Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Secondary Education
June 2007

ELECTRONICS
Written Paper
Foundation Tier

3432/F

F

Thursday 24 May 2007 1.30 pm to 3.00 pm

For this paper you must have:
- 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** questions.
- Answer the questions in the spaces provided.
- Show the working of your calculations.

Information
- The maximum mark for this paper is 120.
- 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		9	
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 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

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

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

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

1 (a) What component can be used to obtain a safe low voltage from the mains supply?

.....

(1 mark)

(b) Name **two** components that can be used to protect a circuit from a current overload.

1 .....

2 .....

(2 marks)

(c) State the colours of these wires in a three-pin mains plug.

(i) Earth .....

(ii) Live .....

(iii) Neutral .....

(3 marks)

(d) To help prevent accidents whilst working on electronics projects, state **two** measures that students should take.

1 .....

2 .....

(2 marks)

(e) State **two** effects on the human body of a large electric current.

1 .....

2 .....

(2 marks)

10

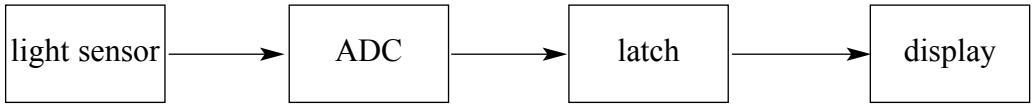
2 For each component named below, draw its symbol and describe its function.

name	symbol	function
resistor		....
diode		....
thermistor		....
capacitor		....
loudspeaker		....

(10 marks)

10

3 The diagram below shows a digital light meter system.
The light level is measured, and its value is then displayed.



(a) Which block represents

(i) an input, ...

(ii) an output, ...

(iii) an analogue process, ...

(iv) a digital process? .....

(4 marks)

(b) In which block could

(i) a D-type flip-flop be used, ...

(ii) an LDR be used, ...

(iii) an op-amp be used, ...

(iv) a 7-segment display be used? .....

(4 marks)

(c) Which block

(i) is a simple memory, ...

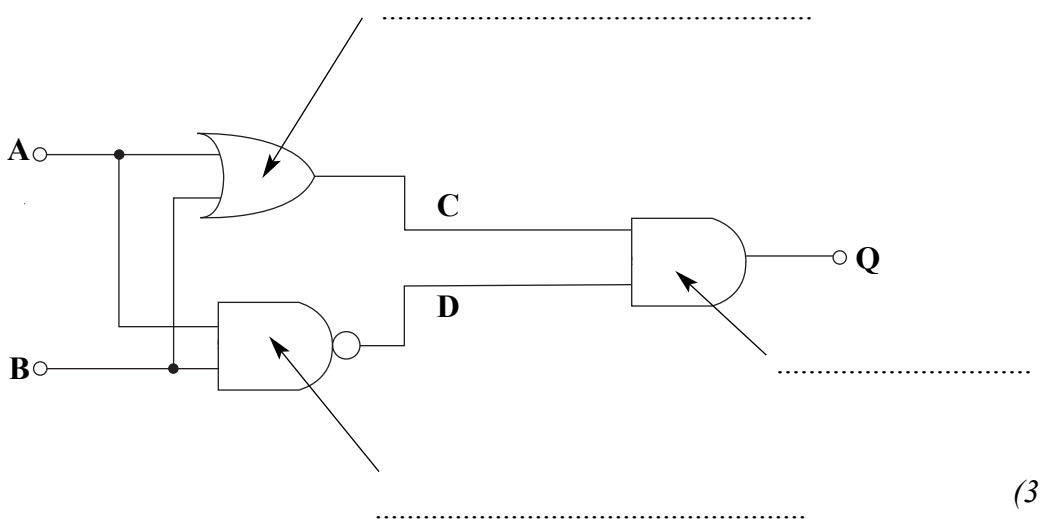
(ii) could use LEDs? .....

(2 marks)

10

Turn over for the next question

4 (a) Label the **three** different types of logic gate in the diagram below.



