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DESIGN & TECHNOLOGY**0445/41**

Paper 4 Systems & Control

May/June 2026**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. Do **not** use correction fluid or tape.
- 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 Figure 1.1 shows two doors and frames, one has been made of a plastic and one is made of hardwood.



Figure 1.1

- (a) Give **two** benefits of using a plastic for a door and frame.

1

.....

2

.....

[2]

- (b) Give **two** benefits of using hardwood for a door and frame.

1

.....

2

.....

[2]



- 2 State what is meant by a 'static load' on a structure.

[1]

- 3 Figure 3.1 shows a rectangular section wooden beam supported in two places. Use sketches and notes to show **two** methods of reducing the effect of the bending force on the wooden beam.

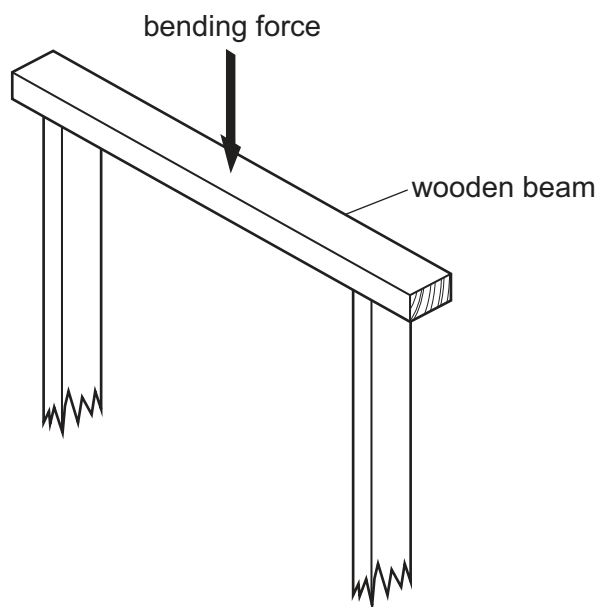


Figure 3.1

[2]

- 4 Figure 4.1 shows a pair of tin snips cutting aluminium.



Figure 4.1

Name the force that the tin snips apply to the aluminium.

[1]

- 5 Sketch and name **two** examples of a third order lever.

[2]

- 6 Figure 6.1 shows a linkage with three fixed pivots and three moving pivots.

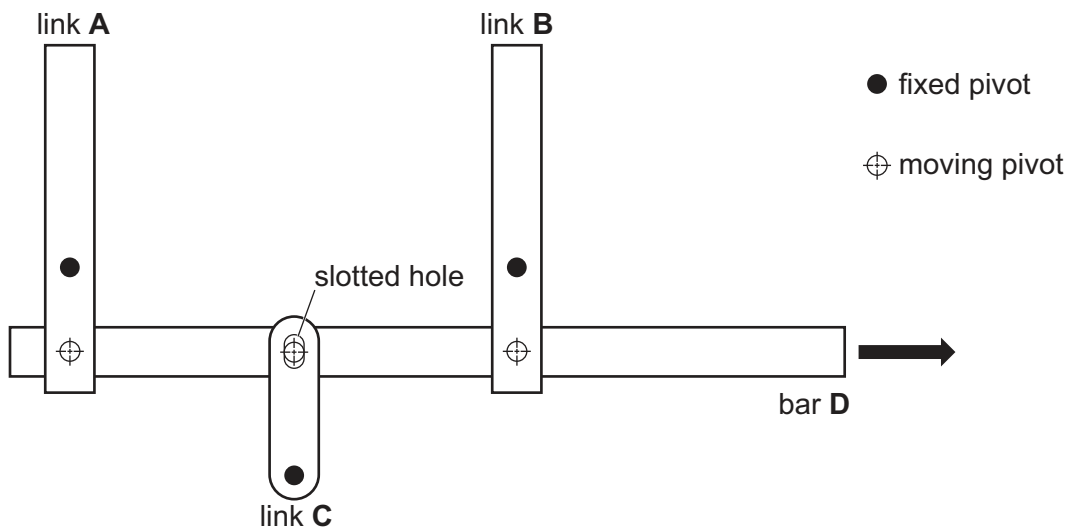


Figure 6.1

- (a) Use arrows to show the movement that will take place in links **A** and **B** when bar **D** is moved to the right. [2]
- (b) Describe the conversion of motion that takes place when bar **D** is moved to the right.
 motion is converted to motion. [2]
- (c) Explain why a slotted hole is needed at the top of link **C**.

