



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

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**DESIGN AND TECHNOLOGY** **0445/41**  
Paper 4 Systems and Control **May/June 2013**  
**1 hour**

Candidates answer on the Question Paper.  
No Additional Materials are required.

**To be taken together with Paper 1 in one session of 2 hours and 15 minutes.**

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.  
Write in dark blue or black pen.  
You may use a soft pencil for any diagrams or graphs.  
Do not use staples, paper clips, highlighters, glue or correction fluid.  
**DO NOT WRITE IN ANY BARCODES.**

You may use a calculator.

- Section A**  
Answer **all** questions.
- Section B**  
Answer **one** question.

At the end of the examination, fasten all your work securely together.  
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
Total	

This document consists of an **17** printed pages and **3** blank pages.

Section A

Answer **all** questions in this section.

1 Fig. 1 shows two circuit symbols.

Add the name of the component to each symbol.

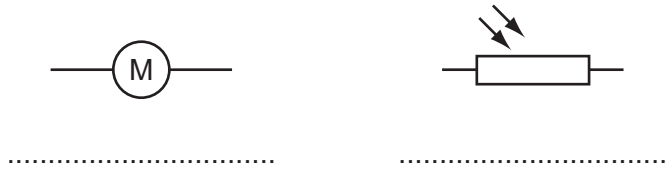


Fig. 1

[2]

2 Complete Fig. 2 to show how the two components can be connected to give a resistance of  $5\text{ k}\Omega$  between points **A** and **B**.

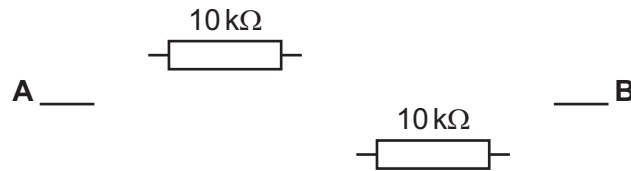


Fig. 2

[2]

3 (a) Name the switch arrangement shown in Fig. 3.



Fig. 3

.....

[1]

(b) Add labels to Fig. 3 to indicate the normally closed (NC) and normally open (NO) terminals. [2]

4 Give **two** examples of natural structures that will resist tension.

1 .....

2 ..... [2]

- 5 Complete the table below by adding a tick (✓) to show which forces the materials are resisting. Only add **one** tick (✓) for each material.

materials	tension	compression	bending
concrete			
steel cable			
laminated wooden beam			

[3]

- 6 Fig. 4 shows the framework for a set of shelves used to carry heavy loads in a storage unit.

Use notes and sketches to show **two** methods of making the framework more rigid when the shelves are loaded.

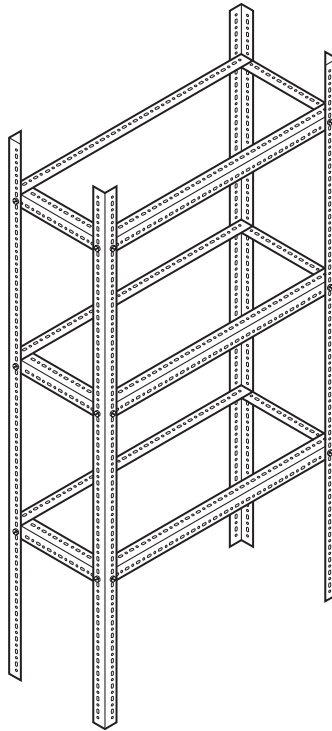


Fig. 4

[2]

- 7 Give **two** advantages of using roller bearings to support an axle compared to plain bearings.

1 .....

2 ..... [2]

8 (a) Fig. 5 shows a drawing of a cam.

Indicate the part of the cam that will provide 'dwell'.

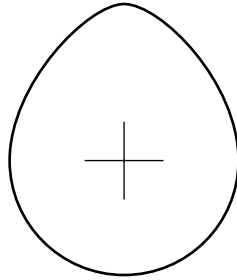


Fig. 5

[1]

(b) Describe the conversion of motion provided by a cam and follower.

.....  
.....

[2]

9 Fig. 6 shows a crank lever, chain ring and pedal from a bicycle.

Add labels to show effort, load and fulcrum.

