



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

\* 7 0 0 7 6 2 2 5 4 9 \*

**DESIGN AND TECHNOLOGY** **0445/43**  
Paper 4 Systems and Control **May/June 2012**  
**1 hour**

Candidates answer on the Question Paper.  
No Additional Materials are required.

**To be taken together with Paper 1 in one session of 2 hours and 15 minutes.**

**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 a soft pencil for any diagrams or graphs.  
Do not use staples, paper clips, highlighters, glue or correction fluid.  
**DO NOT WRITE IN ANY BARCODES.**

You may use a calculator.

**Section A**  
Answer **all** questions.  
**Section B**  
Answer **one** question.

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.

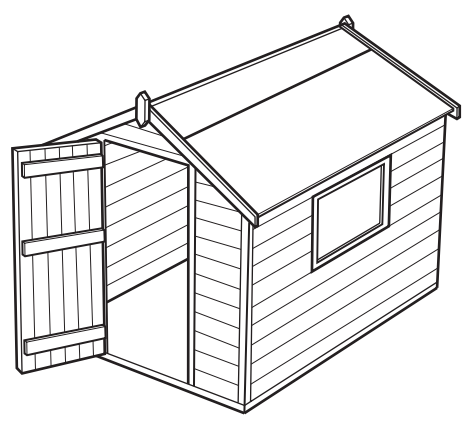
For Examiner's Use	
Section A	
Section B	
<b>Total</b>	

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

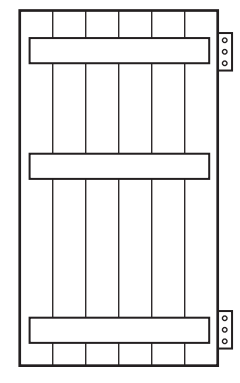
**Section A**

Answer **all** questions in this section.

- 1 Fig. 1a shows a garden shed. The door has structural weakness and needs to be modified to overcome this weakness.



**Fig. 1a**



**Fig. 1b**

- (a) Explain what would happen to the shed door, over a period of time, if the modification was not carried out.

.....

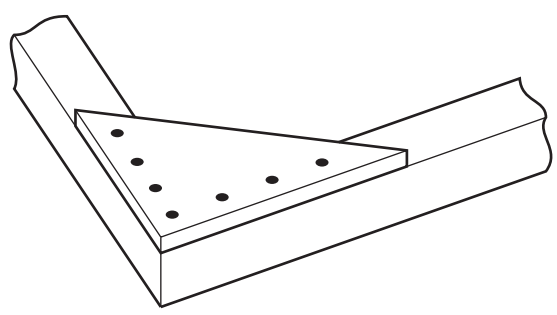
.....

.....

..... [3]

- (b) Show on Fig. 1b how the door can be modified to ensure it has greater structural strength. [2]

- 2 Fig. 2 shows a method of jointing in a framework.



**Fig. 2**

Name the method shown.

..... [1]

3 Fig. 3 shows a graph of load against extension for a metal.

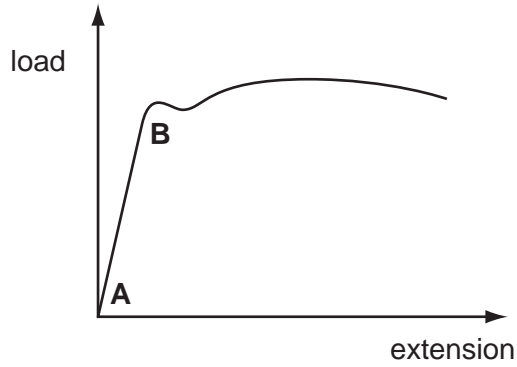


Fig. 3

Explain what is happening between the points A and B.

.....

.....

..... [2]

4 Fig. 4 shows a worm and wormwheel system.

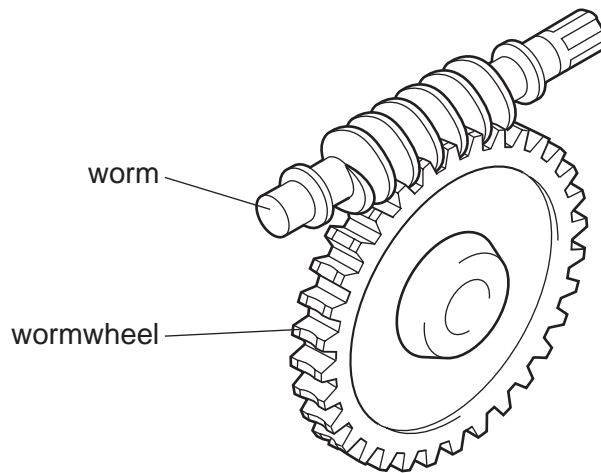


Fig. 4


(a) Label Fig. 4 to show the input gear and output gear.

