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**DESIGN AND TECHNOLOGY**

**0445/41**

Paper 4 Systems and Control

**May/June 2014**

**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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, 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 |  |
|--------------------|--|
| <b>Section A</b>   |  |
| <b>Section B</b>   |  |
| <b>Total</b>       |  |

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

**Section A**

Answer **all** questions in this section.

1 Give **two** examples of natural frame structures.

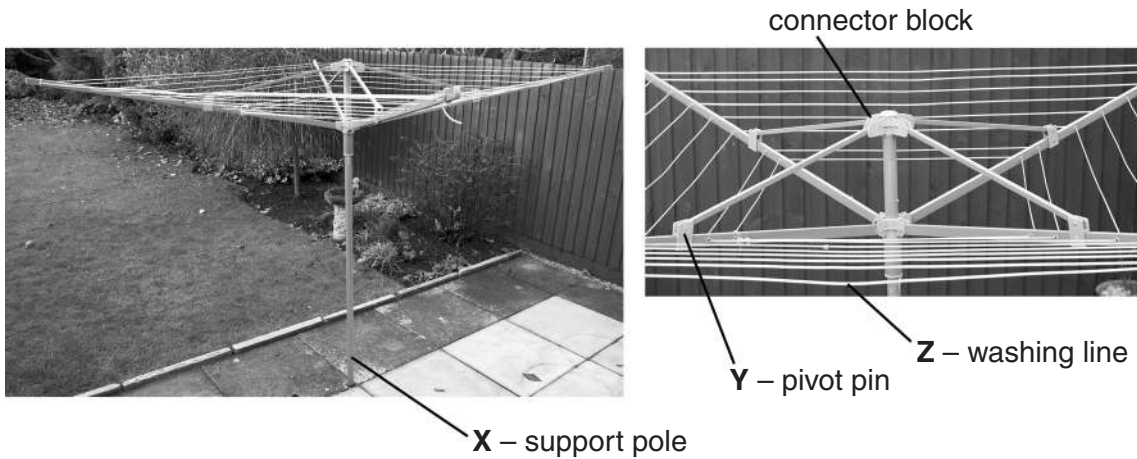
1 .....

2 ..... [2]

2 State the name for a beam that is supported at one end only.

..... [1]

3 (a) Fig. 1 shows views of a rotary clothes drier positioned in a garden.



**Fig. 1**

Name the force that will be applied to the labelled parts of the structure when the rotary clothes drier is in use.

**X** ..... [1]

**Y** ..... [1]

**Z** ..... [1]

(b) Name **one** suitable non-ferrous metal for the clothes drier frame.

..... [1]

(c) Name **one** suitable plastics material for the connector block that joins the parts of the metal frame.

..... [1]

4 (a) Fig. 2 shows three circuit symbols and drawings of five components.

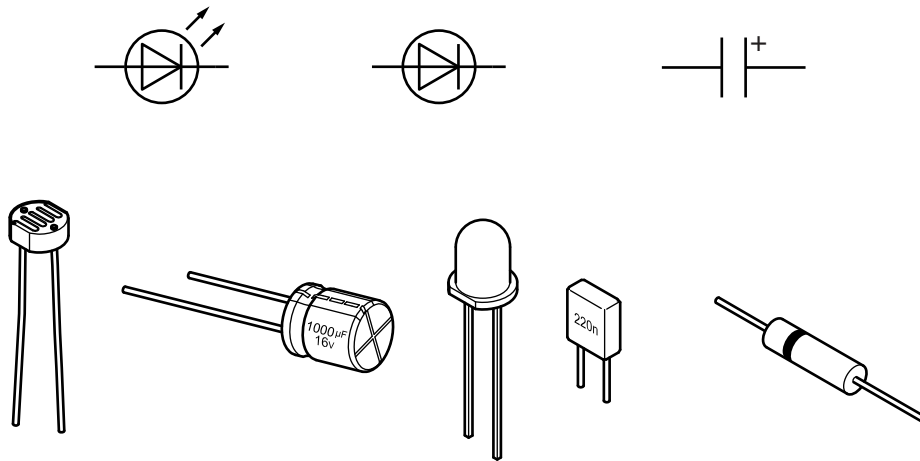


Fig. 2

Draw a line from each circuit symbol to the component that matches the symbol. [3]

(b) The circuit symbols in Fig. 2 are polarised. State what is meant by a 'polarised' component.

