

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

General Certificate of Secondary Education
Summer 2003

**ELECTRONICS
HIGHER TIER**

3432/H



Tuesday 3 June 2003 Afternoon Session

In addition to this paper you will require:

- a pencil and a ruler;
- a calculator.

Time allowed: 2 hours

Instructions

- Use blue or black ink or a ball point pen.
- Fill in the boxes at the top of this page.
- Answer **all** the questions in the spaces provided.
- Show the working of your calculations.

Information

- The maximum mark for this paper is 150.
- Mark allocations 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 reminded of the need for good English and clear presentation in your answers.

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

Information Sheet

The following information may be useful in answering the questions.

1. **Power**

Power = voltage x 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 $\pm 5\%$ SILVER $\pm 10\%$ No fourth band $\pm 20\%$

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

R means $\times 1$

K means $\times 1000$

M means $\times 1\,000\,000$

Position of letter gives the decimal point.

Tolerances are indicated by adding a letter at the end.

J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$

e.g. 5K6J = 5.6 k Ω $\pm 5\%$

5. **Preferred values 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 ten.

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 x rms value

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

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

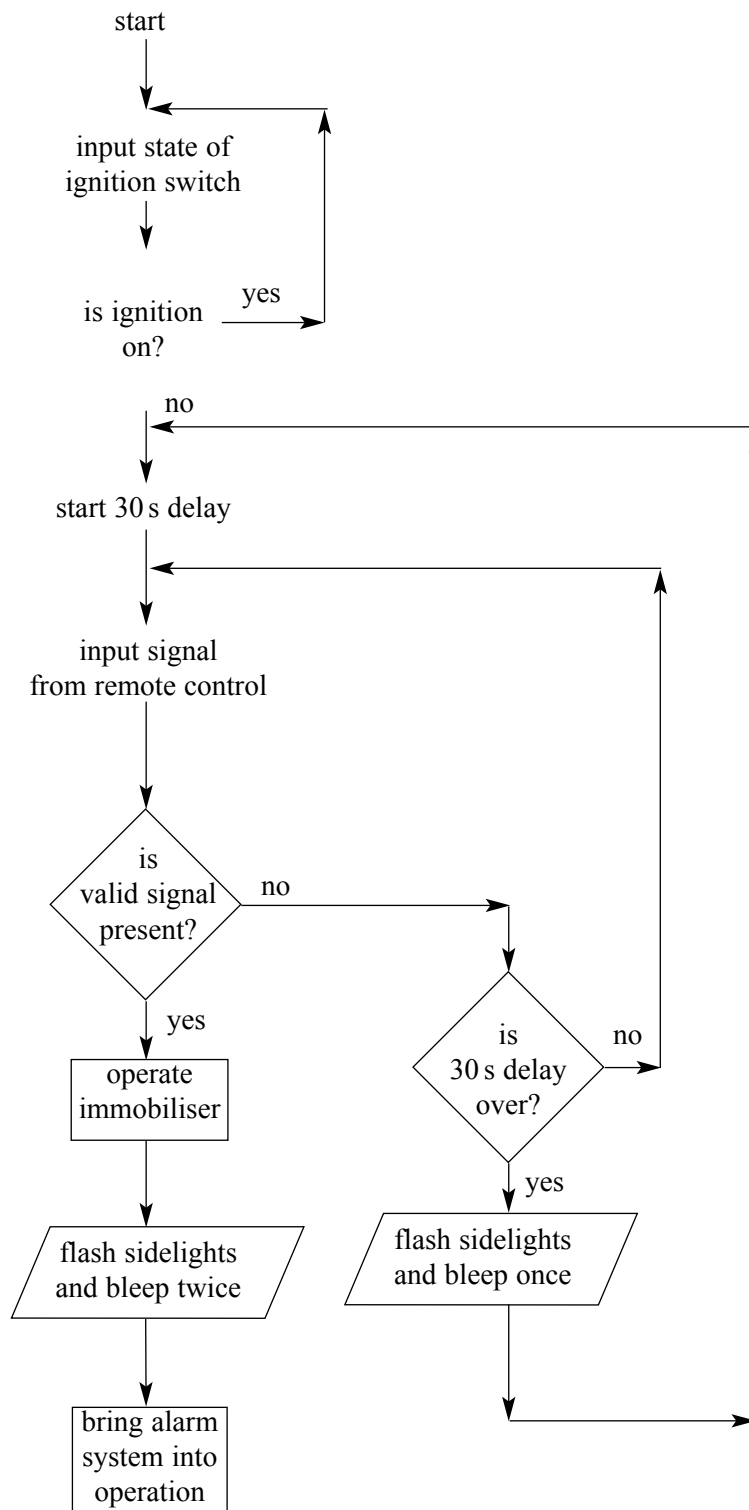
(b) Astable mode, time period $T = \frac{(R_1 + 2R_2) C_1}{1.44}$

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

1 Complete the following statements.

- (a) To obtain a safe low voltage supply from the mains a may be used. (1 mark)
- (b) A component which has a resistance which decreases when its temperature increases is called a (1 mark)
- (c) It is dangerous to fit a fuse with too a value into an appliance. (1 mark)
- (d) Handling electrical equipment with wet hands is very dangerous because water lowers the of the skin. (1 mark)
- (e) A component which may still give a shock after an appliance has been disconnected from the mains is a (1 mark)
- (f) When the current flowing through a circuit varies, a three-terminal regulator keeps the constant. (1 mark)
- (g) The process of converting alternating current into direct current is called (1 mark)
- (h) As well as an input and an output most electronic systems have a sub-system. (1 mark)
- (i) A device which converts an electrical signal into sound waves is a (1 mark)
- (j) A test instrument which produces an alternating voltage at the frequency required by a user is a (1 mark)

- 2 The flowchart describes the operation of a car alarm and immobiliser. Some of the flowchart symbols have been left out.



