WELSH JOINT EDUCATION COMMITTEE

General Certificate of Secondary Education

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294/02

ELECTRONICS

MODULE TEST E2

HIGHER TIER

P.M. FRIDAY, 12 January 2007

(45 minutes)

ADDITIONAL MATERIALS

In addition to this examination 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** the questions 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.

*Answer **all** questions.*

1. The diagram shows the arrangement of the LEDs in a seven-segment display.
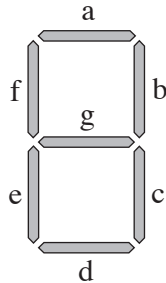
Complete the following table, which shows the number/letter displayed when different segments are lit.

Segment							Letter/Number displayed
a	b	c	d	e	f	g	
1	0						**F**
							3
0	1	1	0	1	1	1	

[3]

2. The diagram shows a pulse generator and a D-type flip-flop.

Pulse Generator

D   Q

CK

Q̅

(a) (i) The D-type must be connected so that it performs a *divide-by-two* action on pulses from the pulse generator.
Draw the two connections needed to do this.

(ii) The frequency of the signal at the Q output is 200 Hz.

What is the frequency of the pulse generator? .... [2]

(b) A D-type flip-flop can also be used for **data transfer**.

(i) The D-type is *rising-edge* triggered. Label a rising-edge on the *Clock Input* graph.

Clock Input

D Input

Q Output

time

time

time
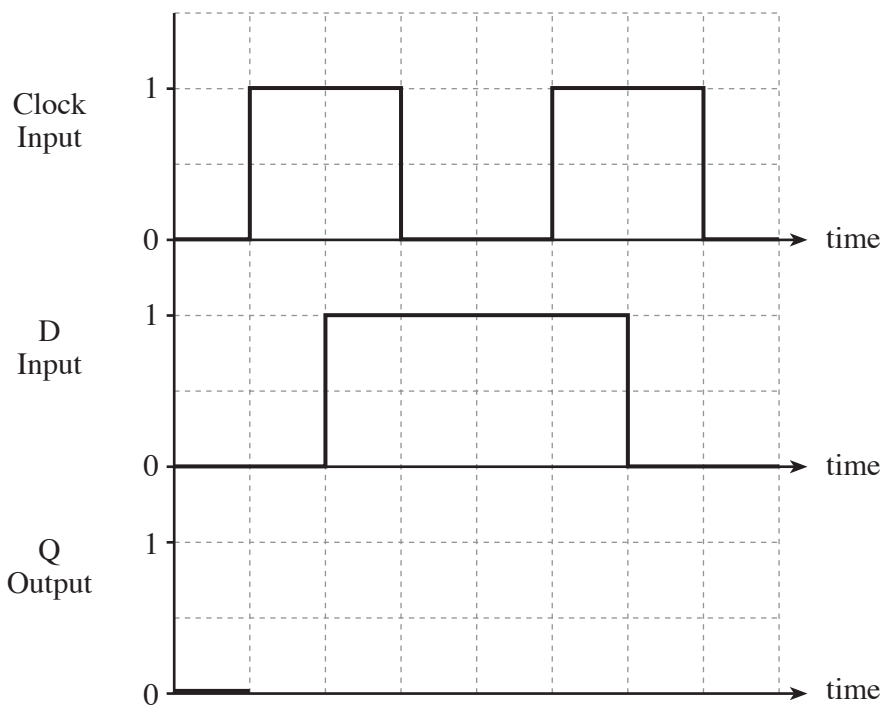
(ii) The signal shown on the graph is applied to the D input.

Complete the graph to show the waveform obtained at the Q output. [3]

Turn over.