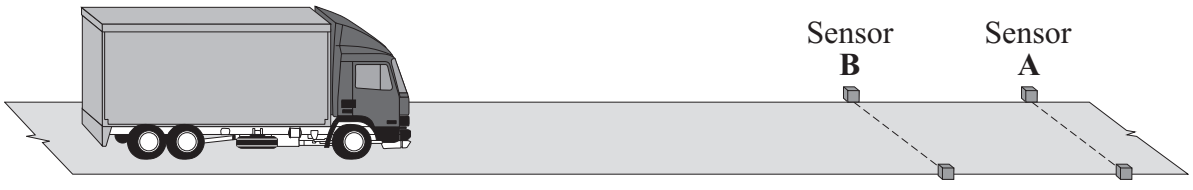
(3 marks)

(b) Complete the truth table below to describe the operation of the circuit in part (a).

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

(6 marks)

(c) The inputs **A** and **B** are connected to beam sensors across a road as shown below. The sensors give a logic 1 when the beam is broken.
A lorry is shown travelling towards the sensors.



On the diagram above, draw the position of the lorry when the output of the system, **Q**, first gives a logic 1.

(1 mark)

10

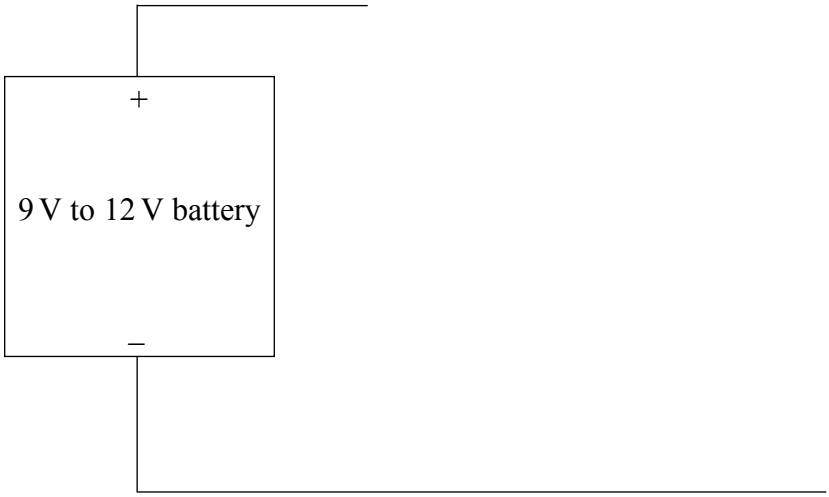
5 A project circuit requires a stable 5 V power supply. For this a student uses a 12 V battery which will discharge down to 9 V towards the end of its useful life.

(a) What type of component can produce a stable output voltage from a varying input voltage?

.....

(1 mark)

(b) Complete the circuit diagram below to show how this component is used for this function. Label the output of your circuit, and include a capacitor that will remove output noise.



(5 marks)

(c) The project circuit draws a current of 0.25 A at 5 V.
Calculate

(i) the overall resistance of the project circuit,

.....

(ii) the power consumption of the project circuit.

.....

(4 marks)

10

6 (a) Label the block diagram of a simple radio receiver system shown below.

Use the following terms

aerial **af amplifier** **demodulator** **loudspeaker** **tuned circuit.**

(5 marks)

(b) In which sub-system would you expect to find

(i) an audio amplifier IC, ...

(ii) a signal diode, ...

(iii) a variable capacitor and an inductor (coil)?

.....

(3 marks)

(c) The simple radio receiver system can only be used with amplitude modulation. On the axes below sketch a voltage time graph for this type of modulated wave.

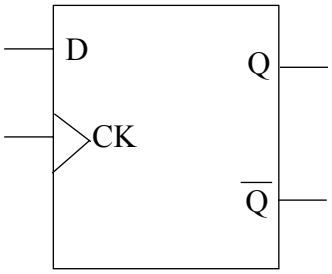
(2 marks)

10

7 (a) A D-type flip-flop is used as a latch.

(i) Name and label the **two** inputs with their full names.

(ii) Label the output.



(3 marks)

(b) Describe the operation of a 4013 type D-type flip-flop.

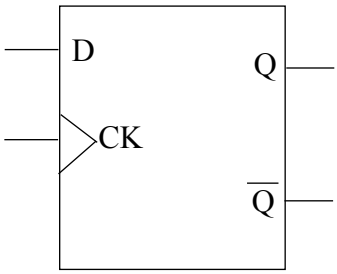
.....

