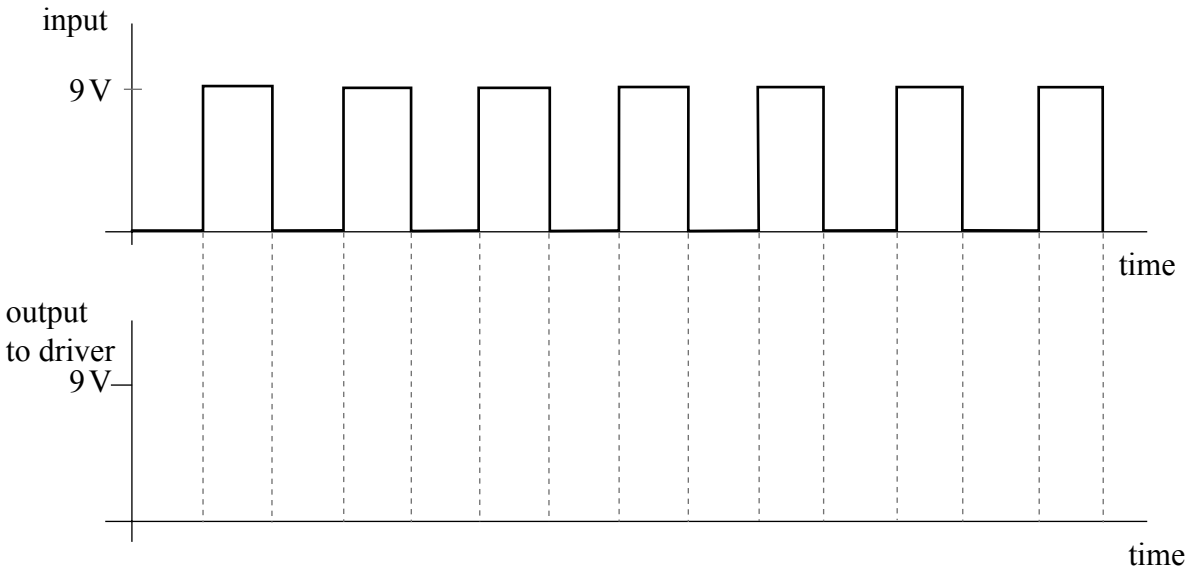
.....

(1 mark)

6 (c) Counter 1 is a 4017 and is connected to its logic subsystem as shown below.



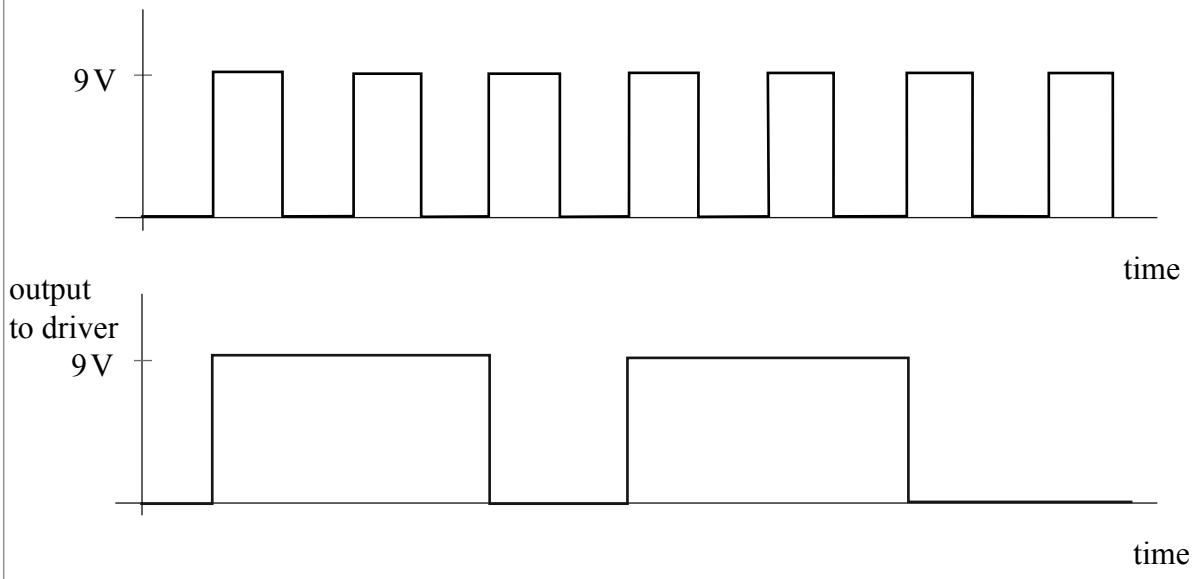
Complete the timing diagram for the output to the driver.
(Assume the counter was reset at the start.)



