



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**DESIGN AND TECHNOLOGY**

Paper 4 Systems and Control

**0445/41**

**May/June 2016**

**1 hour**

Candidates answer on the Question Paper.

No Additional Materials are required.

**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.**

**Section A**

Answer **all** questions in this section.

**Section B**

Answer **one** question in this section.

You may use a calculator.

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.

The total of the marks for this paper is 50.

This document consists of **16** printed pages.

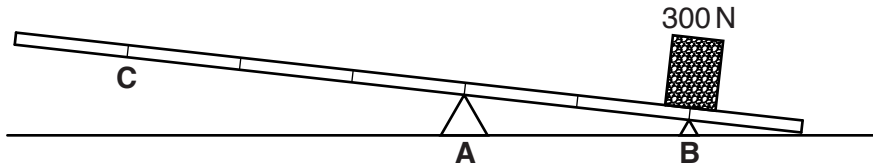
**Section A**

Answer **all** questions in this section.

- 1 (a) State the meaning of a 'moment' in structures.

.....[1]

- (b) (i) Fig. 1 shows a beam resting on support **A** with a load at one end above support **B**.



**Fig. 1**

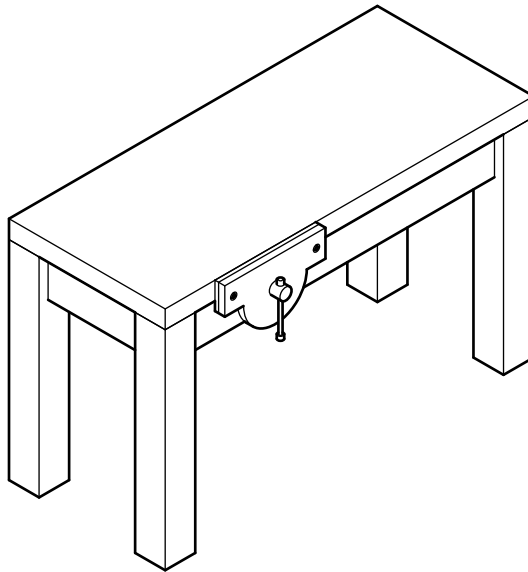
State the value of the force below point **B** that is keeping the beam in equilibrium.

.....[1]

- (ii) Describe what will happen if a 200N load is placed at point **C**.

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

- 2 Fig. 2 shows a workbench.  
The frame of the workbench is not rigid when work is carried out.



**Fig. 2**

Use sketches and notes on Fig. 2 to show how the frame could be made more rigid. [3]

3 Fig. 3 shows a small crack in a concrete beam.



Fig. 3

Describe how the crack can be monitored to see whether it is increasing in size over a period of time.

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

4 (a) Fig. 4 shows an electric motor and a drive shaft.

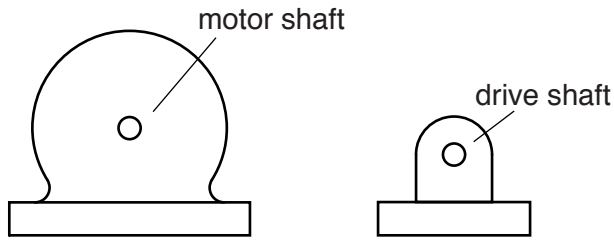


Fig. 4

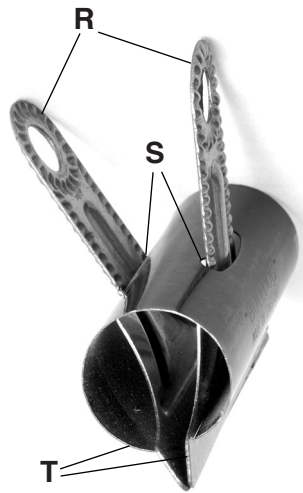
State **three** methods of transmitting motion from a motor shaft to a drive shaft.

1 .....  
2 .....  
3 .....[3]

(b) Give **two** possible effects or outcomes of transmitting motion from one shaft to another.

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

5 (a) A spring paper clip made from a pair of levers is shown in Fig. 5.



Effort	
Load	
Fulcrum	

Fig. 5

Using the letters **R**, **S** and **T** complete the table to show the position of Effort, Load and Fulcrum in the paper clip. [2]

(b) State the order of lever that is used in the paper clip.