3. *(a)* Here is a system that controls a lamp on a stairway. The lamp comes on when the switch is pressed ***but only*** if it is dark. The lamp switches off automatically after 1 minute.
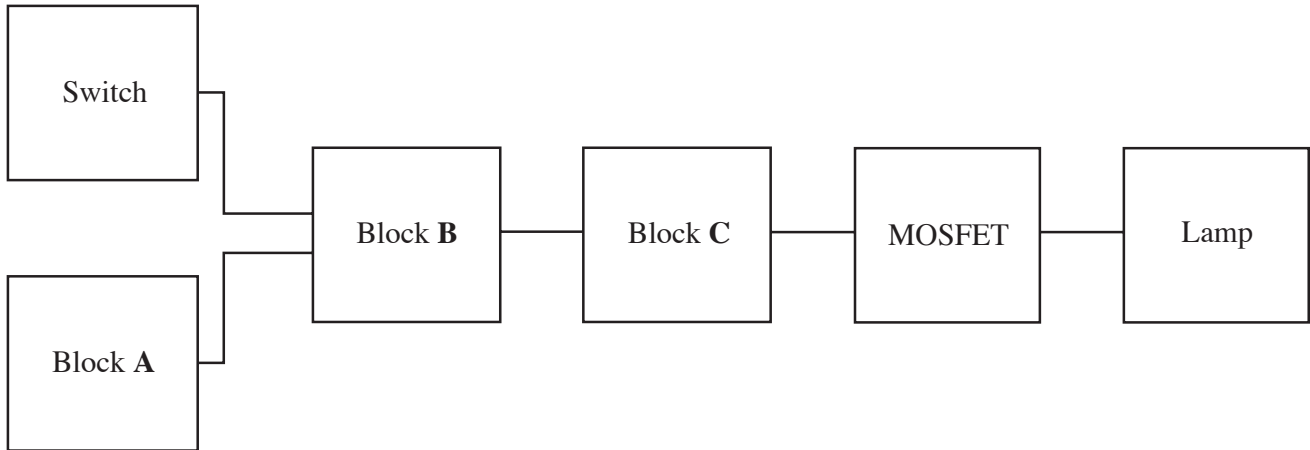
You can choose any of the following sub-systems to use for blocks **A**, **B** and **C**:-

Temperature sensing unit

Light sensing unit

OR gate

Delay unit

Pulse unit

AND gate

Which sub-system is

(i)   a suitable unit for block **A**? ....

(ii) a suitable unit for block **B**? ....

(iii) a suitable unit for block **C**? .... [3]

(b) Complete the circuit diagram to show how the MOSFET is connected to Block **C** and the lamp.

[2]

(c) The lighting control system is an example of electronics being used to conserve energy.

(i) Describe **another** example of electronics being used to conserve energy.

....

....

(ii) Describe **one** benefit of electronics to a hospital patient.

....

....

[2]

Turn over.

4. A logic system has two input sensors A and B, and three outputs P, Q and R.
    The truth table showing how the input sensors control the outputs is shown below.

B	A	P	Q	R
0	0	0	1	1
0	1	0	0	1
1	0	0	0	0
1	1	1	0	0

(a) (i) Look at the P output. Which type of logic gate will provide this?

Logic gate is ....

(ii) Look at the Q output. Which type of logic gate will provide this?

Logic gate is ....

(iii) Look at the R output. It is the inverse of one of the inputs.
Write down an expression to describe this output.

R = ...
[3]

(b) You have a selection of AND, OR, NOT, NOR and NAND gates available.
Draw a labelled diagram to show how the logic system can be made.

A o—   —o P

                                                                  —o Q

B o—

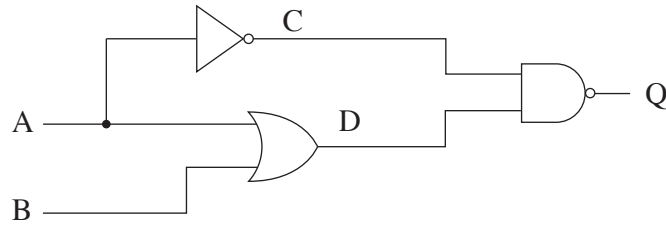   —o R

[3]

(c) A memory IC could be used to give the same output as the logic system. Give one
advantage, other than cost, of designing an electronic system using a memory IC instead of
logic gates. [1]

....

....

5. *(a)* Complete the truth table for the following logic system.

