



ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Technology and Design

Assessment Unit AS 1

assessing

Product Design
and
Systems and Control



[AV111]

MONDAY 22 MAY, MORNING

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided and on the A3 pro forma answer pages.

Answer **all eight** questions in Section A, and both questions in **either** Section B **or** Section C **or** Section D.

An A3 pro forma is provided for Question **11(c)**, Question **12(c),(d)** and **(e)**, Question **13(d)(i)** and **(ii)** and Question **14(d)(i)** and **(ii)**.

At the conclusion of the examination, attach the A3 pro forma answer pages securely to the Answer Booklet with the treasury tag supplied.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80, including a maximum of 4 marks for quality of written communication.

Marks for quality of written communication will be awarded for Questions **8**, **9(b)(ii)**, **10(b)(iii)**, **11(b)(i)**, **12(b)**, **13(b)** and **14(b)(ii)**.

You are provided with an insert for use with Question **13** and Question **14**.

Do not write your answer on the inserts.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

All questions do not carry equal weighting.

Section A**Product Design and Practice**

Answer **all** questions in this section

You are advised to spend approximately **1 hour** on this section.

- 1** Common form and sizes of medium density fibreboard (MDF) are widely used in the manufacture of domestic furniture.
- (i) Explain the term common form and sizes of materials. [2]
- (ii) Give **two** main properties and **one** main working characteristic of MDF which makes it suitable for domestic furniture. [3]
- 2** Polystyrene and ABS are used in a wide range of products.
- (i) Give **two** main reasons why polystyrene is used for fast food packaging. [2]
- (ii) Give **two** main reasons why ABS is used for children's toys. [2]
- 3** (i) Explain the difference between a composite and an alloy when creating new materials. [2]
- Light-emitting polymers are smart materials with a range of characteristics and applications.
- (ii) State **one** main characteristic associated with light-emitting polymers and give **one** specific application. [2]
- 4** Yoghurt pots may be manufactured using the vacuum forming process.
- (i) Give **two** main reasons why the vacuum forming process may be used to manufacture yoghurt pots. [2]
- (ii) With the aid of an annotated sketch describe the vacuum forming process. [4]

5 When planning to manufacture the yoghurt pots the use of computer-integrated manufacture (CIM) was considered.

(i) Explain how CIM could be used for stock control of the yoghurt pots. [2]

When discussing the information that is to be printed on the labels of the yoghurt pots consideration had to be given to the Trade Descriptions Act.

(ii) Briefly outline **two** main characteristics associated with the Trade Descriptions Act. [2]

6 Play park climbing frames and slides may be manufactured using a range of processes to include rolling and welding.

(i) Explain the process of rolling which could be used to form the profile of the slide. [2]

(ii) Explain the process of welding which may be used to permanently join component parts of the climbing frame. [2]

The play park climbing frames and slides are subjected to rigorous inspections before installation.

(iii) Briefly outline **two** main reasons why it is important for the manufacturer to inspect the play park climbing frames and slides before installation. [2]

7 The play park climbing frames may be manufactured from mild steel.

(i) State **two** main specific properties of mild steel which would make it suitable for the play park climbing frames. [2]

The play park climbing frames can be plastic coated to protect them from the environment.

(ii) Explain the process of plastic coating. [3]

8 The design of products may be influenced by social changes or by environmental influences in the form of the 3R's.

(i) With reference to a specific product, explain how **one** main social change has had an influence on its design. [2]

(ii) With reference to a specific product explain how any **one** of the 3R's has influenced the design of your chosen product. [2]

Quality of written communication [2]

Section B

Electronic and Microelectronic Control Systems

Answer both questions in this section **or** both questions in Section C **or** both questions in Section D.

You are advised to spend approximately **1 hour** on this section.

- 9 (a) A control circuit consisting of 3 toggle switches A, B and C, a resistor R and an LED is shown in Fig. 1.