..... [1]

(b) If the wormwheel has 32 teeth, state the gear ratio of the system.

..... [1]

5 Complete the table below showing mechanisms and their actions.

mechanism	sketch	action
spur gears		reduction of speed
crank and slider		

[3]

6 Fig. 5 shows a diagram of a lever system.

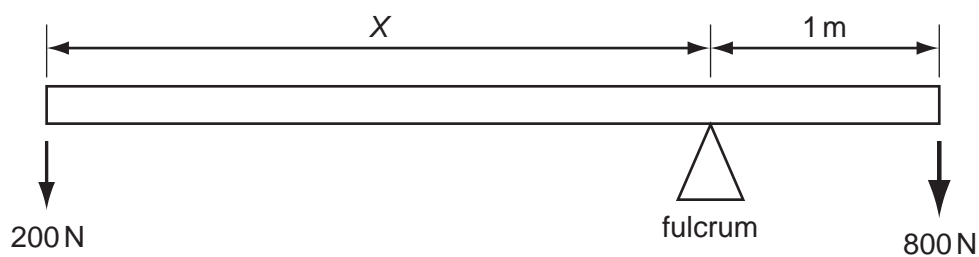


Fig. 5

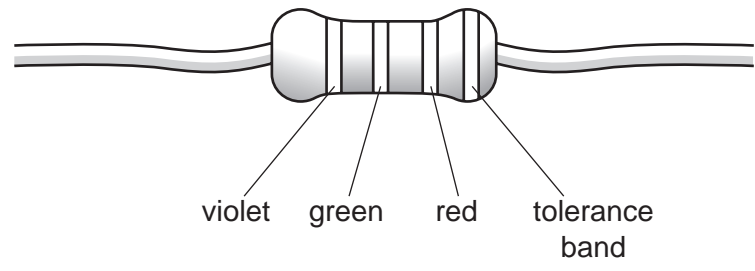
Calculate the length of  $X$  for the lever when it is in equilibrium.

You must show all your working.

[3]

7 The table and diagram below show the colour code system for resistors.

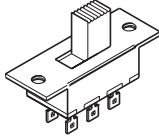
Colour	1st band	2nd band	3rd band	4th band
Black	0	0	-	tolerance band
Brown	1	1	0	
Red	2	2	00	
Orange	3	3	000	
Yellow	4	4	0000	
Green	5	5	00000	
Blue	6	6	000000	
Violet	7	7	0000000	
Grey	8	8	00000000	
White	9	9	000000000	



State the value of this resistor. You do not need to include the tolerance.

..... [3]

8 Complete the table showing switches and their uses.

switch	sketch	uses
[1]		reverse current flow to electric motors to change their direction of rotation
reed switch	[1]	burglar alarm system

9 Explain why care is needed when connecting an electrolytic capacitor in a circuit.

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

10 Draw and label the circuit symbol for a NOR logic gate.

[2]

Section B

Answer **one** question from this section.

