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## 0445/43

May/June 2023

**1 hour**

No additional materials are needed.

- 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.

- 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.

## Section A

Answer **all** questions in this section.

- 1 (a) Name **one** example of each of the following natural structures.

Natural frame structure .....

Natural shell structure .....

Natural mass structure .....

[3]

- (b) Sketch and name **one** example of a man-made mass structure.

[1]

- 2 Fig. 2.1 shows a diving springboard.

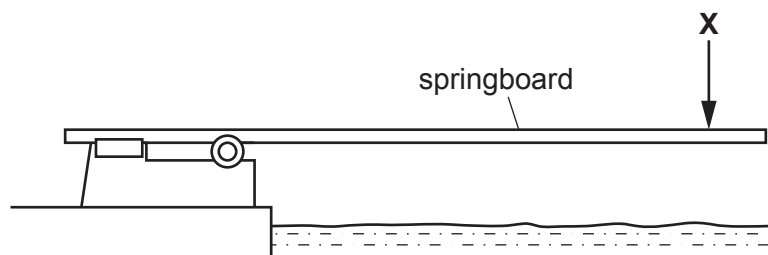


Fig. 2.1

- (a) Name **one** force that will act on the springboard, causing it to deform, when a diver jumps up and lands at point **X**.

..... [1]

- (b) The motion of the diver jumping and landing at point **X** will be converted into movement of the springboard.

State the conversion of motion that will be caused by the diver jumping up and landing at point **X**.

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

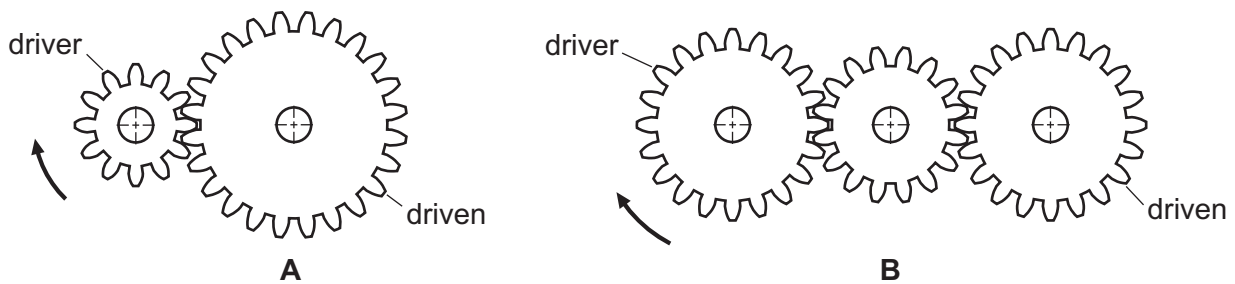
3 (a) Give **two** benefits of using CAD/CAM in batch production.

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

(b) Give **two** drawbacks of using CAD/CAM for one-off production.

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

4 Fig. 4.1 shows two arrangements of spur gears.



**Fig. 4.1**

Describe the changes in output that will occur for each arrangement of spur gears.

- A** .....
- .....
- .....
- B** .....
- .....
- .....
- [4]