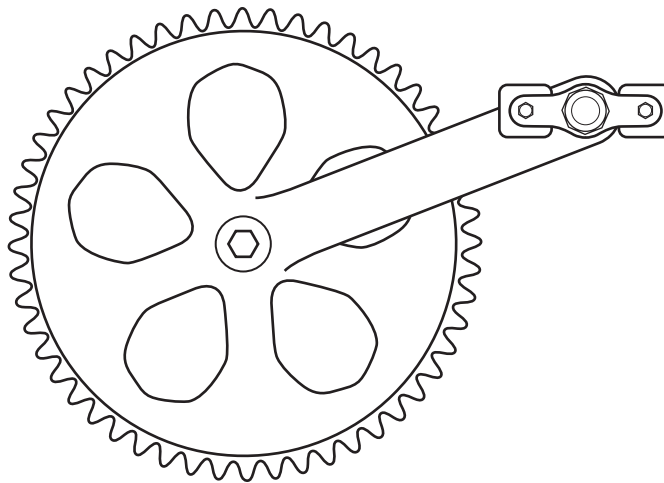


Fig. 6

[3]

10 Fig. 7 shows two views of a wheelbarrow loaded with bricks.

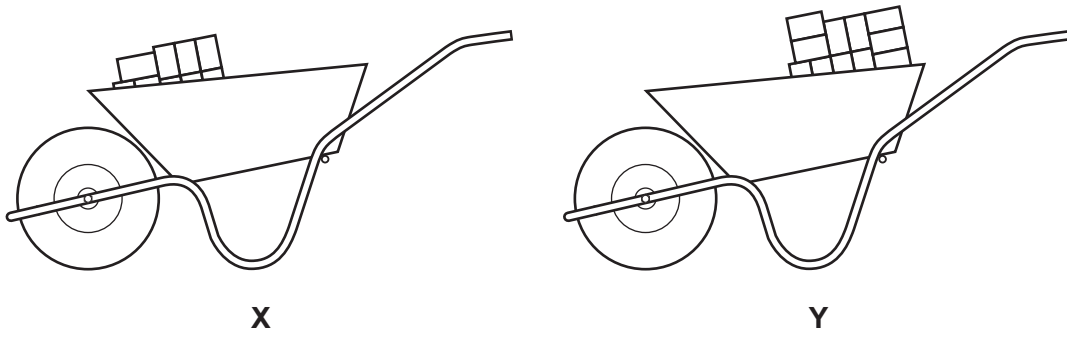


Fig. 7

(a) State the order (class) of lever which is used in a wheelbarrow.

..... [1]

(b) Explain why method X is a more efficient way of loading the wheelbarrow in Fig. 7 than method Y.

.....  
.....  
..... [2]

Section B

Answer **one** question from this section.

11 (a) Fig. 8 shows a model beam set up for testing deflection.

Use notes and sketches to show how the deflection of the beam can be accurately measured.

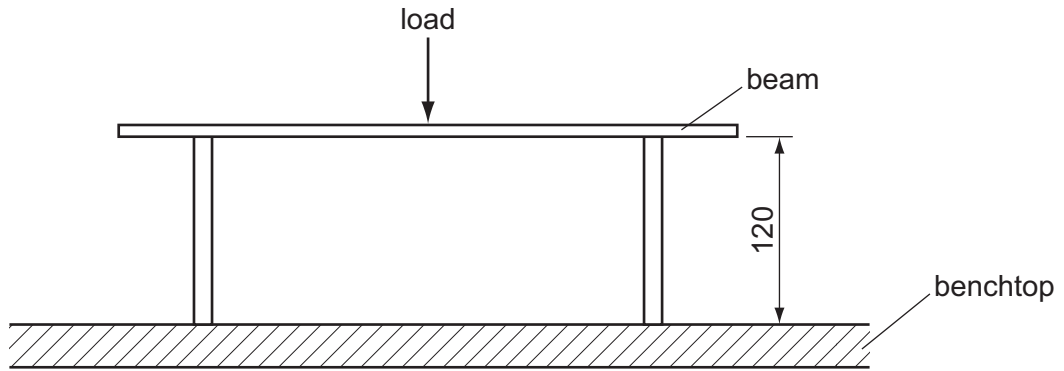


Fig. 8

[4]

(b) (i) Explain the term *factor of safety* with reference to structures.

