# Cambridge IGCSE™

**DESIGN & TECHNOLOGY**  **0445/43**

Paper 4 Systems & Control  **May/June 2021**

**1 hour**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **one** question.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Answer in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

## INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [  ].
- All dimensions are in millimetres.

This document has **20** pages. Any blank pages are indicated.

**[Turn over**

## Section A

Answer **all** questions in this section.

1   A list of materials that can be used in a structure is given below.

**Softwood      Concrete      Steel**

For each material give **one** different property that makes it suitable for use in a structure.

Softwood ...........................................................................................................................

Concrete ...........................................................................................................................

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

2   Use sketches and notes to show how triangulation can be used to prevent a rectangular window frame from distorting while it is being fitted.

[2]

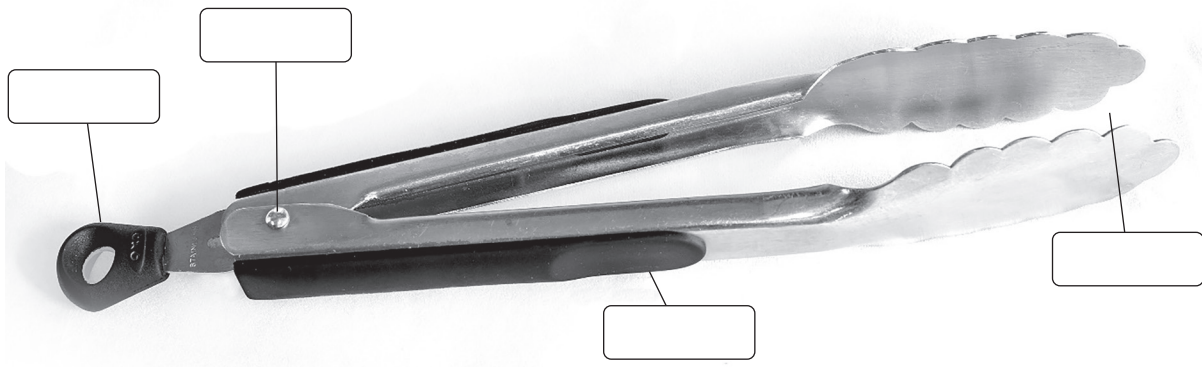**3** Fig. 3.1 shows salad tongs, which are an example of a third order lever.



**Fig. 3.1**

**(a)** Add the positions of the **fulcrum**, **effort** and **load** to Fig. 3.1. [3]

**(b)** Explain how a third order lever is different to first and second order levers.

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**4** Spur gears can be made from brass, nylon or steel.

**(a)** Give **one** different reason for choosing each of these materials.

Brass ................................................................................................................................

Nylon ................................................................................................................................

Steel ................................................................................................................................

[3]

**(b)** Name the applied load that could cause teeth on a spur gear to break off.

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

5   Fig. 5.1 shows a hand held moisture meter for testing moisture content in wood.



hand held moisture meter          meter in use on softwood

**Fig. 5.1**

Give **two** ergonomic features that have been considered in the design of the hand held moisture meter.

1 ...............................................................................................................................................

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

6   Describe the purpose of a specification when designing and making.

    ...............................................................................................................................................

    ...............................................................................................................................................

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

7   Give **two** benefits of using a CNC machine for manufacturing a batch of products.

1 ...............................................................................................................................................

    ...............................................................................................................................................

2 ...............................................................................................................................................

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

**8** Fig. 8.1 shows a simple electronic circuit.
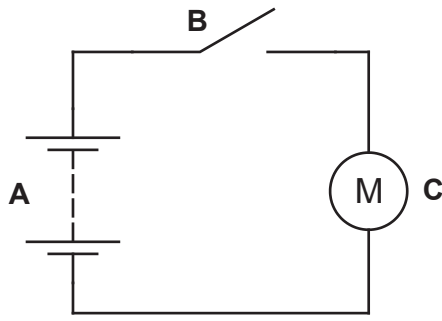


**Fig. 8.1**

Give the names of the components, **A**, **B** and **C** used in the circuit.