.....  
 ..... [1]

5 (a) Fig. 3 shows a relay with the cover removed.

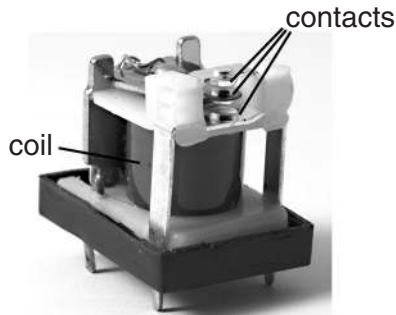


Fig. 3

Describe what will happen when the relay coil is connected to a power supply.

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

(b) Give the name of **one** other component that makes use of a coil.

..... [1]

- 6 A pair of snips used for cutting sheet metal is shown in Fig. 4. The snips use a compound lever action.

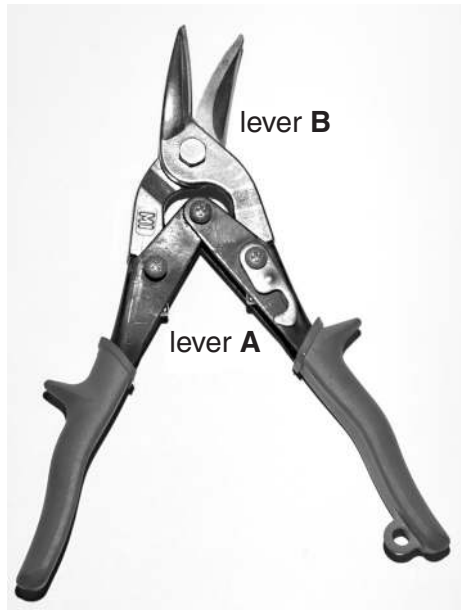


Fig. 4

- (a) Mark the position of the load, effort and fulcrum for lever **A** on Fig. 4. [3]

- (b) State the class of lever **B**.

..... [1]

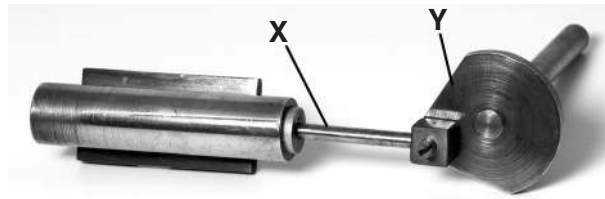
- 7 Give **two** reasons for using a compound lever in a mechanism.

1 .....

2 .....

[2]

8 Fig. 5 shows parts of a model steam engine.



**Fig. 5**

(a) Name parts **X** and **Y** in the mechanism used to convert reciprocating movement to rotary movement.