.....

.....

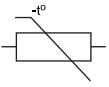
.....

..... [2]



- 7 Table 7.1 shows three electronic symbols. Complete Table 7.1 by giving the component name for each symbol and stating the unit that is associated with the symbol. One has been done for you.

Table 7.1

symbol	component name	unit
		
	battery	volt
		

[4]

- 8 Describe the difference between a toggle switch and a push-to-make switch.

.....

.....

..... [2]



- 9 Figure 9.1 shows two methods of connecting three signal lamps in a circuit.

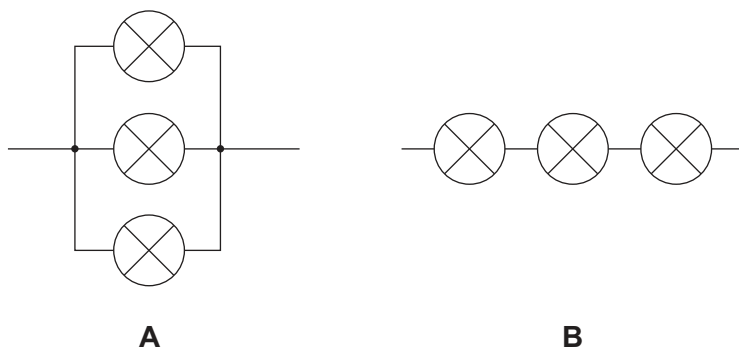


Figure 9.1

- (a) Name the method of connection used in **A**.

..... [1]

- (b) Describe **one** advantage of using method **A** rather than method **B** for connecting the signal lamps.

.....

 [2]



Section B

Answer **one** question from this section.

- 10 Figure 10.1 shows a bridge that can be raised to allow ships to pass underneath the bridge. The bridge deck is raised by a set of four winches, one at each tower. Each winch is operated by winding cables around pulleys and onto drums on each tower, lifting the bridge deck vertically.