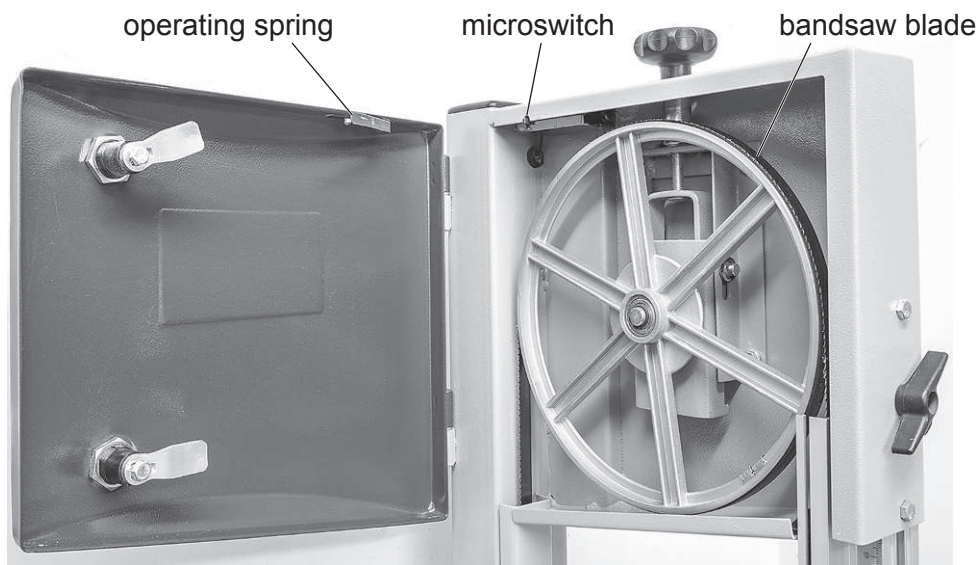
- 5 Give **one** reason for lubricating steel spur gears in a mechanism.

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

- 6 Give **one** result of **not** lubricating a mechanism running at high speed.

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

- 7 Fig. 7.1 shows a microswitch inside the casing of a bandsaw.



**Fig. 7.1**

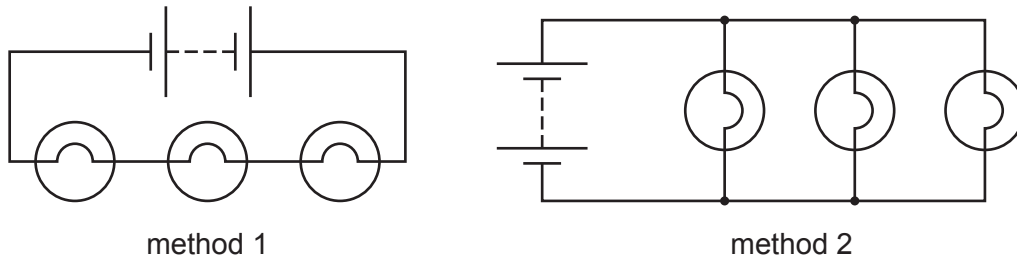
- (a) Give **one** reason why a microswitch is placed in this position.

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

- (b) The contact arrangement that will be needed on the microswitch is PTM.  
 Describe what happens when a PTM switch is operated.

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

- 8 Fig. 8.1 shows two methods of connecting lamps in a circuit.



**Fig. 8.1**

Name each method of connection.

method 1 .....

method 2 .....

[2]

- 9 Complete Table 9.1 by adding the name of each circuit symbol shown.

**Table 9.1**

| symbol | name  |
|--------|-------|
|        | ..... |
|        | ..... |
|        | ..... |

[3]

## Section B

Answer **one** question from this section.

- 10 Fig. 10.1 shows a concrete beam with two reinforcing rods running through it.

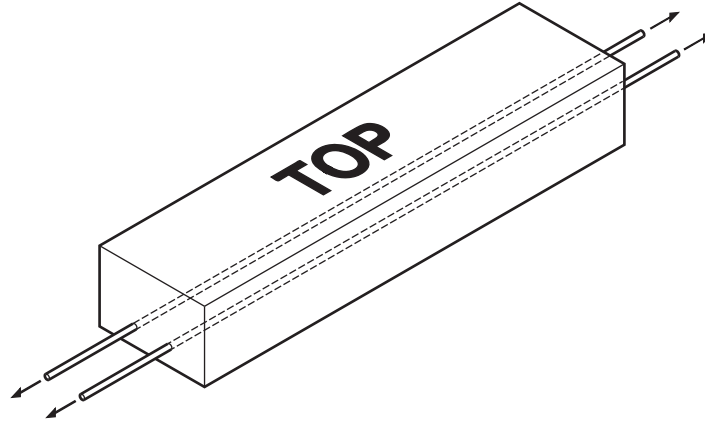


Fig. 10.1

- (a) (i) Give **one** reason for using reinforcing rods in this concrete beam.

