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General Certificate of Secondary Education
June 2004

ELECTRONICS   **3432/F**
Foundation Tier

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Wednesday 9 June 2004   1.30 pm to 3.00 pm

F

In addition to this paper you will require:
- a pencil and a ruler;
- a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or 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 120.
- 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.

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Information Sheet

The following information may be useful in answering the questions.

1. **Power**

   Power = voltage x current;   P = VI

2. **Amplifiers**

   Voltage gain $G_V = \dfrac{V_{OUT}}{V_{IN}}$

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 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 $= \dfrac{\text{voltage}}{\text{current}}$; $R = \dfrac{V}{I}$

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 $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

9. **A.C. waveforms**

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

   (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 $T = \dfrac{(R_1 + 2R_2)\, C_1}{1.44}$

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

1 (a) State **two** effects that an electric current can have on the human body.

1 ....

2 ....

(2 marks)

(b) Describe **two** protective measures that should be taken to improve safety when carrying out electronics project work.

Give a reason in each case.

1st protective measure ....

....

Reason ....

....

2nd protective measure ....

....

Reason ....

....

(4 marks)

(c) Explain the purpose and limitation of a thermal circuit breaker.

Purpose ....

Limitation ....

....

(2 marks)

(d) What device is required to convert the mains supply to a safe voltage for electronics project work?

Explain why it makes the output safe.

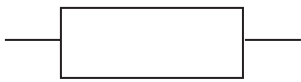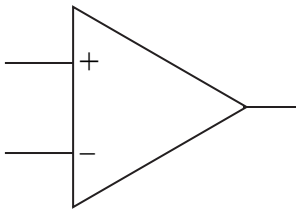Device ....

Explanation ....

....
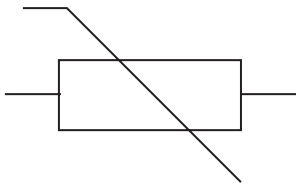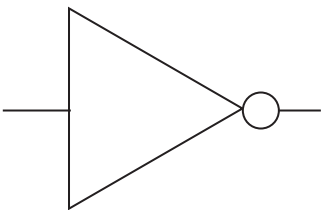
(2 marks)

$\frac{}{10}$

Turn over ▶

**2** Name each of the component symbols shown in the table.

Describe each component by choosing the best word(s) from the list below. Use each description only once.

The number of dotted lines in each description box indicates the number of descriptions that you should select from the list.

comparator	digital	temperature sensor
input device	**limits current**	**logic gate**

symbol	name	description
		....
		....
		....
		....

(10 marks)

$\overline{10}$

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3 The system shown below is a temperature controlled electric fan. It will turn on the fan motor when the temperature exceeds a set level.

| temperature sensor | → | comparator | → | | → | fan motor |
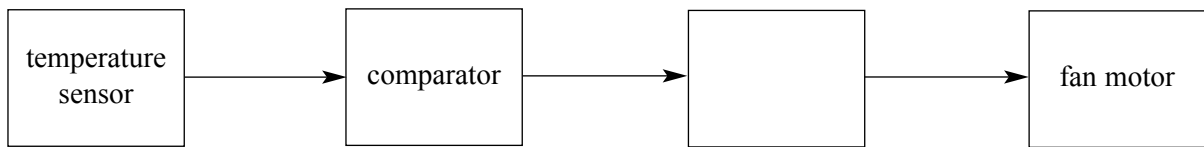
(a) Which of the labelled blocks represents:

   (i) an input? ....

   (ii) an output? ....

   (iii) an analogue to digital converter? ....
   (3 marks)

(b) In which block could:

   (i) an op-amp be used?..

   (ii) a thermistor be used?..

   (iii) a control for varying the set temperature be found?

   ....
   (3 marks)

(c) The maximum comparator output current is 10 mA. The fan motor requires 1 A.

   (i) What process is required in the unlabelled block?

   ....

   (ii) Name an electromagnetic device that could also be used for this process.

   ....

   (iii) Name **two** solid-state electronic devices that could be used for this process.

   1 ....