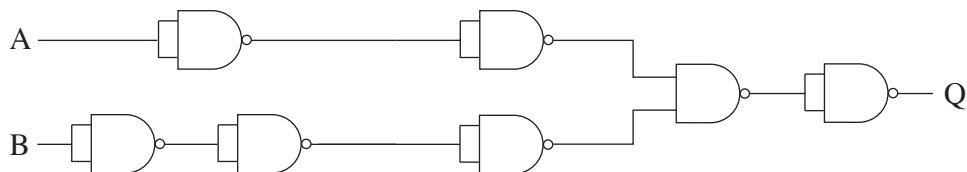| B	A	C	D	Q
0	0			
0	1			
1	0			
1	1			

[3]

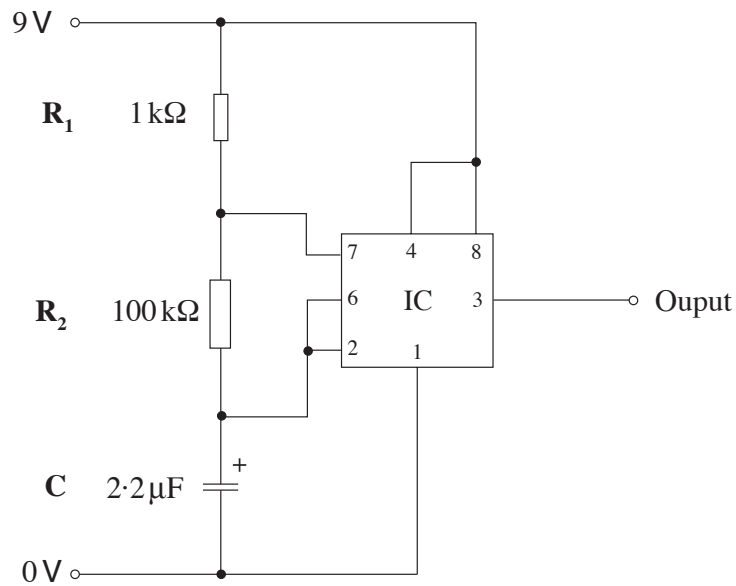*(b)* Redraw the system to produce the same output, but using only NAND gates.

[2]

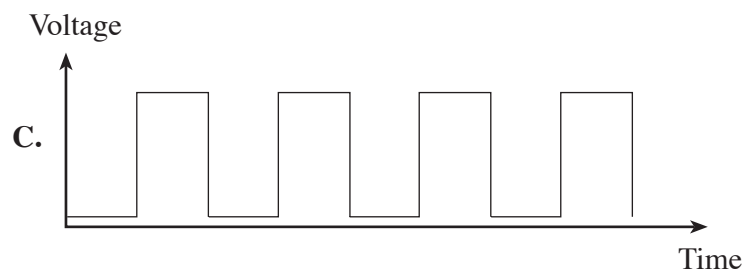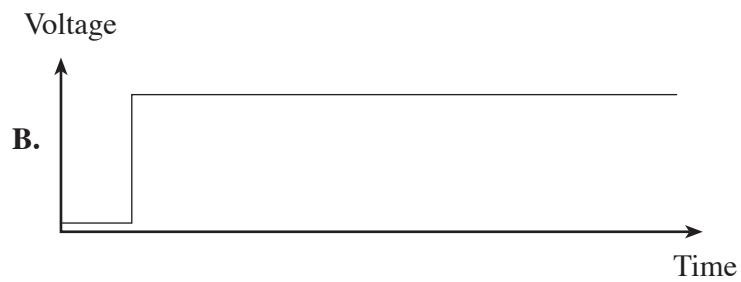*(c)* Here is another system of NAND gates. Simplify it by crossing out any redundant gates.
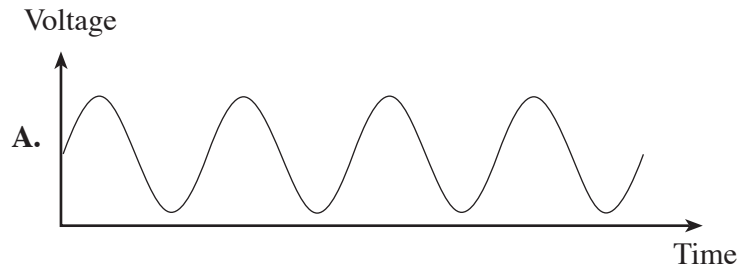

[2]

Turn over.

6. Here is the diagram for an astable circuit based on a 555 timer IC.

(a) Which of the following is the output waveform produced by an astable circuit?

Answer ....