.....

.....

.....

..... [3]

(ii) When a road bridge is being designed give **three** features that may be considered when calculating the factor of safety.

1 .....

2 .....

3 ..... [3]

(c) Fig. 9 shows a bridge supporting the weight of a lorry.

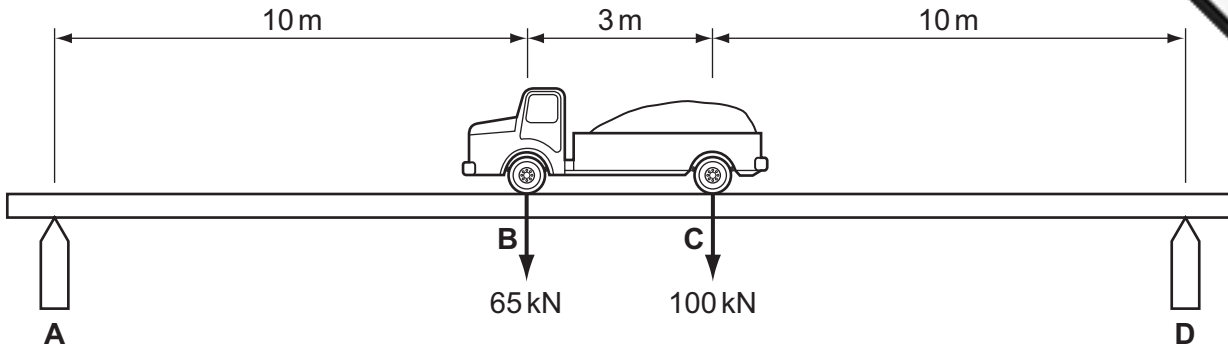


Fig. 9

Calculate the reactions at **A** and **D**.

.....  
 .....  
 .....  
 ..... [4]

(d) Fig. 10 shows three different methods of joining metals used in a structure.

Give a different reason for using each method.

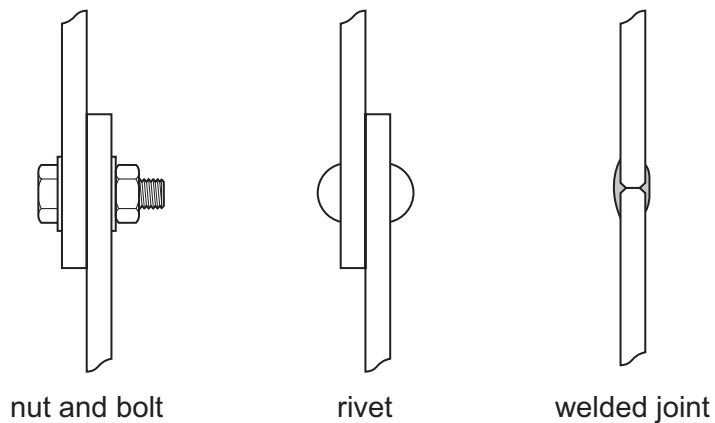


Fig. 10

nut and bolt .....

rivet .....

welded joint ..... [3]

(e) (i) Wooden framing is often used in the construction of houses as shown in Fig. 11.

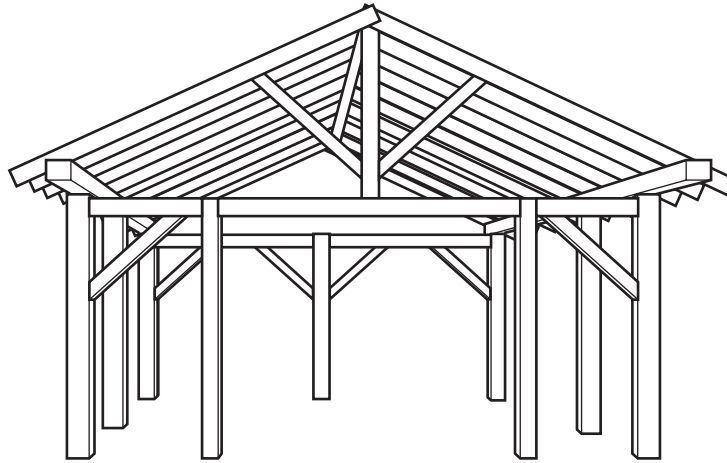


Fig. 11

Give **two** reasons why wood is a suitable material for a house framework.