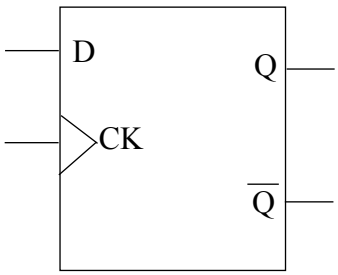
.....

.....

(3 marks)

(c) The D-type flip-flop can also function as a frequency divider. Complete the diagram below to show how two D-type flip-flops can divide an input signal by a factor of four. Label the input and output of your circuit and draw the wire links required.

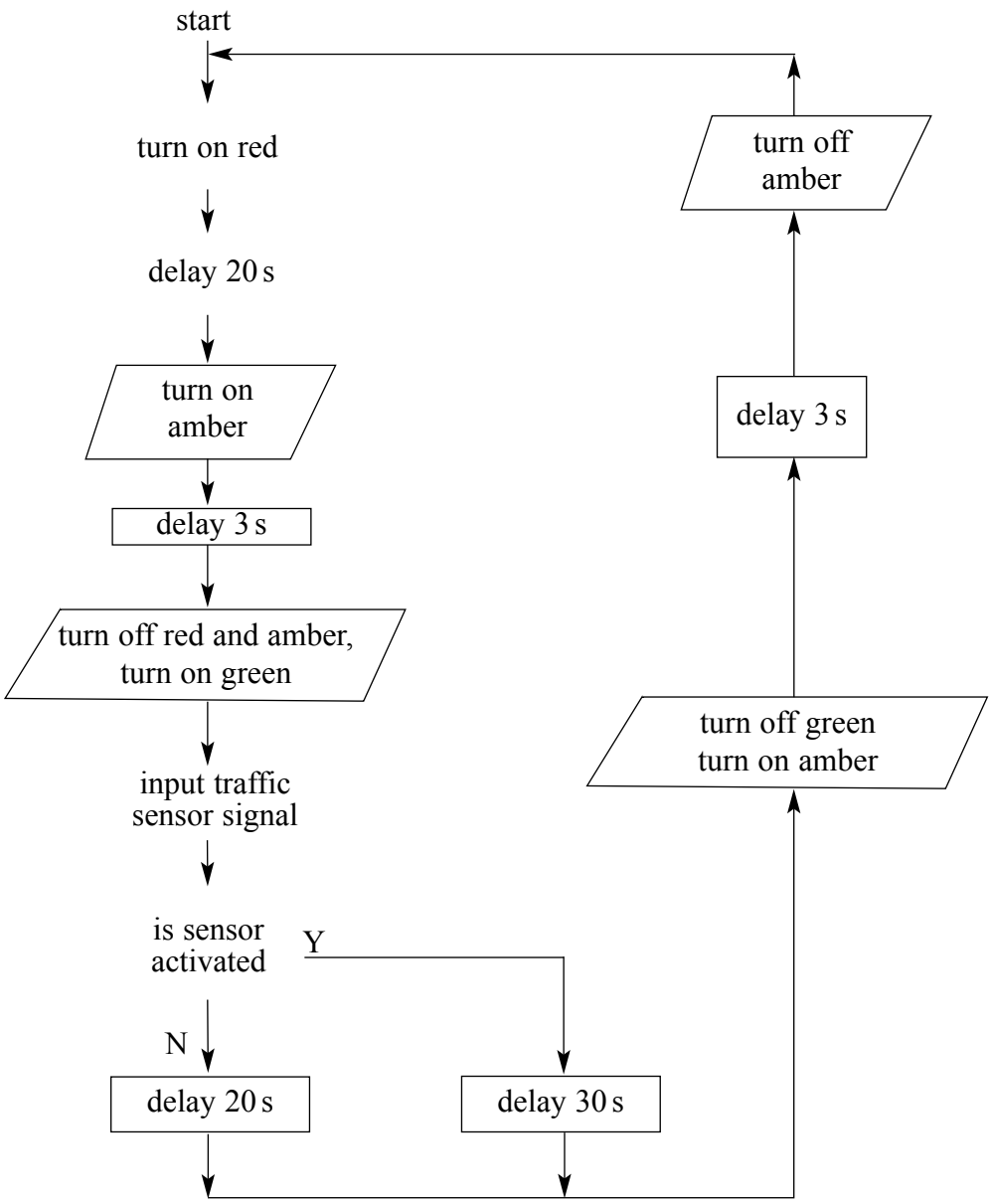




(4 marks)

10

8 The flowchart describes the action of a traffic light system that is capable of reacting to the length of the queue of traffic.



