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DESIGN & TECHNOLOGY

0445/41

Paper 4 Systems & Control

May/June 2025

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 unless otherwise stated.

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



Section A

Answer **all** questions in this section.

- 1 (a) Name **two** fossil fuels.

1

2 [2]

- (b) Explain how solar energy can be used to provide power at night.

.....

.....

..... [2]

- 2 Name the type of structure shown in Fig. 2.1.



Fig. 2.1

..... [1]

- 3 Give **one** reason for using triangulation in a structure.

..... [1]





4 Describe, using examples, the following forces that can act on a structure.

tension

.....

.....

torsion

.....

.....

static load

.....

.....

[6]

5 Explain why spur gears are used to transmit motion in a mechanism.

.....

.....

..... [2]

6 Describe how two shafts can be made to rotate in the same direction using spur gears.

.....

.....

..... [2]

7 Use sketches and notes to show a parallel linkage.

[2]





8 Complete Fig. 8.1 by naming the electronic symbols.

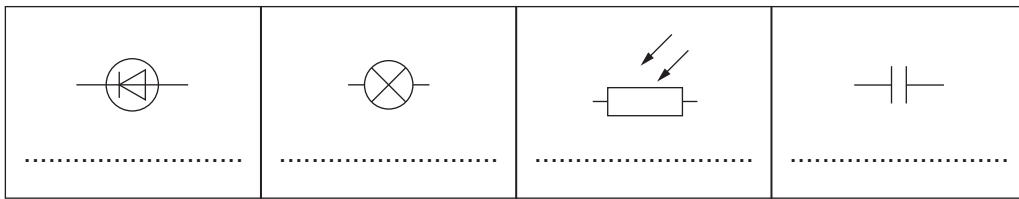


Fig. 8.1

[4]

9 Complete Fig. 9.1 by arranging the resistance values from the lowest value on the left to the highest value on the right.

4.7 k Ω

3 M Ω

100 k Ω

82 R

lowest value

highest value

--	--	--	--

Fig. 9.1

[3]



* 0000800000005 *



5

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Section B

Answer **one** question from this section.

- 10 Fig. 10.1 shows a concrete canopy over the front of a warehouse building. The canopy is supported either side by steel structures that resist forces caused by the weight of the concrete canopy. A detailed view of one of the steel structures is shown.

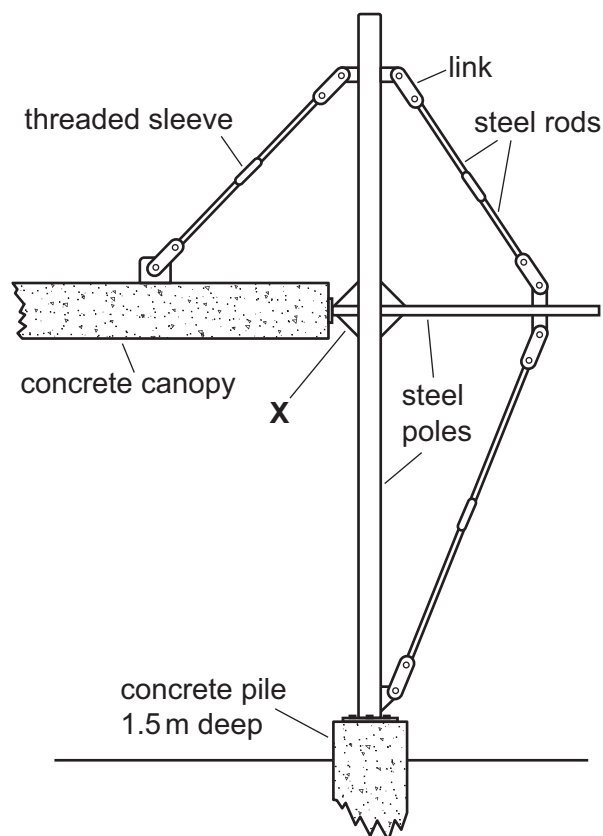


Fig. 10.1

- (a) (i) Name the force acting on each of the steel rods.

..... [1]

- (ii) Explain how the threaded sleeve can be used to provide adjustment on the steel rods.

.....