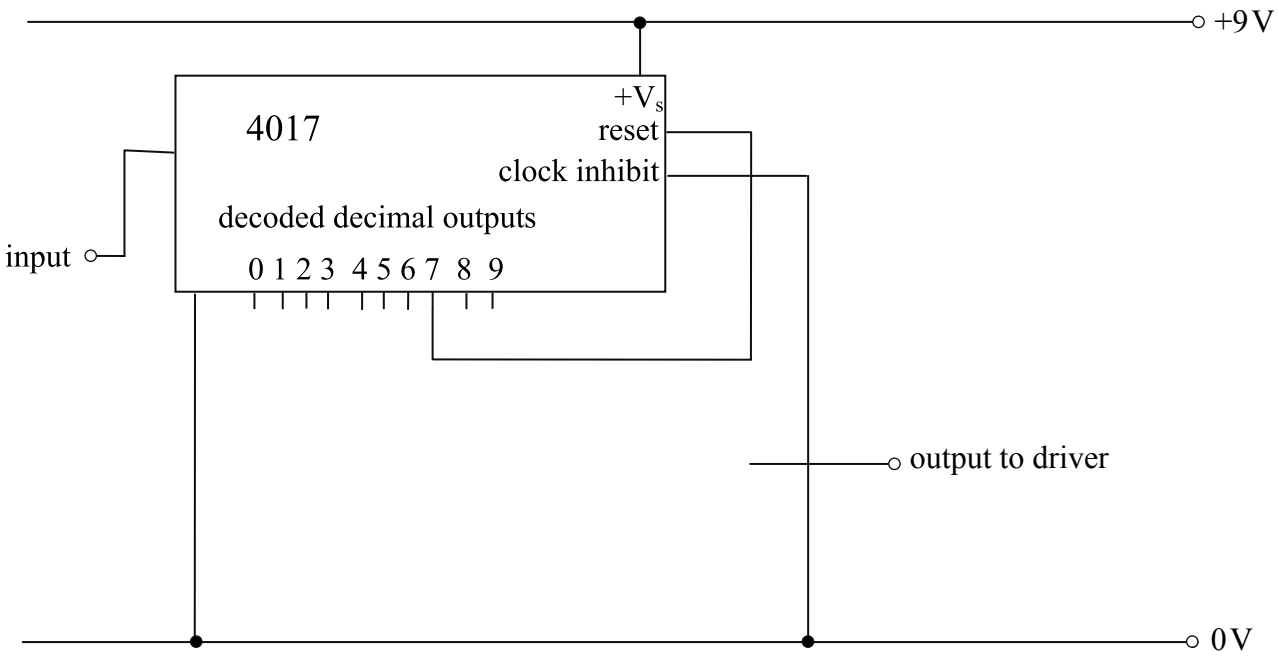
(4 marks)

Question 6 continues on the next page

6 (d) Counter 2 and its logic subsystem have this timing diagram.