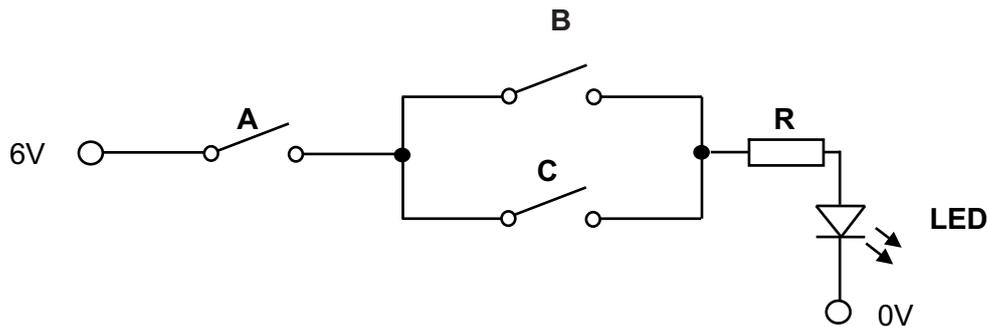
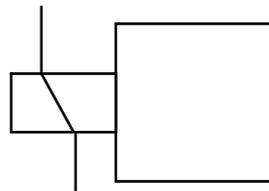


Fig. 1

- (i) With reference to poles(P) and throws(T) state the type of switch shown in Fig. 1. [1]
- (ii) For the circuit shown in Fig. 1 draw a truth table for the combinations of switch positions for A, B and C that turn the LED on. Assume that a closed switch is represented by a '1', an open switch is represented by a '0', an on LED is represented by '1' and an off LED is represented by '0'. [3]
- (iii) The logic control provided by the circuit shown in Fig. 1 could be achieved by using logic gates. Using logic gate symbols draw a logic circuit that could be used to replace the circuit shown in Fig. 1. [3]
- (iv) The resistor R shown in Fig. 1 is required to limit the current in the LED to 30 mA where the forward voltage of the LED is 1.8 volts. Calculate the required value for the resistor R. [2]
- (v) If resistors are available with power ratings of 0.125W, 0.25W, 0.5W and 0.75W calculate the power dissipation by R in Fig. 1 and then select a suitable power rating for the resistor. [2]

- (b) The control circuit in **Fig. 1** is to be altered by removing the LED and using the output from the circuit to operate a 12 volt solenoid valve using a transistor. The electronic symbol for a solenoid valve is shown in **Fig. 2**.



Solenoid valve

Fig. 2

- (i) Draw a circuit diagram showing how the output from the control circuit shown in **Fig. 1** can be used to operate the solenoid valve shown in **Fig. 2** using a transistor and showing any additional components required. [3]
- (ii) An alternative control circuit is required to operate the solenoid valve so that it will remain latched on when the output from the control circuit is off. This can be achieved by utilising a latching relay.
- State **one** advantage of using a latching relay to keep the solenoid switched on. [1]
 - Explain the principle of operation of a latching relay. [2]
- Quality of written communication [1]
- (iii) A thyristor could also be utilised to achieve a latching action for control circuits. State **two** main advantages, other than cost, of using a thyristor rather than a relay. [2]

10 (a) A RC circuit with a normally open reed switch is shown in Fig. 3.

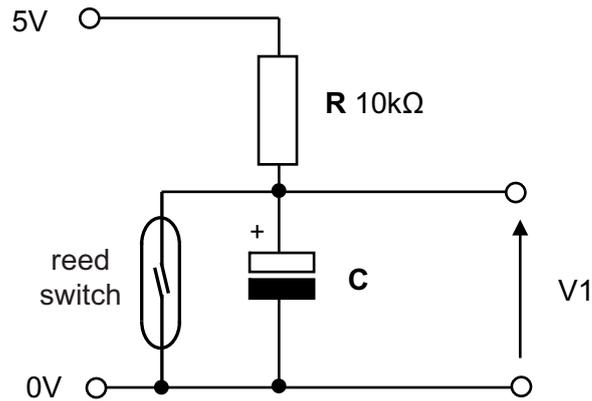


Fig. 3

- (i) State the effect on V_1 in Fig. 3 when a magnet is held close to the reed switch. [1]
- (ii) Calculate the required value for C in Fig. 3 for a time constant of 3 seconds. [2]
- (iii) The circuit in Fig. 3 could be modified so that the time taken to discharge the capacitor is approximately half the time taken to charge the capacitor after the power supply is removed. With the aid of a circuit diagram show how this could be achieved. [2]

(b) The output V_1 from Fig. 3 is to be connected to an input of a comparator as shown in Fig. 4.