.....[1]

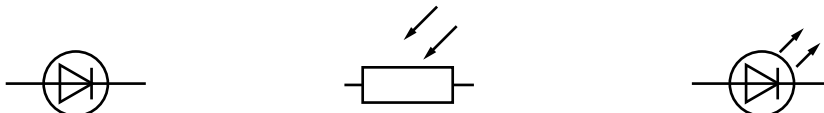
6 (a) Give **three** ways in which LEDs can differ from each other.

- 1 .....
- 2 .....
- 3 .....[3]

(b) State **two** methods used to identify the cathode on an electrolytic capacitor.

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

7 Name the component symbols shown in Fig. 6.



.....

Fig. 6

[3]

## Section B

Answer **one** question in this section.

- 8 (a) (i) Complete the table below by drawing lines linking each material with the correct property. One has been done for you.

Material	Property
mild steel	conducts electricity
hardwood	rusts in damp conditions
concrete	can have natural defects
brass	weak in tension

[3]

- (ii) State **two** ways of treating the surface of mild steel to prevent rust from forming.

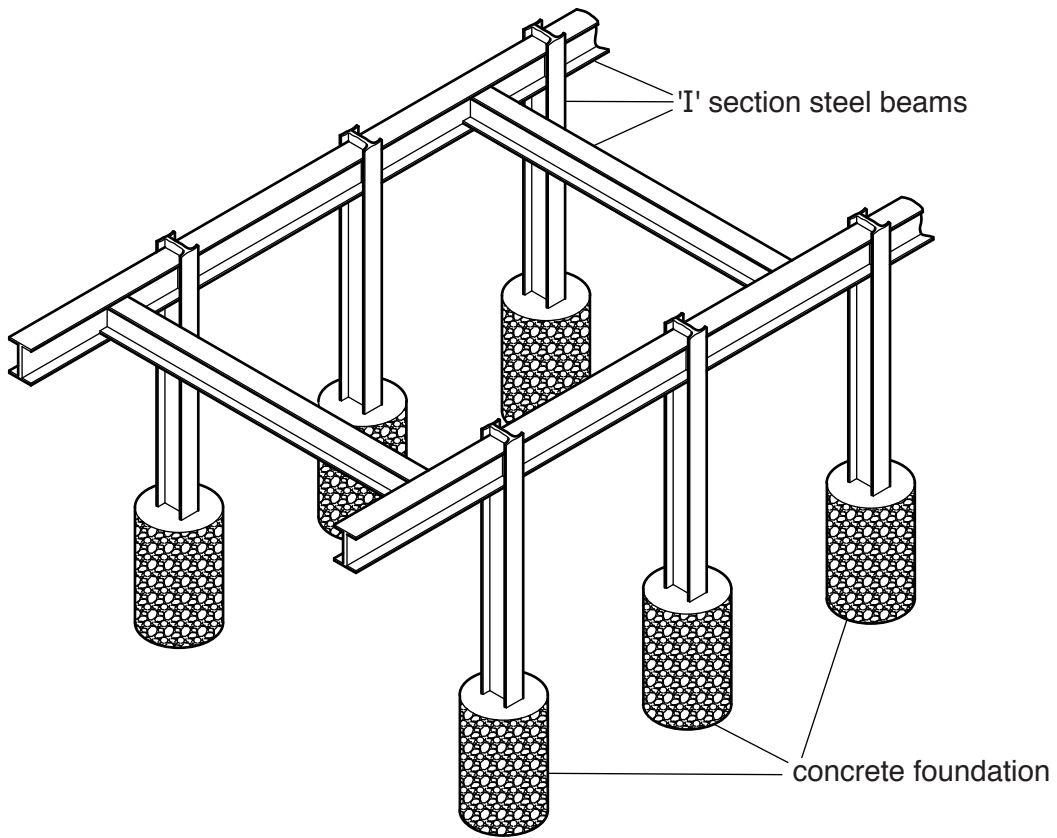
1 .....

2 ..... [2]

- (iii) Bolts made from mild steel can fail when a shear force is applied to them. Use sketches and notes to explain what is meant by a shear force applied to a bolt.

[3]

(b) Fig. 7 shows 'I' section steel beams used in the construction of a building.



**Fig. 7**

(i) Give **two** reasons for using this type of beam rather than a steel beam of rectangular section.

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

(ii) The foundation is made from concrete.  
Explain why this material is suitable for a foundation.

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

(c) (i) Complete the following sentences:

In a structure a strut will resist ..... force.

In a structure a tie will resist ..... force.

[2]

(ii) A wooden roof truss from a small building is shown in Fig. 8.