   2 ....
   (4 marks)

10

Turn over ▶

4 Name each logic gate. Put the name of the logic gate in the space next to it and complete its truth table.

(a)

A o———⤷
B o———⤷)o———oQ   .... gate
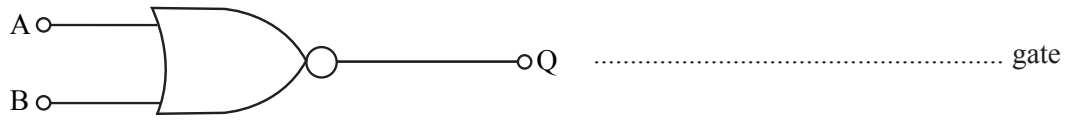
A	B	Q
0	0	
0	1	
1	0	
1	1	

(5 marks)

(b)

A o———⎡
B o———⎣)o———oQ   .... gate
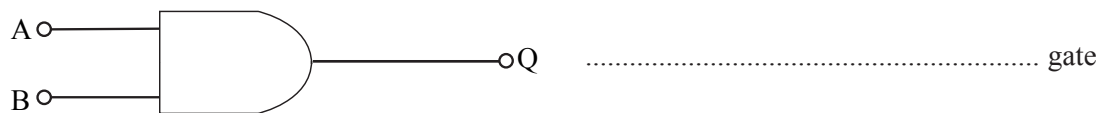
A	B	Q
0	0	
0	1	
1	0	
1	1	

(5 marks)

$\overline{10}$

5 (a) In a domestic audio system (music centre) describe the function of:

(i) the tuner; ....

....

(ii) the loudspeakers. ....

....

(4 marks)

(b) Name **one** way of recording music in:

(i) an analogue form; ....

(ii) a digital form. ....

(2 marks)

(c) (i) What property of the carrier wave is varied in an AM radio signal?

....

(ii) Illustrate your answer with a sketch of an AM signal waveform.

amplitude
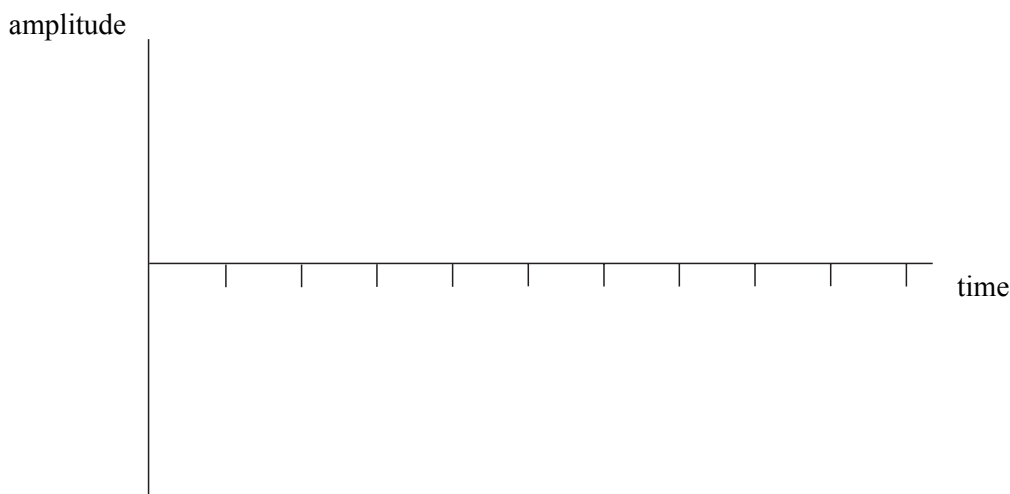
time

(2 marks)

(d) A radio receiver must be both sensitive and selective. Explain both terms.

Sensitivity is the ability of the receiver to ....

....

Selectivity is the ability of the receiver to ....

....

(2 marks)

Turn over ▶

6 A 555 timer IC is used as an astable to produce pulses that are fed to a light-emitting diode and its series resistor R_3.