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

- (ii) The reinforcing rods are held in tension until the concrete has set.  
 When the concrete is fully set the tension on the rods is released.  
 Explain why this is a better method than laying the reinforcing rods in the concrete without tension on them.

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

- (iii) The strain on one tensioning rod is calculated to be 0.00025 when the rod has extended by 0.3 mm.  
 Calculate the original length of the rod.

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

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

- (iv) Fig. 10.1 shows the marking on the top face of the beam.  
Explain the reason for the marking.

.....

.....

.....

..... [2]

- (b) Fig. 10.2 shows three methods of joining lengths of timber.

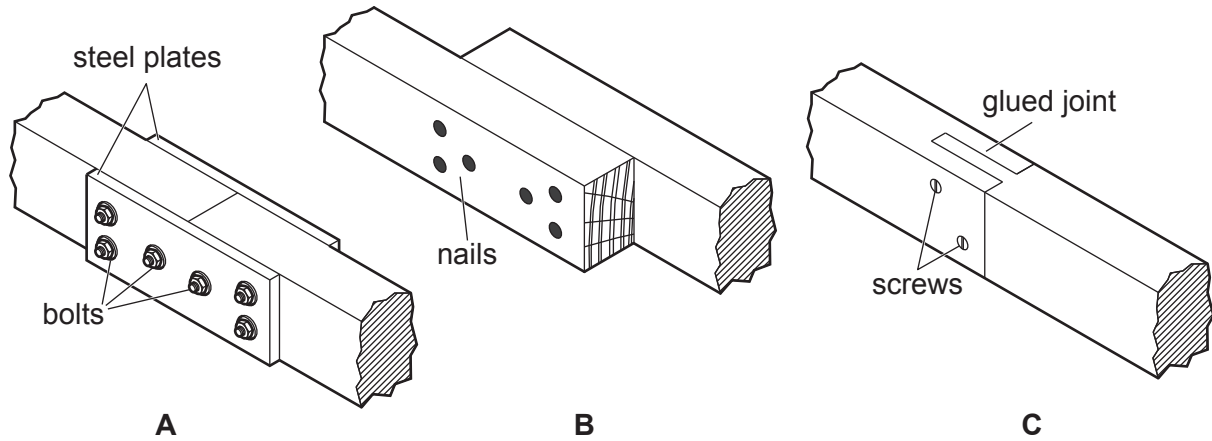


Fig. 10.2

- (i) Give **one** benefit for each method.

**A** .....

.....

**B** .....

.....

**C** .....

..... [3]

- (ii) Give **one** drawback for each method.

**A** .....

.....

**B** .....

.....

**C** .....

.....

- (iii) Describe how the fittings used for connecting the timber could be made resistant to moisture.

.....

.....

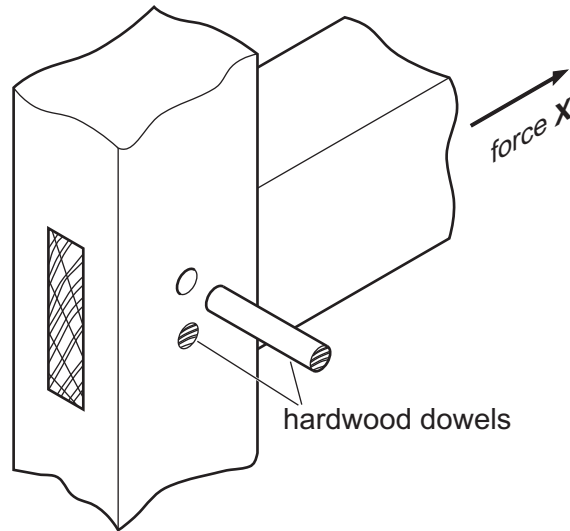
..... [2]

- (c) Joints in structures often need to be reinforced.