**X** .....

**Y** ..... [2]

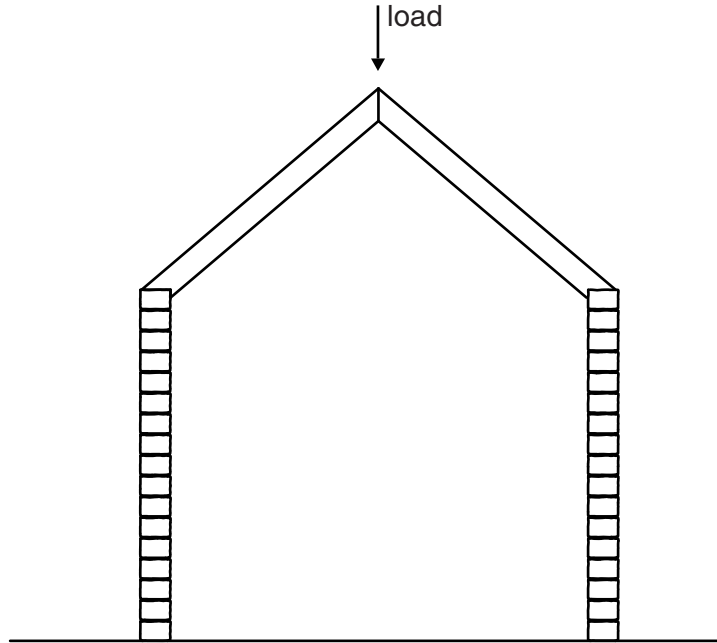
(b) Name a different mechanism to Fig. 5 that will convert rotary movement to reciprocating movement.

..... [2]

**Section B**

Answer **one** question from this section.

- 9 (a) Fig. 6 shows a section through a stone building and the position of the roof timbers.



**Fig. 6**

- (i) Draw on Fig. 6 to show **one** method of preventing the roof timbers from moving outwards when a load is applied to the roof. [2]
- (ii) Draw on Fig. 6 to show **one** method of preventing the walls from bowing out if no alteration is made to the roof timbers. [2]

(b) Composite materials are often used in structures.

- (i) Give **two** examples of composite materials.

1 .....

2 ..... [2]

- (ii) Explain why composite materials are used in a structure.

.....

.....

..... [2]

(c) Fig. 7 shows the wings of a biplane.



**Fig. 7**

(i) Add labels to Fig. 7 to identify a strut and a tie. [2]

(ii) Name the force resisted by a strut.

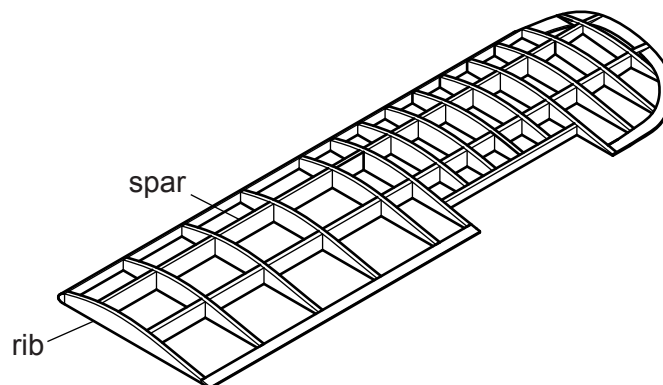
..... [1]

(iii) Name the force resisted by a tie.

..... [1]

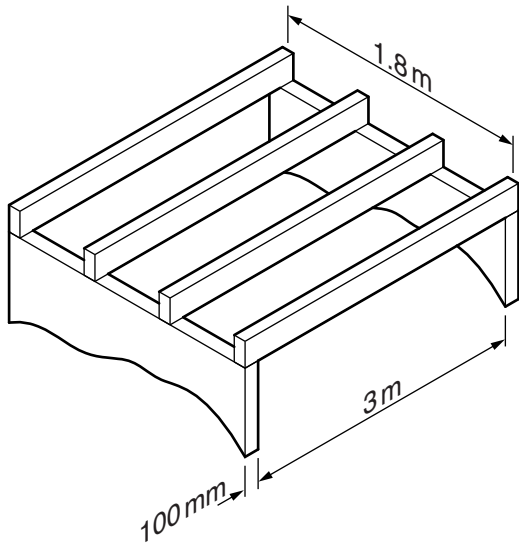
(iv) The wings of the biplane are made from ribs and spars as shown in Fig. 8. State the name for this type of structure.

..... [1]



**Fig. 8**

- (d) Fig. 9 shows two supporting walls with joists for a floor. The table shows the size and spacing of available joists.