1 .....

2 ..... [2]

(ii) Fig. 12 shows two lengths of wood to be used as floor beams.

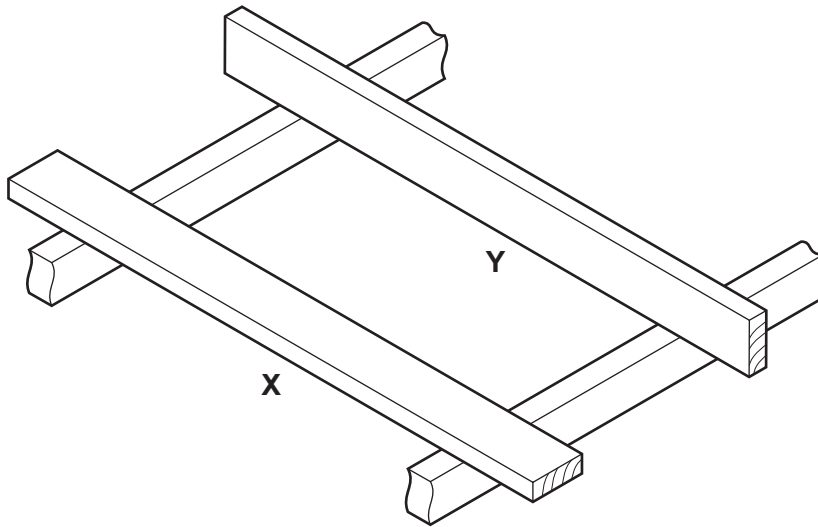
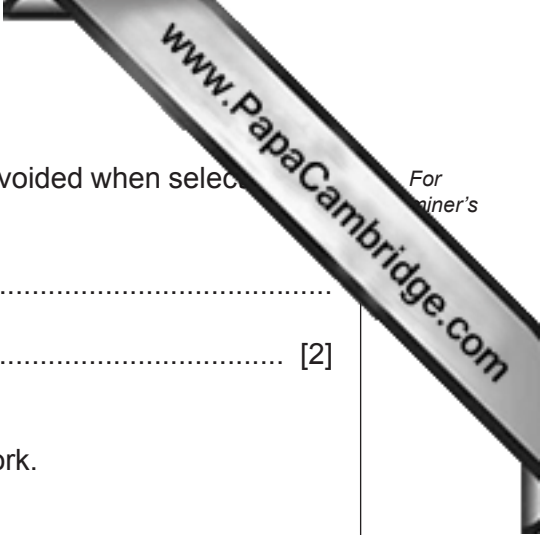


Fig. 12

Explain why the beam should be placed as shown in position Y rather than position X.

.....  
..... [2]





(iii) Describe **two** defects in a length of wood that should be avoided when selecting wood for use in a structure.

1 .....

2 ..... [2]

(f) Describe the difference between a strut and a tie in a framework.

.....

.....

..... [2]

12 (a) Fig. 13 shows two views of a car foot pump.



Fig. 13a

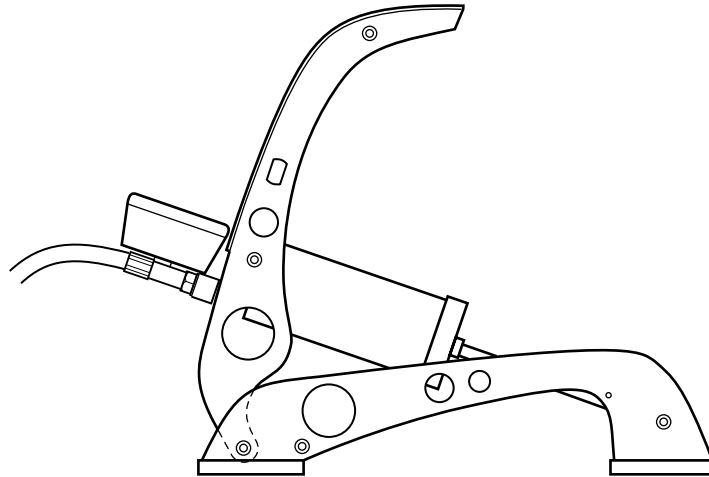


Fig. 13b

(i) Mark on Fig. 13b the position of **three** points that will pivot when the foot pump is operated. [3]