- (i) Use sketches and notes to show the use of the following reinforcement methods:

- gussets
- ribs
- braces.

- (ii) Fig. 10.3 shows a method of providing a right-angled joint in the framework of a timber building. Hardwood dowels are used to secure the joint.



**Fig. 10.3**

Name the force that will act on the dowels when force **X** is applied to the horizontal piece.

..... [1]

- (iii) Use sketches and notes to show **one** way of holding the parts of the joint securely in place without using screws, nails or dowels.

[2]

11 Fig. 11.1 shows a water spray bottle operated by finger pressure on the operating lever.



Fig. 11.1

- (a) (i) Add the letters 'L', 'F' and 'E' to the correct circles in Fig. 11.1 to identify the positions of the load (L), fulcrum (F) and effort (E) on the operating lever. [3]

- (ii) Explain what is meant by the mechanical advantage of a lever.

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

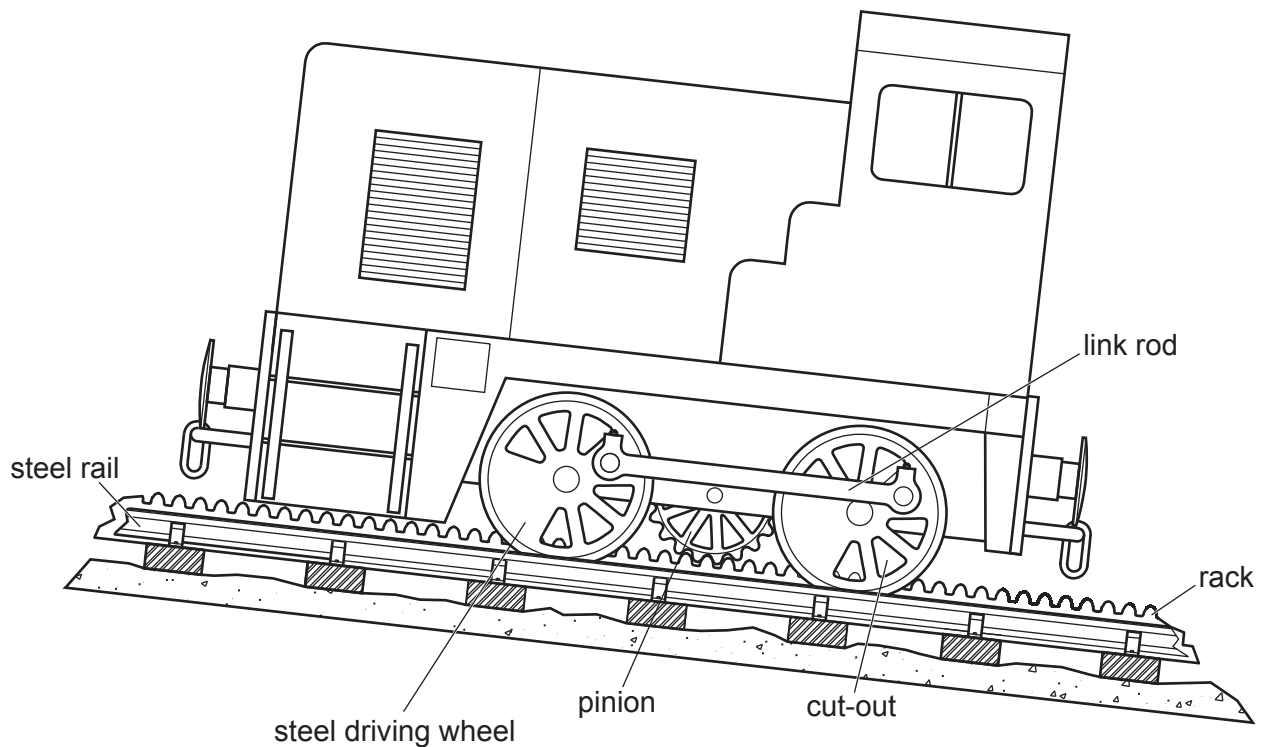
- (iii) Give **one** way of increasing the mechanical advantage of the lever in Fig. 11.1.