11 Fig. 6 shows an incomplete circuit for controlling a greenhouse plant watering system.

component name	component symbol
resistor	
diode	
relay	

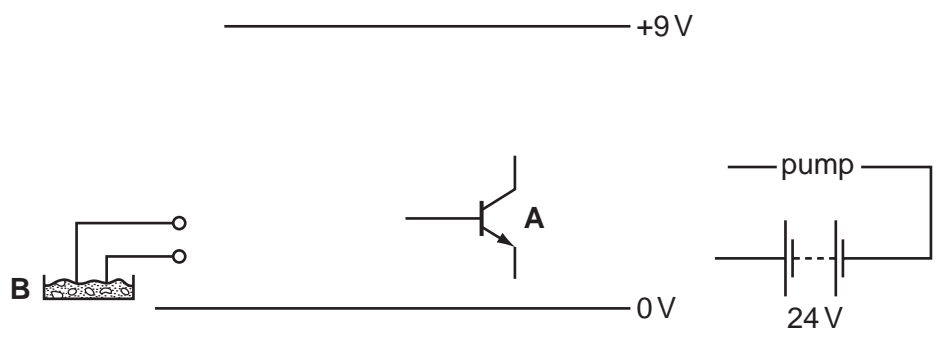
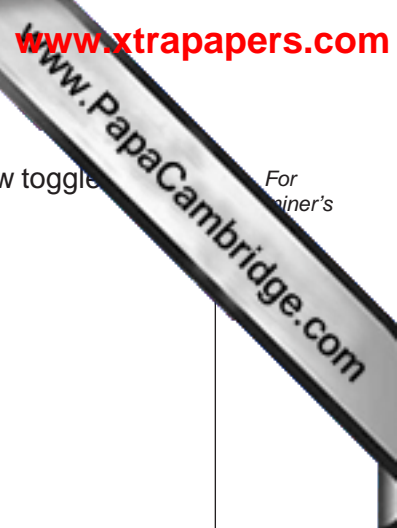


Fig. 6

- (a) (i) Using the components in the table, complete the circuit diagram for the control circuit. [6]
- (ii) State how component **A** would be fixed to a printed circuit board (PCB). [1]
- (iii) State the type of component that would be used at position **B** in the circuit. [2]
- (iv) Name and sketch a component that could be added to the circuit to increase its sensitivity.



(b) It is decided to add an on/off switch to the circuit. A single pole, single throw toggle switch is to be used.

(i) Draw the circuit symbol for this type of switch.

[2]

(ii) Name **one** other type of switch that would be suitable for this application.

..... [1]

(iii) Explain why a push to make (PTM) switch would not be suitable for this application.

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

(c) The circuit uses a resistor.

Explain how a resistor affects the voltage in a circuit.

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

(d) Briefly explain how a relay works.

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



(e) Fig. 7 shows a pair of resistors used to control voltage in a circuit.

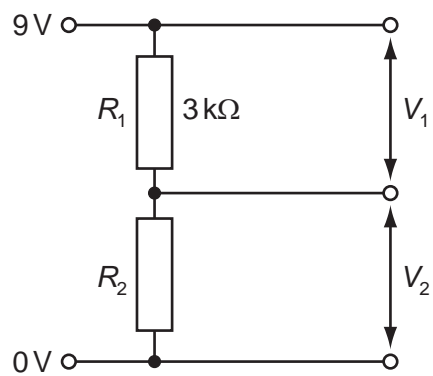


Fig. 7

(i) Name this arrangement of resistors.

..... [1]

(ii) Calculate the value of  $R_2$  if the current in the circuit is 1 mA.

Show all your workings.

[3]

12 Fig. 8 shows a device for launching a ball.

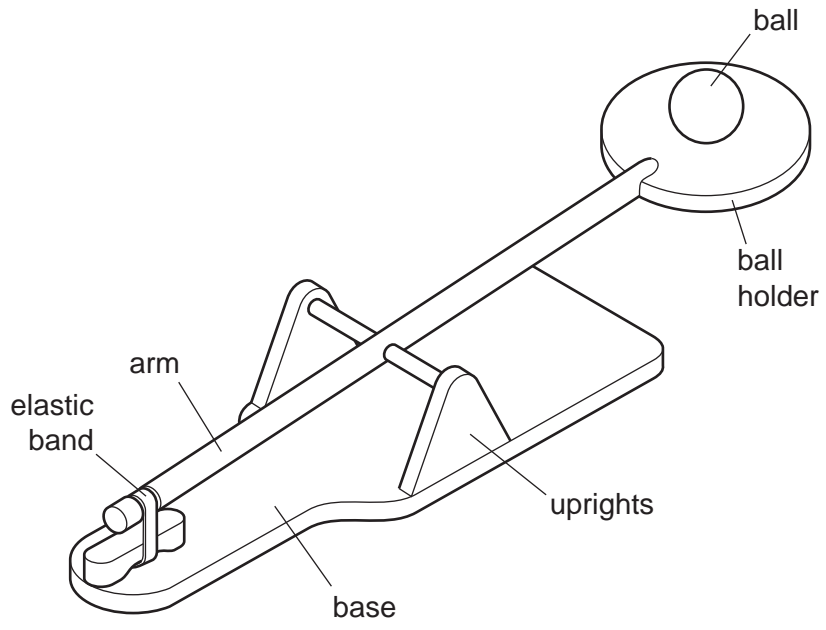


Fig. 8

- (a) (i) Identify the class (order) of lever used in the ball-launching device.  
..... [1]
- (ii) On Fig. 8 label the load, effort and fulcrum for the lever when the ball is launched.  
[3]
- (iii) Explain how the device could be modified so that, when still using one elastic band, the ball could be launched higher.  
.....  
.....  
..... [2]

(b) Fig. 9 shows a diagram of a lever-operated can-crushing device.