(a) Complete the circuit diagram of this system, add and label the two timing resistors, R_1 and R_2, the timing capacitor, C, the LED and its series resistor, R_3.
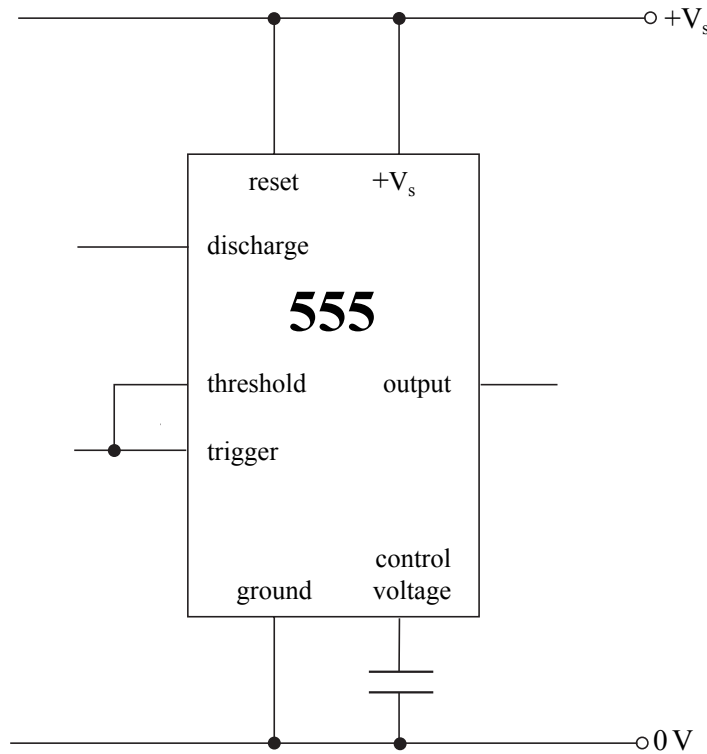
(5 marks)

(b) The output of the 555 timer is 8 V and the forward voltage drop of the LED is 2 V when a current of 20 mA flows through it.

(i) Calculate the voltage across the LED series resistor R_3.

....

(ii) Calculate the required value of R_3.

....
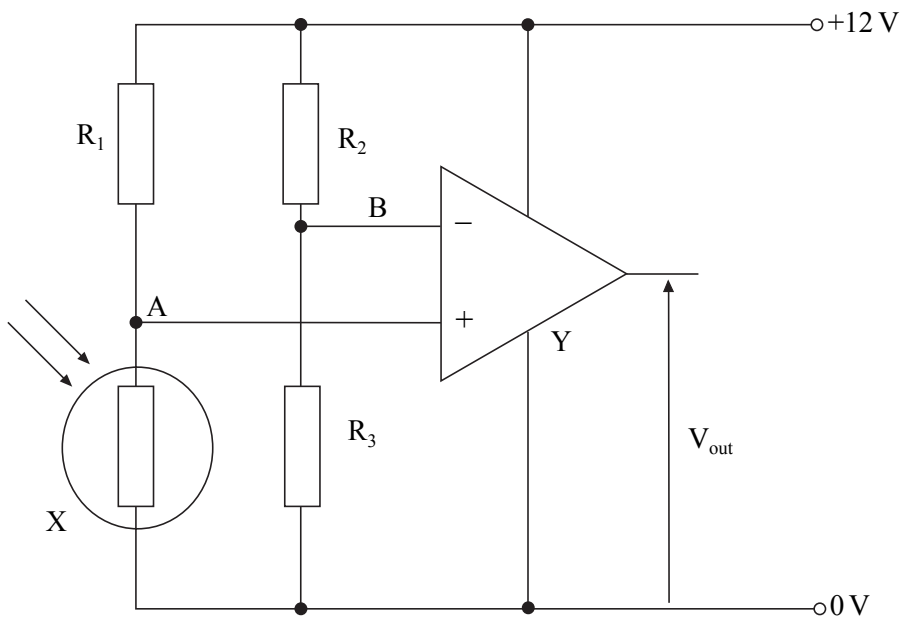
(iii) You should find that the value you have calculated for R_3 is a preferred value. Give its colour code if it is a 5% tolerance component.

....

(5 marks)

10

7 The circuit shown below is of a voltage comparator.

(a) Name the components labelled X and Y.

(i) X ....

(ii) Y ....

(2 marks)

(b) (i) Name the circuit arrangement formed by R_2 and R_3.

....

(ii) What is the purpose of R_2 and R_3 in this circuit?

....

(2 marks)

(c) State the output voltage, V_{out}, of the circuit when:

(i) The voltage at A is greater than the voltage at B; ....

(ii) The voltage at A is less than the voltage at B. ....

(2 marks)

(d) The circuit has a supply voltage of 12 V and a draws a current of 15 mA.