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

- (iv) State the order of lever used in the water spray bottle.

..... [1]

- (b) Fig. 11.2 shows a locomotive used on a rack and pinion mountain railway. The powered driving wheel on each side is connected to the other wheels with link rods.



**Fig. 11.2**

- (i) Explain why the rack and pinion gear is used in addition to a conventional system that relies on friction between the driving wheels and the rails.

.....

.....

.....

..... [3]

- (ii) Give **two** different uses for a rack and pinion gear.

1 .....

2 ..... [2]

- (iii) Describe the reason for using link rods to connect the wheels rather than gears or a belt and pulley.

.....

.....

..... [2]

- (iv) The driving wheels have cut-outs to reduce weight.  
The area opposite to where the link rods are fitted is left solid.  
Give **two** ways that these features can improve the efficiency of the drive system.

1 .....

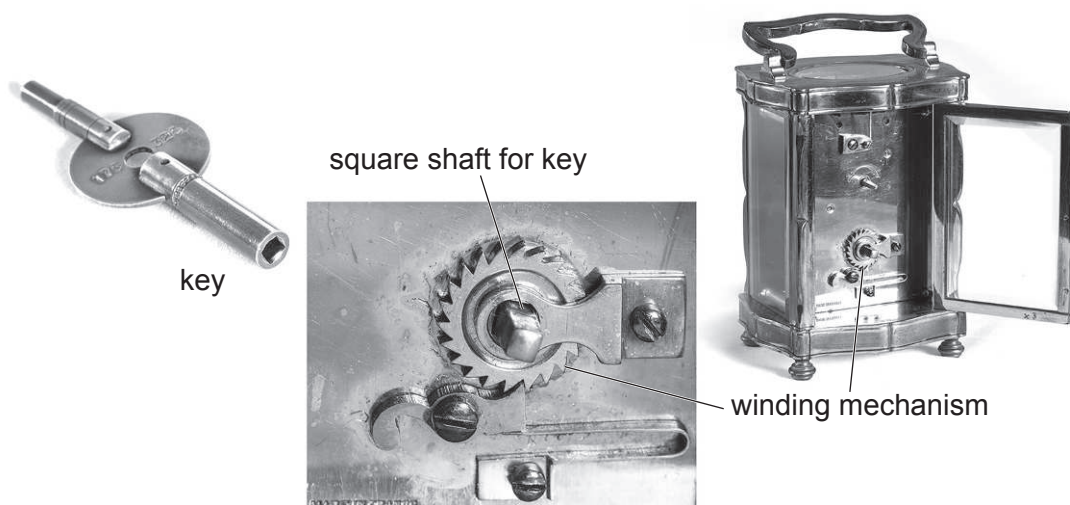
.....

2 .....

.....

[2]