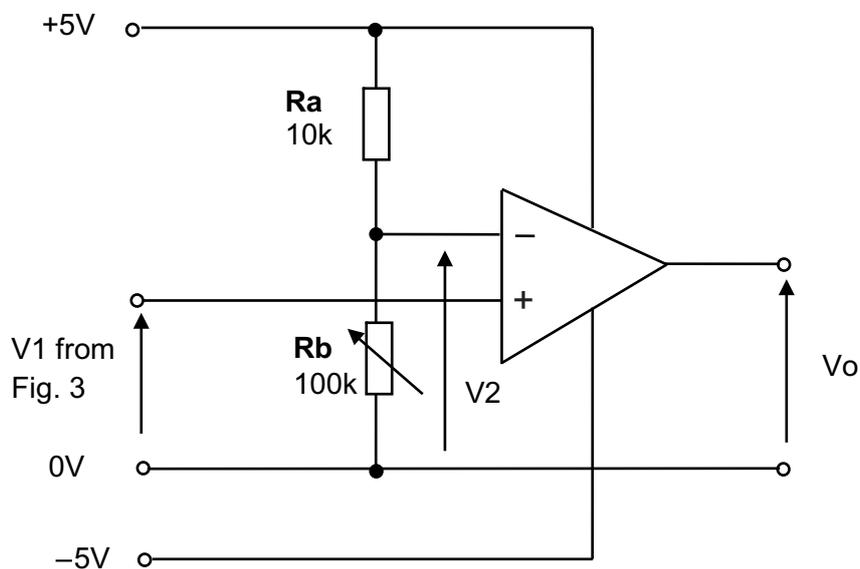


Fig. 4

- (i) The resistor R_b shown in Fig. 4 is a 100k variable resistor. State the resulting voltage V_2 if this resistor is adjusted to its minimum position. [1]
- (ii) Calculate the resulting voltage V_2 in Fig. 4 when the variable resistor R_b is adjusted to a value of 20k. [2]

- (iii) Assuming that the reed switch in **Fig. 3** is initially closed, explain the operation of the circuit shown in **Fig. 4** when the reed switch is opened and remains open. Assume that R_b is adjusted to a value which provides a voltage at V_2 of 3 volts. Your answer should make reference to V_1 , V_2 and V_o . [3]

Quality of written communication [1]

- (c) The output V_o from the comparator circuit, as shown in **Fig. 4**, is used to operate the 555 timer circuit shown in **Fig. 5**, which in turn controls a 5 volt lamp. The lamp is required to flash at a rate of 1 Hertz.

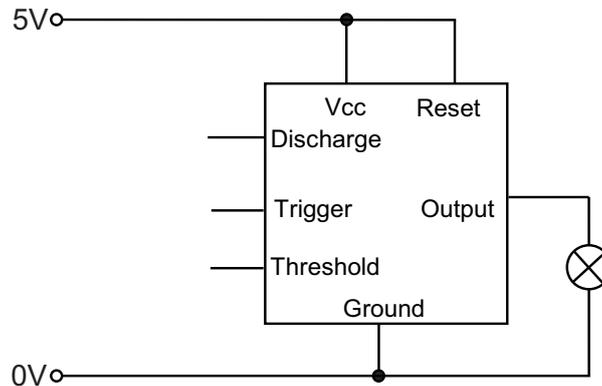


Fig. 5

- (i) Calculate the value of C required for the lamp to flash at a rate of 1 Hertz given that the output frequency of a 555 astable is given by $f = 1.44/(R_1 + 2R_2)C$ where $R_1 = 3\text{ k}\Omega$ and $R_2 = 70\text{ k}\Omega$. [2]
- (ii) Redraw **Fig. 5** in your answer booklet to show how R_1 , R_2 and C are connected to the 555 timer to achieve the desired output. [3]
- (iii) Sketch a graph with labelled axes showing output against time for the 555 circuit in part (i) above labelling the time period (assume a mark to space ratio of 1:1). [3]

Section C

Mechanical and Pneumatic Control Systems

Answer both questions in this section **or** both questions in Section B **or** both questions in Section D.

You are advised to spend approximately **1 hour** on this section.

11 Fig. 6 shows part of a prototype mechanical lifting system. The casing houses various pulleys which can be arranged to satisfy a range of mechanical advantage requirements.

