



Rewarding Learning

**ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2014**

Technology and Design

Assessment Unit AS 1

assessing

**Product Design and
Systems and Control**

[AV111]



TUESDAY 3 JUNE, 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 questions **11(b)**, **12(a)(iv)** and **(v)**, **12(b)**, **13(d)(i)** and **(ii)** and **14(e)(i)** and **(ii)**.

You are provided with an insert for use with questions **13** and **14**. Do not write your answer on the insert.

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(ii)**, **9(d)**, **10(c)(ii)**, **11(a)(ii)**, **12(c)**, **13(b)(i)** 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** Pine and medium density fibreboard (MDF) may be used to manufacture kitchen units.
- (i) Outline **one** main specific property of pine which would make it suitable to be used for kitchen unit doors. [1]
 - (ii) Outline **two** main advantages of MDF which make it suitable to be used for shelves for the kitchen units. [2]
 - (iii) Stains or oils may be used as a finish on the kitchen units. Briefly explain the main purpose of using a stain as a finish on kitchen units and the main purpose of using an oil as a finish on kitchen units. [2]
- 2** When considering a specific material for a garden swing the designer has recommended the use of mild steel.
- (i) Give **two** main properties associated with mild steel which make it suitable for the garden swing and give **one** main disadvantage of using mild steel for the frame of the garden swing. [3]
- One reason why mild steel has been suggested is because it is available in a range of common forms and sizes.
- (ii) Give **two** main reasons why the designer would suggest the use of common forms and sizes for the garden swing. [2]
- 3** Polythene and PVC have long established applications in many products.
- (i) Give **one** specific application for the use of polythene and briefly outline **two** main properties associated with this plastic which make it suitable for your chosen application. [3]
 - (ii) Give **two** main properties associated with PVC which make it suitable for products such as inflatable beach toys, paddling pools and bouncy castles. [2]
- 4** Lacquering, anodising and enamelling are finishes used on metal components and products.
- (i) Briefly explain the purpose of lacquering metal components and products. [1]
 - (ii) Explain the process of anodising. [2]
 - (iii) Briefly outline **two** specific reasons for using enamelling as a process on jewellery. [2]

- 5 Shape memory alloys and light-emitting polymers are classified as smart materials.
- (i) Explain **two** main characteristics associated with shape memory alloys. [2]
 - (ii) Give **one** specific application for the use of light-emitting polymers and briefly outline **one** main characteristic associated with these polymers which makes them suitable for your chosen application. [2]
- 6 Many fizzy drinks bottles are manufactured by the process of blow moulding.
- (i) Give **two** main reasons why the blow moulding process is used to manufacture fizzy drinks bottles. [2]
 - (ii) With the aid of an annotated sketch describe the blow moulding process. [4]
- 7 To assist in the production of fizzy drinks bottles many companies employ the use of computer-integrated manufacture (CIM).
- (i) Describe **two** main advantages of using CIM for companies manufacturing fizzy drinks bottles. [2]
 - (ii) Briefly explain **two** different ways in which computers in CIM could be used for stock control. [2]
- 8 Information produced by a car seat company made reference to the use of anthropometric data and ergonomics.
- (i) Briefly explain what is meant by the term anthropometric data. [1]
 - (ii) Explain what is meant by the term ergonomics and give **two** main reasons why it is important to consider ergonomics in the design of a car seat. [3]
- 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 voltage divider circuit which consists of a power supply, a rotary switch and four fixed resistors is shown in **Fig. 9(a)**.