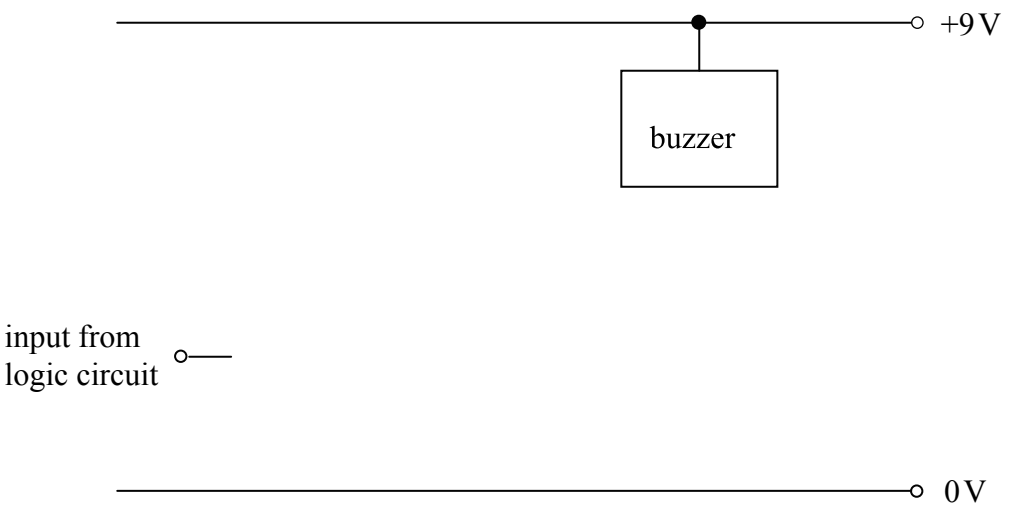


On the diagram below draw three two-input OR gates, connected so as to produce the timing diagram required for counter 2, and its logic subsystem.



(5 marks)

6 (e) Complete this diagram to show how a junction transistor or a MOSFET can be used to switch the buzzer.



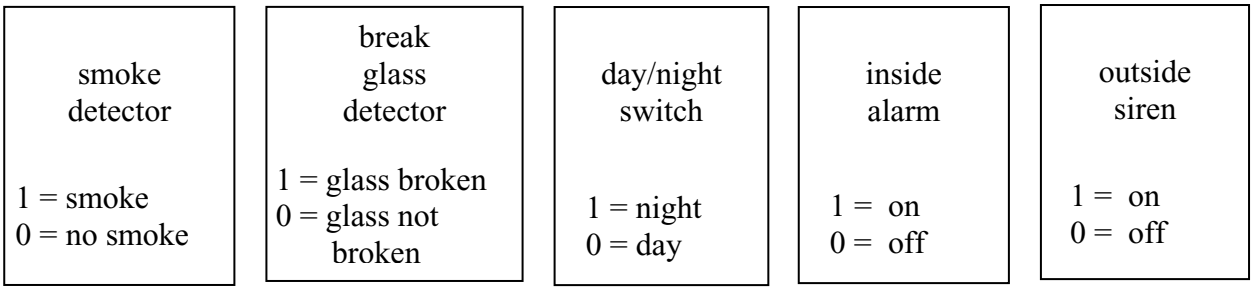
(3 marks)

14

Turn over for the next question

7 A fire alarm system, activated by either a smoke detector or a break glass detector, is to be installed in a school. Initially it is proposed that during the day it should sound an alarm inside the building but at night it should sound a siren outside the building.

This diagram shows how the input and output subsystems operate.