[1]

(b) The **approximate** value of frequency f of the pulse generator is given by the formula.

$$f = \frac{0 \cdot 7}{R_2 C}$$ (where f is in Hz, R_2 is in $M\Omega$ and C is in μF).

Use this formula to calculate the frequency of the pulse generator.

....

....

....

[3]

Turn over.

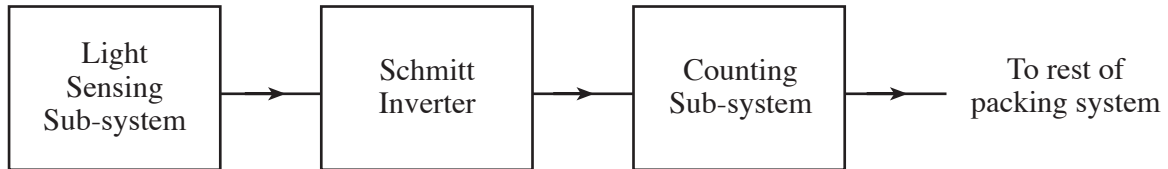**7.** A company packs DVDs into boxes, five to a box.

Part of the packing system is shown in the following block diagram.

```
┌─────────────┐     ┌─────────────┐     ┌─────────────┐
│    Light    │     │             │     │             │
│   Sensing   │ ──► │   Schmitt   │ ──► │  Counting   │ ──►  To rest of
│  Sub-system │     │   Inverter  │     │  Sub-system │      packing system
└─────────────┘     └─────────────┘     └─────────────┘
```

- The counting sub-system contains a 3-bit binary counter and an AND gate

- The system must reset when the **fifth** DVD passes the light sensor

- Taking the reset pin to logic 1 resets the counter

- Bit A of the counter is the least significant bit

- The counter is initially reset

(a) Complete the diagram below to show how the AND gate is connected to the counter to allow it to reset correctly.
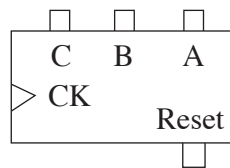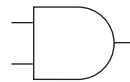
[3]

(b) The Schmitt inverter *cleans up* the signal produced by the light sensor.
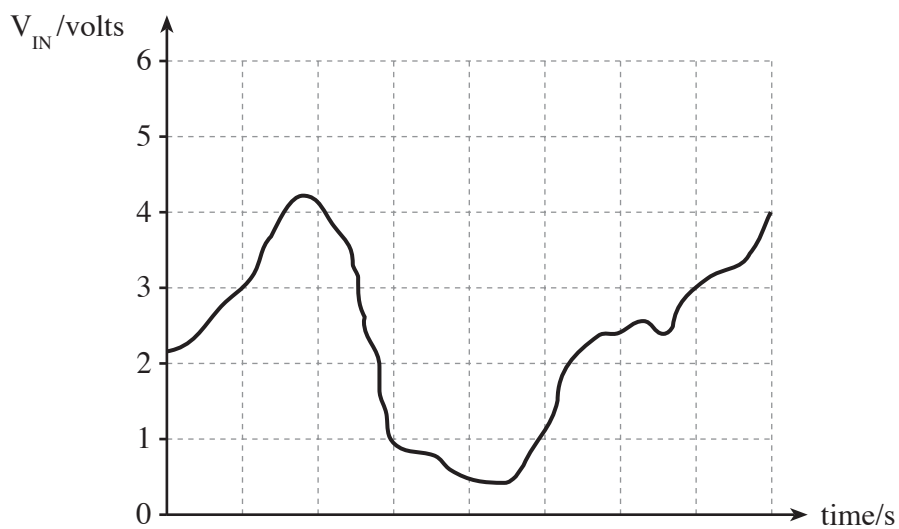Here is part of a data sheet for a Schmitt Inverter:

When connected to 5 V supply:

- Logic 0 = 0 V
- Logic 1 = 5 V
- The output changes from logic 1 to logic 0 when a **rising** input voltage reaches 3 V
- The output changes from logic 0 to logic 1 when a **falling** input voltage reaches 1 V

The signal produced by the light sensor is shown in **Graph 1**.

Complete **Graph 2** to show the signal obtained at the output of the Schmitt Inverter.

Graph 1

Graph 2

[4]