- (a) (i) Draw the correct flowchart symbols where they are missing on the diagram.
 (ii) Label on the flowchart:

a decision box

an input box

a loop

an output box

a process box

(10 marks)

- (b) Using the flowchart in part (a), describe the sequence of events that occur in the 60 seconds after the ignition has been switched off and the remote control is not used to operate the system. What purpose might be served by this sequence of events?

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

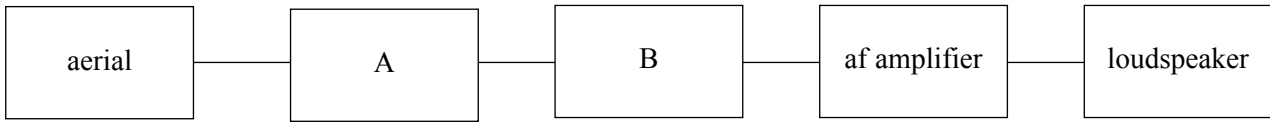
- (c) Using the flowchart in part (a) as a guide, draw a new flowchart to describe the part of the alarm system that would detect anyone entering the car. The system should give a short delay before sounding an audible alarm and flashing lights. While the delay is operating it should be possible to switch the alarm system off using the remote control.

(5 marks)



Turn over ▶

3 A simple radio receiver is made by connecting these sub-systems together.



(a) (i) State the name and function of sub-system A.

Name.....

Function.....

.....

(ii) State the name and function of sub-system B.

Name.....

Function.....

.....

(6 marks)

(b) Explain what is meant by:

(i) sensitivity,

.....

(ii) selectivity.

.....

(4 marks)

(c) Radio signals can be FM or AM.

(i) What do the letters FM stand for?

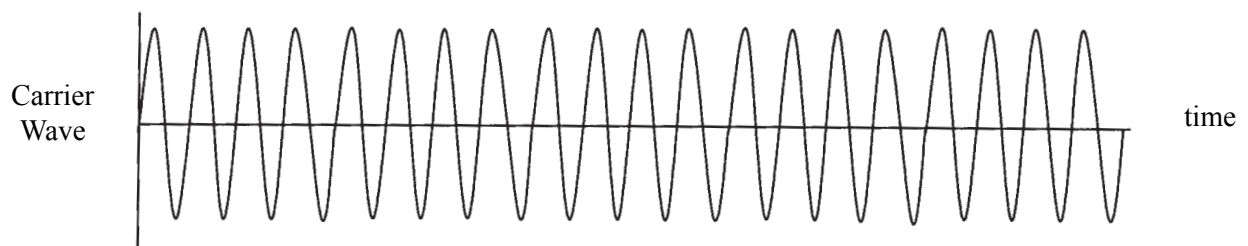
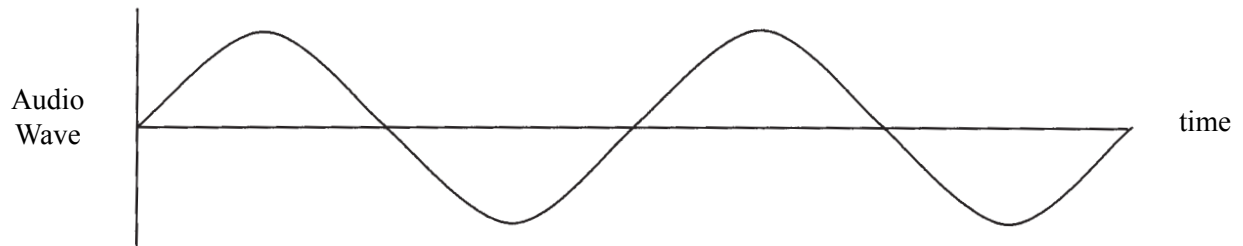
.....

(ii) What do the letters AM stand for?

.....

(2 marks)