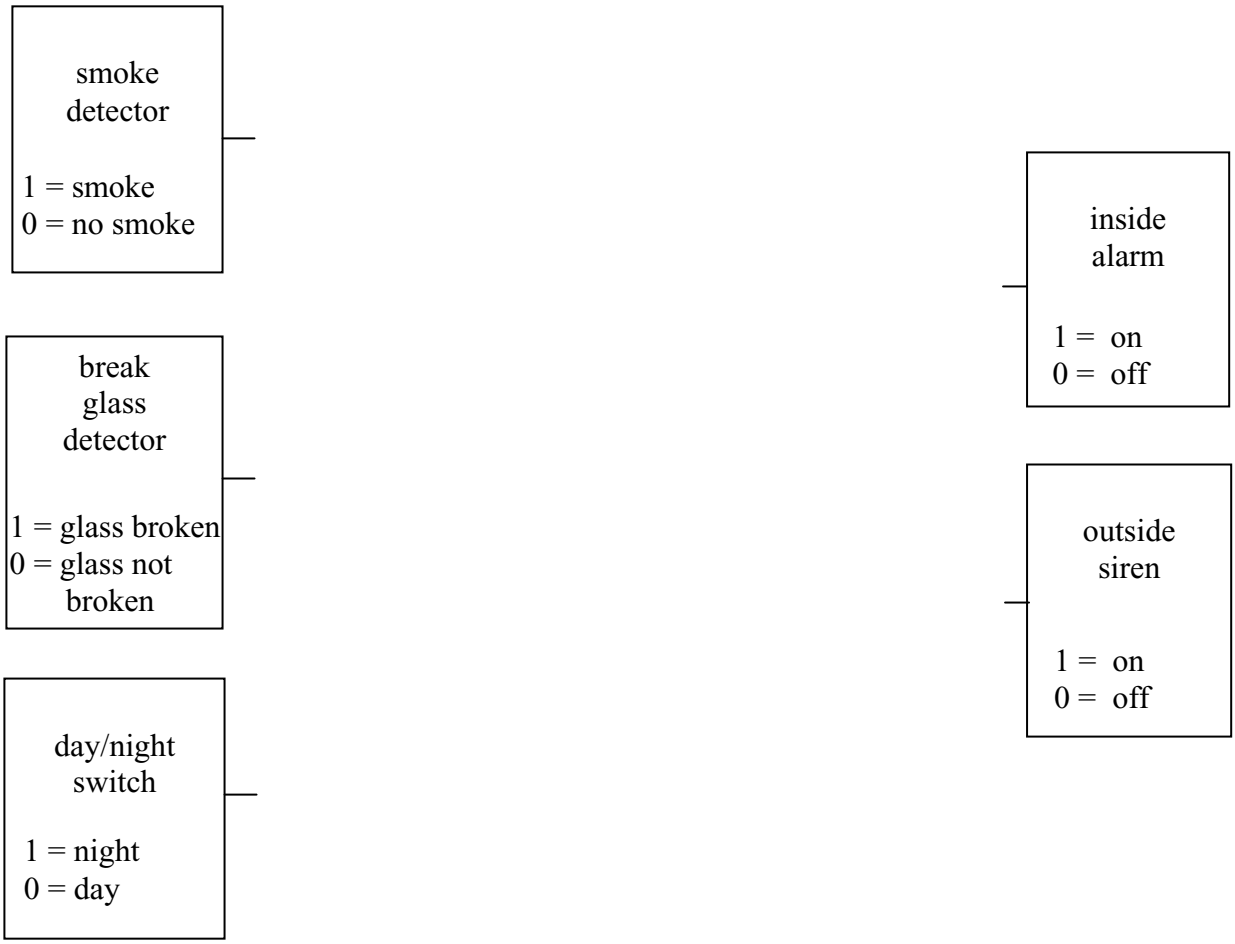
7 (a) Complete these two truth tables for the system.

smoke detector	break glass detector	day/night switch	output to inside alarm
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

smoke detector	break glass detector	day/night switch	output to outside siren
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(4 marks)

7 (b) Using only AND, OR and NOT gates show how this system could be constructed.