**A** ................................................................................................................................................

**B** ................................................................................................................................................

**C** ................................................................................................................................................
[3]

**9** Fig 9.1 shows a toggle switch.
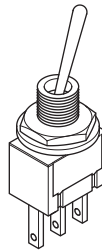


**Fig. 9.1**

Describe the action of the switch.

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**Section B**

Answer **one** question from this section.

**10 (a)** Fig. 10.1 shows a 27 m high structure used to support an illuminated star.
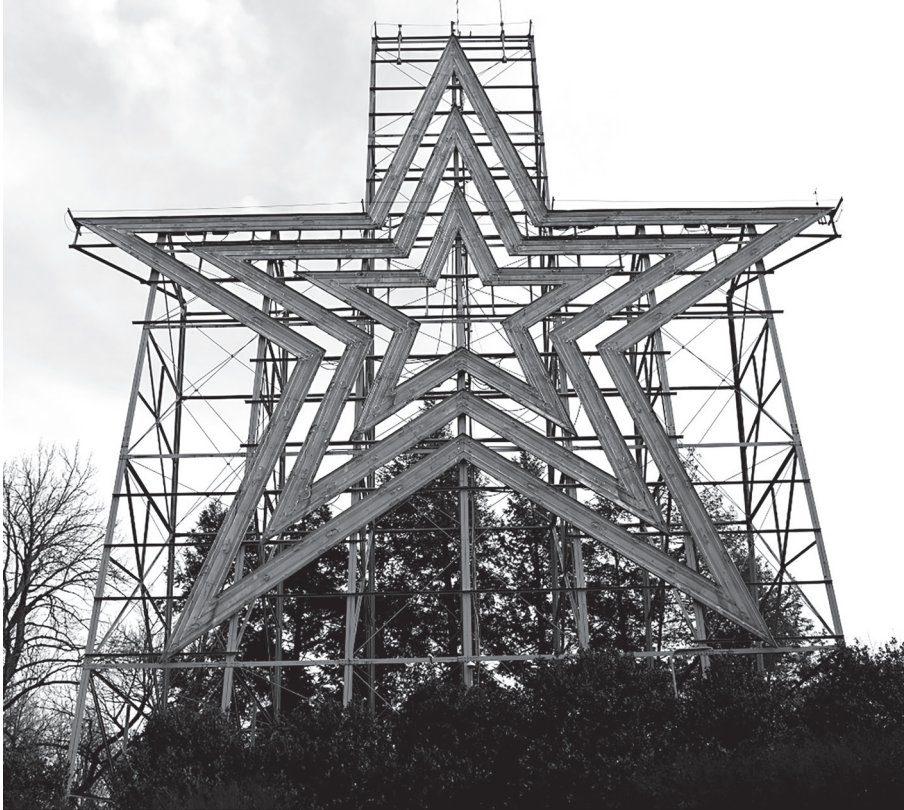


**Fig. 10.1**

**(i)** Name **two** stationary and **two** moving loads that will affect the stability of the structure.

Stationary Loads

1 ........................................................................................................................................

2 ........................................................................................................................................

Moving Loads

1 ........................................................................................................................................

2 ........................................................................................................................................

[4]

**(ii)** Ties and struts are used to keep the illuminated star structure rigid.
State **one** force resisted by a tie and **one** force resisted by a strut.

Tie ....................................................................................................................................

Strut ..................................................................................................................................

[2]

   **(iii)** Give **one** advantage and **one** disadvantage of using struts, rather than ties in the structure.

      Advantage ...................................................................................................................