(a) Calculate the effort required to lift a load of 190N if the lifting system has a velocity ratio of 4 and is operating at an efficiency of 95%.

[4]

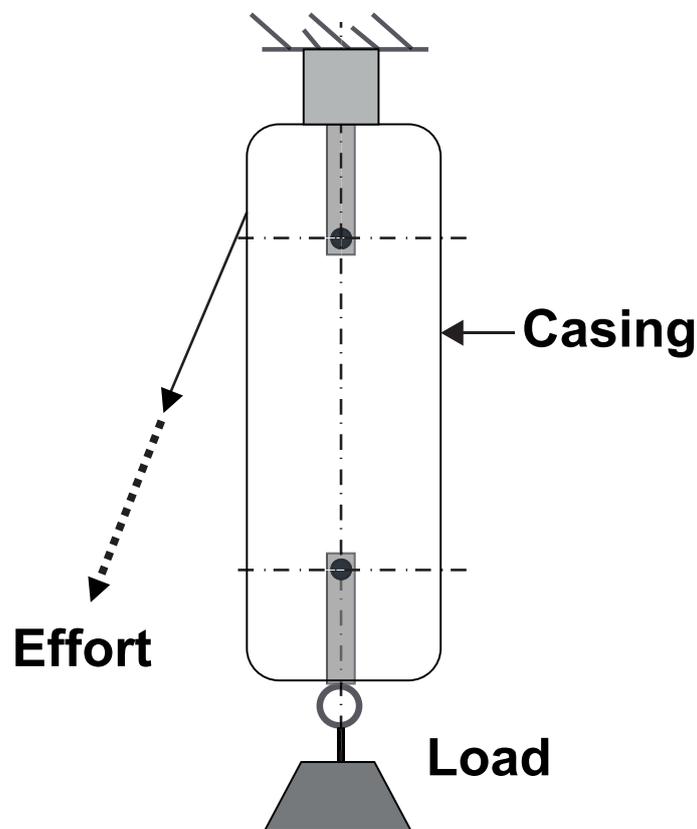


Fig. 6

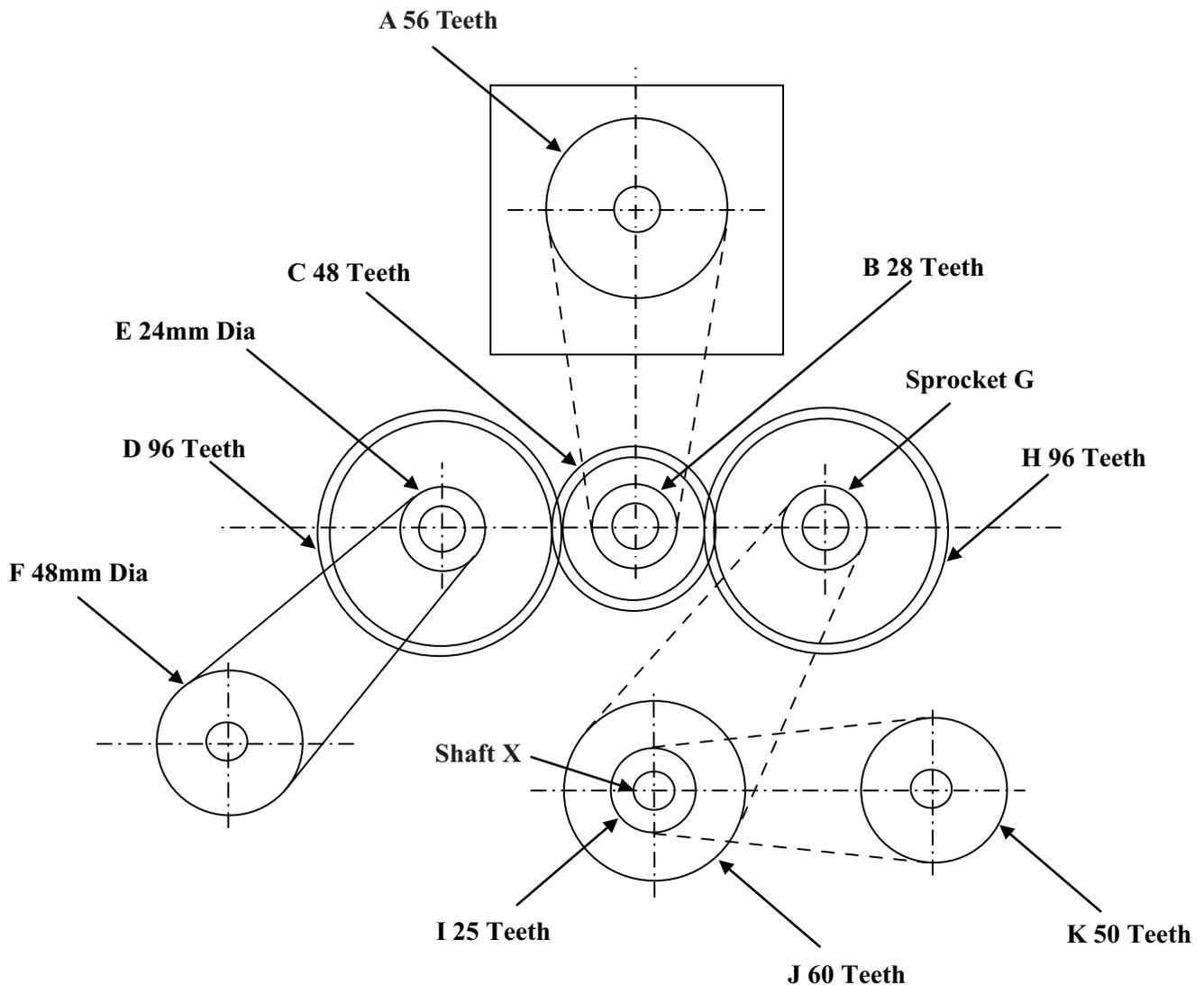


Fig. 7

(b) Fig. 7 shows part of another prototype mechanical system.

- (i) Pulley F is attached to its shaft using a key and keyway. Describe **two** benefits of using this attachment method instead of a grub screw. [2]

Quality of written communication [1]

- (ii) Calculate the velocity ratio between A and F. [4]

- (iii) Calculate the number of teeth on sprocket G required to enable K to rotate at 5 rev/min if H rotates at 60 rev/min. [4]

(c) On the pro forma provided (answer number 11(c)), using an annotated sketch outline any mechanical components required to enable Part A and Part B to move in opposite vertical directions as the handle on Shaft Z is turned. [5]

- 12** The pro forma provided (answer number **12(c)**, **(d)** and **(e)**) shows part of an incomplete pneumatic system.
- (a) Name the activation method at **L**. [1]
- (b) Describe how the air bleed circuit uses air pressure to activate the three port valve. [2]
- Quality of written communication [1]
- (c) On the pro forma provided (answer number **12(c)**, **(d)** and **(e)**), add a single acting cylinder to the circuit which will outstroke when the double acting cylinder instrokes. [2]
- (d) On the pro forma provided (answer number **12(c)**, **(d)** and **(e)**), complete the circuit to enable activations at **A and B and not C or D** to signal the five port valve to outstroke. In your answer show how A is activated. [5]
- (e) On the pro forma provided (answer number **12(c)**, **(d)** and **(e)**), complete the circuit enabling the double acting cylinder to instroke following a time delay once the air bleed or the three port valve at **R** are activated. [5]
- (f) The double acting cylinder (DAC) and the single acting cylinder (SAC) are both supplied with an air pressure of 0.5 N/mm^2 . The DAC has a piston diameter of 80 mm and a piston rod diameter of 8 mm and the SAC has a piston diameter of 60 mm. Calculate the difference in forces produced by the DAC during the instroke and the SAC during the outstroke. Please assume $\pi = 3.14$. [4]

Section D

Product Design

Answer both questions in this section **or** both questions in Section B **or** both questions in Section C.

You are advised to spend approximately **1 hour** on this section.