(5 marks)

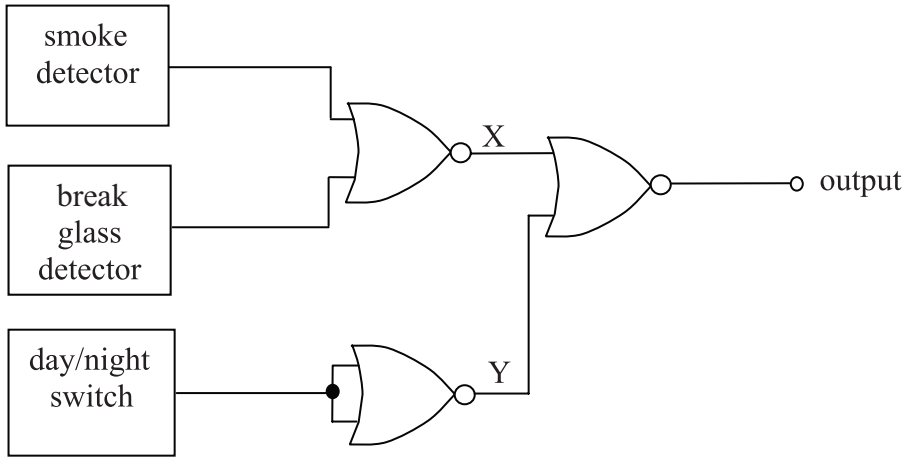
The logic system for the outside siren could also be built using NOR gates.

7 (c) (i) Complete this truth table for a NOR gate.

A	B	S
0	0	
0	1	
1	0	
1	1	

Question 7 continues on the next page

7 (c) (ii) Complete the truth table below for the network of gates.



smoke detector	break glass detector	day/night switch	X	Y	output to outside siren
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

(7 marks)

7 (d) Explain whether this proposed system would provide the building with an adequate level of protection.

.....

.....

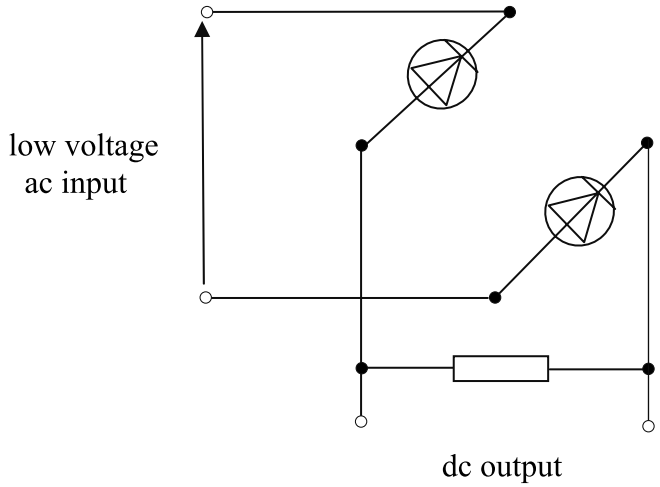
.....

(3 marks)

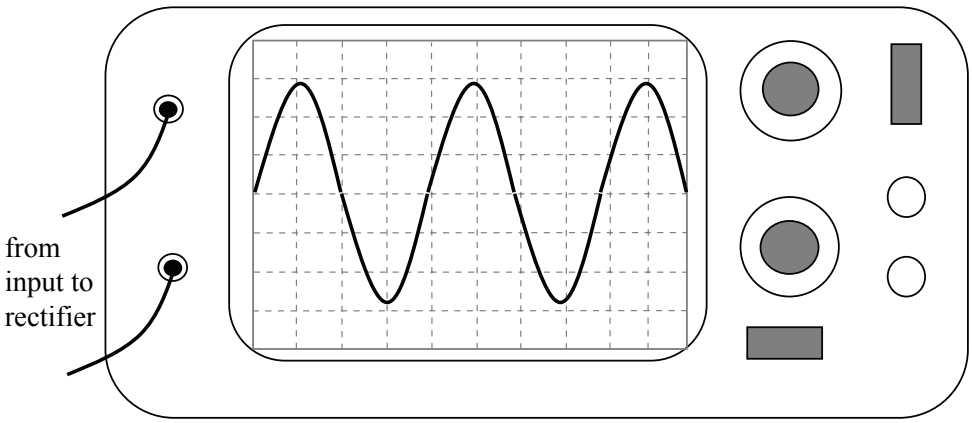
19

8 Some students are investigating using a low voltage power supply in their project. They decide to connect a bridge rectifier to the low voltage alternating supply.