(ii) Give **one** reason for using grease rather than oil to lubricate the pivot points.  
..... [1]

(iii) The action of the foot pump includes a conversion of motion.  
Complete the sentence below.  
..... motion is converted to ..... motion when  
the foot pump is used. [2]

(iv) Explain why the actual Mechanical Advantage achieved by the foot pump is less than the calculated Mechanical Advantage.  
.....  
.....  
..... [2]

(b) Fig. 14 shows the drive mechanism on a bicycle.



Fig. 14

(i) Give **two** reasons for using a chain drive rather than a belt drive to transmit motion on a bicycle.

- 1 .....
- .....
- 2 .....
- ..... [2]

(ii) The bicycle has 3 chain rings and 8 sprockets at the rear wheel.

State the number of gear ratios available.

- ..... [1]

(iii) Calculate the Velocity Ratio when a 52 teeth chain ring and 18 teeth rear sprocket are used.

- .....
- ..... [2]

(iv) Bearings are used on all of the moving parts of a bicycle.

Explain why ball bearings would be used on the chain ring axle.

- .....
- .....
- ..... [2]

(v)

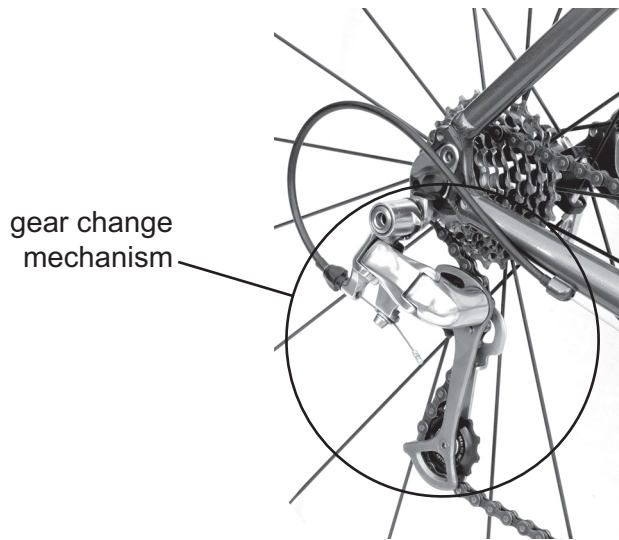


Fig. 15

State the **two** functions of the gear change mechanism shown in Fig. 15.

- 1 .....
- 2 ..... [2]

(c) (i) State **three** types of power source that can be used to operate a mechanism.

- 1 .....
- 2 .....
- 3 ..... [3]

(ii) Explain how improving the design of a mechanism can reduce the energy required to operate the mechanism.

- .....
- .....
- .....
- ..... [3]

- (d) Fig. 16 shows two views of a clamping device that uses a ratchet and pawl to keep its jaws closed. A release trigger will allow the clamp to open.



Fig. 16

Use notes and sketches to show **one** other use of a ratchet and pawl mechanism.

[2]

- 13 (a) When building a circuit the components have to be matched to their symbol or description.
- (i) Complete Fig. 17 by matching the component to the symbol or description. One has been done for you.

1	relay
2	capacitor
3	
4	fixed resistor
5	

Fig. 17

[4]

- (ii) The list below gives component values available for a time delay circuit.

capacitor values				
100 nF	2200 pF	470 $\mu$ F	100 $\mu$ F	330 nF

resistor values				
100 $\Omega$	2 M $\Omega$	270 k $\Omega$	6.8 $\Omega$	1.5 k $\Omega$

State the values of the **two** components that will give the longest delay.

.....

..... [2]

- (iii) When using an integrated circuit (IC) it is important to know the pin numbers.