**Floor Joist sizes and spans**

Maximum span in metres for joist spacing of

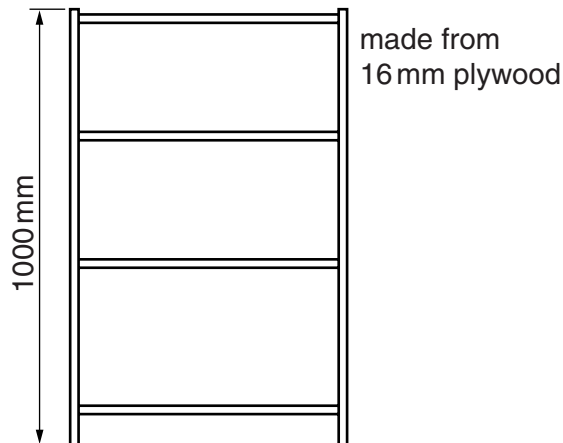
| Size of joists | 400 mm | 450 mm | 600 mm |
|----------------|--------|--------|--------|
| 97 × 47        | 1.93   | 1.82   | 1.47   |
| 145 × 47       | 2.99   | 2.92   | 2.59   |
| 170 × 47       | 3.55   | 3.42   | 2.95   |
| 195 × 47       | 4.07   | 3.91   | 3.41   |

**Fig. 9**

- (i) Choose the joist size and spacing which is the best match to the span.

Size of joist ..... × ..... Spacing..... [3]

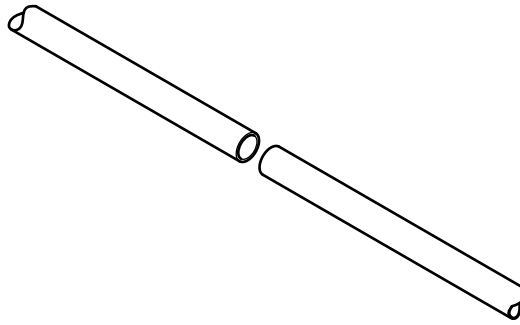
- (ii) Fig. 10 shows a design for a bookcase to be made from manufactured board. Use sketches and notes to show how the shelves can be prevented from bending due to the weight of books. Include details of materials and construction used.



**Fig. 10**



- (e) Fig. 11 shows two  $\text{Ø}25\text{mm}$  steel tubes that will be joined end to end to provide an extended length. Welding the tube end to end would not be structurally sound.



**Fig. 11**

Use sketches and notes to show how the steel tubes can be joined so that they are in line and the joint will resist bending. [3]

- (f) Cranes and other lifting devices have the safe working load marked clearly on them. Explain what is meant by the term 'safe working load'. Make reference to 'safety factor' in your answer.

.....

.....

..... [3]

10 Fig. 12 shows details of a 0 – 25mm micrometer screw gauge used for taking accurate measurements.

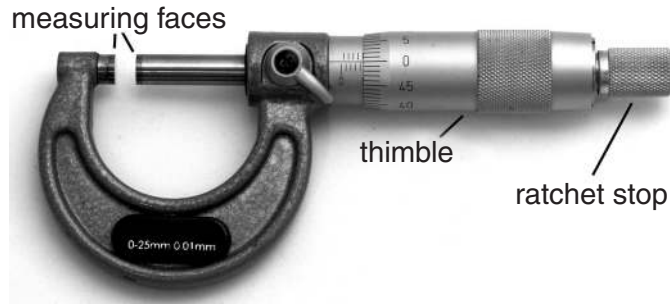
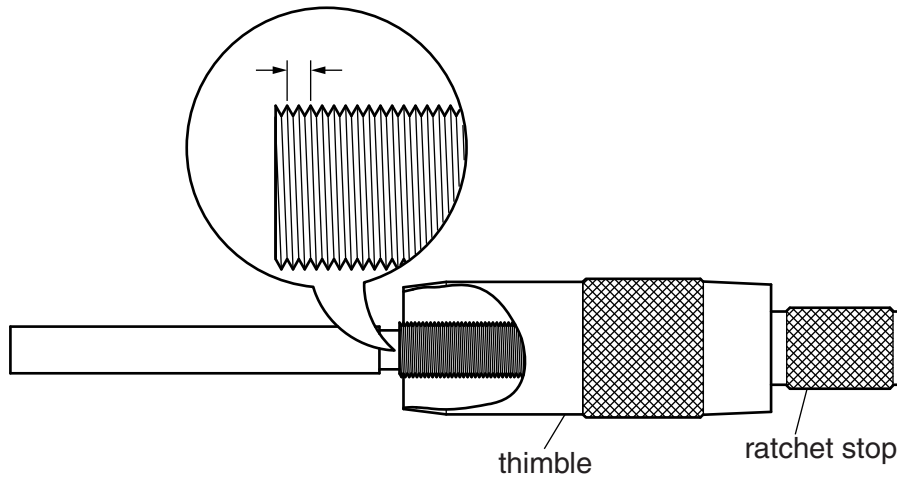