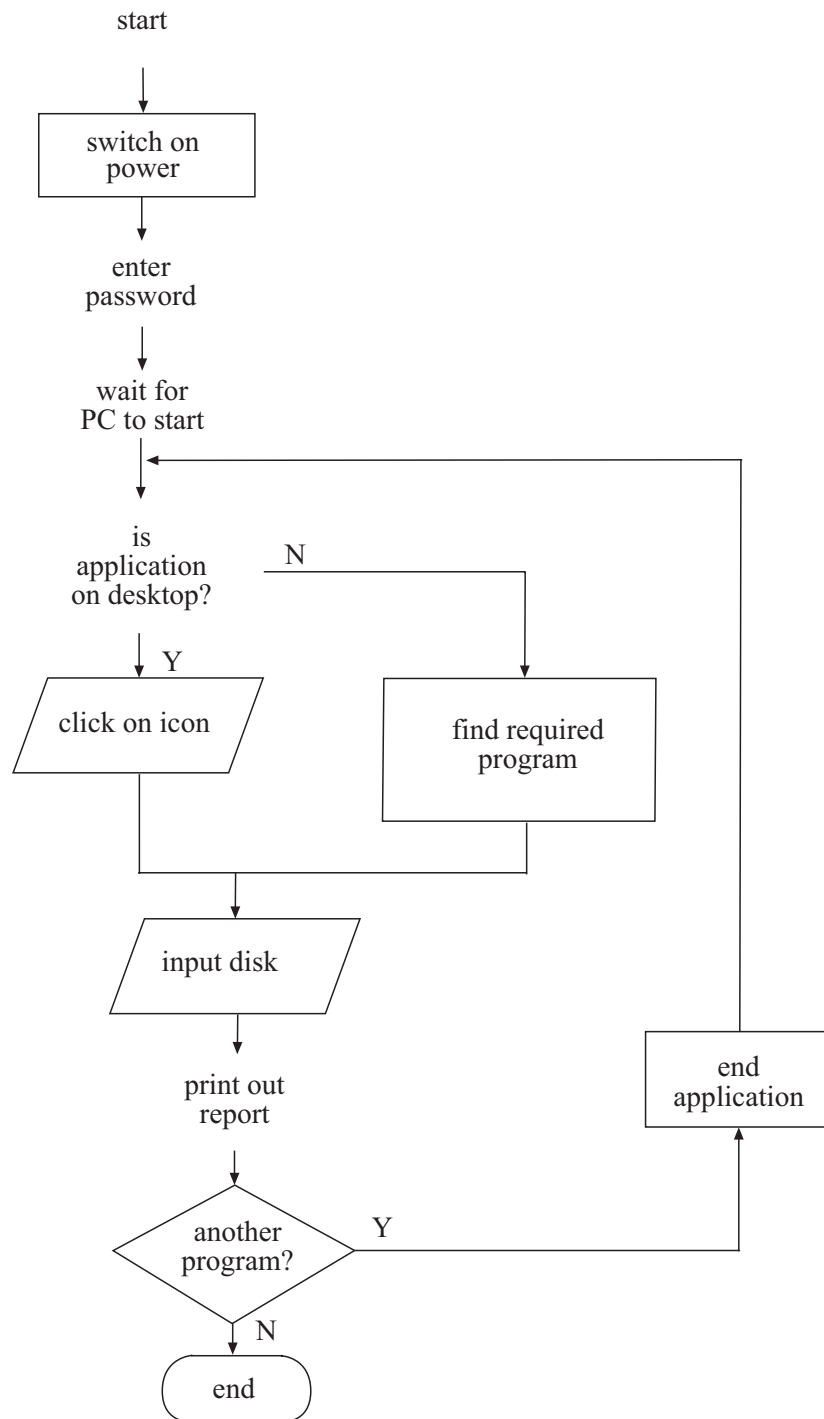(i) State the unit of power. ....

(ii) Calculate the power that the circuit consumes. ....

(iii) Name a suitable component for providing a stable 12 V for this circuit.

....