Complete Fig. 18 to show the numbers of the two pins indicated on the 8 pin IC.

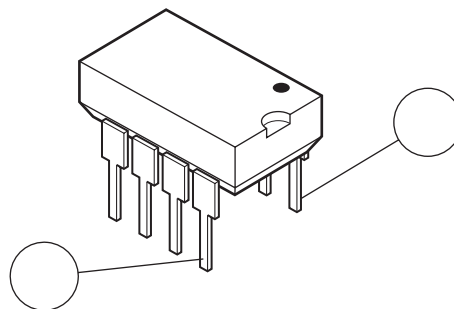


Fig. 18

[2]

- (b) A warning device is required to indicate when the temperature falls below a set level. The circuit shown in Fig. 19 is based on a 555 timer IC. When it has triggered, the warning LED will remain lit until the 555 timer resets.

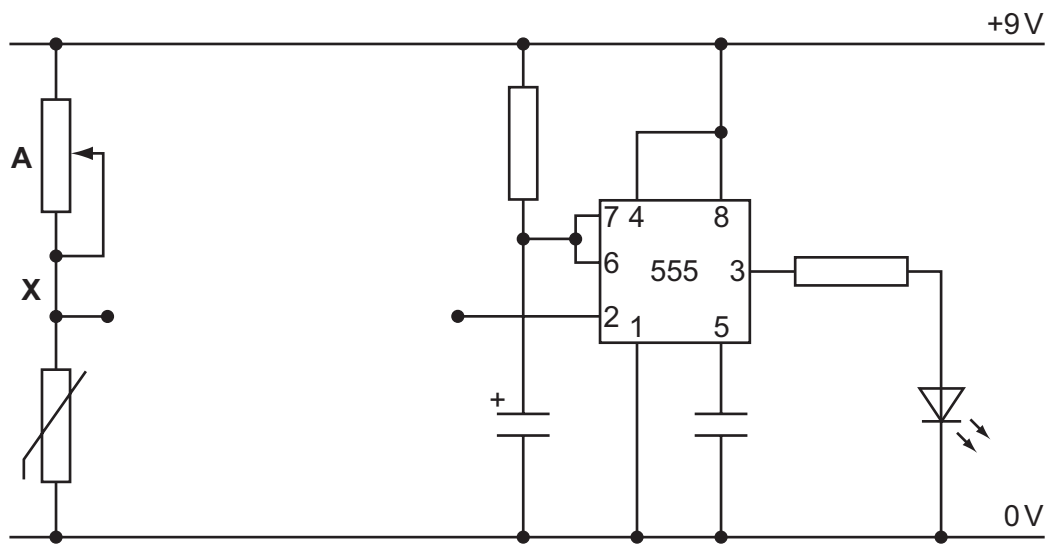


Fig. 19

- (i) Describe the purpose of component A. [1]
- .....
- (ii) Calculate the voltage at point X when component A is set at 40 kΩ and the thermistor resistance is 3 kΩ. [2]
- Use the potential divider formula  $V_{out} = \frac{R_2}{R_2 + R_1} \times V_{in}$
- .....
- .....
- .....
- (iii) A transistor switch is used between point X and pin 2 of the timer. Complete the circuit in Fig. 19 to show the transistor switch connected. [3]

(c) When the circuit is built and tested, it triggers after 7 minutes 30 seconds and the LED remains on for 10 minutes.

(i) Complete Fig. 20 to show the graph of the 555 timer output.

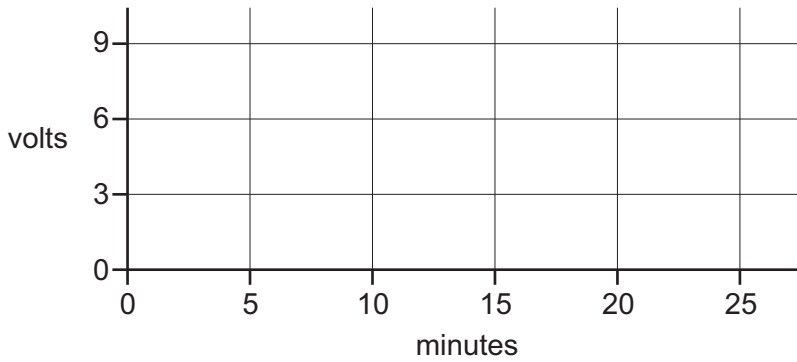


Fig. 20

[2]

(ii) The time for the LED to stay on had been calculated as 8 minutes.