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

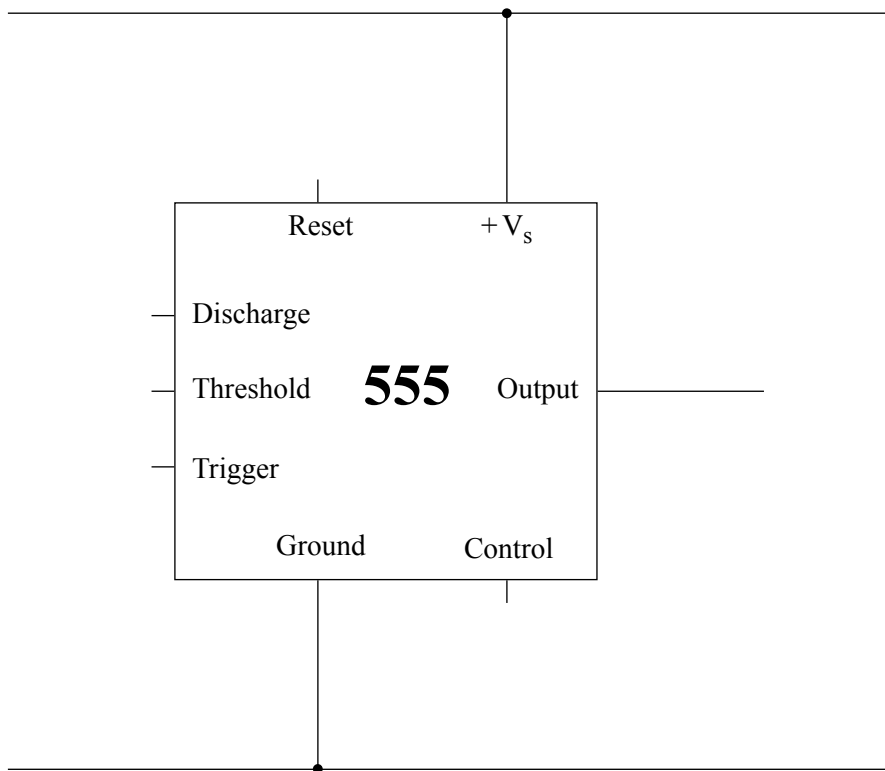


(4 marks)

- 4 A student makes an electronic doorbell system for the front and back doors of a house. The system is designed to make a different sequence of sounds depending on which switch is pressed. People in the house would then know which door to open.

Part of the system is an astable using a 555 timer IC which provides pulses to a 4017 counter IC.

- (a) Complete the diagram below to show how a 555 timer IC is connected as an astable. On the diagram, draw **two** resistors, **two** capacitors and wire links to complete it.



(6 marks)

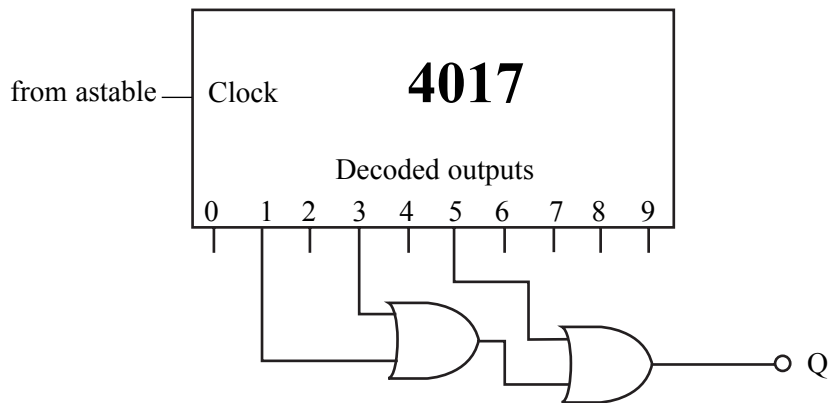
- (b) (i) The 4017 counter has ten decoded outputs. Describe what happens to the logic levels at these outputs as pulses are fed into its clock input.

.....

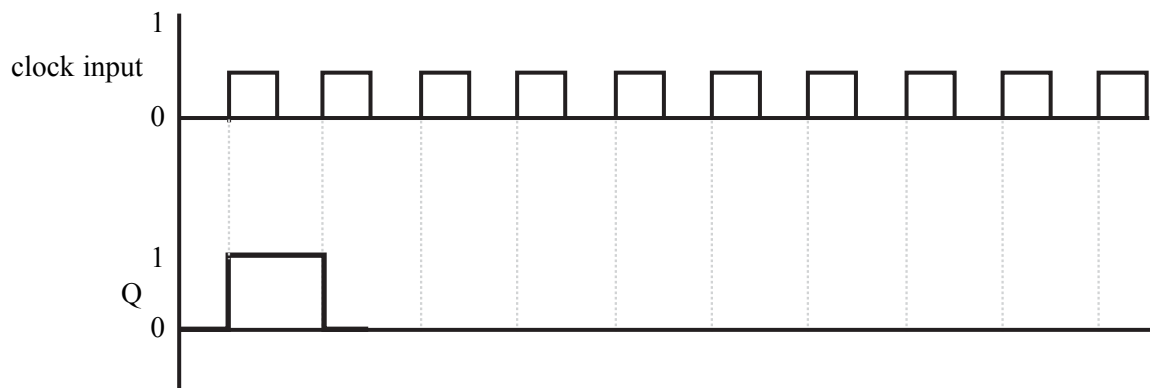
.....

.....

(ii) Logic gates are connected to some of the 4017 outputs as on the diagram below.



Complete the timing diagram below to show the output from Q as pulses are fed into the clock input.



(iii) The logic output Q controls a buzzer, describe the pattern of sound made when the system operates.

.....

.....

.....