13 Fig. 8 on the insert page shows photographs of a camping stool.

- (a) (i) Briefly outline **one** main aspect in support of the view that this is a low cost product. [1]
- (ii) Briefly outline **two** specific performance criteria that a designer would need to include in a specification for the camping stool. [2]
- (iii) Briefly outline **two** main criteria that would influence the selection of the material to be used for the legs of the camping stool as shown in **Fig. 8**. [2]
- (b) When designing the camping stool formative and summative evaluation techniques were employed.
- Distinguish between formative and summative evaluation techniques. [2]
- Quality of written communication [1]
- (c) As a result of these evaluations the designer not only considered replacing the material for the centre support bracket with a glass reinforced plastic (GRP) but also considered incorporating holograms onto the fabric seat of the product.
- (i) Briefly outline **two** main properties of GRP which make it suitable for the centre support bracket. [2]
- (ii) State what is meant by a hologram and give **one** main reason why the company may want to use this modern material. [2]
- (d) With the aid of detailed annotated sketches, using the blank A3 pro forma answer page (answer number **13(d)(i) and (ii)**), complete each of the following:
- (i) A suitable design that can be used for each of the three legs to enable the user to quickly extend the length of each leg. X-X on **Fig. 8** shows the position where your design should provide extension. [4]
- (ii) A bar chart that can simply and clearly communicate to a customer the information from the table shown below on each of the three camping stools.

Maximum loading	Frame type	Seat fabric colours	Maximum vertical height
Camping stool 1 (40kg)	Light gauge material	Orange, blue and green	300 mm
Camping stool 2 (60kg)	Medium gauge material	Blue and green	400 mm
Camping stool 3 (80kg)	Heavy gauge material	Black only	500 mm

14 Fig. 9 on the insert page shows photographs of a three way mains adapter.

- (a) Briefly explain the purpose of a design brief. [1]
- (b) In an attempt to produce a more innovative adapter for the market the design team used the technique of thought showers.

- (i) Outline **two** main characteristics associated with thought showers. [2]

One design idea which was generated by this technique resulted in the company applying for a patent.

- (ii) Outline **two** main specific characteristics associated with a patent and give **one** main reason why it would be beneficial for the company to have a patent for the product. [3]

Quality of written communication [1]

- (c) The three way mains adapter shown in **Fig. 9** is to be partly packaged using solid white board.

- (i) Briefly outline **two** main characteristics associated with solid white board which make it suitable for packaging. [2]

- (ii) With the aid of an annotated sketch explain the process of die cutting which could be used to cut out the profile for the packaging of the three way mains adapter. [3]

- (d) With the aid of detailed annotated sketches, using the blank A3 pro forma answer page (answer number **14(d)(i) and (ii)**), complete each of the following:

- (i) An appropriate design of an accessory which will securely hold a mobile phone (measuring 130 mm by 60 mm by 10 mm) while it is being charged. Show how your design is attached to the three way mains adapter. [4]

Safety plug covers like the one shown in **Fig. 9** are often inserted into wall sockets and adapters as a safety feature.

- (ii) Produce an appropriate design which would enable people with limited finger mobility to remove the existing safety plug cover from the three way mains adapter. Explain how your design would be suitable for people with limited finger mobility. [4]

THIS IS THE END OF THE QUESTION PAPER

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Question No. 11(c)

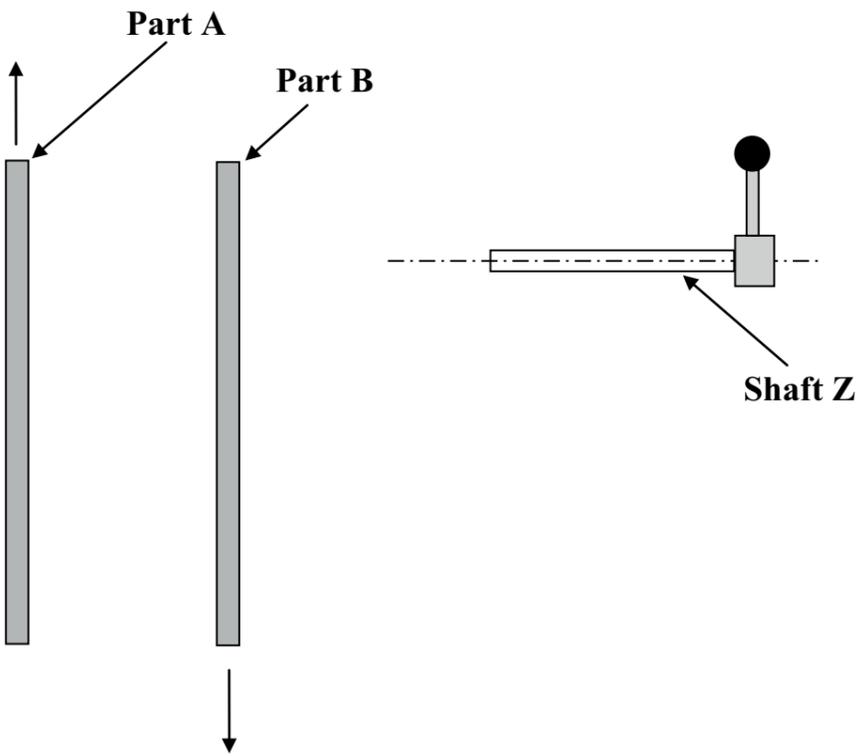
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Pro forma answer page
(answer number 11(c))