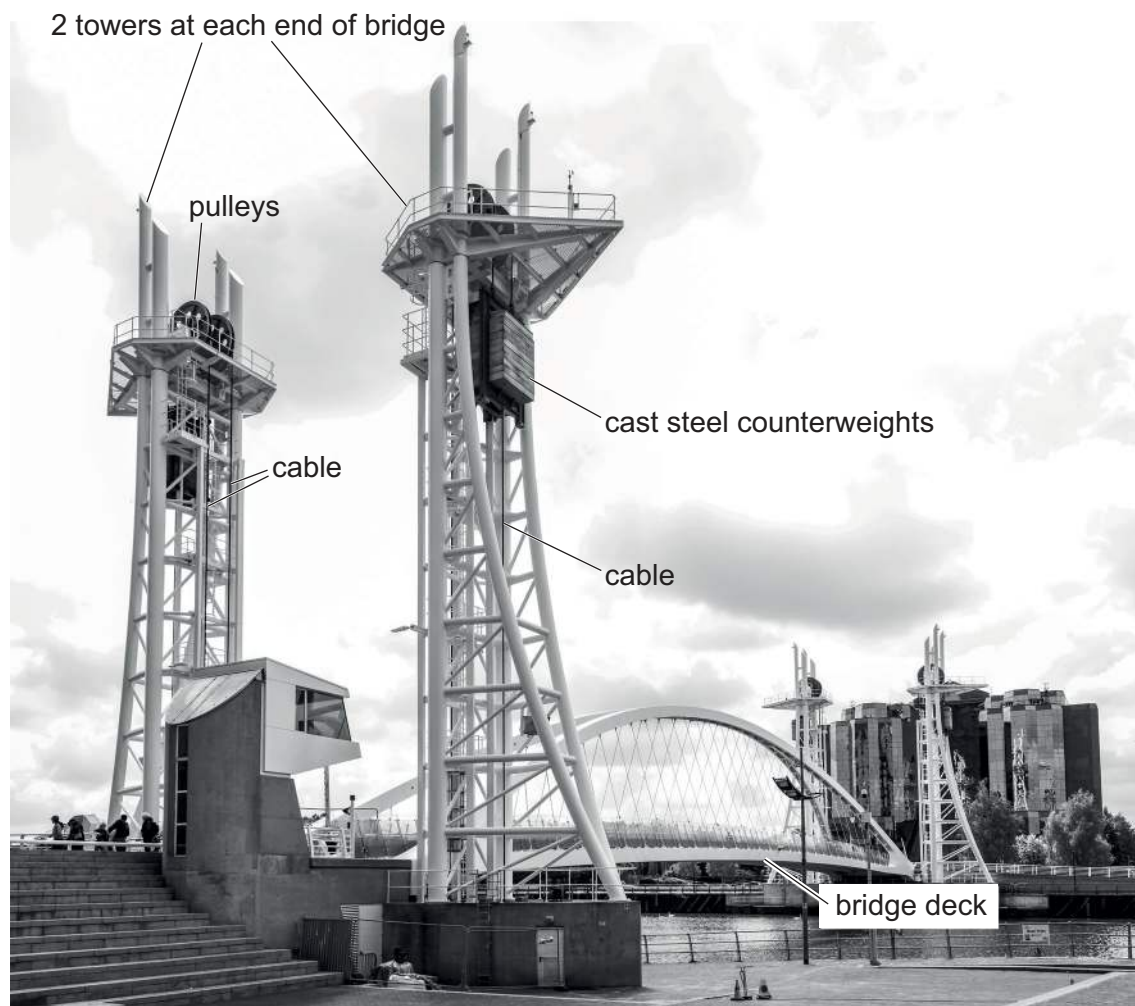


Figure 10.1

- (a) (i) Describe the function of the counterweights.

.....

.....

..... [2]

- (ii) Give **one** reason for using cast steel for the counterweights.

..... [1]





- (iii) Each of the cables must be tested before use on the bridge.
Explain why the cables need to be tested.

.....

 [2]

- (iv) A 10 m length of cable is found to be 10.01 m long when under load.
Calculate the strain in the cable.

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

.....

 [2]

- (b) (i) The bridge deck is designed to withstand both static and moving loads.
Give **two** examples of each type of load.

static load

1
 2

moving load

1
 2 [4]

- (ii) Explain, using an example, what is meant by the term 'Factor of Safety' regarding the loads that the bridge deck will withstand.

.....

 [2]



- (c) (i) Use sketches and notes to show the following structural features and the force that each will resist.

On each feature use arrows to show the direction of the forces being resisted.

strut

force resisted

tie

force resisted

[6]



- (ii) Figure 10.2 shows two steel tubes that form part of a structure.

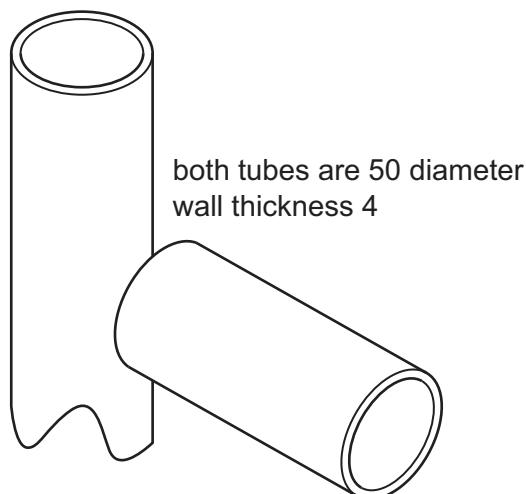


Figure 10.2

Give **two** stages when **permanently** joining the steel tubes in Figure 10.2 in the position shown.

- 1
-
- 2
-

[2]

- (iii) The joint on the tubes in Figure 10.2 may need to be reinforced. Use sketches and notes to show **one** way of reinforcing the joint.

[2]



(d) Structures are often designed using temporary methods of joining the parts together.

Give **two** benefits of using temporary joining methods in a structure.

1

2

[2]





11 (a) Figure 11.1 shows a tractor with a front loader.