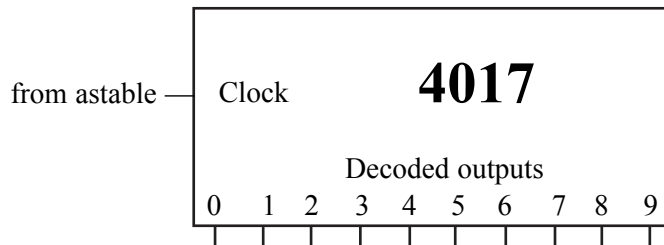
QUESTION 4 CONTINUES ON THE NEXT PAGE

Turn over ▶

- (iv) To make a different pattern of sound from the buzzer a different logic system is needed. Draw a logic diagram to show how to make the following pattern of sound:

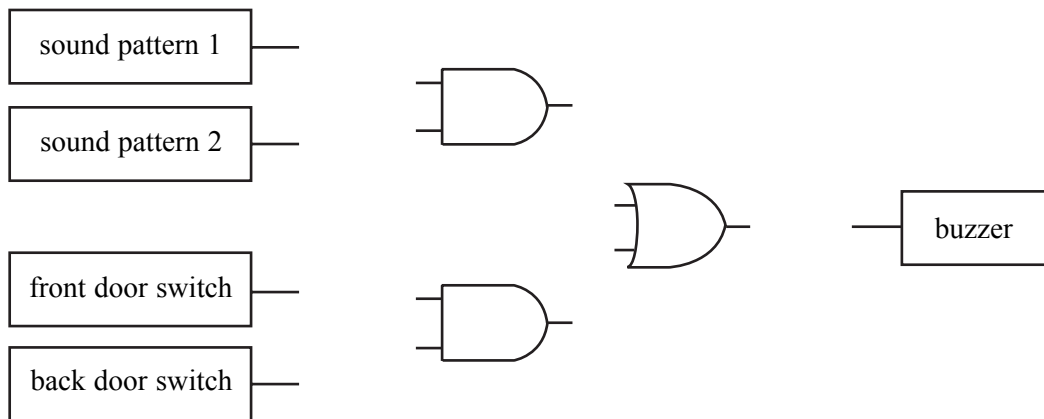
short buzz, short gap, longer buzz, longer gap.

A 4017 IC diagram has been drawn for you to add suitable logic gates.



(12 marks)

- (c) (i) Each output from the logic system in part (b) opposite must only be sent to the buzzer when the relevant doorbell is pressed.
Complete the diagram below showing how the gates and sub-systems are connected.

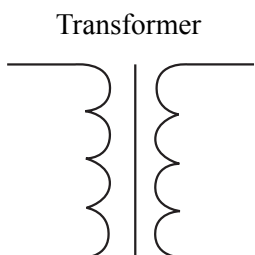


- (ii) This system still has one problem in that pressing either switch for a short time may give no output at all. Explain why this is and suggest a way of solving this problem.

.....

(6 marks)

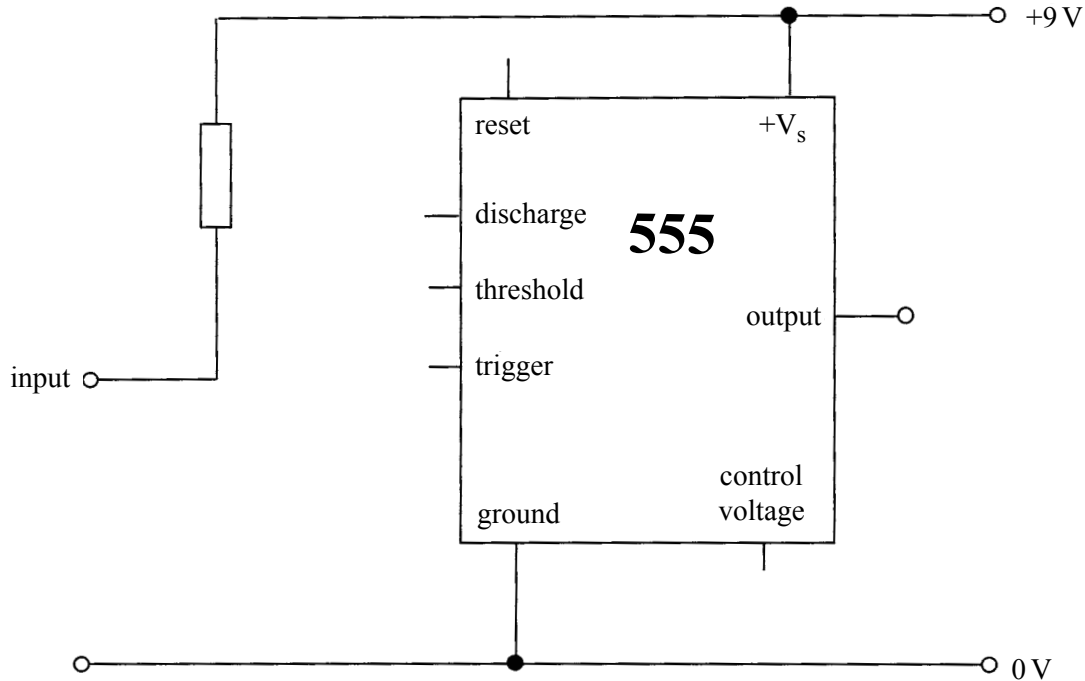
- (d) The electronic doorbell system operates from the mains supply using a transformer. Which component can:
- (i) rectify the transformer output?.....
 - (ii) smooth the rectified output?.....
 - (iii) stabilise the smoothed output?
 - (iv) Draw below a labelled circuit diagram of a suitable rectified, smoothed, regulated power supply that would operate from the transformer secondary.



(6 marks)

5 When someone approaches a front door a light is automatically switched on for 30 seconds.

- (a) (i) A 555 timer IC connected as a monostable produces the time delay. Complete the diagram below to show how the 555 timer should be connected. Add **two** capacitors, **one** resistor and the wire links needed.