 [3]





- (iii) Part **X** in Fig. 10.1 is one of four features at the point where the steel poles are joined. Name part **X** and explain the part that it plays in supporting the concrete canopy.

.....

.....

..... [3]

- (iv) State the purpose of the links at each end of the steel rods.

.....

..... [1]

- (v) A concrete pile 1.5 m deep is used as the foundation for the steel structure. Give **two** reasons why concrete is used as the foundation.

1

2 [2]

- (b) Fig. 10.2 shows the same wheelbarrow loaded with bricks in two different ways.

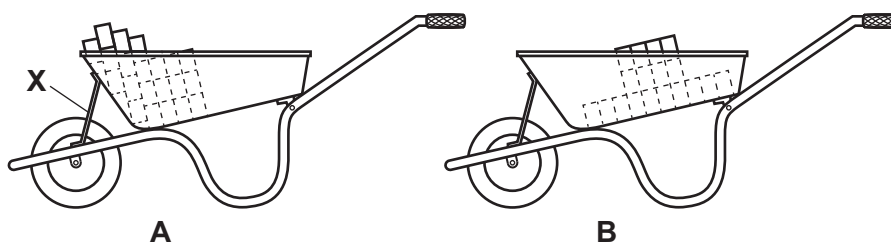


Fig. 10.2

- (i) State the order of lever that is used in a wheelbarrow.

..... [1]

- (ii) Name the type of structural member at **X**.

..... [1]





- (iii) Explain the change in efficiency caused by the different methods of loading the wheelbarrow.

.....

.....

..... [3]

- (iv) Describe how equilibrium is maintained when a wheelbarrow is in use.

.....

.....

..... [2]

- (v) Fig. 10.3 shows wheelbarrow **A** loaded with 38 bricks, each brick weighing 2.1 kg. Calculate the effort required to lift the loaded wheelbarrow.

$$1 \text{ kg} = 9.81 \text{ N}$$

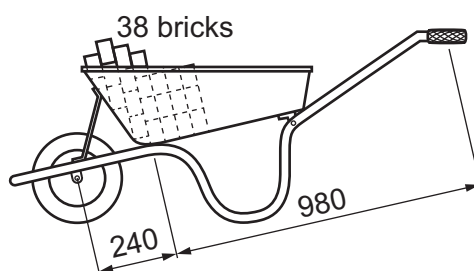


Fig. 10.3

.....

.....

.....

..... [3]





(c) Fig. 10.4 shows a roof truss made of softwood.

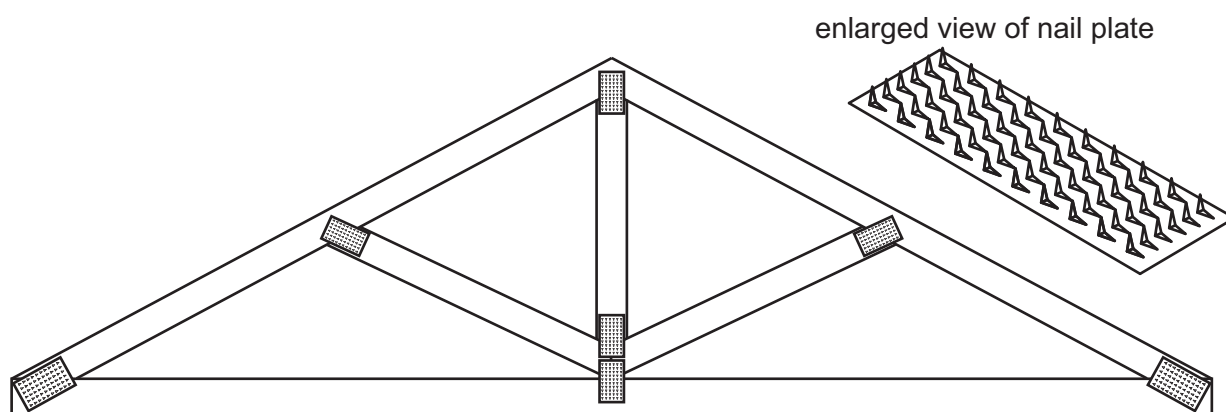


Fig. 10.4

- (i) The softwood is joined using nail plates.
Give **two** advantages of using nail plates rather than traditional joints.