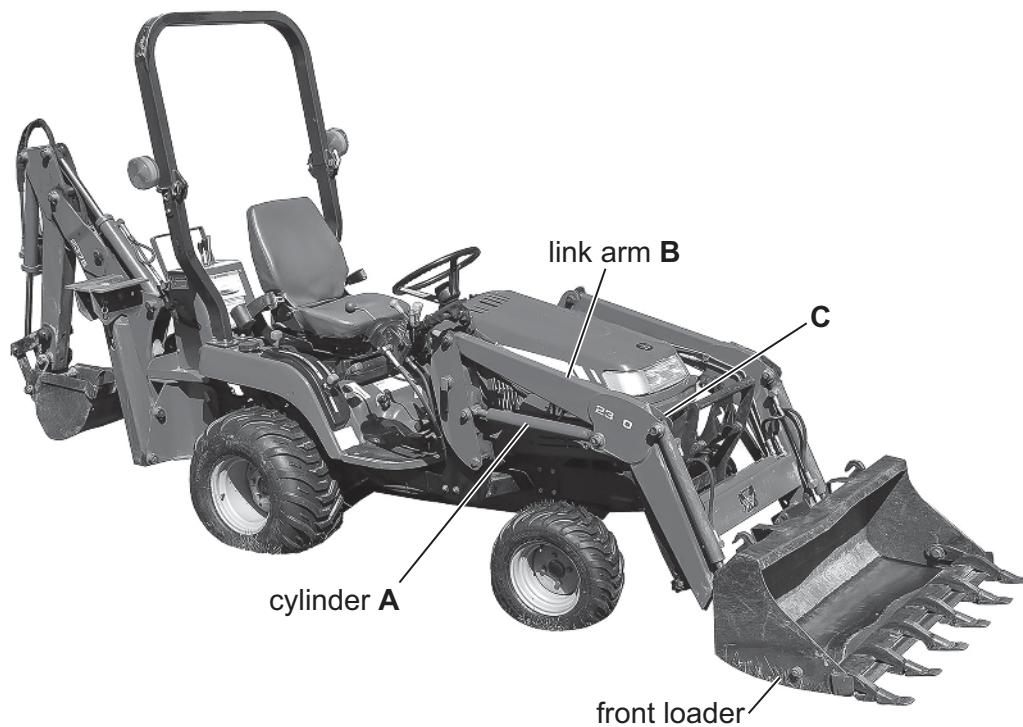


Figure 11.1

Figure 11.2 shows a detailed view of link arm B.

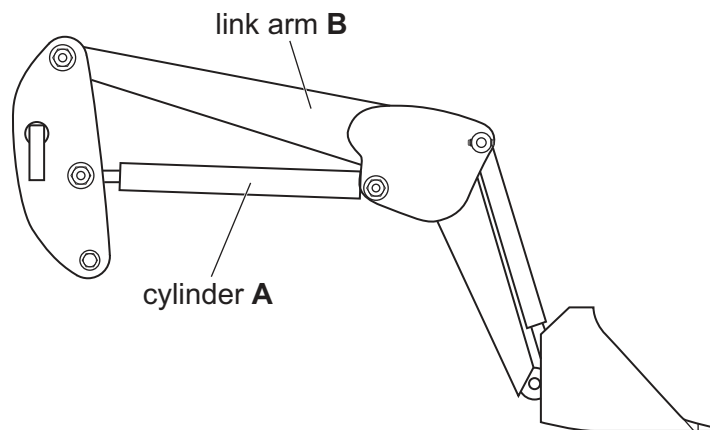


Figure 11.2

- (i) Link arm B is a lever used to operate the front loader.
Mark the position of the fulcrum of link arm B on Figure 11.2. [1]
- (ii) Describe what will happen to link arm B and the front loader when cylinder A is extended.

.....

.....

..... [2]



- (iii) Figure 11.3 shows an enlarged view of **C** in Figure 11.1. Component **D** is a grease nipple.



Figure 11.3

State **one** benefit of using a grease nipple.

..... [1]

- (iv) Explain why a plain bearing would be suitable to support the axle.

.....

 [2]

- (v) The tractor uses a rack and pinion steering mechanism. Use sketches and notes to show how a rack and pinion system converts motion on the steering mechanism.

(b) Figure 11.4 shows a gear system.