- (ii) The timing capacitor and resistor have values of $100\ \mu\text{F}$ and $270\ \text{k}\Omega$ respectively. Show that they produce the required time interval. Your answer must be corrected to the nearest second.

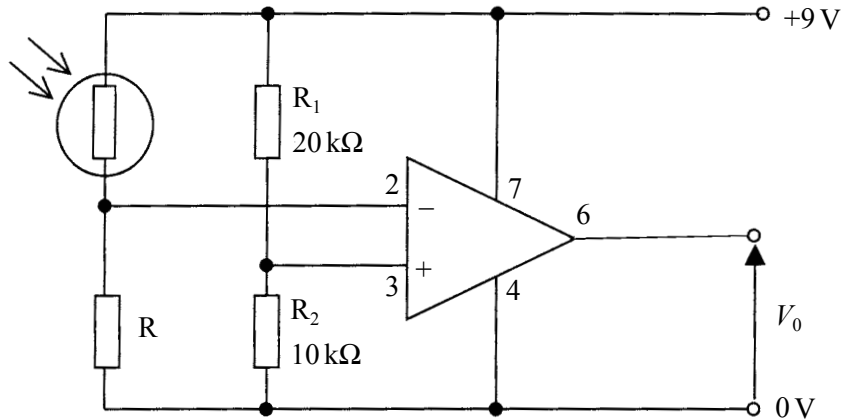
.....

.....

.....

(9 marks)

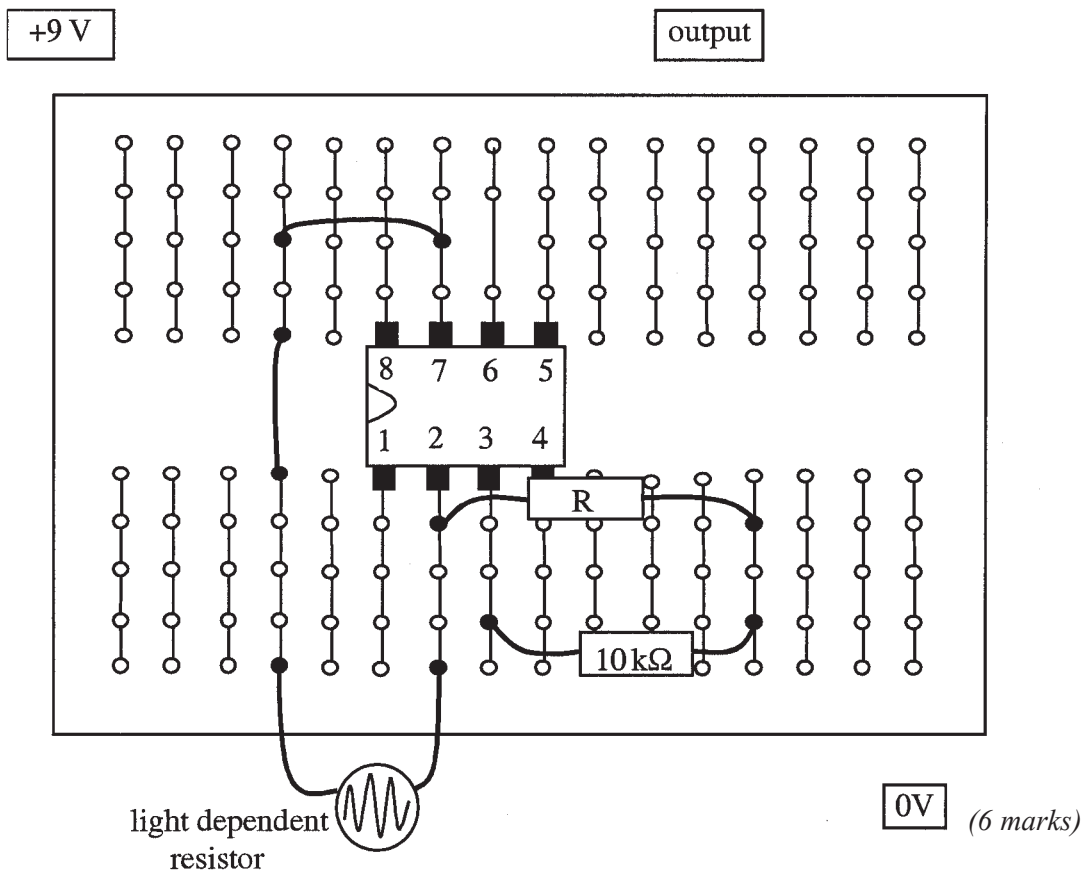
- (b) The light is only to operate at night. A light dependent resistor (LDR) is used in this circuit to sense when it is dark.



- (i) What type of op-amp circuit is this?

.....

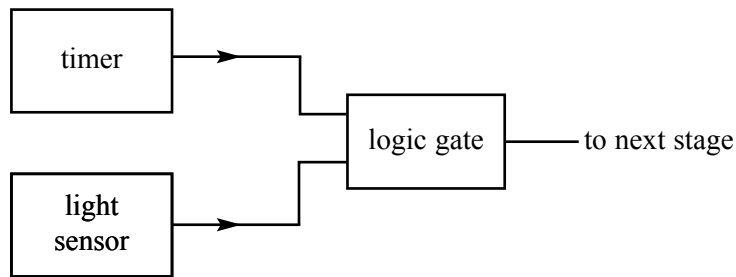
- (ii) In order to test this sub-system a breadboard was used. Complete this diagram by adding the 20 kΩ resistor, all the wire links needed and connections to the power supply and output.