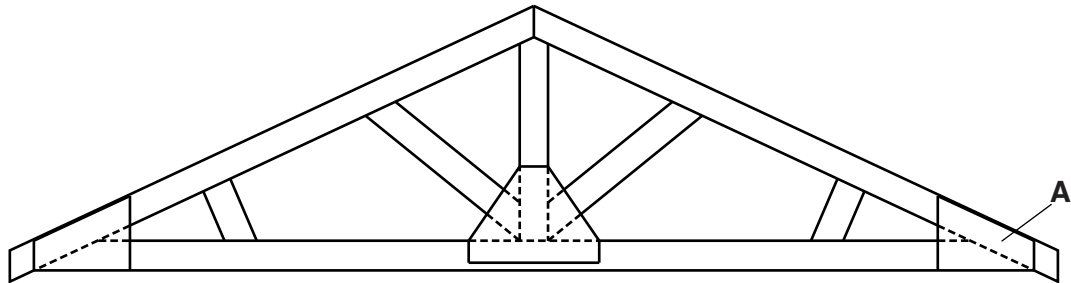


Fig. 8

Add labels to Fig. 8 to identify the following features:

- a strut
- a tie
- a gusset plate.

[3]

(iii) Use sketches and notes to show how the joint at **A** could be constructed.

[3]

(iv) Give **two** problems that can occur when using wood as a structural member.

1 .....

2 ..... [2]

(v) Explain the difference between a static load and a dynamic load in a structure.

.....

.....

..... [2]

9 Fig. 9 shows part of a small robot vehicle which is driven by two motors, one on either side.

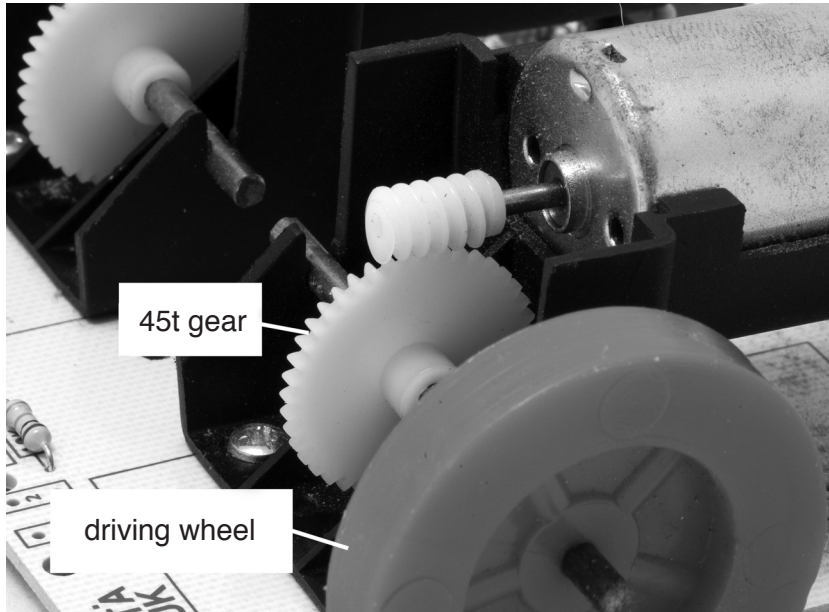


Fig. 9

(a) (i) Name the gear system connecting the motor to the driving wheel.

.....[1]

(ii) Give **two** reasons for using this gear system.

1 .....

2 .....[2]

(iii) State the ratio of the gear system.

.....[2]

(b) Fig. 10 shows the symbol for a double acting reed switch pneumatic cylinder.

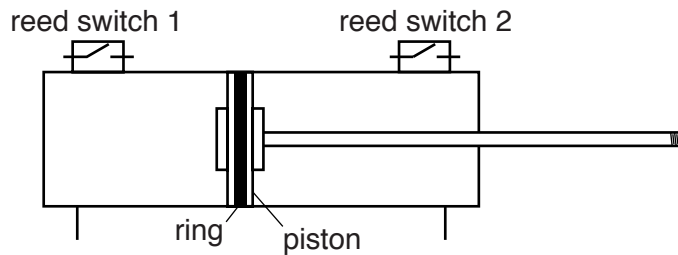


Fig. 10

(i) Describe how the ring operates the reed switches.

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



- (ii) Complete the table below to show the state of the reed switches for each position of the cylinder piston.

	instroked	moving/central	outstroked
reed switch 1			
reed switch 2			

[3]

- (iii) Explain how this type of cylinder can allow a pneumatic and an electronic system to be integrated.