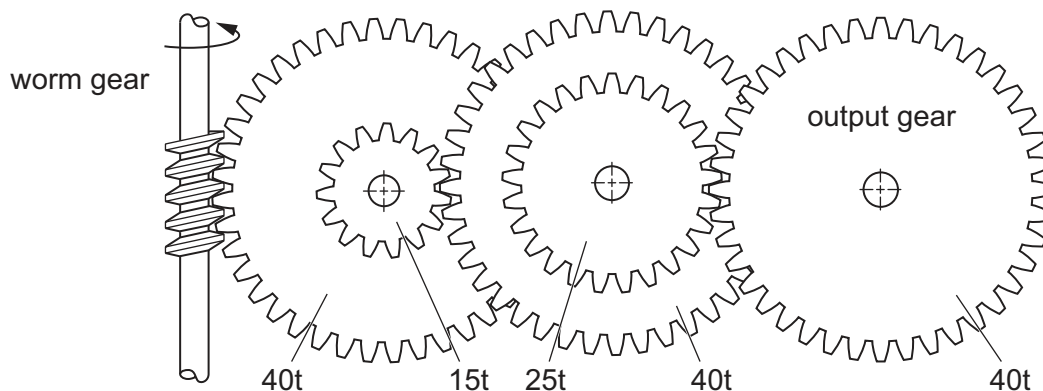


Figure 11.4

(i) Draw an arrow on Figure 11.4 to show the direction of rotation of the output gear. [1]

(ii) Calculate the total reduction ratio of the gear system.

.....

.....

.....

.....

..... [4]

(iii) Calculate the speed of the output gear when the worm gear rotates at 600 rpm.

.....

.....

..... [2]

(iv) Give **two** causes of loss of efficiency in the gear system.

1

.....

2

..... [2]



(c) Figure 11.5 shows a toothed belt connecting two pulleys.

- (i) Draw on Figure 11.5 to show a method of maintaining tension in the belt when the two pulleys must remain at a constant distance apart.

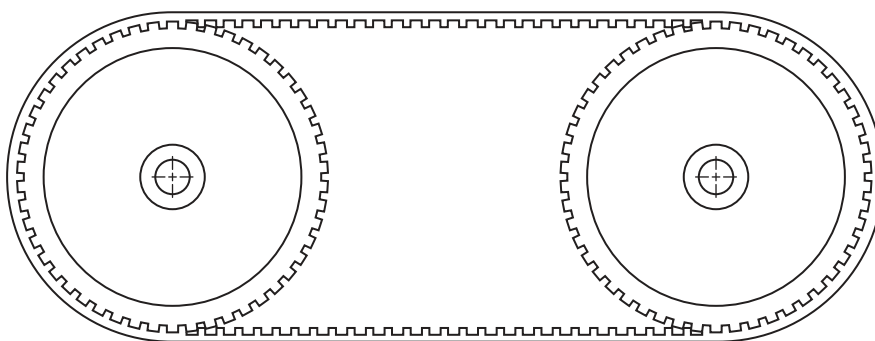


Figure 11.5

[3]

- (ii) Give **two** advantages that a toothed belt has over a vee belt.

1

2 [2]

- (iii) Give **two** advantages that a sprocket and chain drive has over a toothed belt.

1

2 [2]



12 (a) Figure 12.1 shows a 4000 series logic integrated circuit (IC) and the pin diagram for the IC.