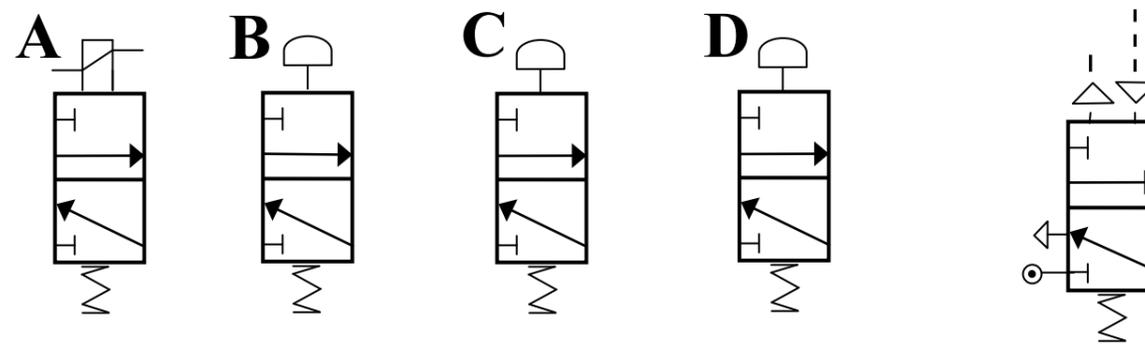
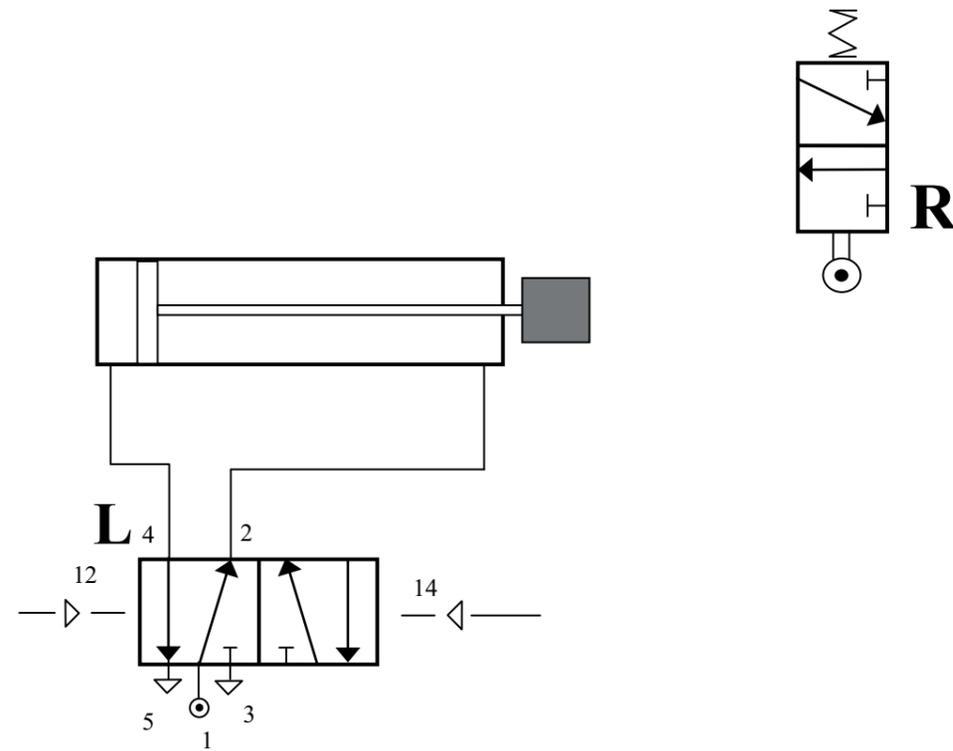
Question No. 12(c), (d) and (e)

