



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2013

Technology and Design

Assessment Unit AS 1

assessing

Product Design and
Systems and Control

[AV111]



THURSDAY 10 JANUARY, 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 page provided.

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 **12(b)**, **(c)** and **(d)**, **13(b)(i)** and **(ii)** and **14(d)(i)** and **(ii)**. You are provided with an insert for use with Questions **13** and **14**.

At the conclusion of the examination, attach the A3 pro forma answer page 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 (QWC) will be awarded for Questions **8**, **9(a)(iii)**, **10(a)(iv)**, **11(c)(ii)**, **12(e)**, **13(a)(v)** and **14(b)**.

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** When selecting a specific wood or metal for an outdoor picnic table a designer needs to consider the properties of the materials and the environmental conditions they will be subjected to.
- (i) Briefly explain what is meant by a property in relation to a material. [1]
- (ii) Briefly outline **two** main reasons why a designer needs to consider the stability of specific woods before making a choice. [2]
- (iii) Suggest a suitable metal for bolts which are used to join a picnic table together, in order to make them suitable for the outdoor environment. [1]
- 2** Plywood, hardboard, medium density fibreboard (MDF) and chipboard offer many advantages making them suitable for a wide range of applications.
- (i) Briefly outline **one** main advantage plywood has compared to hardboard. [1]
- (ii) Briefly outline **two** advantages MDF has compared to chipboard. [2]
- (iii) Give **one** specific application for plywood and **one** specific application for MDF. [2]
- 3** Metals are supplied in a range of forms.
- (i) State **two** different available forms in which metal is supplied. [2]
- (ii) Give **one** main reason for each below, why:
- Copper is used in printed circuit boards.
 - High carbon steel is used for drill bits.
 - Aluminium is used for ladders. [3]

- 4 Domestic guttering, water, gas, sewer and drain pipes may be manufactured by the process of extrusion.
- (i) Suggest a suitable material for the extrusion process. [1]
 - (ii) Briefly outline **one** main reason why extrusion is the most suitable process for the manufacture of these products. [1]
 - (iii) With the aid of an annotated sketch describe the extrusion process. [4]
- 5 Composites, alloys and piezoelectric materials are used in a variety of products.
- (i) Briefly explain what is meant by a composite. [1]
 - (ii) Briefly explain what is meant by an alloy. [1]
 - (iii) State **one** specific application for the use of piezoelectric material and briefly outline **one** main characteristic which makes it a suitable material for your chosen application. [2]
- 6 Continuous, cell and just-in-time (JIT) production are different types of production methods.
- (i) Briefly outline **one** main characteristic associated with continuous production. [1]
 - (ii) Describe **two** main characteristics associated with cell production. [2]
 - (iii) Describe **two** main characteristics associated with just-in-time (JIT) production. [2]

7 Wasting involves the use of workshop hand tools, manual and CNC machine tools when processing materials.

(i) Briefly explain what is meant by the term wasting when processing materials. [1]

(ii) There are risks associated with using common manufacturing and hand processes and methods used to minimise them.

For a specific manufacturing process of your choice briefly outline **two** main associated risks and **two** main methods used to minimise them. [4]

8 Changes in fashion and social changes have influenced the design of many products.

(i) With reference to a suitable specific product of your choice, outline **one** main change in fashion and explain what influence this has had on its design. [2]

(ii) With reference to a suitable specific product of your choice, outline **one** main social change and explain what influence this has had on its design. [2]

Quality of written communication [2]

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(Section B begins overleaf)

Section B

Electronic and Microelectronic Control Systems

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

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

- 9 (a) Three logic gates are connected as shown in **Fig. 9(a)**.