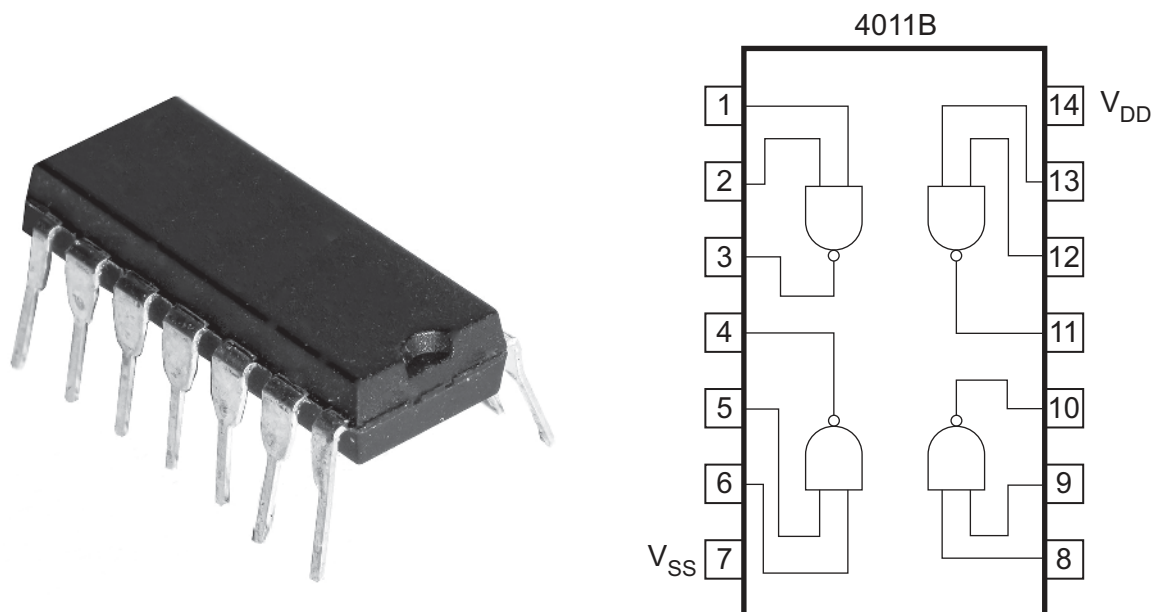


Figure 12.1

(i) Describe fully the type of 4000 series logic IC shown in Figure 12.1.

.....

 [2]

(ii) Give the pin number of the positive power connection to the IC in Figure 12.1.

..... [1]

(iii) State **two** ways of identifying pin 1 on the IC.

1
 2 [2]



- (iv) Use a sketch to show how two of the logic gates from the IC can be combined to give the logic function shown in Table 12.1.

Table 12.1

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

[2]

- (b) (i) Number the terms from the list in Table 12.2 to show the correct sequence of soldering an IC to a printed circuit board (PCB).
The first and last stages have been added for you.

Table 12.2

sequence	stage
1	bend all legs in slightly
	bend over two diagonally opposite legs
	check that all legs have gone through holes
	align the IC and push legs through holes in PCB
	apply solder to the joint
	use soldering iron to heat both leg and solder pad
	identify pin 1 on the IC
8	repeat for remaining legs

[3]



- (ii) Mistakes can occur when soldering components into a PCB.
Describe how an incorrect value resistor can be removed from a PCB.

.....

.....

.....

..... [3]

- (iii) State **one** method, other than soldering, of making connections to a PCB.

..... [1]

- (c) An 8-second time delay is required for a door lock.
The door is to be unlocked for 8-seconds before automatically re-locking.
A 555 timer monostable circuit is chosen to provide the delay.

- (i) Figure 12.2 shows the circuit diagram for the 555 timer monostable circuit.

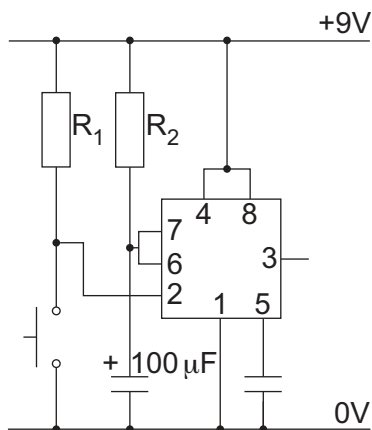


Figure 12.2

State what is meant by the term 'monostable'.

.....

..... [1]

- (ii) Calculate the component values needed to provide an 8 second time delay.

Use the formula $t = 1.1 RC$

.....

.....

.....

..... [3]



- (iii) The $100\mu\text{F}$ capacitor is polarised and has a tolerance in value of $\pm 20\%$. Explain how this tolerance, which will affect the length of delay, can be overcome.

.....

.....

..... [2]

- (iv) The output of the circuit will operate a solenoid in the door lock. Complete Figure 12.3 to show how an NPN bipolar transistor can be used to operate the solenoid.

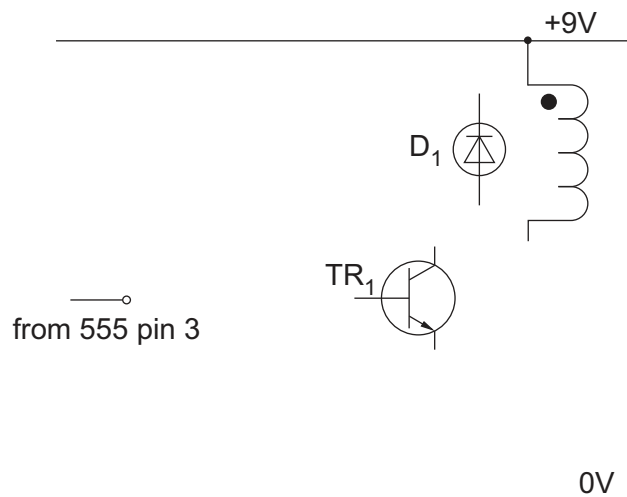


Figure 12.3

[3]

- (v) Explain why diode D_1 is included in the circuit.

.....

.....

..... [2]





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