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

**(b)** Fig. 10.2 shows part of a structure that has been joined using three bolts and nuts.



steel strip 70 x 10

3 x M10 bolts x 30 long
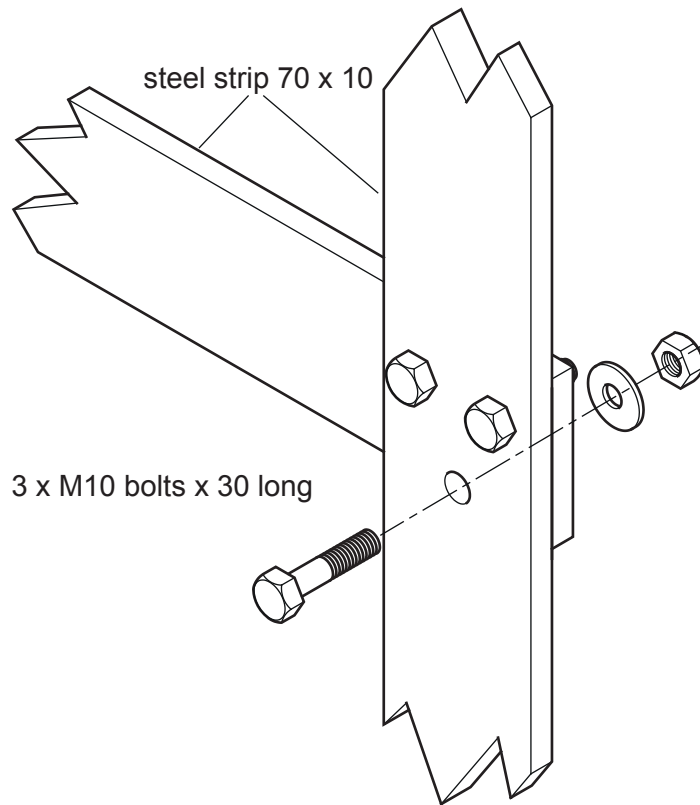
**Fig. 10.2**

   **(i)** Explain why more than one bolt is required in the joint.

      ...................................................................................................................................

      ...................................................................................................................................

      ...................................................................................................................................

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

**(ii)** When the nut is fully tight, the 30 mm length of bolt passing through the plate has stretched to 30.1 mm.
Calculate the strain in the bolt.

Use the formula: $\text{Strain} = \dfrac{\text{change in length}}{\text{original length}}$

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.......................................................................................................................................

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

**(iii)** Explain how torsion and shear could affect the bolt and its threads if the nut is over-tightened.

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

**(iv)** Give **two** possible reasons for joining the materials with bolts and nuts rather than welding the materials together.

1 ....................................................................................................................................

2 ....................................................................................................................................

[2]

**(c)** Fig. 10.3 shows two methods of extending the length of a wooden beam.
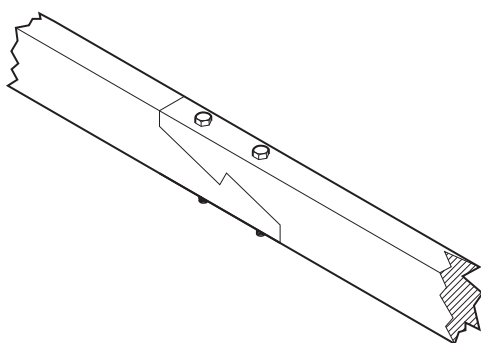
Method **A** − cut joint with reinforcing bolts        Method **B** − beam ends cut square with bolted plates either side
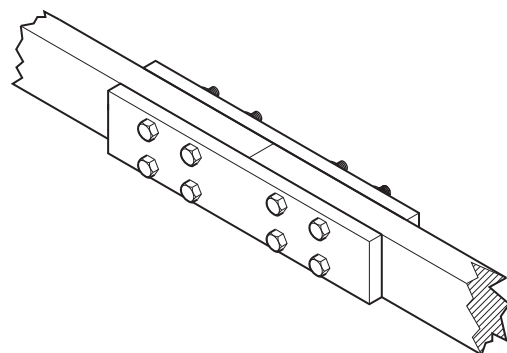
**Fig. 10.3**

**(i)** Give **one** reason why extending a wooden beam may be necessary.

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

**(ii)** Describe **one** advantage of method **B** when compared to method **A**.

..........................................................................................................................................