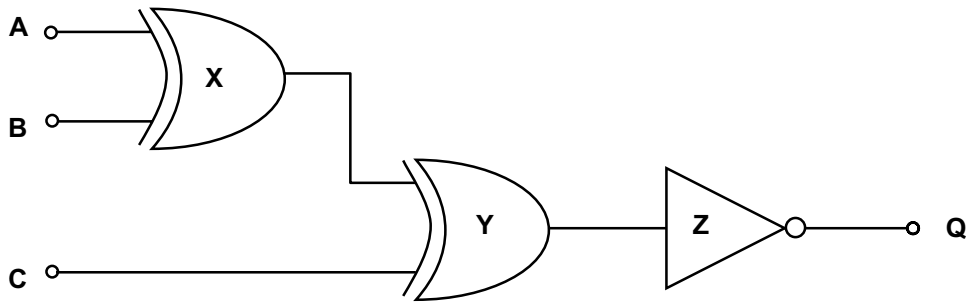


Fig. 9(a)

- (i) Name the logic gate labelled **X** shown in **Fig. 9(a)**. [1]
- (ii) Draw a truth table for all combinations of A, B and C and the corresponding output Q for the circuit shown in **Fig. 9(a)**. [4]
- (iii) The logic circuit shown in **Fig. 9(a)** could be constructed using a programmable system such as a PIC. Describe **one** advantage and **one** disadvantage (apart from cost) of using a programmable system such as a PIC to make the circuit in **Fig. 9(a)**. [2]
- Quality of written communication [1]

(b) An incomplete circuit (based on a 555 timer) is shown in **Fig. 9(b)**. The output is to be used to control a solenoid valve.

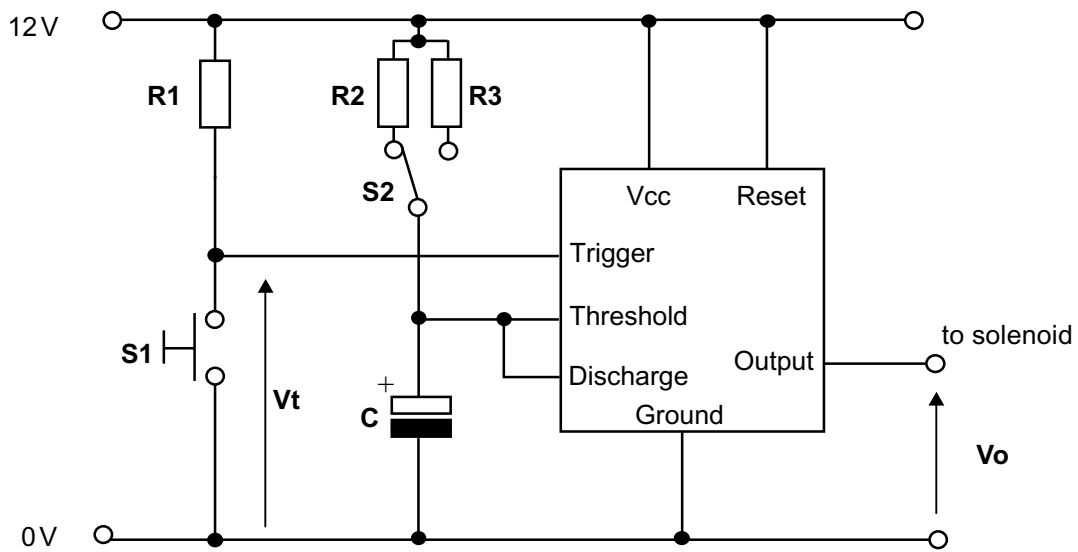


Fig. 9(b)

- (i) For the circuit shown in **Fig. 9(b)**, sketch and label a graph showing the following:
- Voltage V_t against time when **S1** has been momentarily pressed and then released.
 - On the same axes the voltage V_o against time when the switch **S1** has been momentarily pressed and then released. You may assume that the time period of the circuit is 2.2 seconds. [4]
- (ii) The output from the circuit shown in **Fig. 9(b)** is to be on for either 2.2 seconds or 5.7 seconds depending on the position of switch **S2**. Calculate the corresponding values for **R2** and **R3** when $C = 10 \mu\text{F}$ and given that the output is on for a period $T = 1.1 \times C \times R$ (where R can be either **R2** or **R3**). [4]
- (iii) A solenoid is to be connected to the output from the circuit shown in **Fig. 9(b)** using a **darlington pair** arrangement. With the aid of an annotated circuit diagram show how this could be achieved using a **darlington pair** and give **two** reasons why this arrangement is used. [4]

10 (a) A voltage divider circuit is shown in Fig. 10(a).