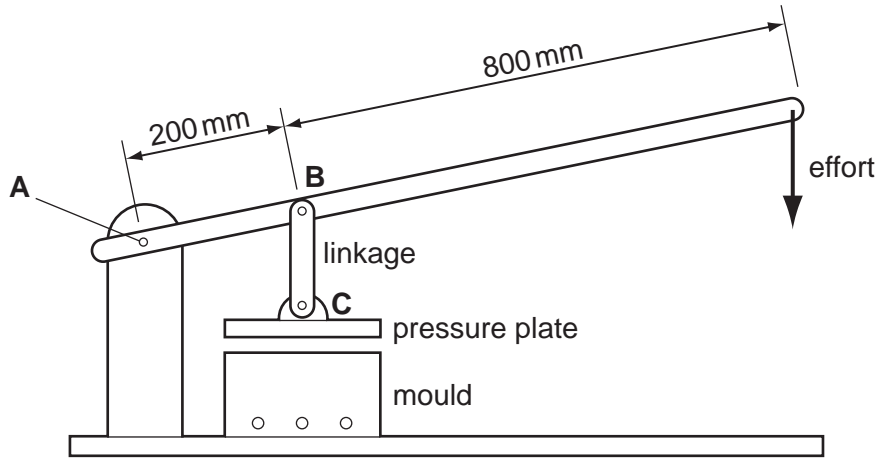


Fig. 9

(i) Calculate the effort required to generate a force of 400 N at the pressure plate C. The pivot A is fixed.

Show all your workings.

[3]

(ii) Complete the statement below.

The type of force acting on pin B is .....

[1]

(c) Fig. 10 shows a mechanism for motion conversion.

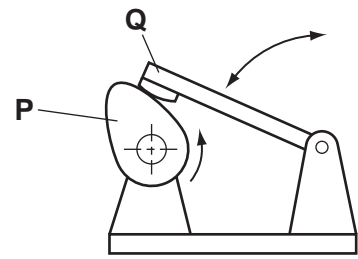


Fig. 10

(i) Name the **two** types of motion shown in Fig. 10.

..... [1]

..... [1]

(ii) Give the specific names of parts **P** and **Q**.

**P** ..... [2]

**Q** ..... [2]

(iii) Give **two** applications for the mechanism shown in Fig. 10.

.....

..... [2]

(d) Fig. 11 shows a rack and pinion mechanism.

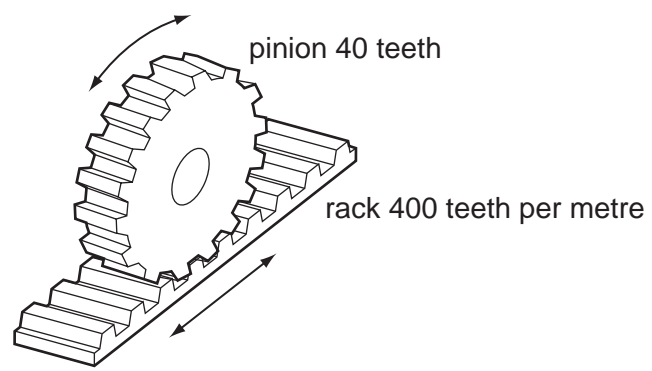


Fig. 11

(i) Give **one** example of the use of a rack and pinion system.

..... [1]

(ii) For the rack and pinion system shown in Fig. 11, calculate the distance moved by the rack for one rotation of the pinion gear wheel.

Show all your working.

[3]

(e) The use of bearings and lubrication is important in mechanical systems.

(i) Explain how the use of bearings and lubrication reduces the amount of power needed to drive a mechanism.

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

(ii) State **one** type of lubricant used in a motor vehicle transmission system.