Explain why the actual output time of 10 minutes does not match the calculated time.

.....  
..... [2]

(d) A multimeter is to be used to measure the current flow in the circuit.

Complete Fig. 21 to show:

- the correct setting on the multimeter dial;
- the correct connections to the circuit and battery.

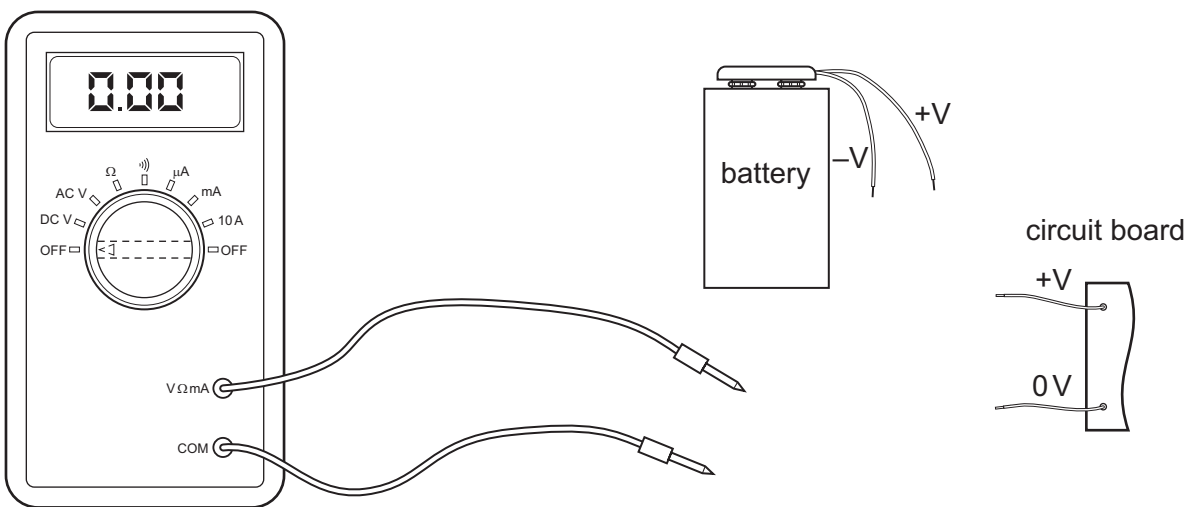
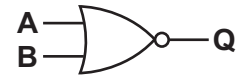
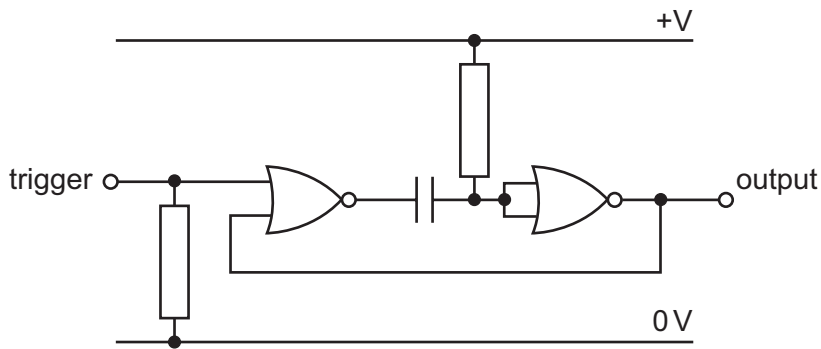


Fig. 21

[3]



(e) A circuit for a short time delay can be made from logic gates as shown in Fig. 22.



A	B	Q
0	0	
0	1	
1	0	
1	1	

Fig. 22

(i) State the name of the logic gate used in the circuit.

..... [1]

(ii) Complete the truth table in Fig. 22 for the type of logic gate used.

[1]

(iii) One of the logic gates has both inputs joined.

Describe the effect of this on the output of the logic gate.

.....  
 .....  
 ..... [2]





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