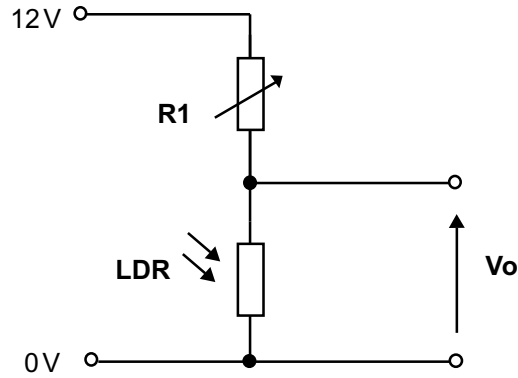


Fig. 10(a)

- (i) State the relationship between light intensity and resistance for a Light Dependent Resistor (LDR). [1]

- (ii) Briefly describe what happens to V_o in Fig. 10(a) when the light conditions change from light to dark. [2]

- (iii) Suggest **one** reason why resistor R1 is a variable type resistor as shown in Fig. 10(a). [1]

- (iv) Fixed resistors have a tolerance. Explain with an example, what is meant by the term tolerance when referring to fixed resistors. [2]

- Quality of written communication [1]

- (v) Calculate the maximum and minimum values for V_o in Fig. 10(a) if the resistance of R1 is set at $12\text{ k}\Omega$ and the resistance of the LDR ranges from $200\ \Omega$ to $20\text{ k}\Omega$. [4]

(b) A 12 volt 50 Watt bulb is shown in **Fig. 10(b)**.



Fig. 10(b)

Calculate the maximum current that can flow in the bulb shown in **Fig. 10(b)** when operating at 12 volts. [2]

(c) The voltage divider shown in **Fig. 10(a)** is to be used in conjunction with a **comparator**, based on an op amp to switch a security light bulb rated at 24 volts.

Using a labelled and annotated diagram, design a complete op amp based comparator circuit with suitable driving circuitry to control the security light.

The security light should switch on when the light level falls below a pre-determined level. [7]

Section C

Mechanical and Pneumatic Control Systems

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

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

- 11 Fig. 11** shows a mechanical system incorporating a motor, pulleys, sprockets and gears.
- (a) (i) State the direction of rotation at **J** if **A** rotates in an anticlockwise direction. [1]
- (ii) The velocity ratio between E and F is 2:1. Calculate the output speed at **Gear G** if **D** rotates at 162 rev/min. [2]
- (iii) Calculate the overall velocity ratio between **A** and **D**. [3]
- (iv) Calculate the number of teeth required at **Gear J** for it to have a speed of 320 rev/min if **B** rotates 300 rev/min. Please note that **Gear J** is not drawn to scale on **Fig. 11**. [4]
- (b) (i) Pulley **A** is attached to the motor shaft using a cotter pin. Using an annotated sketch outline the main features of this arrangement. [3]
- (ii) Apart from keys and keyways name **one** other suitable mechanical method which could be used to fix pulleys to shafts. [1]
- (c) (i) Name a suitable pulley belt which could transmit rotary motion from a driver to a driven shaft which are at right angles to each other and explain why this belt is suitable. [2]
- (ii) A self-adjusting jockey wheel is to be added between pulleys **A** and **B**. Using an annotated sketch outline the main features of this arrangement. Include in your answer an explanation of how a self-adjusting jockey wheel works and why it may be required. [3]
- Quality of written communication [1]