..........................................................................................................................................

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

**(iii)** Laminating is another way of making a long beam.
Use sketches and notes to show a laminated beam.

[2]

**(d)** Fig. 10.4 shows a playground see-saw mounted on a hard rubber spring.



hard rubber spring
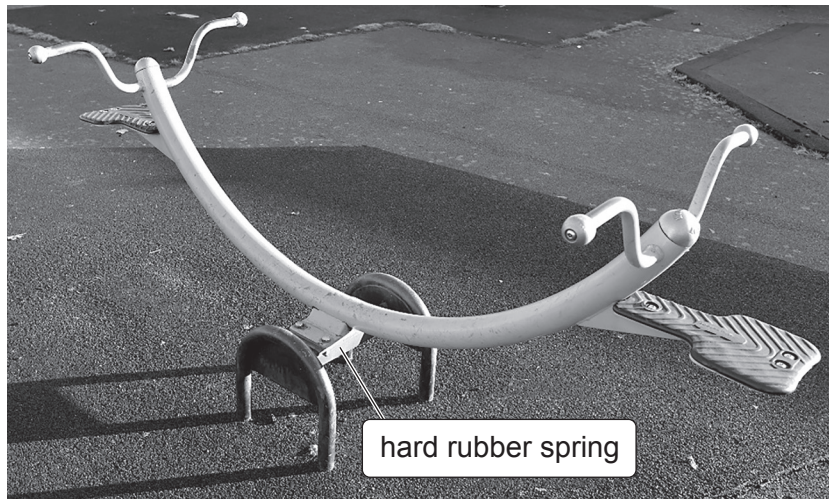
**Fig. 10.4**

Explain why the see-saw may not be in a state of equilibrium when it is in use.

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

11 (a) (i) Use sketches and notes to show the meaning of the term 'dwell' in a cam.

[2]

(ii) Fig. 11.1 shows the profile of a cam and a follower.



roller
follower

cam
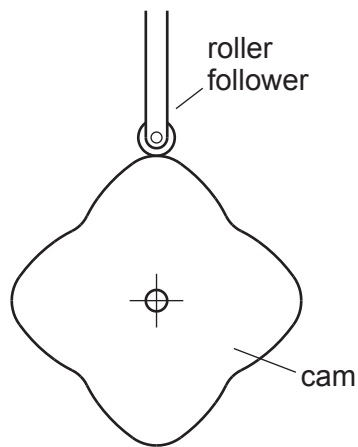
**Fig. 11.1**

Describe the movement of the follower for one rotation of the cam.

.................................................................................................................................................

.................................................................................................................................................

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

(iii) Give **one** benefit of using a roller follower for this cam.

.................................................................................................................................................

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

**(b)** Fig. 11.2 shows a ratchet and pawl mechanism used to tension a fence wire.



fence wire

tapered square head
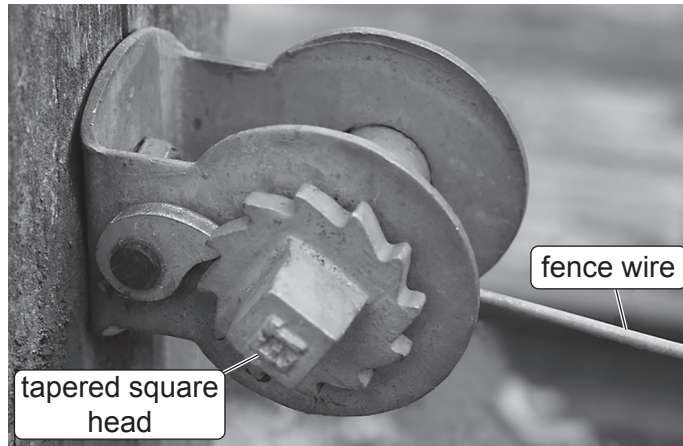
**Fig. 11.2**

(i) Explain how a ratchet and pawl mechanism operates.