Fig. 12

(a) The micrometer screw gauge opens or closes exactly 0.5 mm for each complete turn of the thimble.

(i) Complete Fig. 13 by adding a measurement to the dimension.



[1]

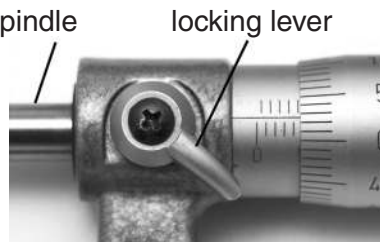
Fig. 13

(ii) State the number of turns of the thimble needed to close the micrometer from 25 mm to 17 mm.

.....[1]

(iii) The ratchet stop includes a ratchet and pawl mechanism to avoid over-tightening. Use sketches and notes to show how a ratchet and pawl mechanism operates. [3]

- (iv) When the locking lever shown in Fig. 14 is moved clockwise it locks the spindle in place.

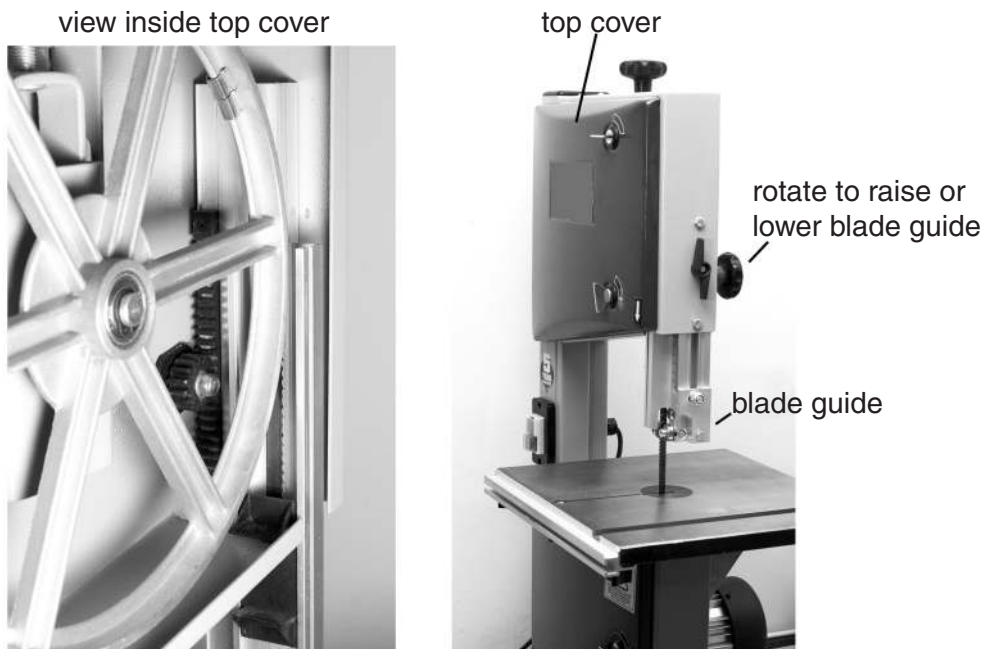


**Fig. 14**

State the class of lever that is used.