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

(5 marks)

(b) Label on the flowchart

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

(5 marks)

(c) (i) From **start** how long does it take before the green light turns on?

.....

(ii) The traffic sensor is activated by a long queue of traffic. How does this alter the behaviour of the traffic light system compared to a short queue of traffic?

.....

(iii) How many times in one cycle of the flowchart is the amber light switched on?

.....

(iv) What is the total length of time the amber light is switched on in one cycle of the flowchart?

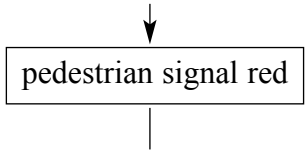
.....

(v) What is the length of time from when the red light switches on, to the next time it switches on if there is a long queue of traffic?

.....

(5 marks)

(d) A pedestrian crossing system normally shows a green light to traffic and a red symbol to pedestrians. A button is pressed by a pedestrian wishing to cross the road. After a 10s delay the traffic lights change to red and the pedestrian is shown a green symbol. The pedestrian then has 15s to cross the road before the pedestrian symbol changes back to red. Complete the flowchart to show how this pedestrian crossing system operates.



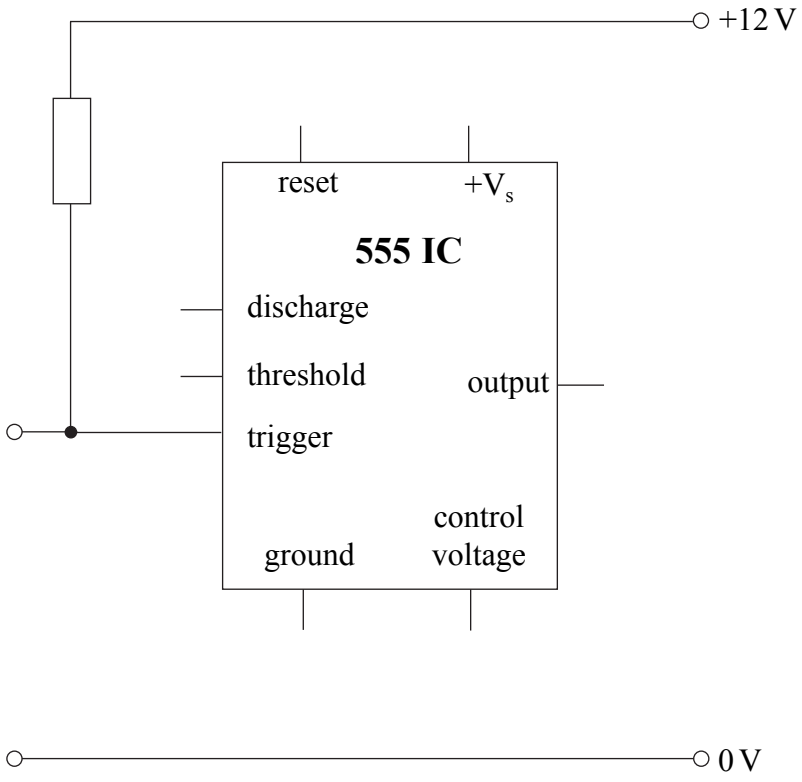
(5 marks)

20

9 A student decides to construct a traffic light system similar to that described in Question 8 part (a) and part (b), using 555 IC monostables as the timing sub-systems.

It is not necessary to have completed your answer to Question 8 before attempting this question.

(a) Complete the circuit diagram below to show how the 555 IC should be connected to form a monostable. Include a timing resistor and capacitor, and any other components or connections required. Label the connection to the next stage.



(8 marks)

(b) The traffic light output transducers are high power LEDs which have a maximum forward voltage of 4V when conducting a maximum current of 450 mA.
Explain why they cannot be directly coupled to the logic gates or the timer in the system.

.....

(1 mark)

(c) LEDs should always be operated with a series resistor. The supply voltage for the system is 12 V.