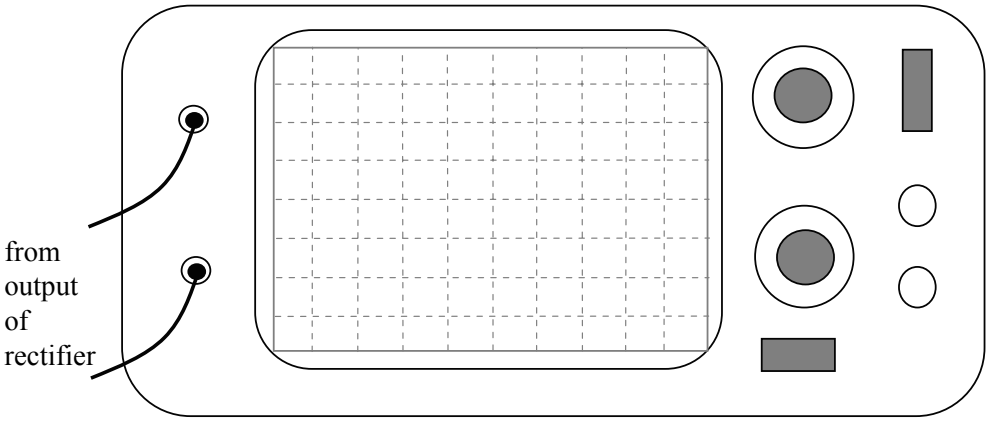
8 (a) (i) Complete this diagram of a bridge rectifier by adding **two** missing components.



8 (a) (ii) When an oscilloscope is connected across the ac input the display shown below is produced.



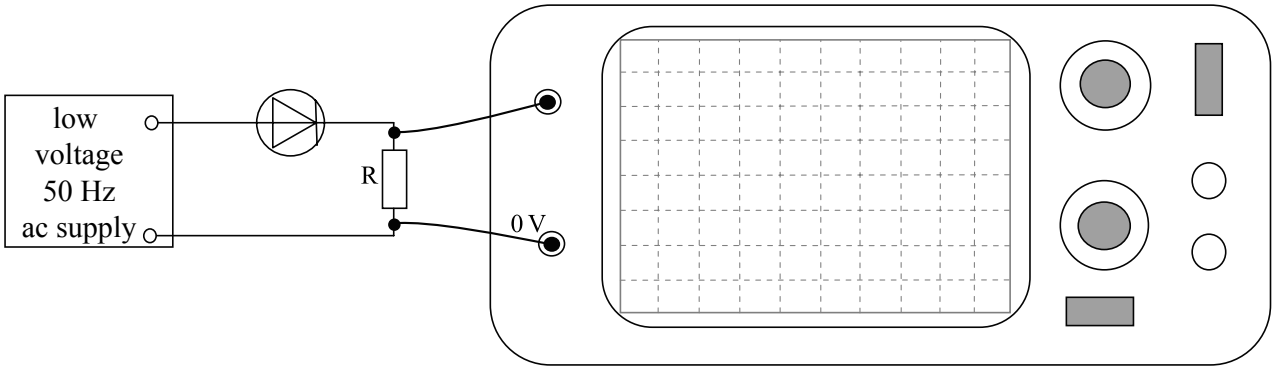
On the blank screen, sketch what you would expect to see if the oscilloscope was connected across the dc output of the completed rectifier.