..... [1]

- (b) Fig. 15 shows a small bandsaw and the mechanism used to adjust the height of the blade guide.



**Fig. 15**

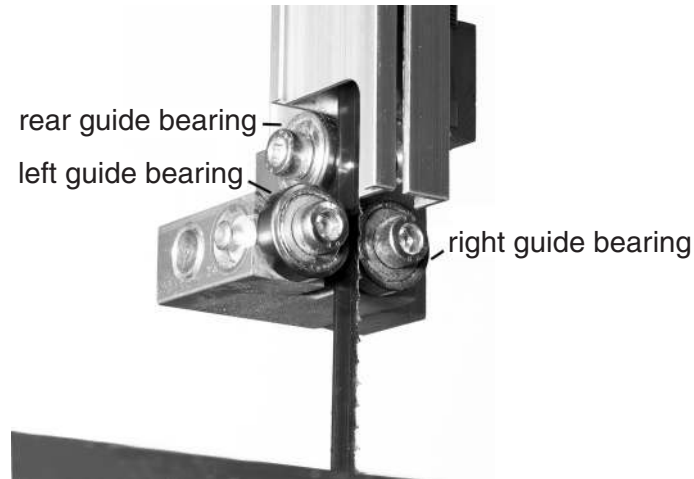
- (i) Name the mechanism used for adjusting the height of the blade guide.

..... [2]

- (ii) State the conversion of motion that takes place when the mechanism is used.

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

(iii) Fig. 16 shows three 'sealed for life' ball bearings used to guide and support the blade.



**Fig. 16**

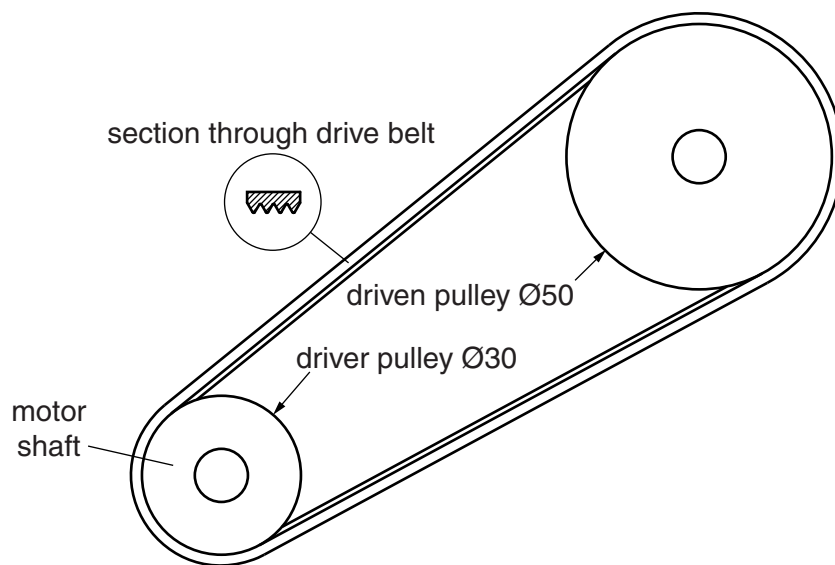
Give **two** benefits of using ball bearings rather than plain bearings.

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

(iv) Give **two** reasons why 'sealed for life' bearings are specified for the bandsaw.

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

(c) The bandsaw drive wheel is connected to the motor by the belt and pulley shown in Fig. 17.



**Fig. 17**

(i) Explain why this type of belt has been chosen rather than a flat belt.

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

(ii) The driving pulley has a diameter of 30 mm, the driven pulley has a diameter of 50 mm. Describe the effect of using these pulleys.

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

(iii) Calculate the speed of the motor when the driven pulley is turning at 840 rpm.