1

.....

2

.....

[2]

- (ii) Describe the defects that a manufacturer would look for when selecting lengths of softwood for use in the roof truss.

.....

.....

.....

..... [3]





- 11 Fig. 11.1 shows two views of a badge-making machine which is used to press a clear plastic sheet over a paper badge and badge blank.

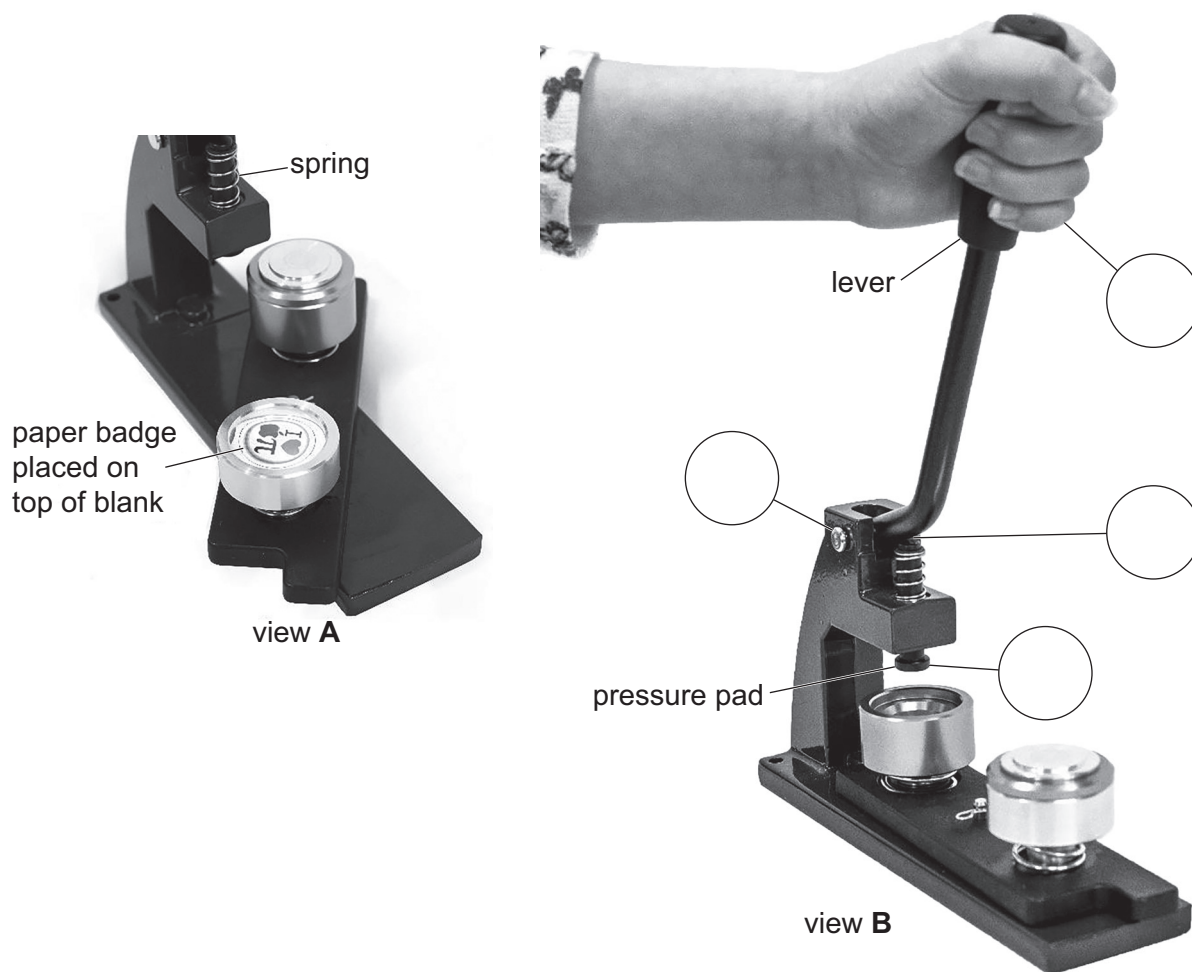


Fig. 11.1

- (a) (i) State the order of lever used in the badge-making machine.