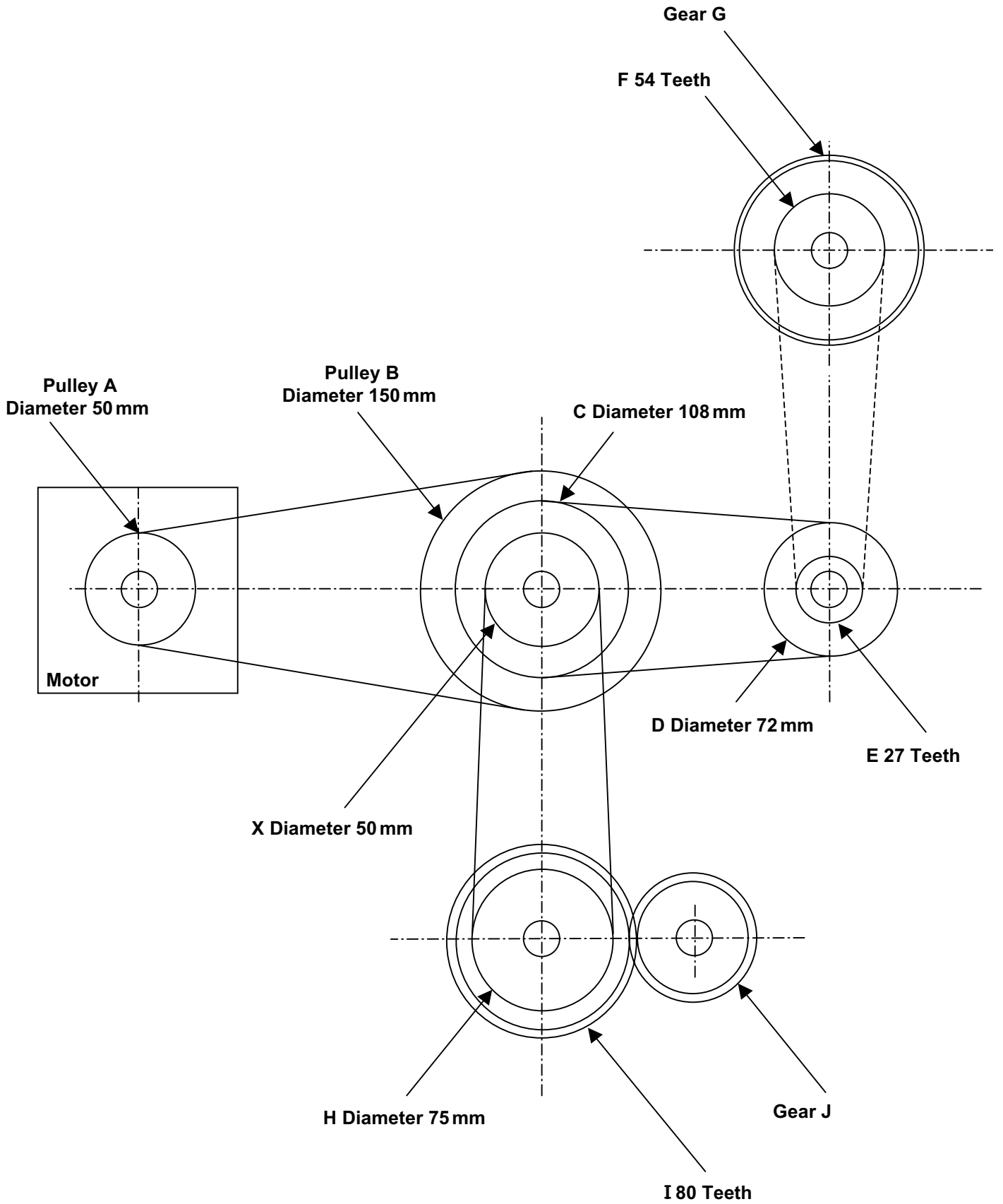


Fig. 11

12 Fig. 12 shows part of an incomplete pneumatic circuit incorporating two double acting cylinders.

- (a) (i) State the purpose of the symbol shown on **Port 1** on the five port valve. [1]

(ii) Name the activation method at valve **A**. [1]

(iii) Name the activation method at valve **C**. [1]
- (b) On the pro forma provided (answer number **12(b), (c) and (d)**) complete the circuit enabling double acting cylinder **P** to outstroke if 3 port valves **A or B or C or D** are activated. [5]
- (c) On the pro forma provided (answer number **12(b), (c) and (d)**) add piping to enable the double acting cylinder **Q** to outstroke as the double acting cylinder **P** instrokes. [2]
- (d) On the pro forma provided (answer number **12(b), (c) and (d)**) complete the circuit and add any additional components to enable the double acting cylinder **P** to instroke after a delay in time following an outstroke. [4]
- (e) Describe in detail the full operation of the air bleed used to activate three port valve **D**. Your answer should include references to the names of the components, activation method and air flow. [2]