QUESTION 5 CONTINUES ON THE NEXT PAGE

Turn over ▶

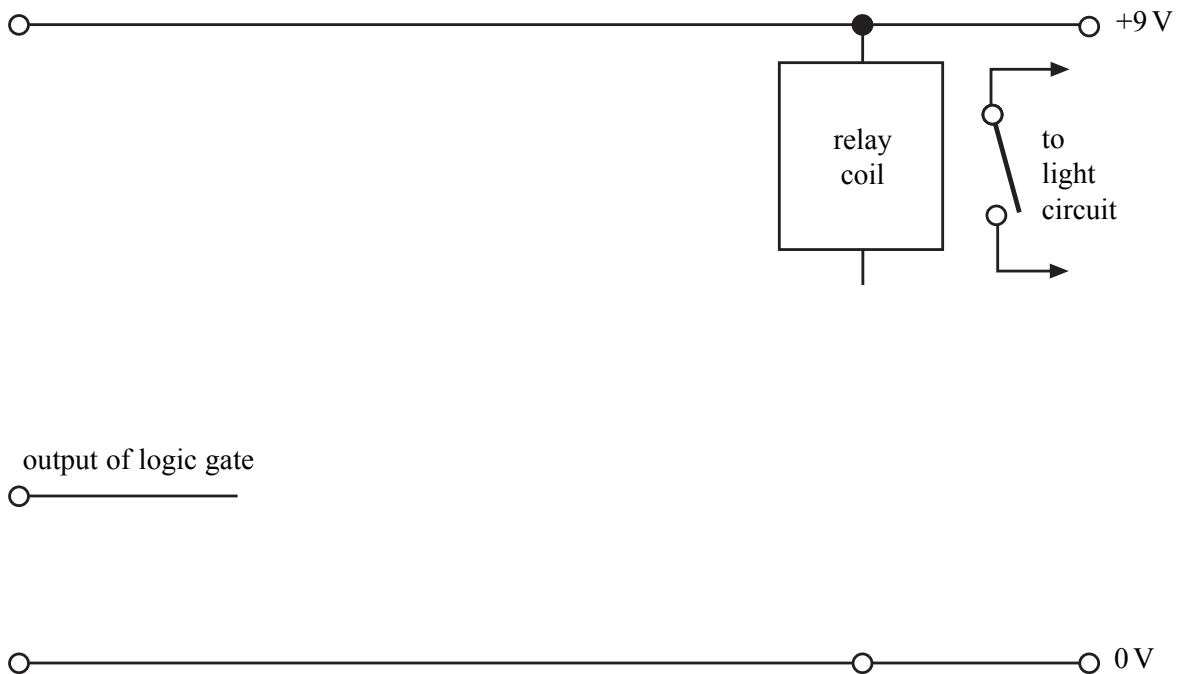
(c) The sub-systems are connected as shown:



(i) The light sensor has a high output in the dark. What type of gate should be used for the logic shown in the system diagram?

.....

(ii) Complete the circuit diagram below to show how a transistor can be used to amplify the current from the logic gate so that a relay can be used to switch on the light.



(iii) Add to the circuit diagram a diode which will protect the transistor.

(6 marks)

6 (a) Explain what is meant by these terms in computing.

(i) Hardware

.....

(ii) Software.....

.....

(4 marks)

(b) Computers use binary numbers.

(i) Write down the decimal numbers equal to binary 1101.

.....

(ii) Write down the binary number equal to decimal 9.

.....

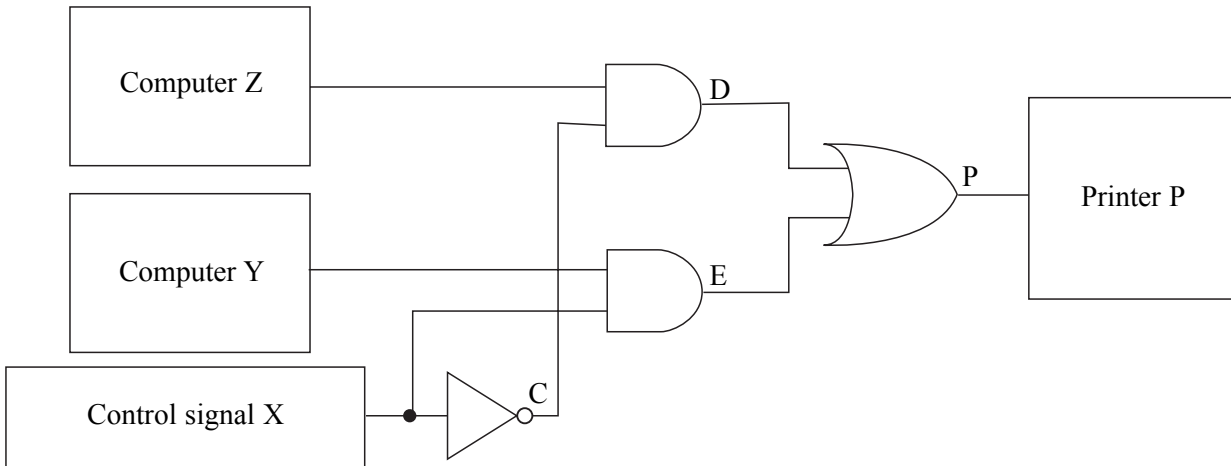
(2 marks)

(c) (i) Complete these truth tables for AND and OR gates.