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Pro forma answer page
 (answer number 12(c), (d) and (e))

Question No. 13(d)(i) and (ii)

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Pro forma answer page
(answer number 13(d)(i) and (ii))

Question No. 14(d)(i) and (ii)

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Pro forma answer page
(answer number 14(d)(i) and (ii))

GCE Advanced Subsidiary (AS) Technology and Design
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(for use with Question 13)

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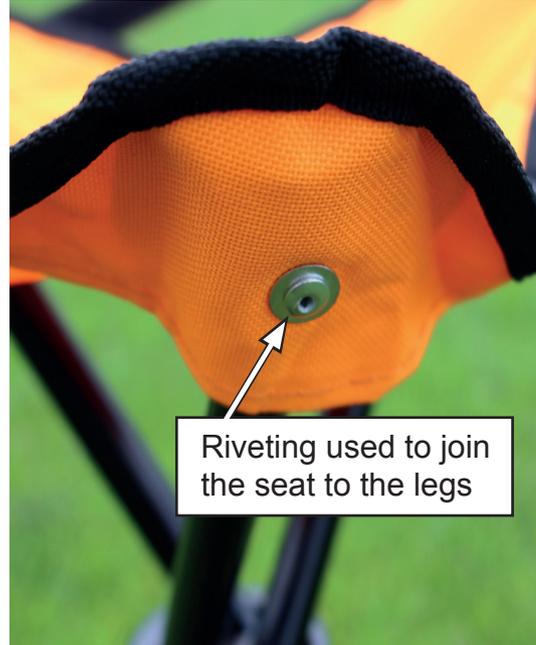


Fig. 8

GCE Advanced Subsidiary (AS) Technology and Design
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(for use with Question 14)

Do not write your answers on this insert

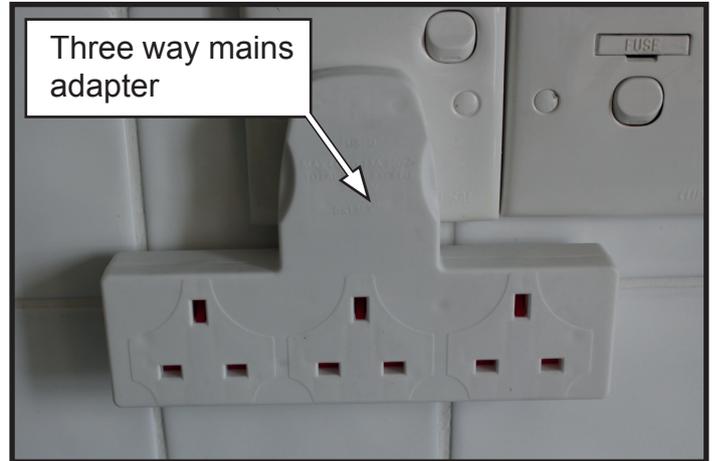
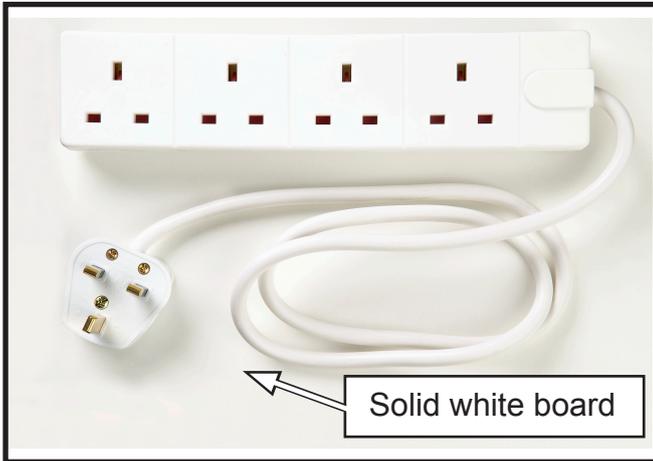


Photo 1 © Steve Gorton / Thinkstock Photos 2,3,4 © Chief Examiner

Fig. 9