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

(iv) Use sketches and notes to show **two** different ways of transmitting motion from a motor to a final drive other than a belt and pulley system.

[4]

- 11 (a) Complete the table below to show units for resistance and capacitance in order of value. Two have been done for you.

|             |          |  |       |
|-------------|----------|--|-------|
|             | small    |  | large |
| resistance  | $\Omega$ |  |       |
| capacitance |          |  | F     |

$\Omega$                        $\mu\text{F}$                        $\text{M}\Omega$                        $\text{pF}$                        $\text{k}\Omega$                       F

[4]

- (b) Fig. 18 shows four switch symbols.

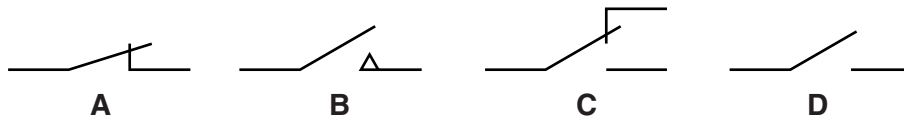


Fig. 18

- (i) State which symbol shows a SPDT switch.

..... [1]

- (ii) Explain the difference in action between a toggle switch and a push to make switch.

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

- (c) (i) Fig. 19 shows a circuit to charge and discharge a capacitor through a resistor.

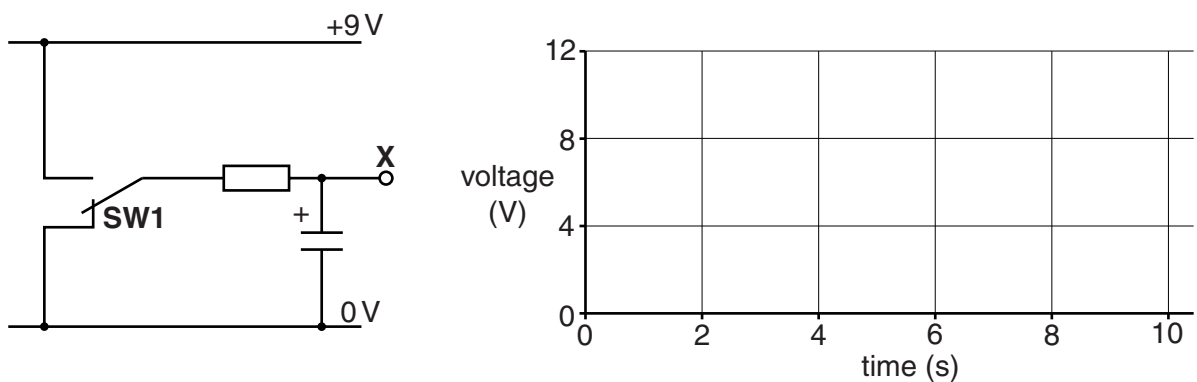


Fig. 19

Complete the graph to show the voltage at X when SW1 is connected to the power for 5 seconds and is then switched back to connect to 0V. [3]

(ii) The circuit in Fig. 20 uses a resistor and capacitor to provide a delay.

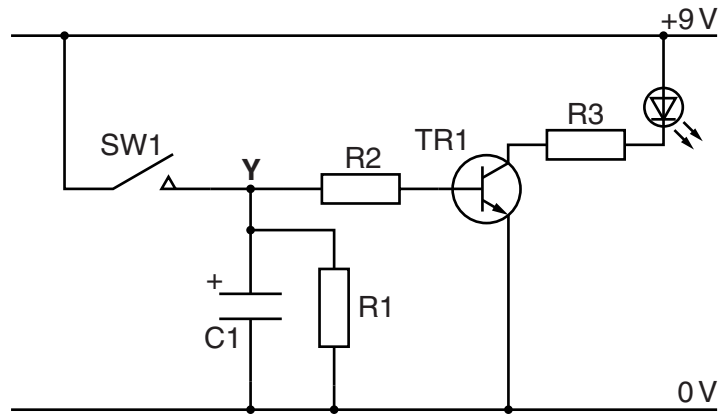


Fig. 20

Give **two** ways by which the delay in the circuit can be increased.