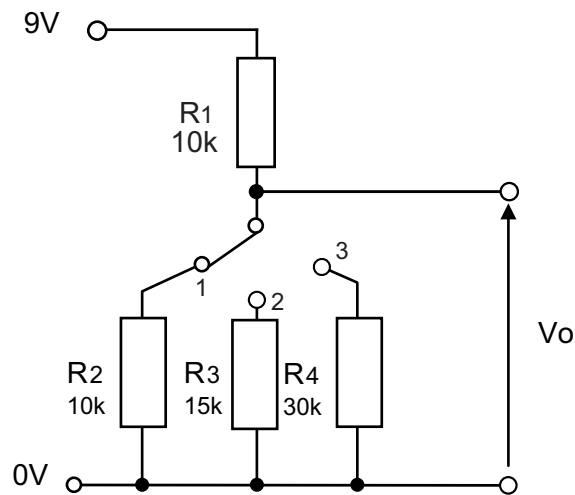


Fig. 9(a)

- (i) State the purpose of the rotary switch in the voltage divider circuit shown in **Fig. 9(a)**. [1]

- (ii) Calculate the voltage for V_o in **Fig. 9(a)** when the rotary switch is moved to position 3. [2]

- (b) An incomplete 555 timer based circuit is shown in **Fig. 9(b)**. The time period for the circuit, which is 4 seconds, is triggered by means of a reed switch, symbol not drawn, which is inserted at position **S1**.

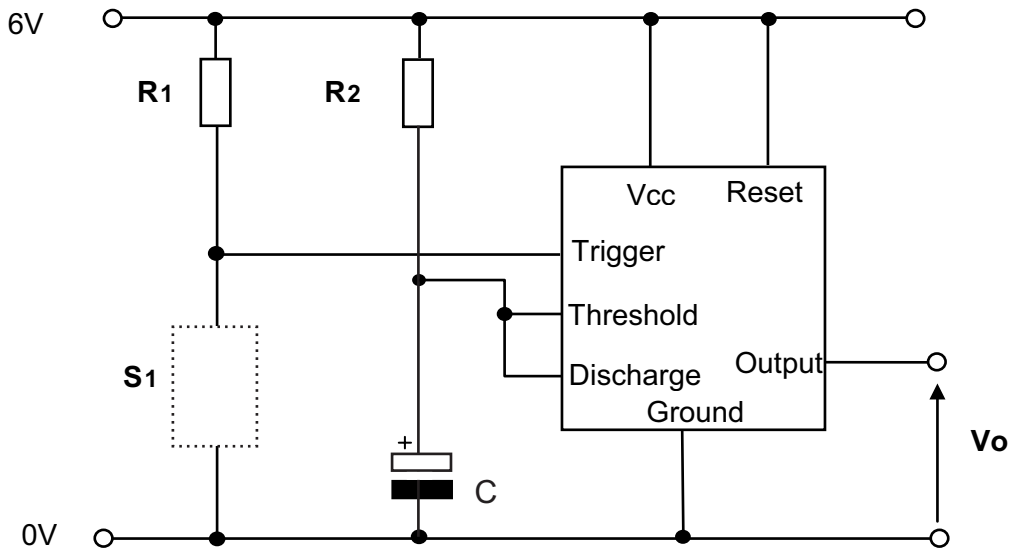


Fig. 9(b)

- (i) Explain with the aid of a diagram how the circuit shown in **Fig. 9(b)** could be modified to enable the time period to be adjustable. [2]
- (ii) Using an annotated diagram, explain the operation of a reed switch and how it can be used in conjunction with the resistor as shown in **Fig. 9(b)** in order to trigger the time period. [3]
- (iii) For the timer circuit shown in **Fig. 9(b)**, sketch a graph with labelled axes to show the voltage V_o against time when the reed switch has been momentarily closed and then opened. Indicate the time period on the graph. [3]
- (iv) If the time period for the circuit shown in **Fig. 9(b)** is given by $T = 1.1 \times R_2 \times C$ (where $R_2 = 6.8\text{k}\Omega$), then calculate the required value for the component C. [2]

- (c) The output V_o from the timer circuit shown in **Fig. 9(b)** is to be used to switch on a 12 volt lamp using the transistor arrangement shown in **Fig. 9(c)**.

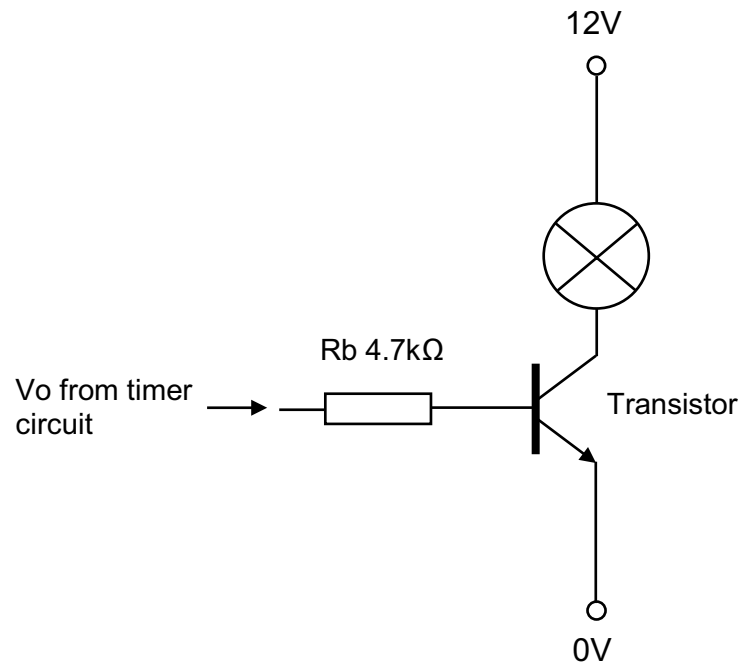


Fig. 9(c)

- (i) Explain what is meant by the current gain (h_{fe}) of a transistor. [1]
- (ii) Calculate the current gain (h_{fe}) of the transistor shown in **Fig.9(c)** if the base/emitter voltage (V_{be}) is 0.6V and the resistance of the illuminated lamp is 20ohms. Assume the output V_o from the timer circuit is 6 volts. [2]
- (d) Electronic systems can be classified as either on/off or continuous. Explain the difference between the terms on/off and continuous when referring to electronic systems and give **one** specific example of each. [3]
- Quality of written communication [1]

10 (a) An SPST switch is shown in Fig. 10(a).

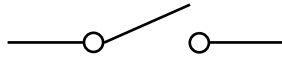


Fig. 10(a)

Show with the aid of **two** circuit diagrams, how SPST switches can be arranged to provide:

- OR logic.
- AND logic.

[2]

(b) An SR flip flop based circuit that utilises an SPDT switch is shown in Fig. 10(b). The switch Sw is shown in position 1 and the output Q is logic '1'.

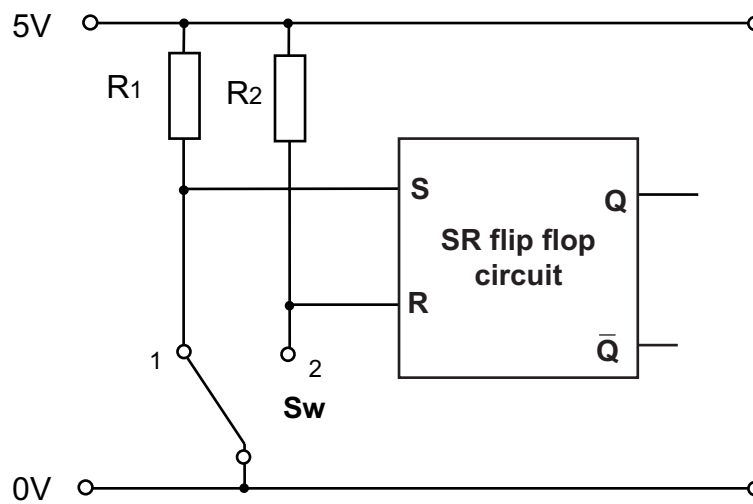


Fig. 10(b)

- (i) Explain the purpose of the resistors R1 and R2 shown in Fig. 10(b). [2]
- (ii) Show how NAND gates can be connected to make the SR flip flop circuit shown in Fig. 10(b). [2]
- (iii) With reference to the labels S, R, Q and \bar{Q} draw a truth table for the operation of the circuit shown in Fig. 10(b) when the switch is in position 1 and position 2. [4]

- (c) The Q output from the logic circuit in **Fig. 10(b)** is connected to two LEDs via a protective resistor R as shown in **Fig. 10(c)**.

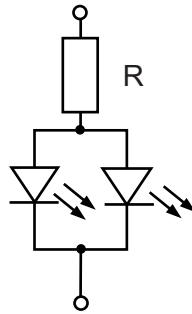


Fig. 10(c)

- (i) The resistor R shown in **Fig. 10(c)** is required to limit the current in each LED to 5 mA where the forward voltage of each LED is 2.2 volts. Calculate the following:
- The required value for the resistor R.
 - The power dissipated by the resistor R. [3]
- (Assume that the voltage at Q is 5V when high)

- (ii) The resistor R in **Fig. 10(c)** is to be selected from the E12 series of resistors shown below.
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82.

Choose a suitable value for resistor R from the E12 series and explain your choice of value. [2]

Quality of written communication [1]

- (d) The logic circuit shown in **Fig. 10(b)** can be considered a type of latching circuit. A double pole double throw (DPDT) relay can also be utilised in order to achieve a latching action. Explain with the aid of a circuit diagram how a DPDT relay can be connected to achieve a latched output voltage. Include a means of resetting the output. [4]

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(Questions continue overleaf)

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. 11(a) shows part of a prototype mechanical system.

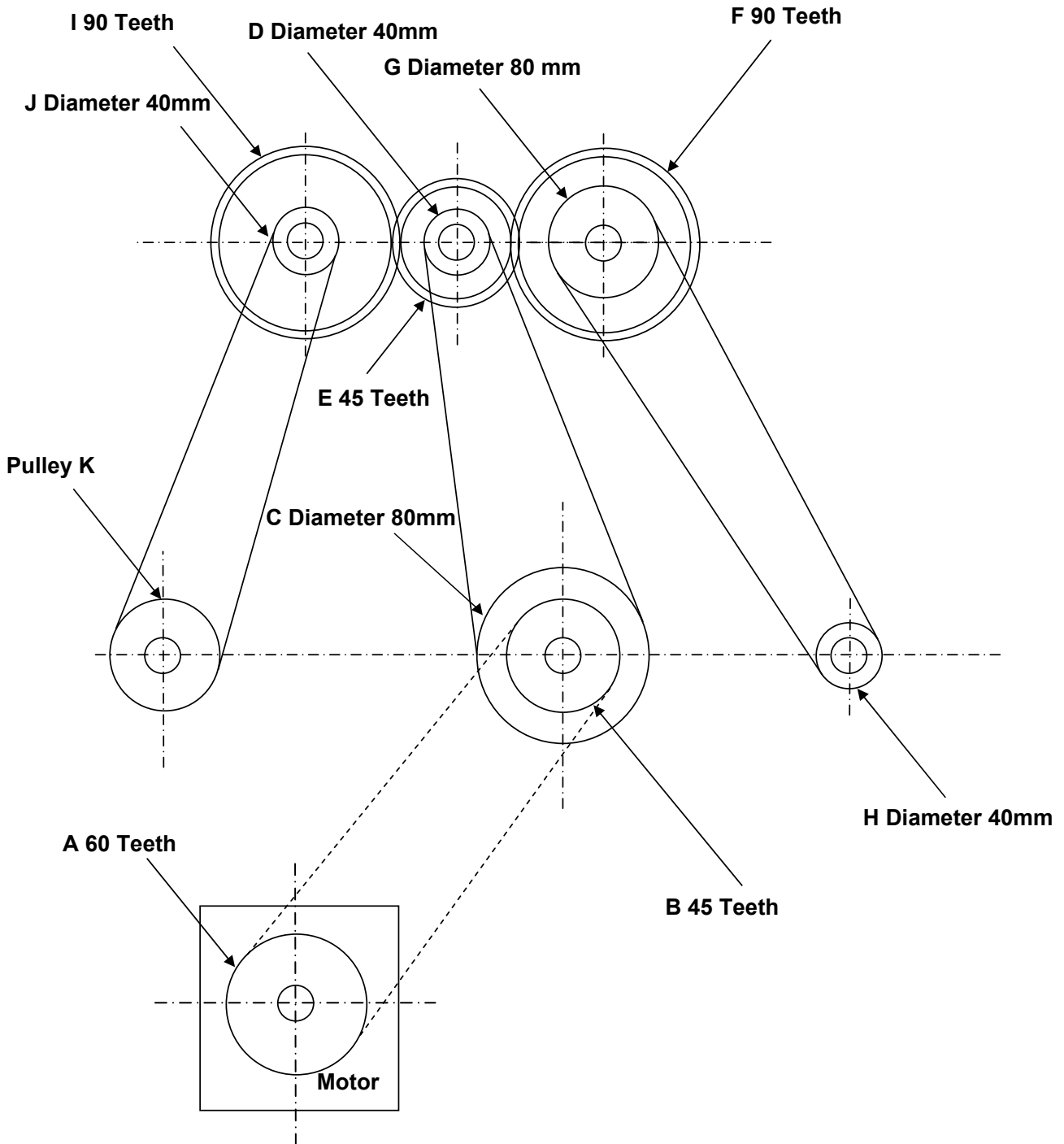


Fig. 11(a)
Not drawn to scale

- (a) (i) State the direction of rotation at pulley **H** if sprocket **A** rotates in a clockwise direction. [1]
- (ii) Self-adjusting jockey wheels can be employed in pulley systems. Explain why they may be required and how they function. [2]
- Quality of written communication [1]
- (iii) During testing, part of the mechanical system was found to be operating at 80% efficiency with a velocity ratio of 5. Calculate the mechanical advantage. [2]
- (iv) Calculate the speed of rotation at gear **F** if sprocket **B** rotates at 260 rev/min. [2]
- (v) Calculate the velocity ratio between sprocket **A** and pulley **H**. [3]
- (vi) Calculate the size of pulley **K** if the motor rotates at 90 rev/min and **K** rotates at 60 rev/min. [3]
- (b) The pro forma (answer number **11(b)**) shows an incomplete mechanical system which incorporates a rotating shaft and slider. The slider is required to reciprocate slowly being driven by the shaft which rotates quickly. On the pro forma (answer number **11(b)**), sketch and label any mechanical components to enable the slider to reciprocate at a rate which is considerably less than the rotational speed of the shaft. [6]

12 The pro forma (answer number **12(a)(iv)** and **(v)**) shows an incomplete pneumatic system incorporating a double acting cylinder.

- (a) (i) State the purpose of **port 5** on the five port valve. [1]
- (ii) Name the activation method at **A**. [1]
- (iii) Name the activation method at **F**. [1]
- (iv) On the pro forma provided (answer number **12(a)(iv)** and **(v)**) complete the circuit enabling the double acting cylinder to outstroke slowly if 3 port valves **A** and **C** but **not B** are activated. Please note that if **B** is activated the double acting cylinder should not outstroke. [5]
- (v) On the pro forma provided (answer number **12(a)(iv)** and **(v)**) complete the circuit enabling the double acting cylinder to instroke when valves **G** and **F** and valves **E** or **D** are activated. [4]
- (b) The pro forma (answer number **12(b)**) shows a single acting cylinder connected to a brush to be used to clean work areas. When the circuit is complete an activation at **P** will outstroke the brush slowly which will then instroke slowly when deactivated. Complete the circuit on the pro forma provided (answer number **12(b)**) to achieve this desired operation. [2]

(c) Fig. 12(c) below shows a complete pneumatic circuit. With reference to the specific components describe how the circuit produces the signal to instroke following an outstroke. [2]

Quality of written communication [1]

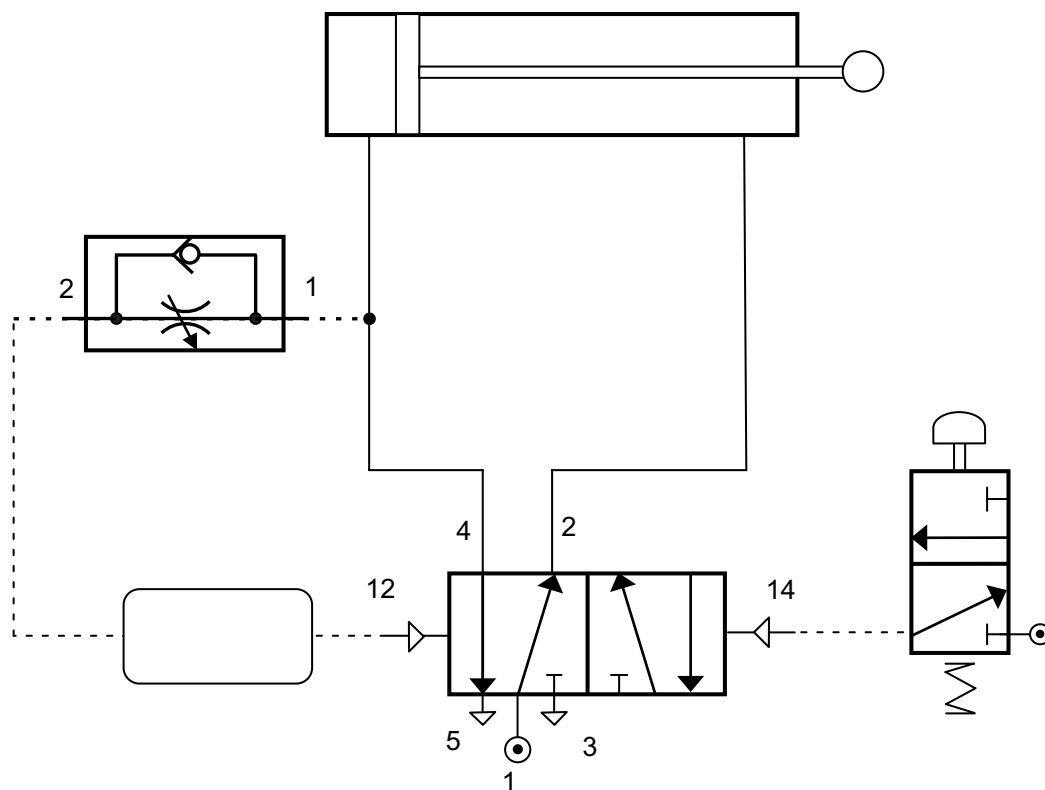


Fig. 12(c)

(d) A double acting cylinder is supplied with an air pressure of 0.25 N/mm^2 , has a piston diameter of 60 mm and a piston rod diameter of 6 mm . Calculate the force produced by the cylinder during the instroke. Please assume $\pi = 3.14$. [3]

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 (a) Fig. 13** on the insert sheet shows a litter picker produced by a company for lifting lightweight items.
- (i)** Outline **two** specific performance criteria that the user would require from the litter picker. [2]
 - (ii)** Analyse the product shown in **Fig. 13** and briefly outline **two** main criteria that would have influenced the selection of aluminium alloy for the body of the litter picker. [2]
 - (iii)** Analyse the product shown in **Fig. 13** and briefly outline **two** different aspects in support of the view that this is a low cost product. [2]
- (b)** Prior to large scale production of the litter picker the company applied for design rights and patents.
- (i)** Explain **two** main characteristics associated with design rights. [2]
Quality of written communication [1]
 - (ii)** Briefly explain **two** main characteristics associated with patents. [2]
- (c)** The company is considering changing the material of the main body from aluminium alloy to carbon fibre reinforced plastic (CFRP).
- Briefly explain **one** main property of carbon fibre reinforced plastic (CFRP) which would make it suitable for the main body of the litter picker. [1]
- (d)** With the aid of detailed annotated sketches, using the blank A3 pro forma answer page (answer number **13(d)(i)** and **(ii)**), suggest an appropriate solution for each of the following:
- (i)** A means of enabling the handle to have adjustment to accommodate different heights of people. [4]
 - (ii)** A method of keeping the gripper closed to improve storage. [4]