(6 marks)

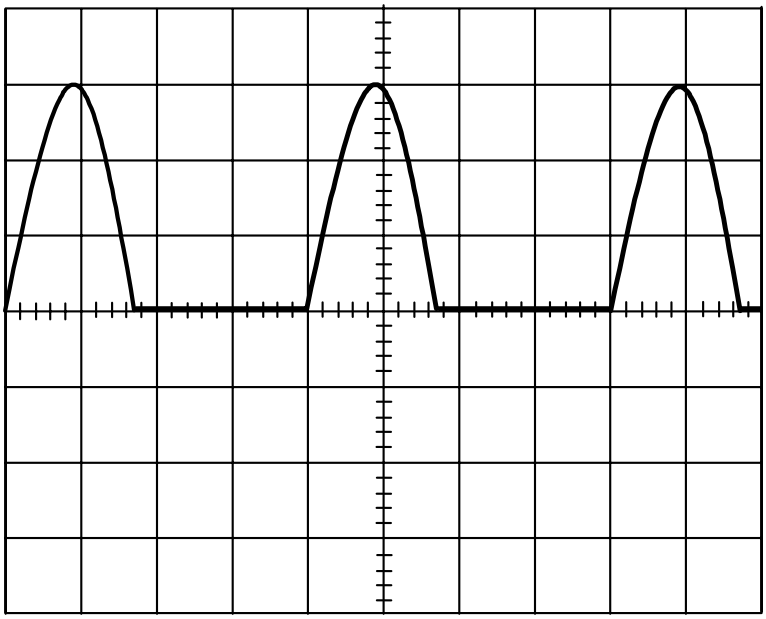
Turn over ▸

The students then decide to use the low voltage supply to produce pulses. They connect a diode, resistor (R) and oscilloscope as shown below.



They obtained the following display on the screen.

Y (vertical) sensitivity is set to 2 V per division



8 (b) (i) Use the display on **page 22** to calculate the peak voltage across resistor R.

.....

8 (b) (ii) The frequency of the ac is 50 Hz. Use this value to calculate the time period of the waveform.

.....

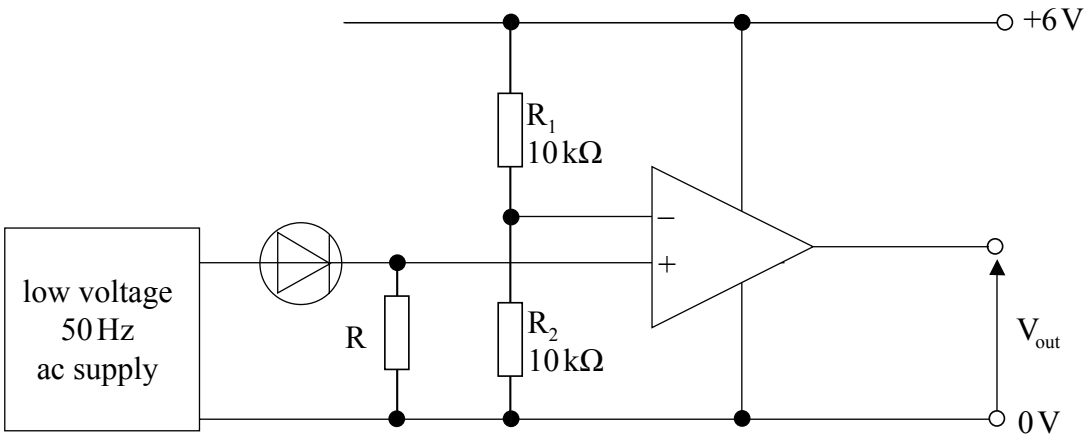
8 (b) (iii) Calculate the time base setting in ms per division which produced this display.

.....