Quality of written communication [1]
- (f) Double acting cylinder **Q** is supplied with an air pressure of 0.5 N/mm^2 and produces a force during the outstroke of 320 N and has a piston rod diameter of 12 mm . Calculate the force during the instroke. Please assume $\pi = 3.14$. [3]

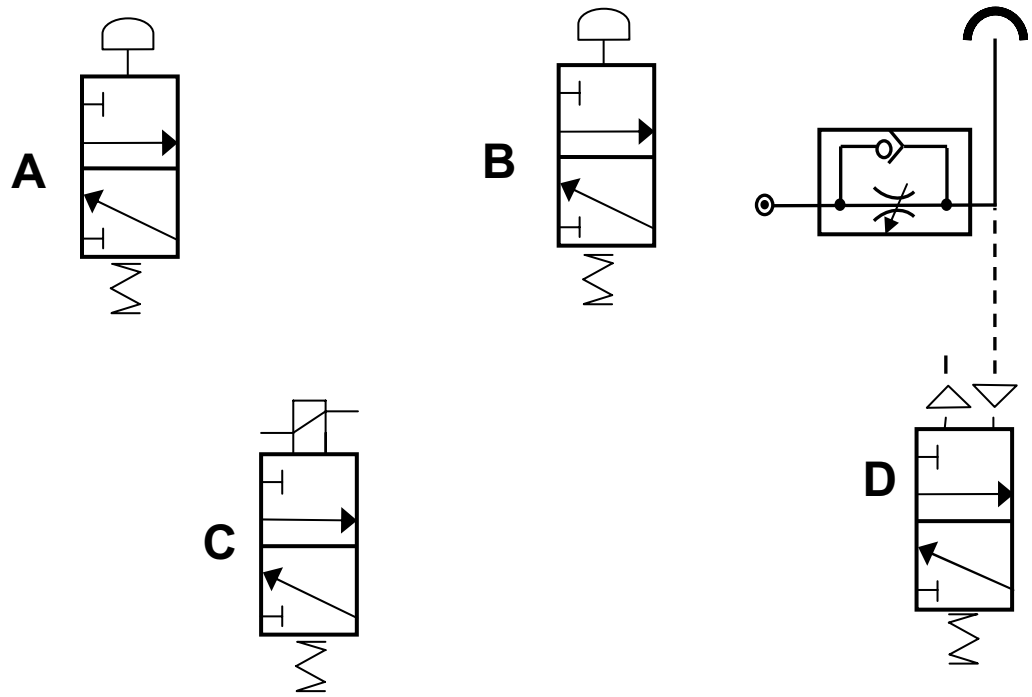
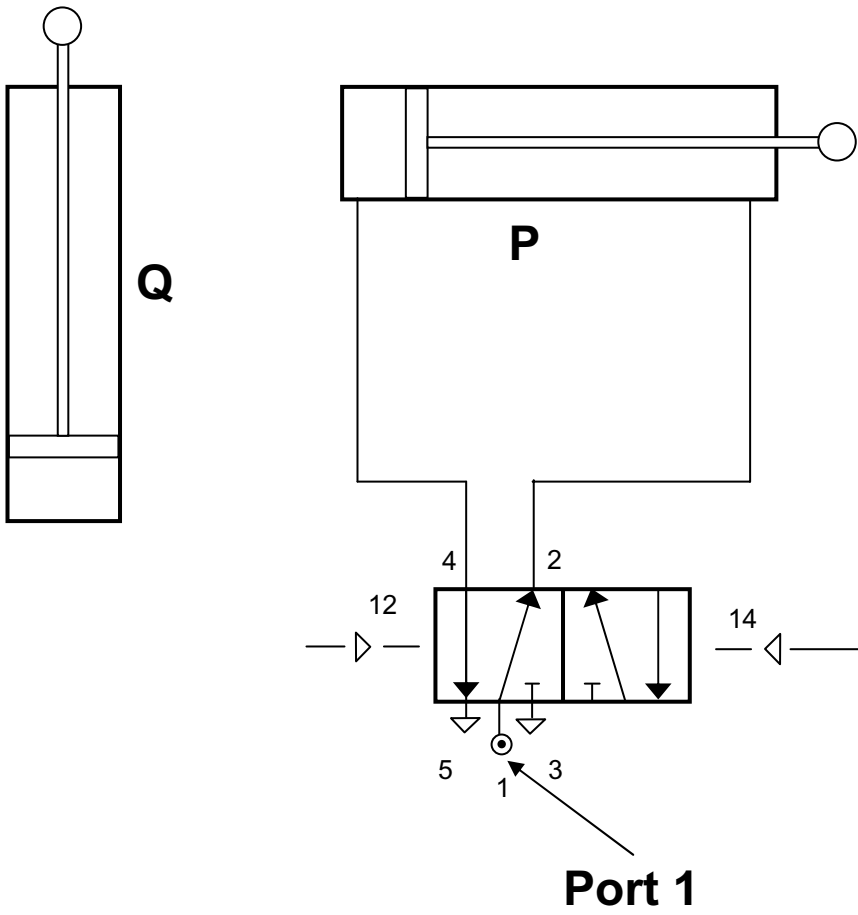