AND		
A	B	output
0	0	
0	1	
1	0	
1	1	

OR		
A	B	output
0	0	
0	1	
1	0	
1	1	

Two computers are connected to the same printer using this circuit.



(ii) Complete this truth table for the whole system.

X	Y	Z	C	D	E	P
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

(iii) Explain how the control signal is used to select which computer is connected to the printer.

.....

.....

.....

(10 marks)

7 Two students are building an amplifier for a cassette player.

Some of the data for the IC when used in a possible circuit are given in this table:

IC used in circuit	Minimum supply voltage/V	Maximum supply voltage/V	Power output/mW	Bandwidth/kHz
LM380	8	22	2000	0 - 100

(a) (i) State what is meant by bandwidth.

.....

(ii) Calculate the maximum output power which could be obtained from the LM380 circuit if a test signal of frequency 100 kHz was applied to the input.

.....

(iii) Explain why the amplifier does not have to be designed to handle signals with a frequency of 100 kHz.

.....

(5 marks)

(b) (i) The input test signal to the amplifier is sinusoidal and has a frequency of 200 Hz. Calculate the period of the signal.

.....

(ii) Calculate the peak output power when the amplifier output voltage has a peak value of 2.5 V across a 4 Ω loudspeaker.

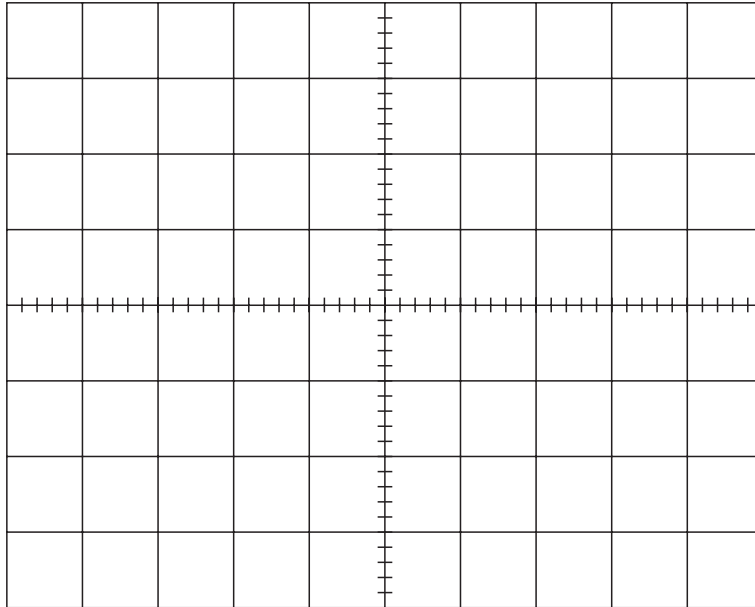
.....

(iii) Calculate the rms value of the output voltage.

.....

- (iv) An oscilloscope is connected to the output of the amplifier to see what the signal looks like. Draw the trace seen on the oscilloscope screen for this signal and the settings given below.

Y (vertical) sensitivity is set to 1 V per division
 Time base (horizontal) is set to 1 ms per division



- (v) The peak input voltage is 200 mV. Calculate the voltage gain of the amplifier at this frequency.

.....

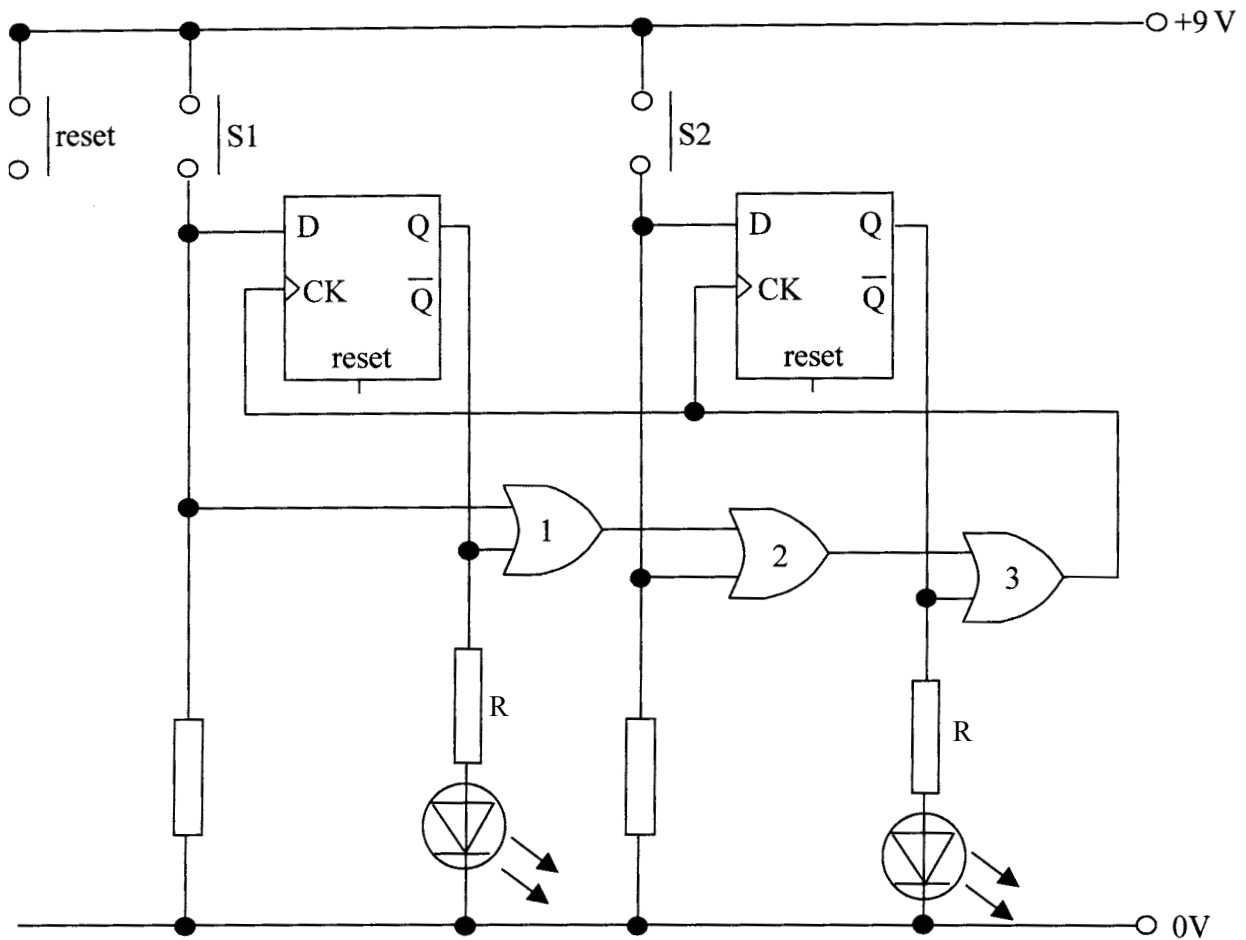
(11 marks)