..... [1]

13 Fig. 12 shows a shackle bolt.

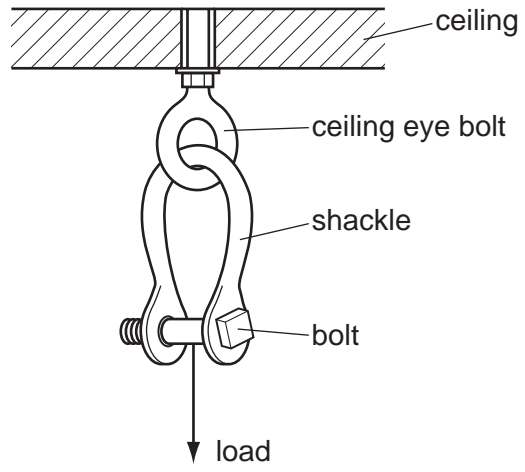


Fig. 12

(a) (i) State the forces acting in the shackle and the bolt when loaded as shown in Fig. 12.

Shackle ..... [1]

Bolt ..... [2]

(ii) State **one** property of mild steel that makes it suitable for this type of loading.  
..... [1]

(b) Explain how the design of the shackle helps to distribute stress when it is loaded.  
.....  
.....  
.....  
..... [3]

(c) The shackle uses a threaded bolt as a temporary fixing.  
(i) Explain why a threaded bolt is used in the shackle arrangement.  
.....  
.....  
..... [2]

(ii) Name **one** permanent fixing method used in structures and give a specific example of the use of this type of fixing method.

Name ..... [1]

Example ..... [1]

(d) Fig. 13 shows a framework for a temporary outdoor stage.

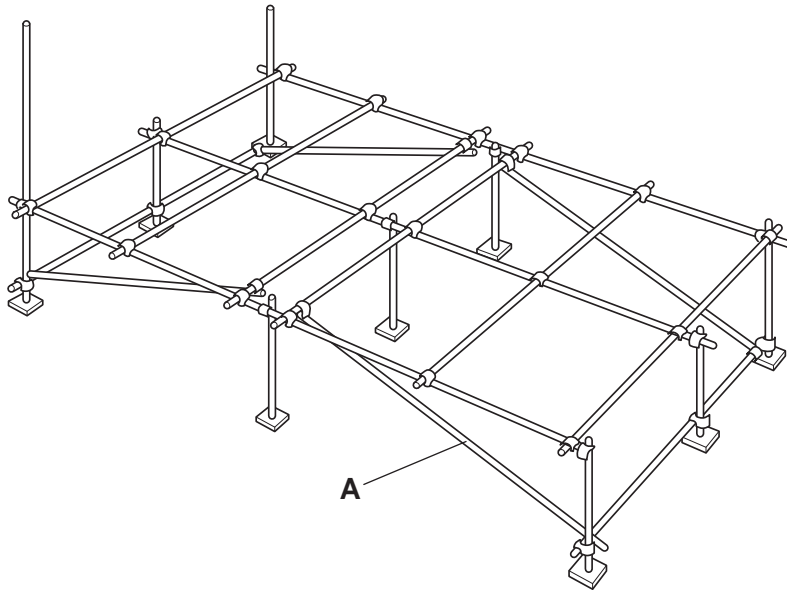


Fig. 13

Name and state the purpose of part A.

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

(e) Use notes and sketches to explain the term *redundant member*.

(f) Fig. 14 shows a test sample used in an experiment to test a material's ability to withstand stress loading.

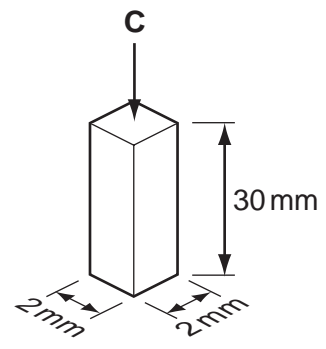


Fig. 14

(i) Calculate the compressive force, **C**, that would produce a stress of 250 N/mm<sup>2</sup> on this sample.

Show all your working.

[3]

(ii) The sample also experiences strain. Explain what is meant by the term *strain*.

.....

.....

..... [3]

(iii) The sample is compressed from 30 mm to 29.94 mm due to the compressive force. Calculate the strain on the sample. Show all your working.

[3]

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