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

- (c) (i) Give **one** safety precaution, in each case, that should be taken when the following power sources are used to drive mechanical systems.

Compressed air .....  
 ..... [1]

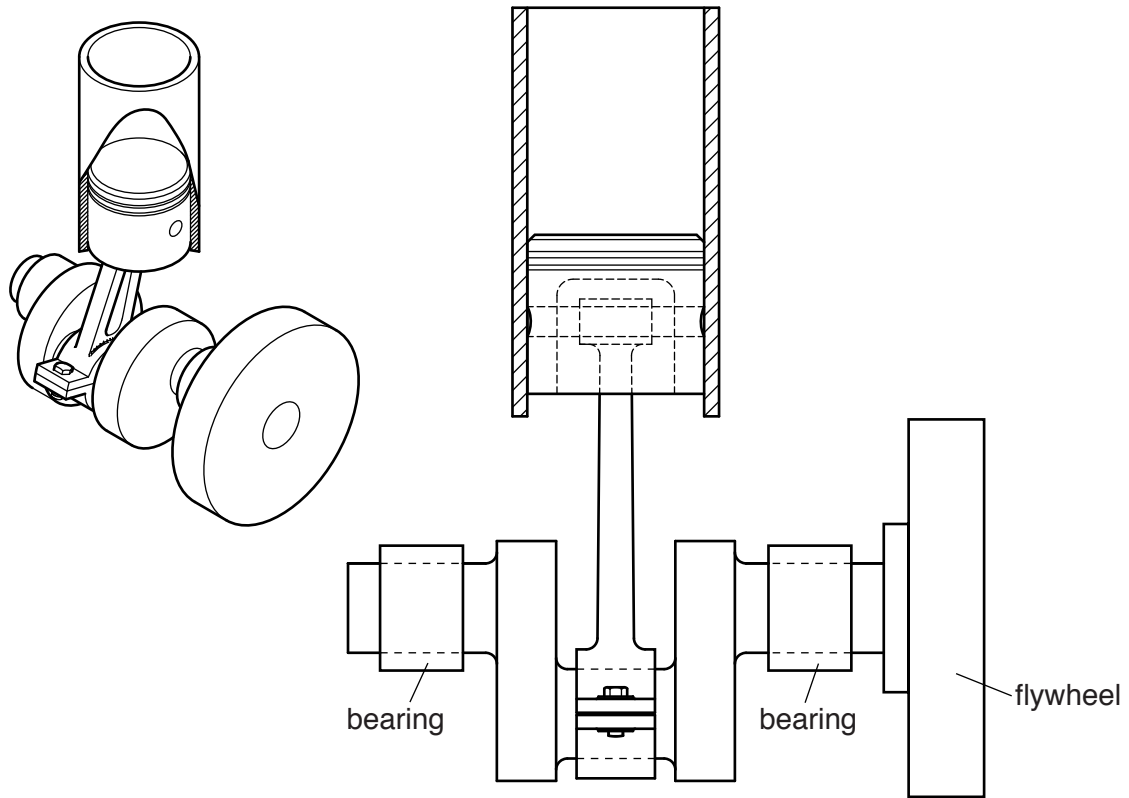
Mains electricity .....  
 ..... [1]

- (ii) Wind energy can be used to power mechanical systems such as agricultural pumps. Give **one** benefit and **one** drawback of using wind energy as a power source.

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

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

(d) Fig. 11 shows the main parts of a single cylinder internal combustion engine.



**Fig. 11**

- (i) Indicate on Fig. 11 the following parts:
- piston
  - crankshaft
  - cylinder.
- [3]
- (ii) Give the conversion of motion that takes place in the engine.
- ..... motion is converted to ..... motion [2]
- (iii) Draw on Fig. 11 to show **two** places where lubrication would be required. [2]

(iv) Fig. 12 shows a bearing that could be used in an internal combustion engine.



**Fig. 12**

Give **two** reasons for using this type of bearing.

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

- 10 (a) A student wishes to make an electronic counter that will generate numbers from 0 to 9. Fig. 13 shows a block diagram of the system that will be used to control the length of time that the counter will ‘roll’ for before settling on one number. The 4017 counter IC counts from 0 to 9 repeatedly; each output will control one LED. The two inputs are an astable signal and a push to make (PTM) switch. The two inputs are an astable signal and a push to make (PTM) switch.