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...................................................................................................................................

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

(ii) Use sketches and notes to show a design for a tool suitable for turning the tapered square head on the mechanism.

[3]

(iii) Give **one** possible reason for the taper on the square head.

...................................................................................................................................

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

(iv) Describe how the tension in the fence wire can be released.

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

**(c)** Fig 11.3 shows a compound pulley system that transfers drive from an electric motor to a small lathe. The system uses two belts.
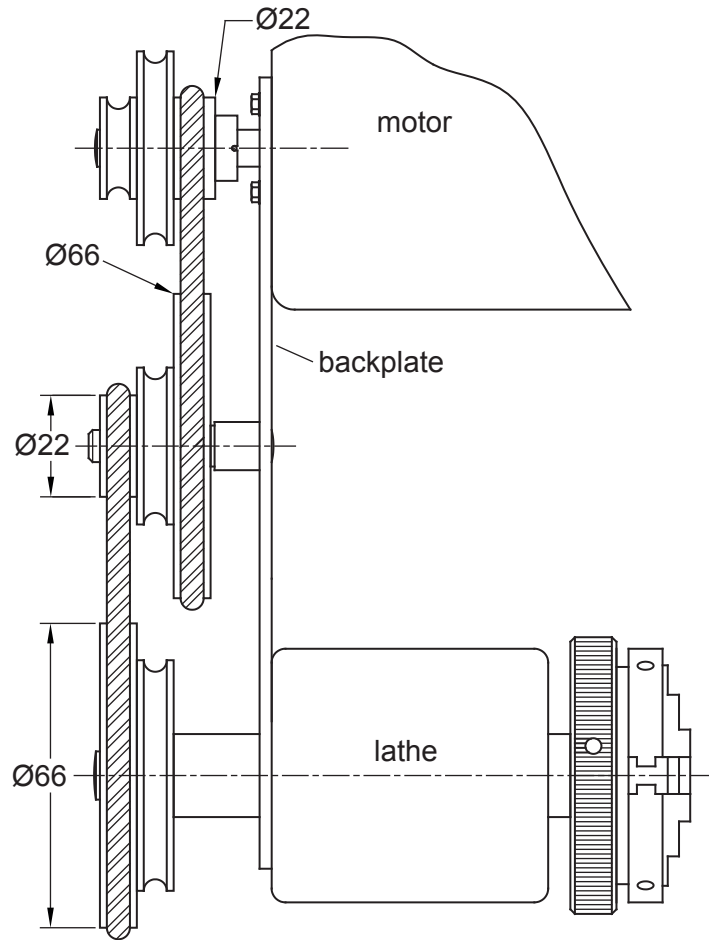


**Fig. 11.3**

**(i)** Calculate the output speed to the lathe with the belts in the position shown.
The motor is turning at 1215 rpm.

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

**(ii)** Fig. 11.4 shows how the motor is mounted onto the backplate.
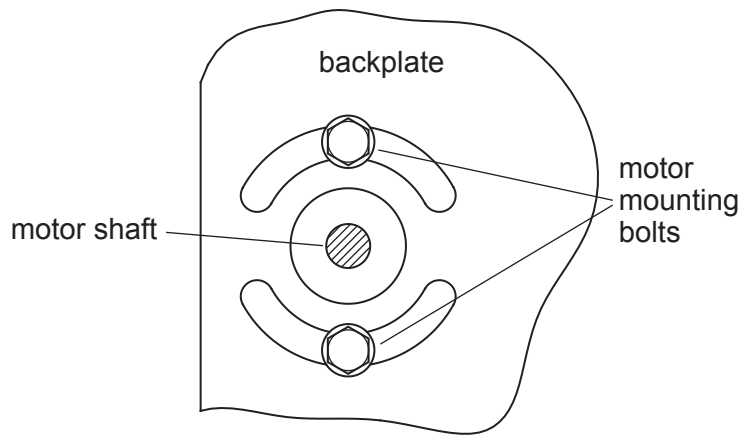


**Fig. 11.4**

Give **one** reason why slots are used instead of round holes to mount the motor.