(4 marks)

10

Turn over ▶

8 This flowchart is for printing out a piece of work from a floppy disk using a computer.

(a) Draw the correct flowchart symbols where they are missing on the diagram. *(5 marks)*

(b) Label on the flowchart: an input box   an output box   a compare box
                                   a process box   a loop

(5 marks)

(c)   Draw in the space below a flowchart for switching on a CD player, reading the number of tracks,
       selecting a track and playing it. Include a loop so that another track can be chosen and played.
       Complete your flowchart by ejecting the CD and switching off the player.
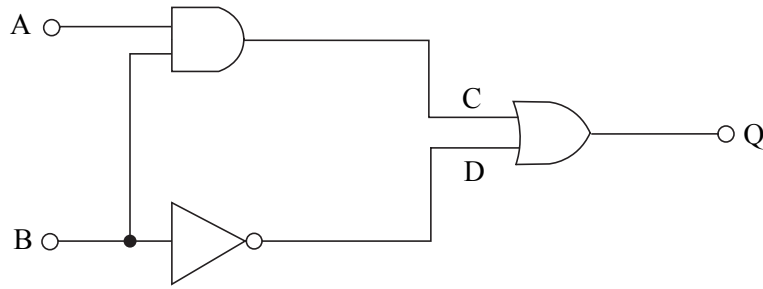   You may use the flowchart on the **page 10** as a guide.

(10 marks)

$\dfrac{}{20}$

Turn over ▶

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

9   A logic diagram is shown below.

(a)   Complete the truth table below to show the operation of the circuit.

A	B	C	D	Q
0	0			
0	1			
1	0			
1	1			

(4 marks)

(b)   Input A is from a door sensor, which gives a logic 1 when the door is closed and a logic 0 when the door is opened.

Input B is from a light sensor that gives a logic 1 in the dark and a logic 0 in the light.

(i)   Name the component that would be suitable to use as a light sensor.

    ....

(ii)   Name the component that would be suitable to use as a door sensor.

    ....

(iii)   State the combination of physical inputs that will make Q logic 0.

    .... and ....

(4 marks)
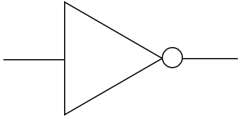
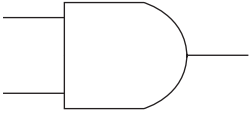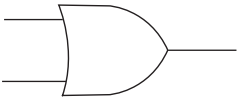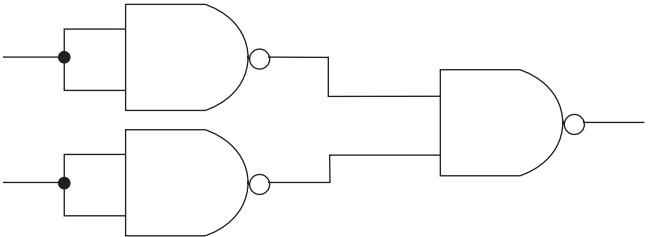**QUESTION 9 CONTINUES ON THE NEXT PAGE**

Turn over ▶

(c)   Three different types of logic gate are used in the design of the logic circuit and so three separate logic ICs would be required. This can be reduced to one IC by re-designing the circuit.

It was decided to re-design the logic circuit using NAND gates only.

(i)   Name the only other type of gate that could be used to re-design the logic circuit.

....
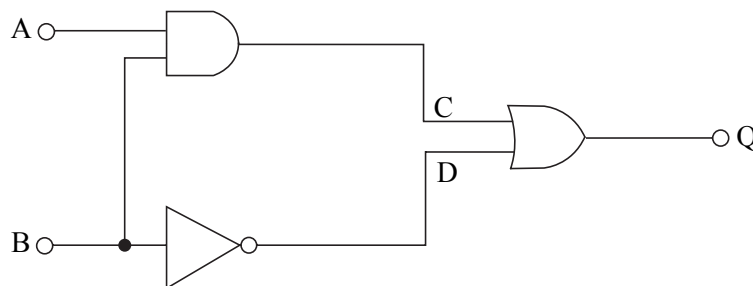
(ii)   Complete the table below to show how each required gate can be made from NAND gates.

required gate	NAND gate equivalent

(4 marks)

(d)   The original logic diagram is shown below.

Re-draw the original logic diagram shown on **page 14** using the NAND gate equivalents from the table in part (c)(ii).

(i)   Complete the diagram below.

(ii)   There should be two places on the diagram where a NAND gate used as an inverter is followed immediately by another NAND gate inverter.

In these cases they could each be replaced by a wire link. Draw rings around each pair of gates that could be replaced by wires.

(iii)   In the space below draw the final circuit, which uses only two NAND gates.

(13 marks)

(e)   The logic gate IC has four NAND gates. On the diagram below draw all the connections, label inputs and output to show a design for construction of the final circuit using gates on one side of the IC.

(5 marks)

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE