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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)**

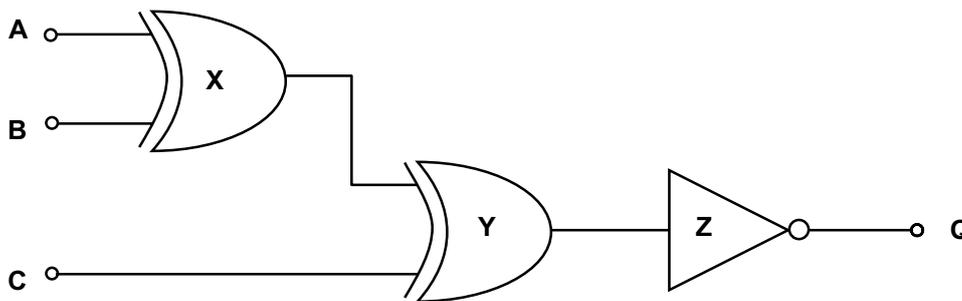
## Section B

## 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.

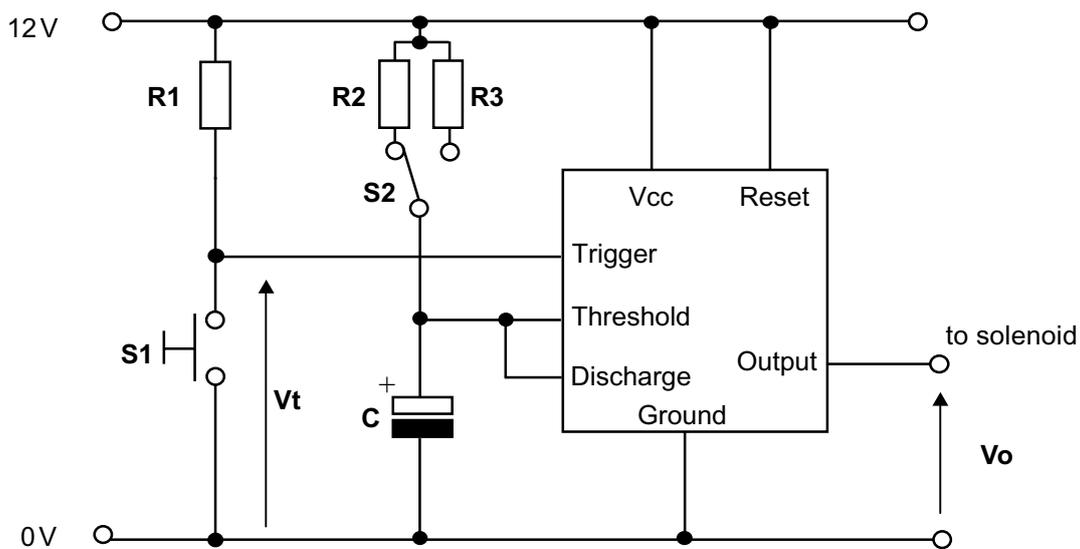


Fig. 9(b)

- (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).

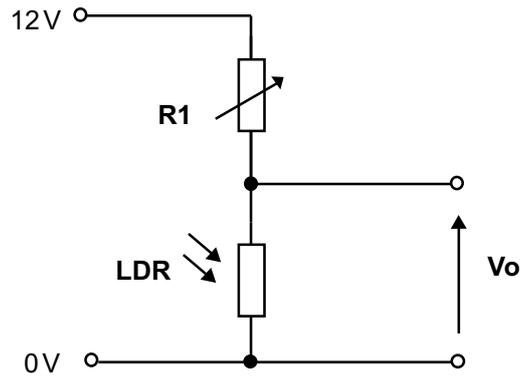


Fig. 10(a)

- (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]

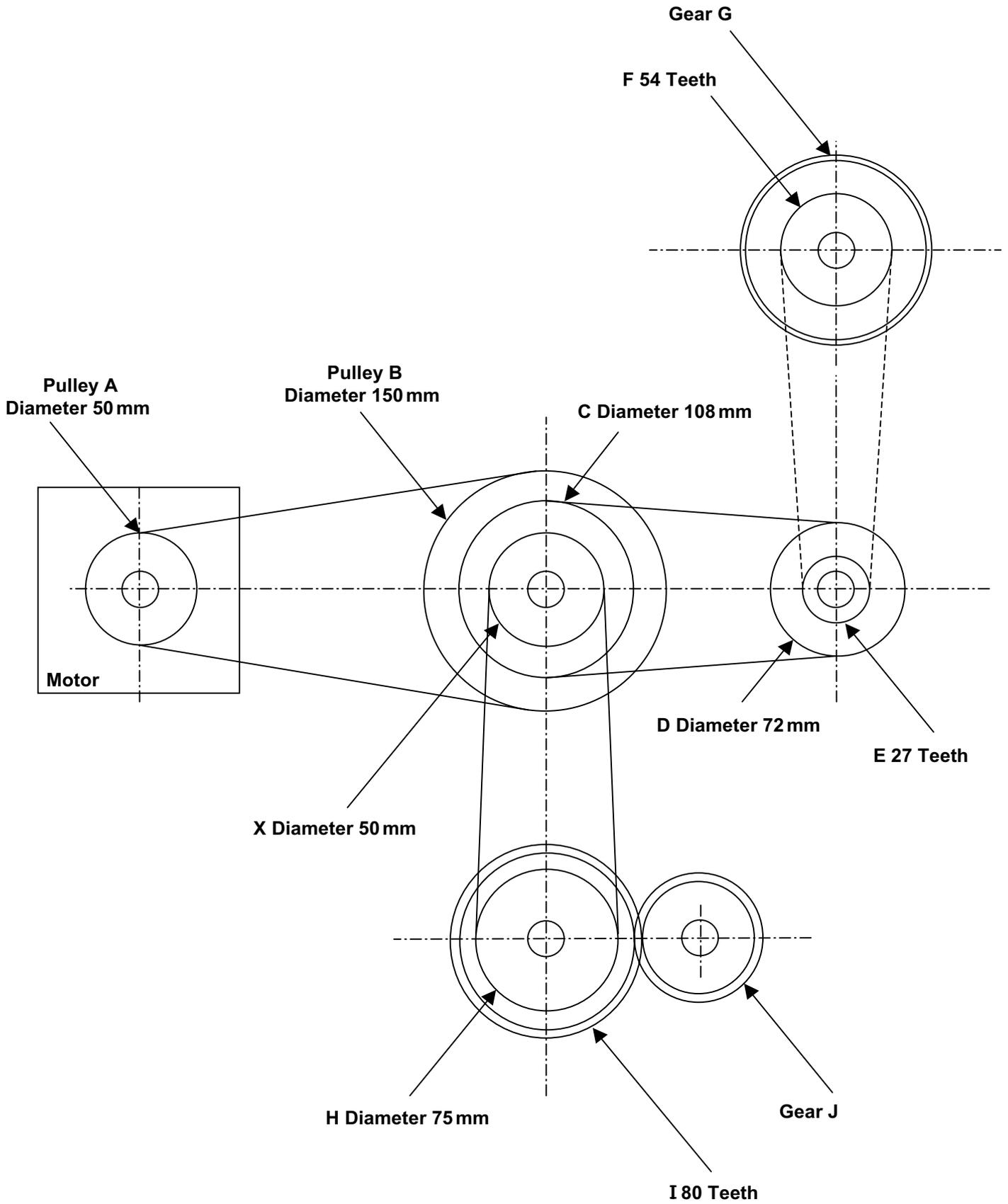


Fig. 11

**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  $0.5 \text{ N/mm}^2$  and produces a force during the outstroke of  $320 \text{ N}$  and has a piston rod diameter of  $12 \text{ mm}$ . Calculate the force during the instroke. Please assume  $\pi = 3.14$ . [3]

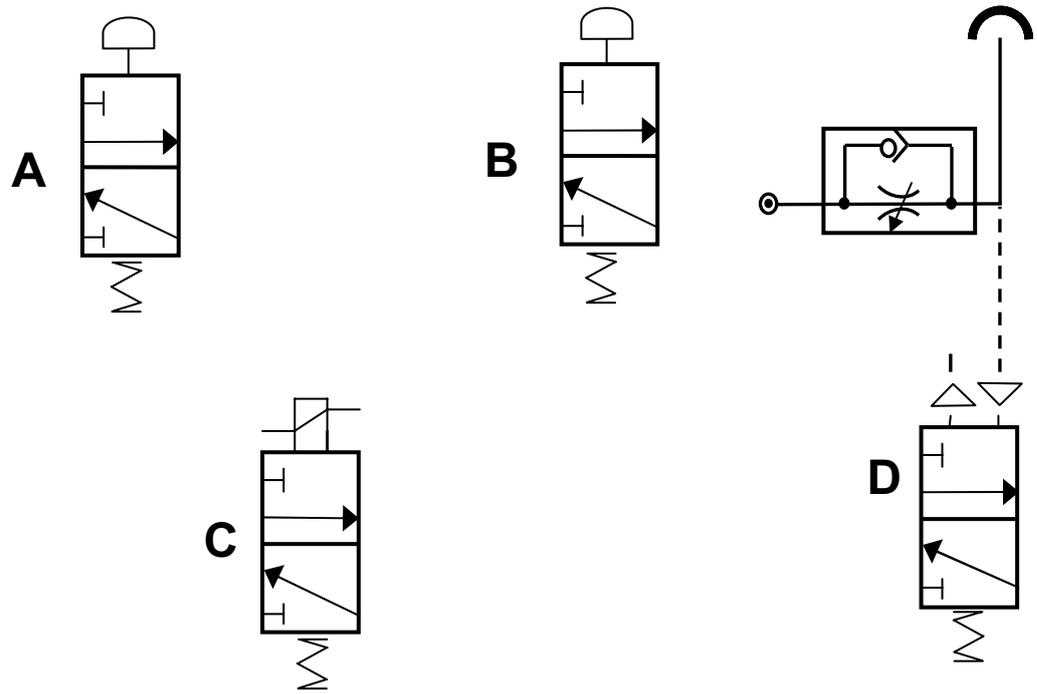
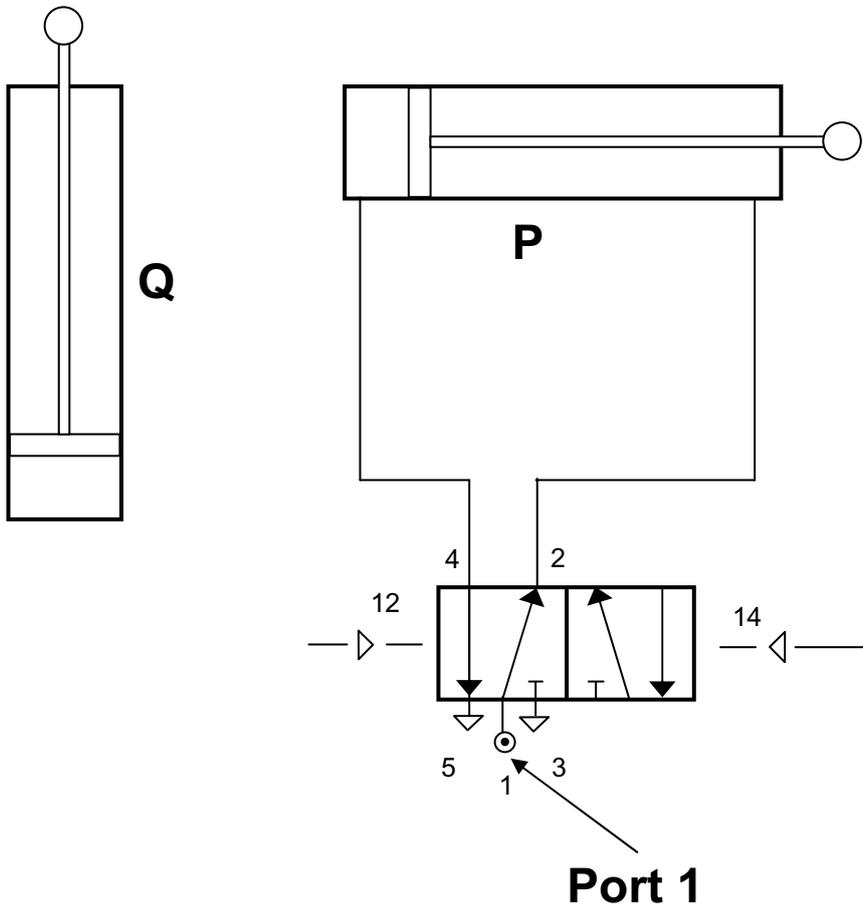


Fig. 12

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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]

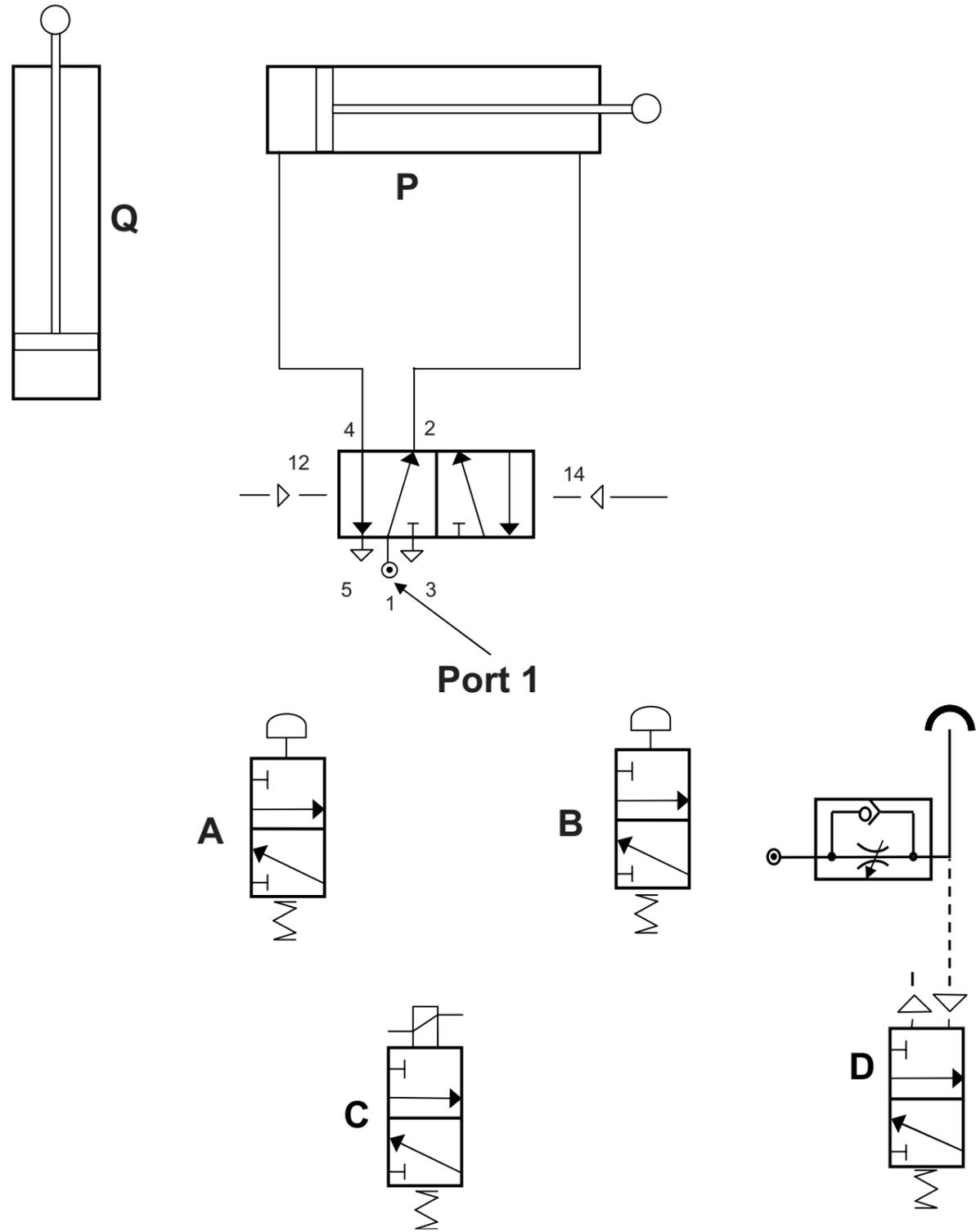
**(ii)** The skateboard is susceptible to damage caused by collision with kerbs and other obstacles. Design a suitable solution for this problem which is easily replaced if it becomes damaged. [4]

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

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

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Candidate Number

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(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