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

**(d)** Fig 11.5 shows a drill chuck and chuck key.
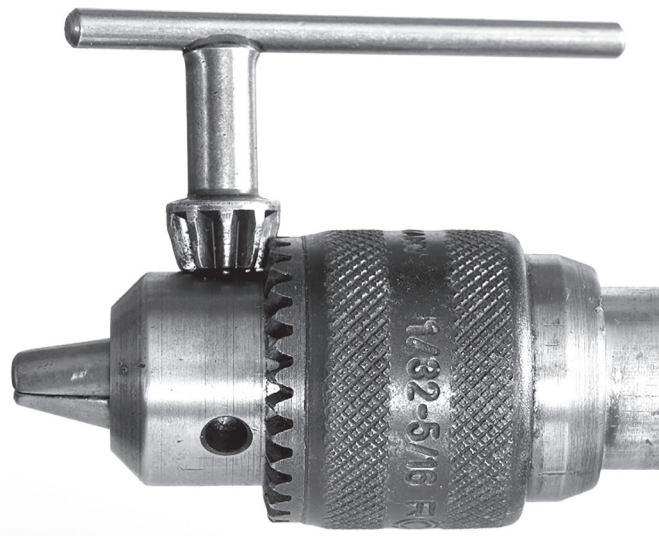


**Fig. 11.5**

**(i)** State the type of gear that is used between the drill chuck and chuck key.

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

**(ii)** Describe the **two** features in Fig. 11.5 that together provide the mechanical advantage of the chuck key.

1 ..........................................................................................................................................

...............................................................................................................................................

2 ..........................................................................................................................................

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

**(iii)** The axes of the chuck and chuck key are at 90° to each other.
A worm gear is another type of gear that will connect axes at 90° to each other.
Give **two** reasons for using a worm gear in a mechanism.

1 ..........................................................................................................................................

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2 ..........................................................................................................................................

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

**12 (a)** Fig. 12.1 shows a resistor colour code chart and a fixed resistor.

| Colour | Band 1 | Band 2 | Multiplier | Tolerance |
|--------|--------|--------|------------|-----------|
| Black | 0 | 0 | × 1 | |
| Brown | 1 | 1 | × 10 | ± 1% |
| Red | 2 | 2 | × 100 | ± 2% |
| Orange | 3 | 3 | × 1K | |
| Yellow | 4 | 4 | × 10K | |
| Green | 5 | 5 | × 100K | ± 0.5% |
| Blue | 6 | 6 | × 1M | |
| Violet | 7 | 7 | × 10M | |
| Grey | 8 | 8 | | |
| White | 9 | 9 | | |
| Gold | | | × .1 | ± 5% |
| Silver | | | × .01 | ±10% |
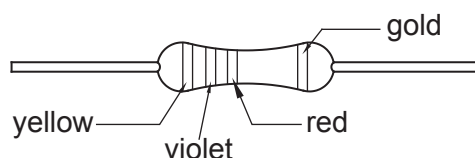


**Fig. 12.1**

**(i)** Describe the information given by the coloured bands on the resistor, including the tolerance band.

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

**(ii)** State the value of the resistor.

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

**(iii)** Give the range of resistance values that could be expected in a large batch of these resistors.

Lowest value ...........................................................................................................................

Highest value ..........................................................................................................................

[2]

**(iv)** Calculate the power rating of a 100 Ω resistor used in a 9 V circuit.

Use the formulae: $I = V/R$ and $P = V \times I$

Circle the most suitable resistor from the list below.