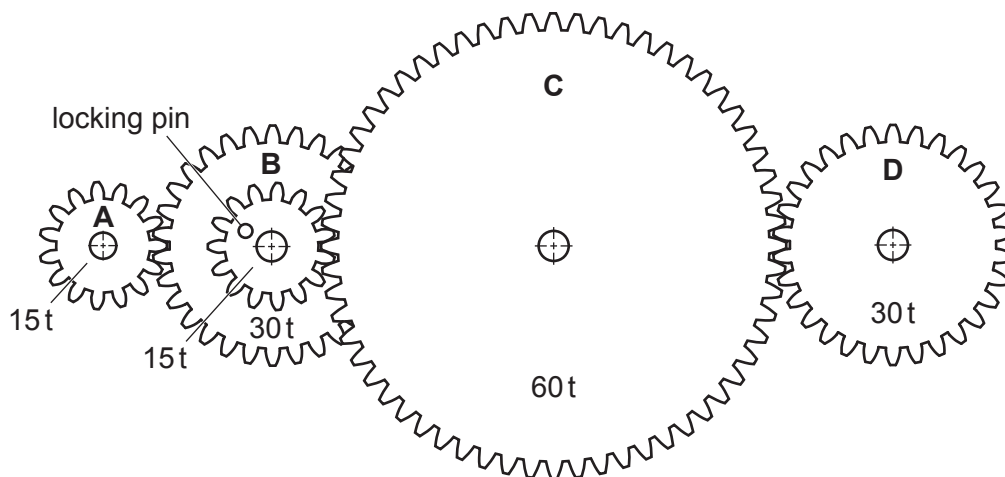
- (c) Fig. 11.3 shows a clock with an enlarged view of the winding mechanism and the key used to wind the clock.



**Fig. 11.3**

- (i) Draw on the enlarged view in Fig. 11.3 to show the direction that the key will be turned. [1]
- (ii) Name the winding mechanism in Fig. 11.3.  
..... and ..... [2]
- (iii) Describe the reason for using this mechanism.  
.....  
.....  
.....  
..... [2]

- (d) Fig. 11.4 shows a compound gear train. The 15t and 30t gears **B** are locked together by a pin.



**Fig. 11.4**

Calculate the speed of the driven gear **D** when the driver gear **A** rotates at 336 rpm.

.....

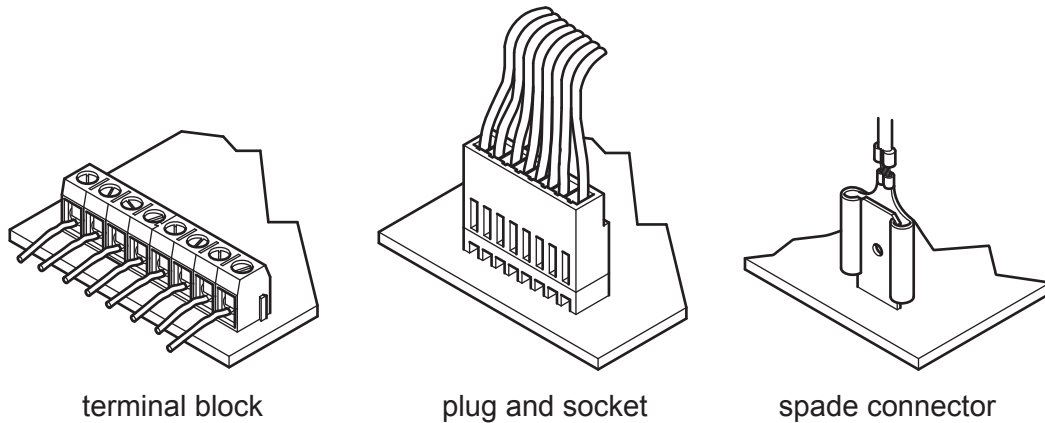
.....

.....

.....

..... [4]

12 (a) Fig. 12.1 shows three methods of making connections to an electronic circuit.



**Fig. 12.1**

(i) Give **one** benefit for each method.

terminal block .....

.....

plug and socket .....

.....

spade connector .....

.....

[3]

(ii) State **two** health and safety precautions other than Personal Protective Equipment (PPE) that should be taken when constructing a printed circuit board (PCB).

1 .....