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

(ii) What current will flow through the series resistor? .....

(iii) Calculate the required value of the series resistor.

.....

(iv) What preferred value of resistor from the E24 series should be chosen here?

.....

(5 marks)

(d) It is decided to use an npn bipolar transistor to drive the LED and its series resistor. Draw the circuit diagram for the LED and its driver. Label the leads of the transistor and include a component that will limit the current to the input of the driver circuit.

(6 marks)

Question 9 continues on the next page

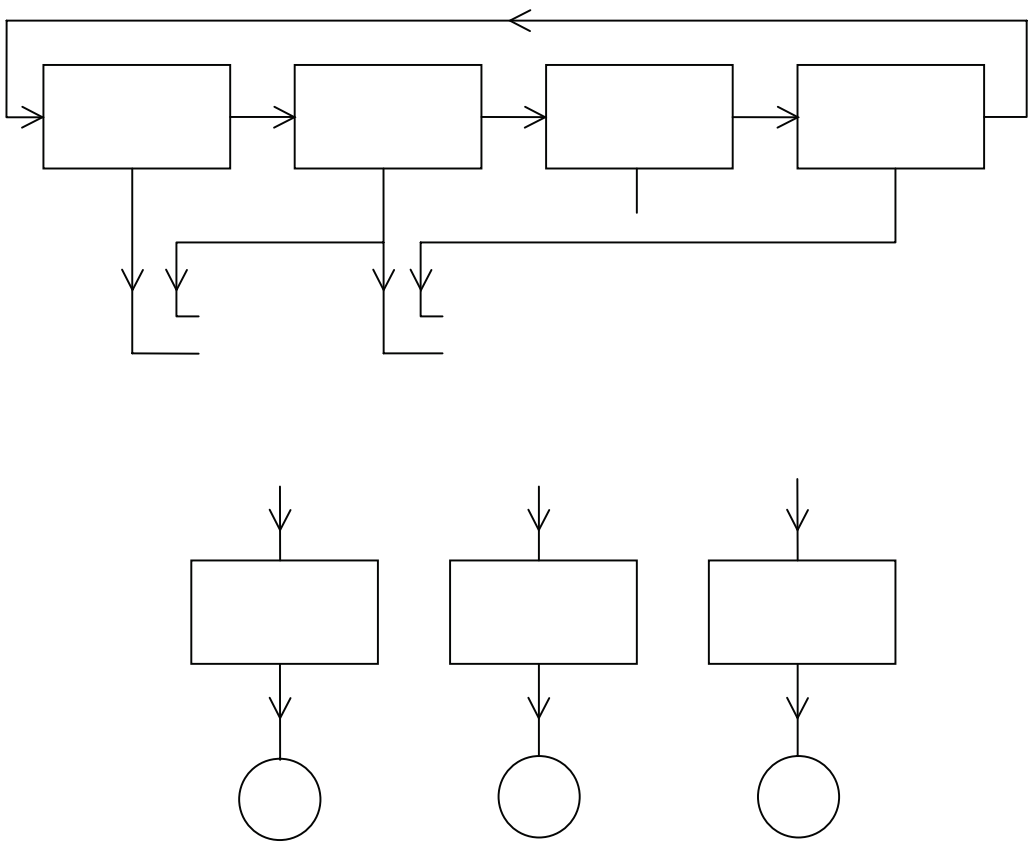
(e) When the system is first switched on, the first 555 IC monostable is triggered to provide a signal to turn on the red light for 20 s. The output from this sub-system triggers a second 555 IC monostable to turn on the amber light for 3 s and also keep the red light on during this period.

The red light driver sub-system operates when the 20 s timer or the 3 s timer is high.

At the end of the 3 s period a third 555 IC monostable is triggered for a period of 20 s to operate the green light.

A fourth 555 IC monostable is triggered at the end of this 20 s period to turn the amber light on for a further 3 s, after which the first monostable is triggered and the cycle is repeated. The amber light driver sub-system operates when either of the 3 s timers are high.

Complete the system diagram below labelling the **four** 555 timers with their respective on times; drawing in **two** logic gates; labelling **three** lamp drivers; and mark the red, amber and green lights with R, A, and G. Label each sub-system and complete the connections between them.



(10 marks)

30

END OF QUESTIONS

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