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

(iii) State the approximate voltage at **Y** when the LED switches off.

..... [1]

(d) An alarm system uses inputs from two sensors as shown in Fig. 21.

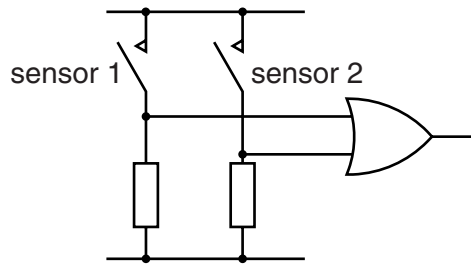


Fig. 21

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

..... [1]

(ii) Complete the truth table below for the logic gate.

| in 1 | in 2 | out |
|------|------|-----|
| 0    | 0    |     |
| 0    | 1    |     |
| 1    | 0    |     |
| 1    | 1    |     |

[2]

(iii) Fig. 22 shows two logic gates that could be used as an alternative.

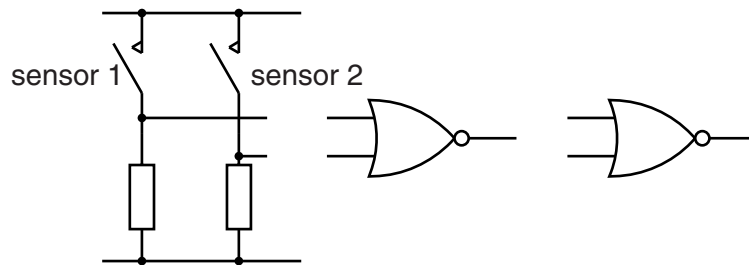


Fig. 22

Complete the connections to make the same logic as shown in Fig. 21.

[2]



(e) When an alarm system is triggered the output needs to be latched.

(i) Explain why a 'latched' signal is needed for the output of the alarm system.

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

(ii) The circuit in Fig. 23 uses a relay to latch the output signal from an alarm.

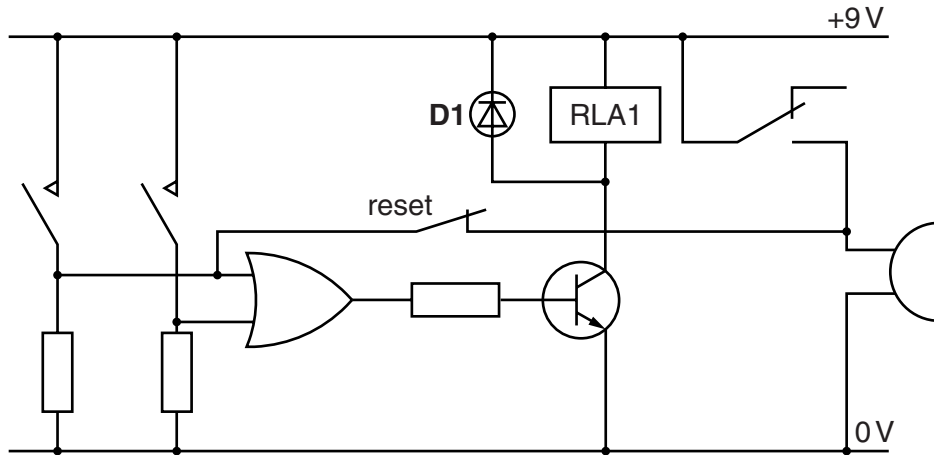


Fig. 23

Explain how the latching action operates.

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

(iii) Give the purpose of **D1** in the circuit.

..... [1]

(iv) The relay coil has a resistance of 100 ohms.  
 Calculate the current that will pass through the collector-emitter circuit of the transistor.

Use the formula  $I = \frac{V}{R}$

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





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