..... [1]

- (ii) Indicate the positions of the load, effort and fulcrum on view B. [3]

- (iii) Describe the conversion of motion that will take place when the lever is operated.

..... to motion [2]

- (iv) State the purpose of the spring labelled in view A.

..... [1]



(b) Fig. 11.2 shows a block and tackle mechanism.

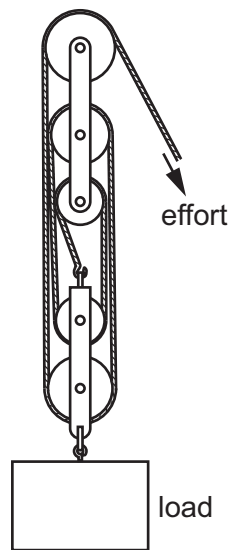


Fig. 11.2

- (i) Calculate the effort needed to raise a load of 1250 N if the efficiency of the block and tackle is 88%.

.....

.....

.....

..... [4]

- (ii) Explain the factors that could cause the block and tackle system to lose efficiency.

.....

.....

..... [2]

- (iii) Give **two** ways that the efficiency could be increased.

1

.....

2

..... [2]





(c) Fig. 11.3 shows a gravity fed oiler used to lubricate a shaft on an industrial machine.

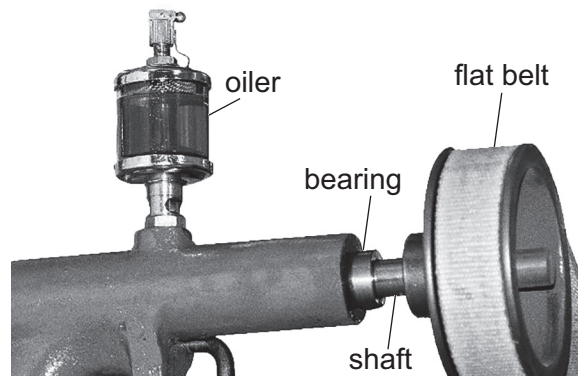


Fig. 11.3

(i) Describe the maintenance that needs to be carried out on the gravity fed oiler.

.....

.....

..... [2]

(ii) State the most likely type of bearing that will be fitted to allow the shaft to rotate.

..... [1]

(iii) Give **one** alternative type of bearing that will reduce the maintenance required.

..... [1]

(iv) Give **two** drawbacks of using a flat belt to transmit motion.

1

.....

2

..... [2]





(v) Add sketches and notes to Fig. 11.4 to show **one** method of keeping a flat belt in tension.

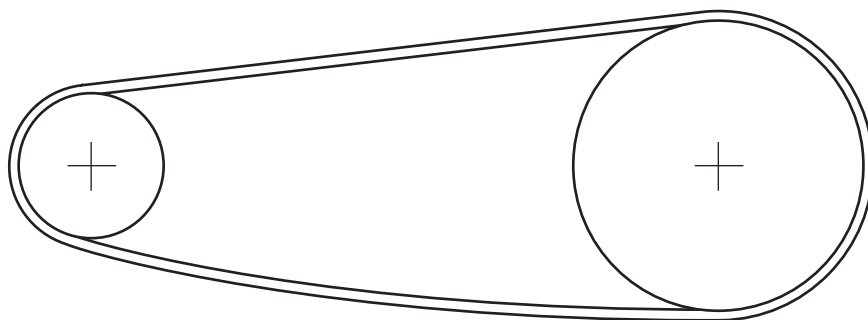


Fig. 11.4

[4]





- 12 Fig. 12.1 shows a conveyor belt used to move boxes in a manufacturing unit. A sensor circuit will stop the conveyor belt when a box is between the light source and light sensor to allow boxes to be removed.