(6 marks)

Question 8 continues on the next page

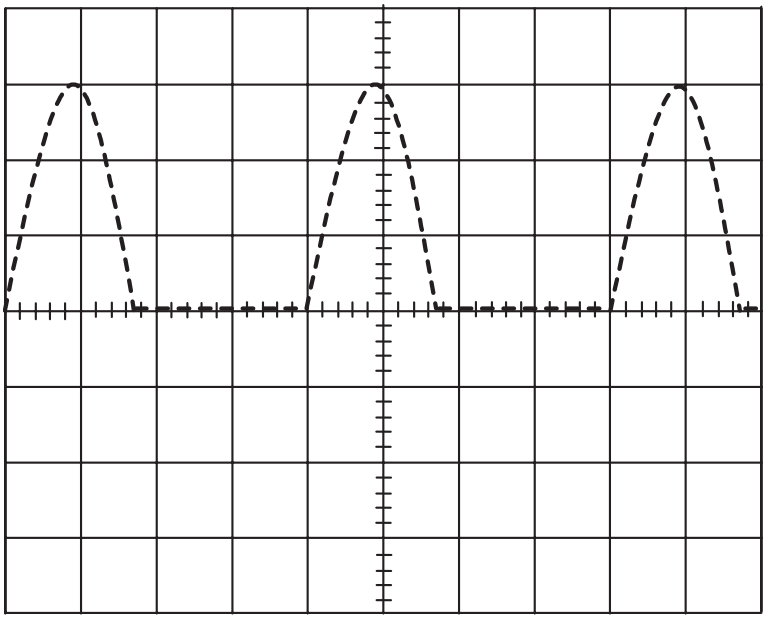
They use the voltage across the resistor (R) as the input to a comparator circuit.



8 (c) (i) Calculate the value of the input voltage when the output of the comparator switches from low to high.

.....

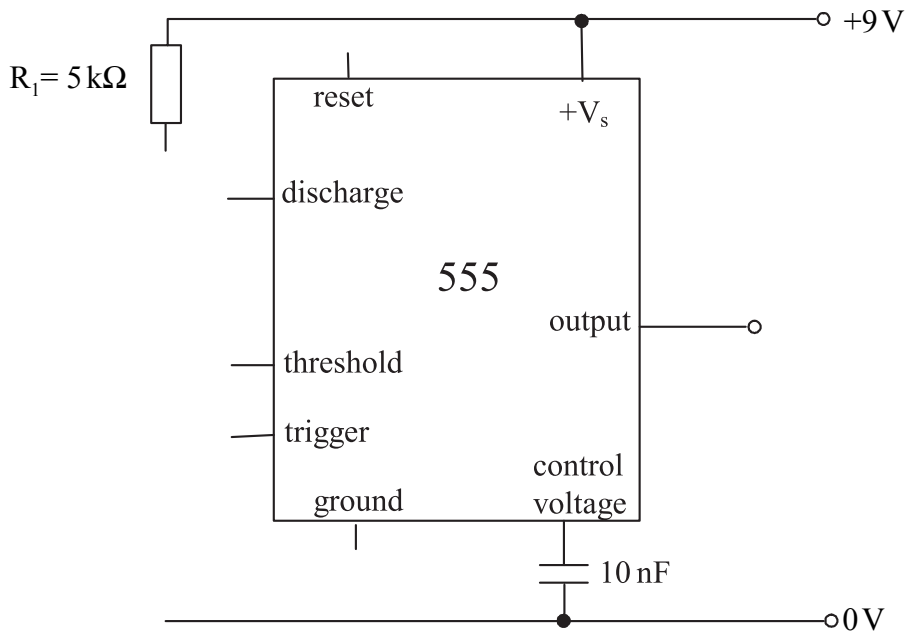
8 (c) (ii) Draw what will be seen on the display of the oscilloscope if it is now connected across the output of the comparator. (Use the original display as a guide. It is shown as a dotted line.)



(4 marks)

An alternative way of producing pulses is to use a 555 timer connected as an astable.

8 (d) (i) Complete this diagram by adding a 22 kΩ resistor (R_2) and a 1 μF timing capacitor C and any missing connections.



8 (d) (ii) Calculate the period of the pulses produced by this astable.

.....

.....

.....

8 (d) (iii) Calculate the frequency of the pulses.

.....

.....

(10 marks)

26

END OF QUESTIONS

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