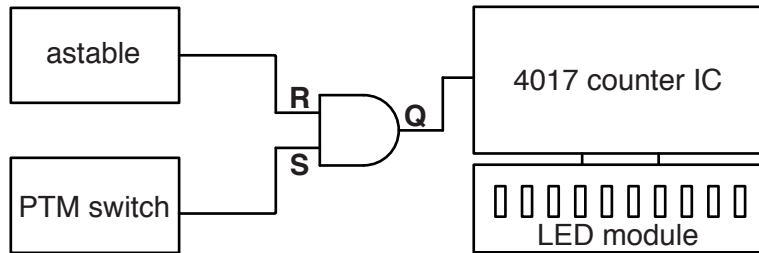


Fig. 13

- (i) Use sketches and notes to describe an astable signal.

[2]

- (ii) Describe the action of a PTM switch.

.....

.....

.....[2]

- (iii) Fig. 14 shows the PTM switch connected to a multimeter ready for testing. Indicate on Fig. 14 the multimeter setting that should be used for the test.

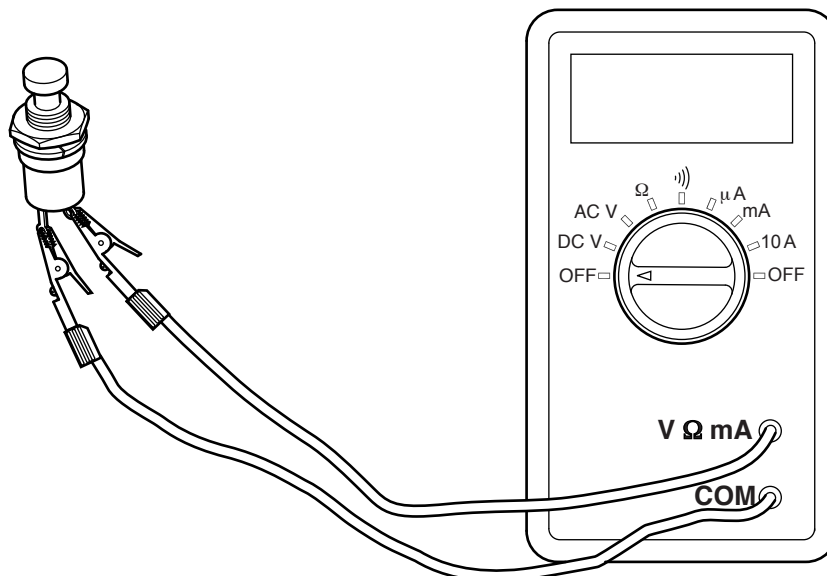


Fig. 14

[1]

(iv) Add the reading to the multimeter display that could be expected when a correctly working PTM switch is pressed. [1]

(v) Name the logic gate used in Fig. 13 and complete the truth table below for the gate.

Name of logic gate .....

R	S	Q
0	0	
0	1	
1	0	
1	1	

[2]

(vi) Complete Fig. 15 to show how input **S** can be at a normal level of 0V but change to +9V when the PTM switch is closed.

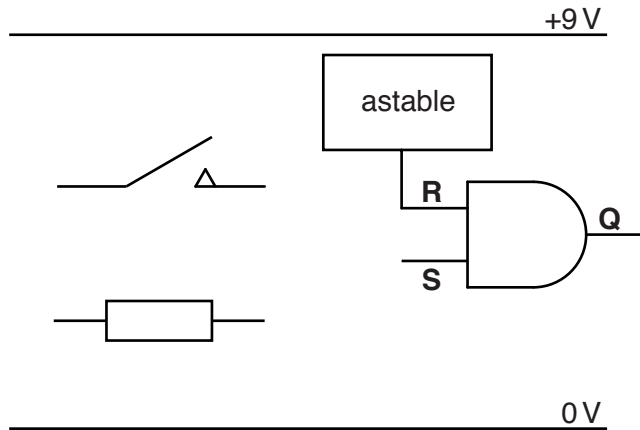


Fig. 15

[3]

(vii) Explain why the astable signal will only appear at point **Q** when the PTM switch is pressed.

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

(b) Fig. 16 shows details of the astable circuit.