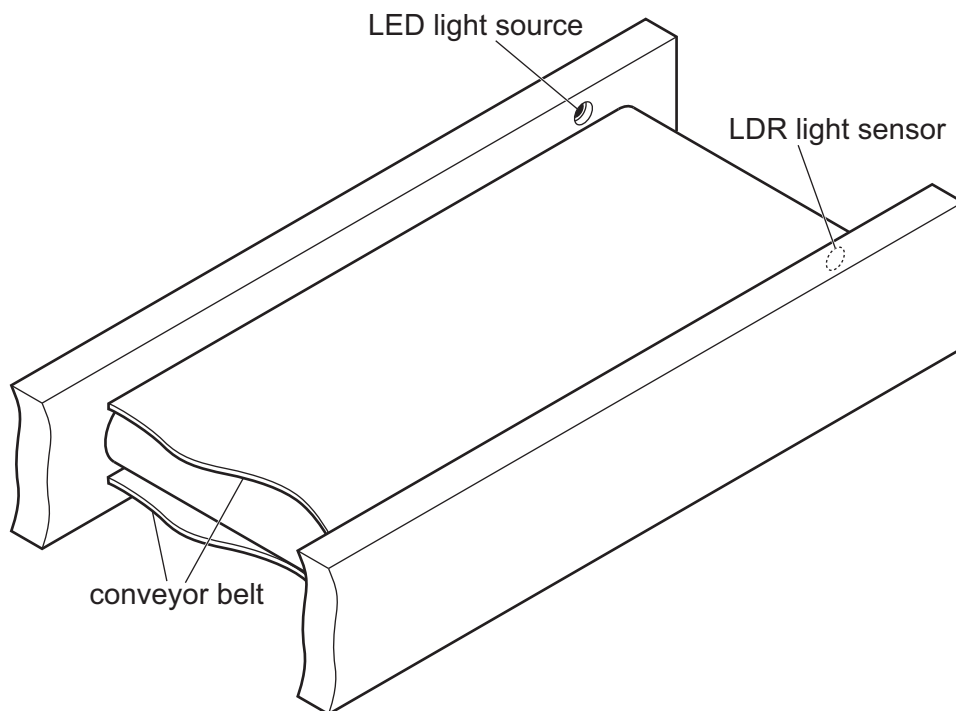


Fig. 12.1

- (a) The conveyor belt circuit includes several components that have to be fitted the correct way around.
- (i) State **one** method of identifying the negative leg (cathode) on the following components.
- Signal diode
- LED (light emitting diode) [2]
- (ii) Fig. 12.2 shows the symbol for an NPN transistor.

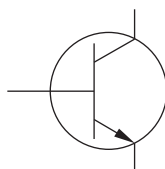


Fig. 12.2

Add labels to the symbol to identify the base (b), collector (c) and emitter (e).

[2]





(iii) State the **two** possible functions of an NPN transistor in a circuit.

1

2

[2]

(b) Fig. 12.3 shows part of the sensor circuit used to stop the conveyor belt, allowing boxes to be removed by a worker.

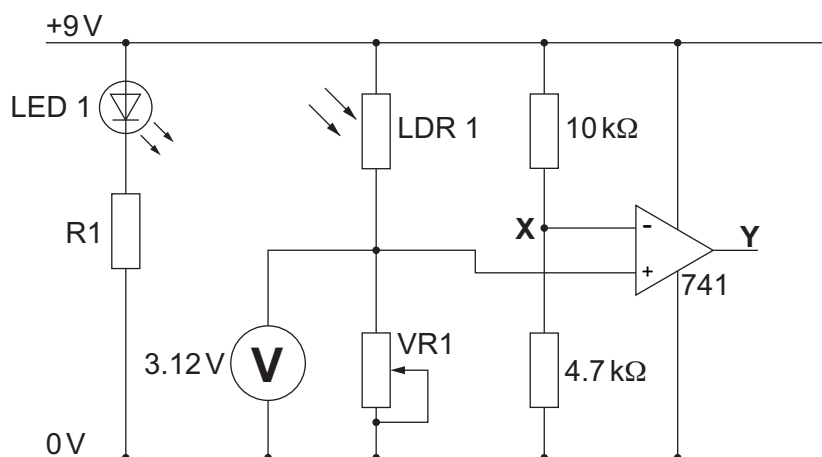


Fig. 12.3

(i) Calculate the voltage at point X in the circuit.

Use the formula $V_{\text{out}} = \frac{V_{\text{in}} \times R_2}{(R_1 + R_2)}$

.....

 [3]

(ii) The 741 operational amplifier (OP AMP) is used as a comparator to compare the input voltages.
 Explain the operation of the comparator.

.....

 [2]

(iii) State the voltage at point Y, the output of the OP AMP.