Fig. 12

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Section D

Product Design

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

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

- 13 (a)** With reference to **Fig. 13(a), (b), (c) and (d)** on the insert sheet;
- (i)** Briefly outline **two** specific criteria that a designer would need to include in a manufacturing specification for the casing of the toaster. [2]
 - (ii)** Suggest a suitable material for the casing of the toaster and give **two** main reasons why it is suitable for the product. [3]
 - (iii)** For the product shown in **Fig. 13** briefly outline **two** different marketing constraints that the company would need to consider. [2]
 - (iv)** For the product shown in **Fig. 13** briefly outline **two** different ways in which the designer has taken into consideration the safety of the user. [2]
 - (v)** For the product shown in **Fig. 13** explain **two** main factors which may have influenced the designer to produce this particular **form**. [2]
- Quality of written communication [1]
- (b)** With the aid of detailed annotated sketches, using the blank A3 pro forma answer page (answer number **13(b)(i) and (ii)**), complete each of the following:
- (i)** An appropriate design of a pictogram for the side of the toaster as shown in **Fig. 13(c)** to remind the user to switch off the appliance at the wall socket after use. [4]
 - (ii)** A low cost ergonomically designed utensil which minimises the use of materials while assisting the user to lift the warm toast out of the toaster (**Fig. 13(d)**). Justify how your design is low cost and how you have considered ergonomics. [4]

14 Fig. 14 on the insert page shows a photograph of a skateboard designed for the teenage market.

(a) The bend on the curve of the plywood skateboard deck shown in **Fig. 14** can be created by the process of steam bending.

(i) With the use of an annotated sketch explain the process of steam bending. [3]

(ii) To improve the visual appeal of the skateboard reflective films are to be added. Briefly outline **two** main characteristics associated with reflective films which would make them suitable for the skateboard. [2]

(iii) Given the range of processes used to manufacture the skateboard, the company has taken a number of steps to comply with the Health and Safety at Work Act. Briefly outline **two** main characteristics associated with the Health and Safety at Work Act which would apply to the manufacturing of products in general. [2]

(b) In an attempt to produce a more innovative range of skateboards the company's design team have employed the technique of "thought showers".

Explain **two** main characteristics associated with "thought showers". [2]

Quality of written communication [1]

(c) One idea which developed from the "thought showers" was to use Kevlar for the deck of the skateboard.

Briefly outline **two** main characteristics associated with Kevlar which make it suitable for the deck of the skateboard. [2]