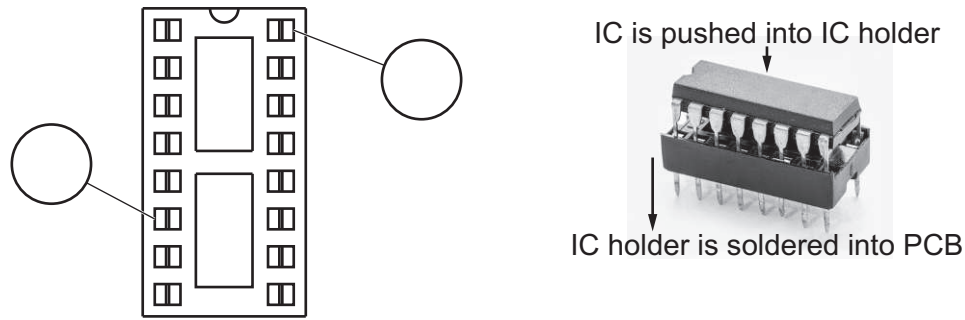
.....

2 .....

.....

[2]

- (iii) Fig. 12.2 shows details of an IC holder. Add the IC holder pin numbers to the circles.



**Fig. 12.2**

[2]

- (iv) Explain why a commercial manufacturer would be likely to solder ICs directly into a circuit rather than using an IC holder.

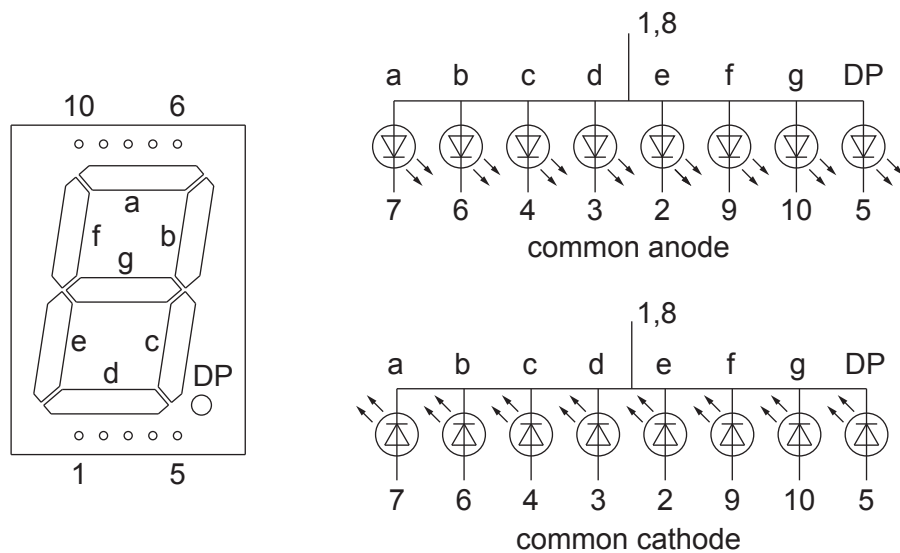
.....

.....

.....

..... [2]

- (b) Fig. 12.3 shows details of a seven segment display taken from a catalogue.



**Fig. 12.3**

- (i) Shade the segments on Fig. 12.3 that will be lit to display the number '2'.

[1]

- (ii) The display is available in a common anode or a common cathode version. Explain how they are different and why there is a need for both versions.

.....

.....

.....

..... [3]

- (iii) Current limiting resistors are used on each segment of the display. The supply voltage to be used is +9V and the forward voltage of each LED segment is 1.65V. Calculate the value of resistor needed to limit the current through each LED segment to 30mA.

.....

.....

.....

..... [3]

- (c) A frost monitor is required for a greenhouse to sound an alarm when the temperature falls below 3°C. Fig. 12.4 shows part of a simulated CAD circuit for the greenhouse frost monitor.