- (c) State what type of cable should be used to connect the cassette player to the amplifier and explain your choice.

.....

(2 marks)

8 The circuit below is for use in a quiz game so that the referee can tell which of two players has pressed his switch first. It is complete except for connections to the reset switch.



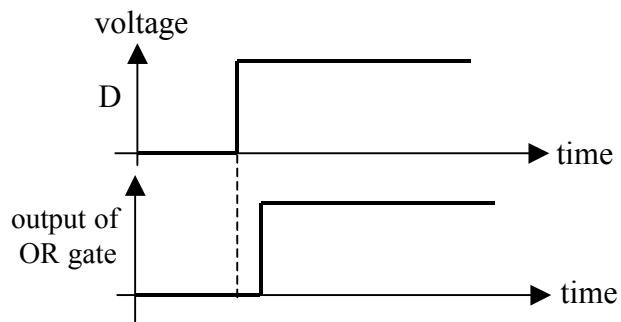
(a) On the diagram above add **one** extra component and the connecting wires which are needed to allow the referee to reset the circuit.

(2 marks)

(b) (i) What is the voltage at the data input of the first flip-flop when the switch S1 is pressed?

.....

(ii) A very short time after the switch S1 is pressed the output of OR gate 3 becomes high.

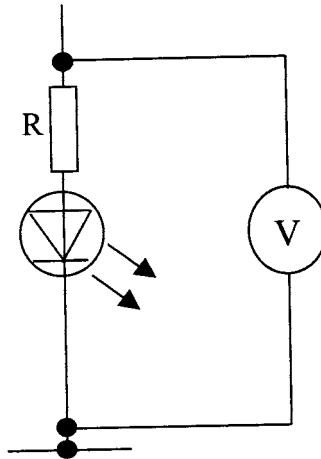


Explain why this causes the Q output of the first flip-flop to go high.

.....

(3 marks)

- (c) When the circuit has been built it is found that the LEDs do not light up to full brightness. A voltmeter is connected as shown:



The voltmeter reads 9 V. The LEDs require 2 V and a current of 20 mA. It is thought that R might have too high a value.

- (i) On the diagram above draw the symbol for an ammeter, which would allow the current through the LED to be measured.

If the LEDs were to light to full brightness;

- (ii) state the current in amps which should flow through R,

.....

- (iii) calculate what the voltage across R should be,

.....

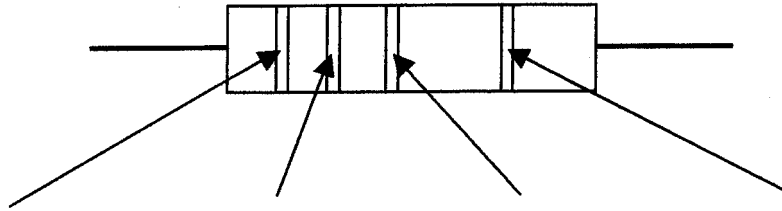
- (iv) calculate the value required for R.

.....

QUESTION 8 CONTINUES ON THE NEXT PAGE

Turn over ►

- (v) The actual value of R in the circuit is $820\ \Omega$. Label the colour of each band on this resistor if it has a tolerance of 5%.



- (vi) A $620\ \Omega$ resistor is connected in parallel with the $820\ \Omega$ resistor. Calculate the combined resistance of this pair.

.....

.....

.....

- (vii) Explain why the LED should now operate correctly.

.....

(14 marks)

19

END OF QUESTIONS