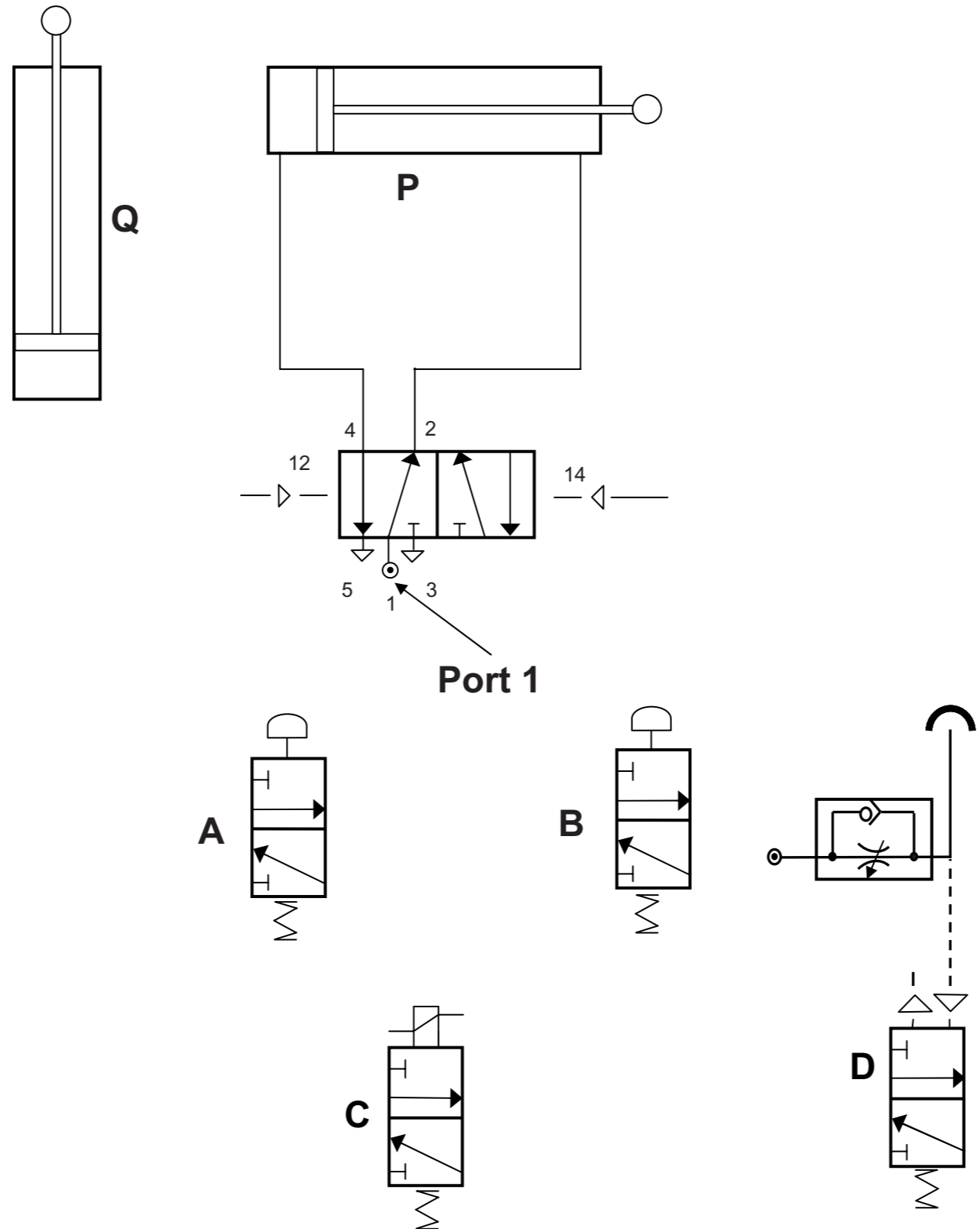
(d) On the blank A3 pro forma answer page (answer number **14(d) (i) and (ii)**) produce **one** possible solution for each of the following situations:

(i) The skateboard can continue uncontrollably in the event of the user falling off. This may cause a hazard to people nearby. Design a low cost and easily operated means which minimises this risk. [4]

(ii) The skateboard is susceptible to damage caused by collision with kerbs and other obstacles. Design a suitable solution for this problem which is easily replaced if it becomes damaged. [4]

THIS IS THE END OF THE QUESTION PAPER

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

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

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Assessment Unit AS 1 Unit 1
January 2013

Centre Number

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Candidate Number

**Pro forma answer page
(answer number 13(b)(i) and (ii))**

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

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Candidate Number

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

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(for use with Question 13)

Do not write your answers on this insert



Fig. 13(a)



Fig. 13(b)



Fig. 13(c)



Fig. 13(d)

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Fig. 13

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(for use with Question 14)

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Fig. 14(a)



Fig. 14(b)

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Fig. 14