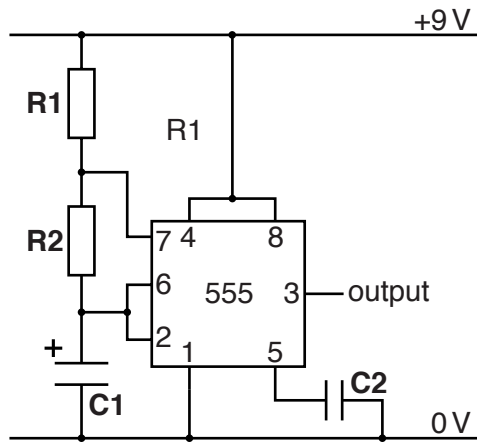


Fig. 16

(i) The following values were used for the timing components.

$$C1 = 1 \mu\text{F} \quad R1 = 1 \text{ k}\Omega \quad R2 = 10 \text{ k}\Omega$$

Calculate the frequency of the astable circuit.

Use the formula  $f = \frac{1.44}{(R1+2R2)C1}$

.....

.....

.....[3]

(ii) Fig. 17 shows the pin diagram of the counter IC that will be used in the dice alongside the circuit diagram.

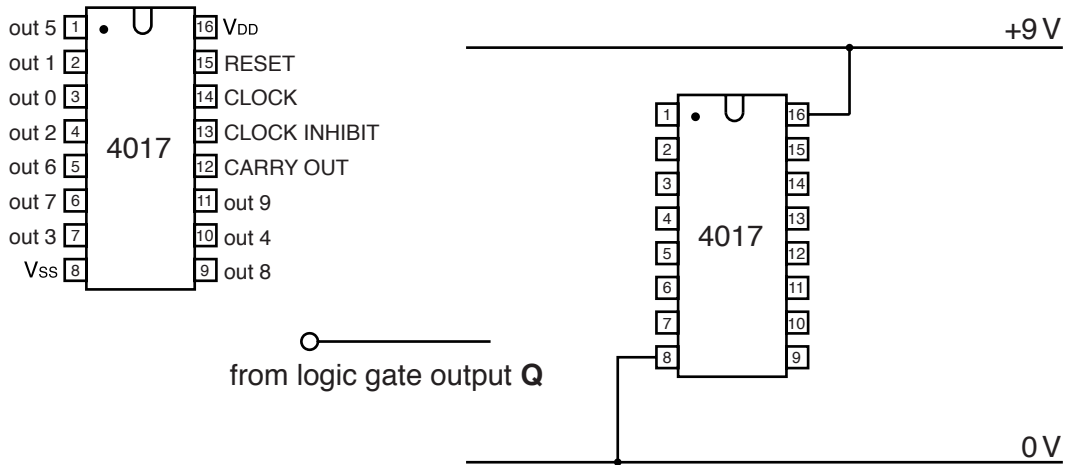


Fig. 17

Add the following connections to the circuit diagram in Fig. 17.

- CLOCK INHIBIT to 0V
- RESET to 0V
- Logic gate output **Q** to pin 14

[3]

(c) Each output from the counter IC is connected through a transistor to an LED. Complete the LED and transistor driver connections on Fig. 18.

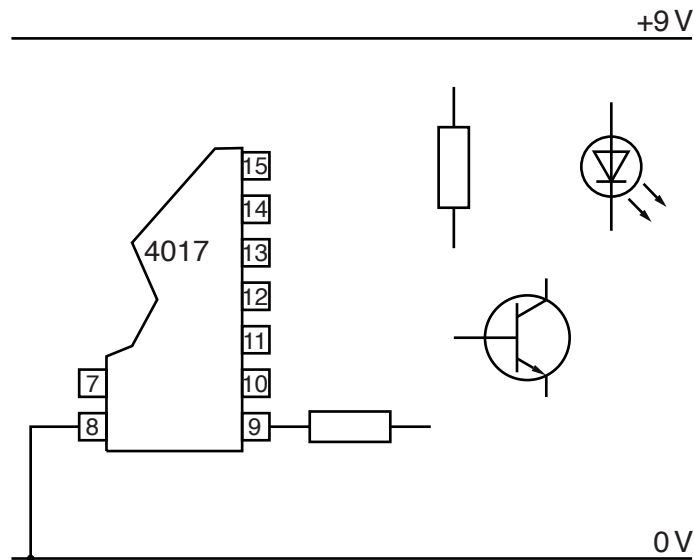


Fig. 18

[3]

Question 10(d) is printed on the next page

(d) During construction of the circuit an LED is soldered into the printed circuit board the wrong way around.

Describe how the LED can be removed from the board.

Name all tools that will be required.

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

[3]

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