..... [1]





- (iv) Describe how the OP AMP, which is in an 8 pin dual in-line package, can be correctly fitted into an integrated circuit (IC) holder.

.....

.....

..... [2]

- (v) Fig. 12.4 shows three different types of component that could be used for VR1.

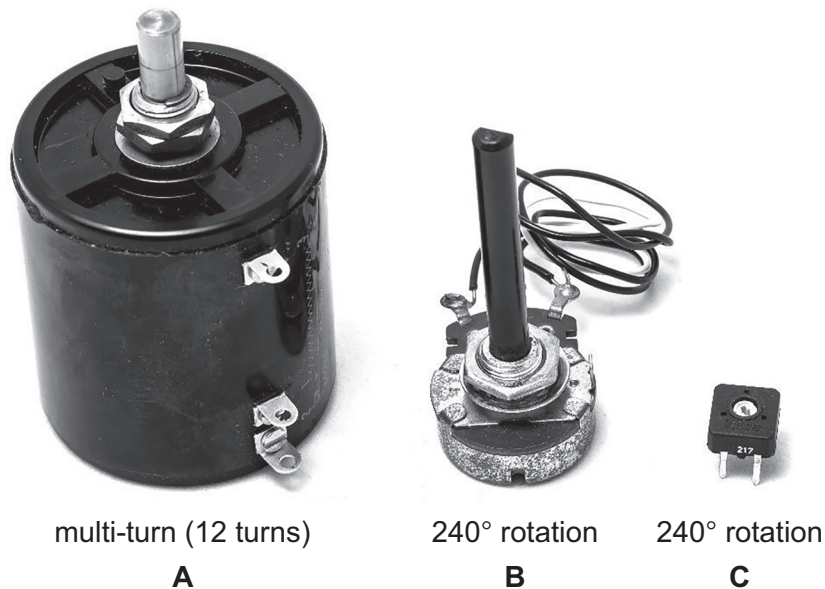


Fig. 12.4

Give **one** different benefit and **one** different drawback of using each type of component.

Component **A**

Benefit

Drawback

Component **B**

Benefit

Drawback

Component **C**

Benefit

Drawback

[6]



(c) Fig. 12.5 shows the output circuit used to operate the conveyor motor.

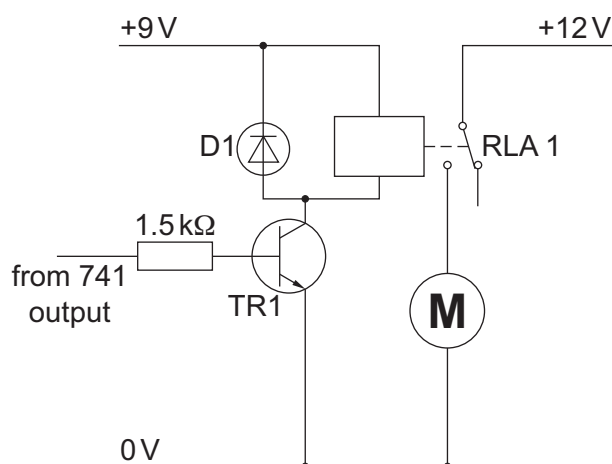


Fig. 12.5

- (i) The motor is controlled by relay RLA 1.
Give **two** points that would appear in a technical description of the relay.

1

2

[2]

- (ii) Fig. 12.6 shows an SPDT relay and the relay symbol. The relay has 5 connection points.

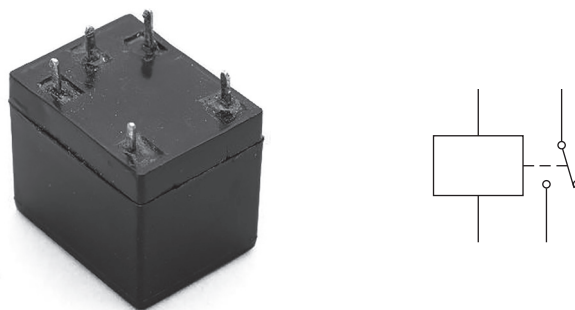


Fig. 12.6

Describe how the two connections for the coil can be identified using a multimeter.

.....

 [3]









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