**0.25 W**      **0.33 W**      **1 W**      **5 W**      **0.125 W**      **0.5 W**

[3]

**(b)** Fig. 12.2 shows one method of forming an electrical connection in a circuit.



screw terminal block
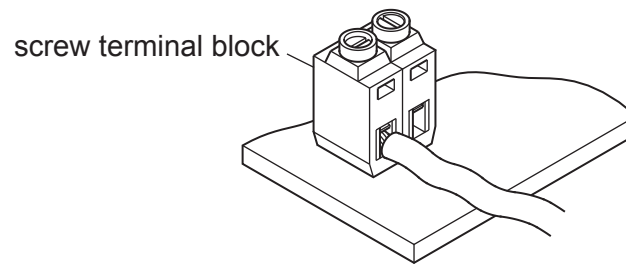
**Fig. 12.2**

**(i)** Use sketches and notes to show **two** different methods of making electrical connections. Show **one** temporary method and **one** permanent method.

Temporary method

Permanent method

[2]

**(ii)** Fig. 12.3 shows a multimeter that will be used to test the connection between the terminal block screw and connected wire in Fig. 12.2.
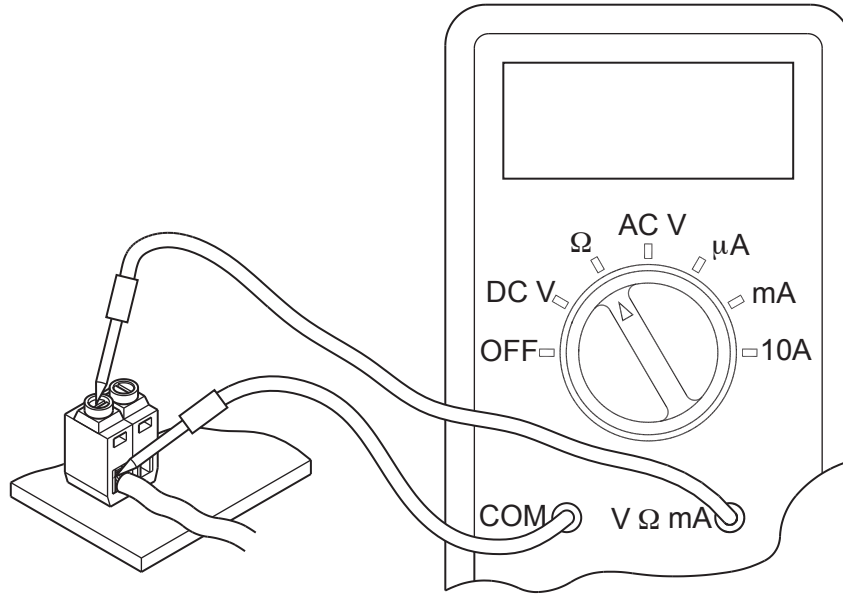


**Fig. 12.3**

State what is being measured by the multimeter on the Ω setting.

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

**(iii)** State the meaning of the following readings on the multimeter screen.

*0.00* ..........................................................................................................................

*1* ..........................................................................................................................

[2]

**(c)** Many electronic signals are very brief and do not give enough time for an indicator LED to light when testing for the signal.
To make the signal visible a 555 monostable circuit can be used to extend the length of the signal.

**(i)** The brief electronic signal will be passed through a NOT gate to provide a high to low signal to trigger the 555 monostable circuit.
Draw the symbol for a NOT gate.

[1]