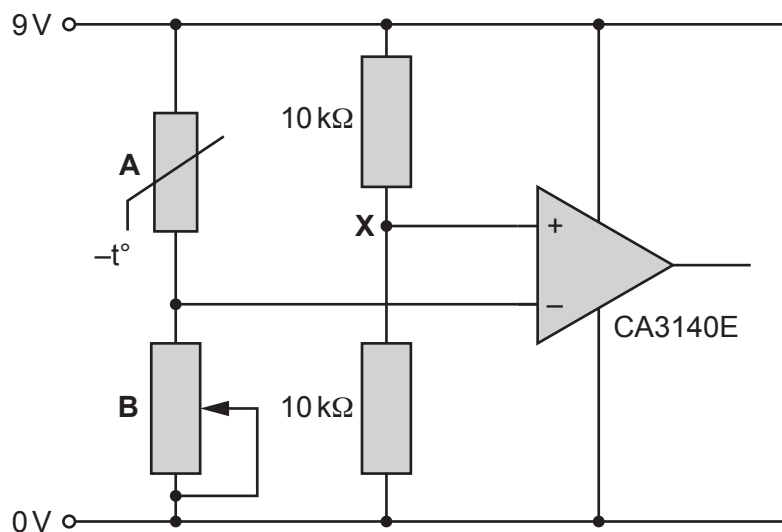


Fig. 12.4

(i) Give **two** benefits of using a simulated CAD circuit.

1 .....

.....

2 .....

.....

[2]

(ii) State the names of components **A** and **B**.

Component **A** .....

Component **B** .....

[2]

(iii) Describe the purpose of the operational amplifier CA3140E.

.....

.....

.....

.....

.....

[3]

(iv) Fig. 12.5 shows the final circuit for the output of the greenhouse frost monitor.

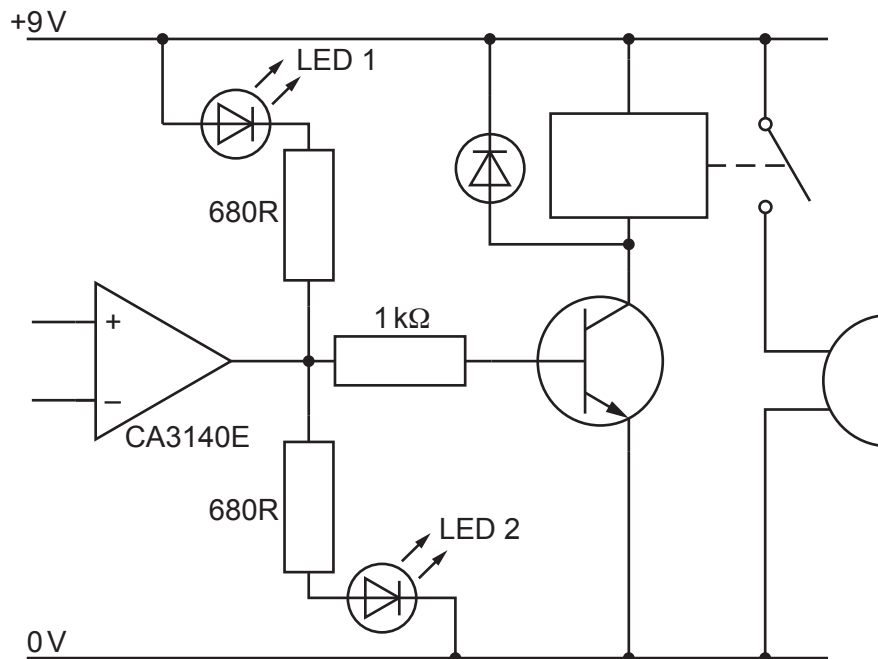


Fig. 12.5

Use the following statements to complete the descriptions of the output below.  
Not all statements will be used.

**LED 1 is on**

**LED 2 is on**

**both LEDs are on**

**LED 1 and the buzzer are both on**

**LED 2 and the buzzer are both on.**

When the operational amplifier output is low .....

.....

When the operational amplifier output is high .....

.....

[2]

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