**(ii)** The electronic signal to be tested is shown in Fig. 12.4a.
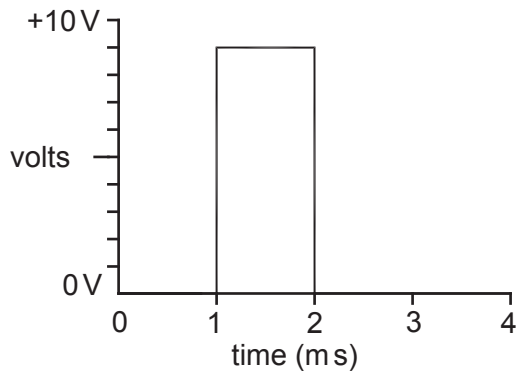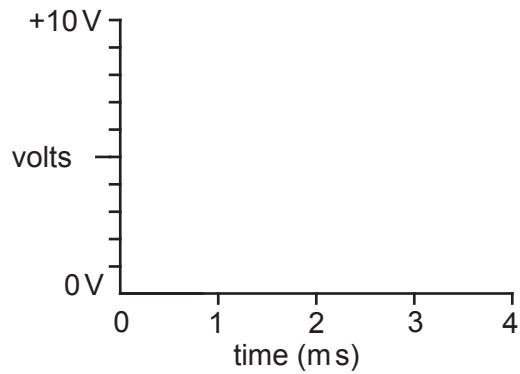


**Fig. 12.4a**                          **Fig. 12.4b**

Complete Fig. 12.4b to show the result of passing the signal through a NOT gate.    [1]

**(iii)** Fig. 12.5 shows the 555 Monostable circuit.
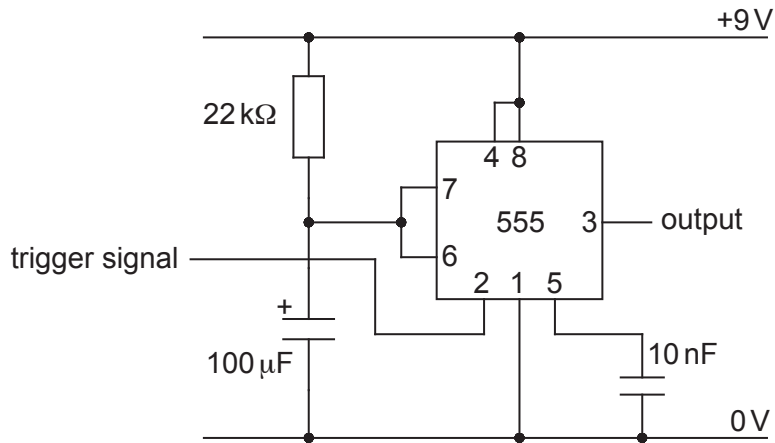


**Fig. 12.5**

Calculate the length of the output signal from the circuit.
Use the formula: t = 1.1 RC.

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

**(iv)** A polarised capacitor and a non-polarised capacitor are used in the circuit.
Describe the difference between the two types of capacitor.

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

**(d)** Fig. 12.6 shows a 6 V relay and the circuit symbol for the relay.
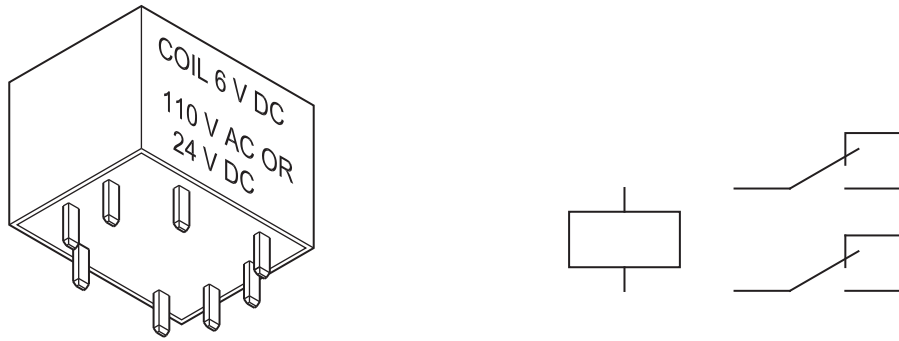


**Fig. 12.6**

**(i)** State **two** pieces of information that could appear in a catalogue to describe the 6 V relay.

1 ......................................................................................................................................

2 ......................................................................................................................................

[2]

**(ii)** State why a diode is used in any relay driver circuit that includes a transistor.

...........................................................................................................................................

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

**(iii)** Draw a diode in the correct position on the circuit in Fig. 12.7.



**Fig. 12.7**

[2]

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