14 Fig. 14 on the insert page shows photographs of a wall mounted bicycle rack produced by a company which designs and manufactures a wide range of storage racks.

(a) Before the company starts to manufacture any new products in its range extensive use is made of modelling.

Outline **two** main reasons why a company would produce models. [2]

(b) When planning to manufacture the product the company used critical path analysis.

Explain **two** main characteristics associated with critical path analysis. [2]

Quality of written communication [1]

(c) In addition to the wall mounted bicycle racks the company can manufacture customised fittings and brackets using a CNC lathe.

Describe the CNC lathe process outlining the main stages involved in producing a component part. [4]

(d) Risk assessment is an important safety requirement when manufacturing.

Explain any **three** stages from the five stage risk assessment. [3]

(e) (i) On the blank A3 pro forma answer page (answer number **14(e)(i)** and **(ii)**) produce a detailed sketch of a pictogram. This pictogram will be printed onto the packaging for the bicycle rack to remind the user that this product is only suitable for supporting one bicycle. [4]

When setting the bicycle onto the rack shown in **Fig. 14** it is important to prevent it from making contact with the wall in order to avoid damage.

(ii) On the blank A3 pro forma answer page (answer number **14 (e)(i)** and **(ii)**) produce detailed annotated sketches of a low cost design to fit on the support bars that will allow the user to quickly adjust the distance the bicycle can be positioned away from the wall. [4]

THIS IS THE END OF THE QUESTION PAPER



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Technology and Design

Assessment Unit AS 1

assessing

**Product Design and
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[AV111]

TUESDAY 3 JUNE, MORNING



INSERT

for use with Questions 13 and 14

GCE Advanced Subsidiary (AS)
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(for use with Question 13)

Do not write your answers on this insert



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Fig. 13

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(for use with Question 14)

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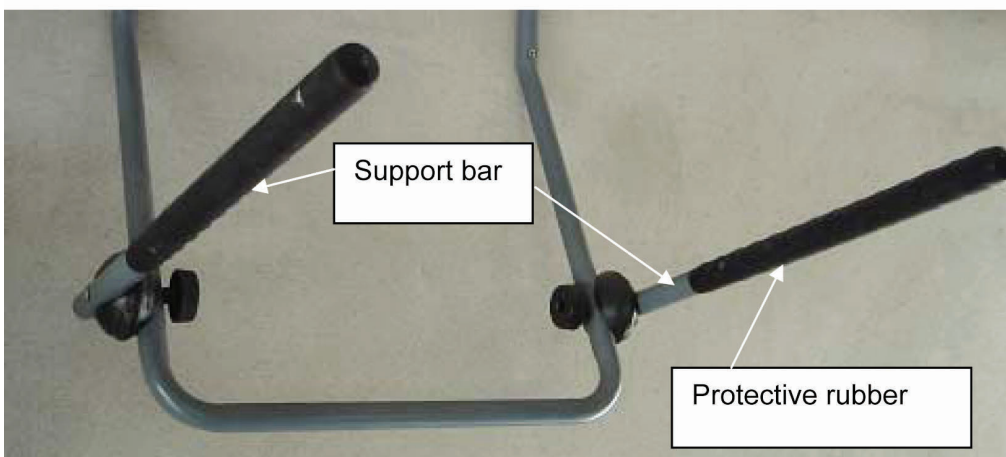
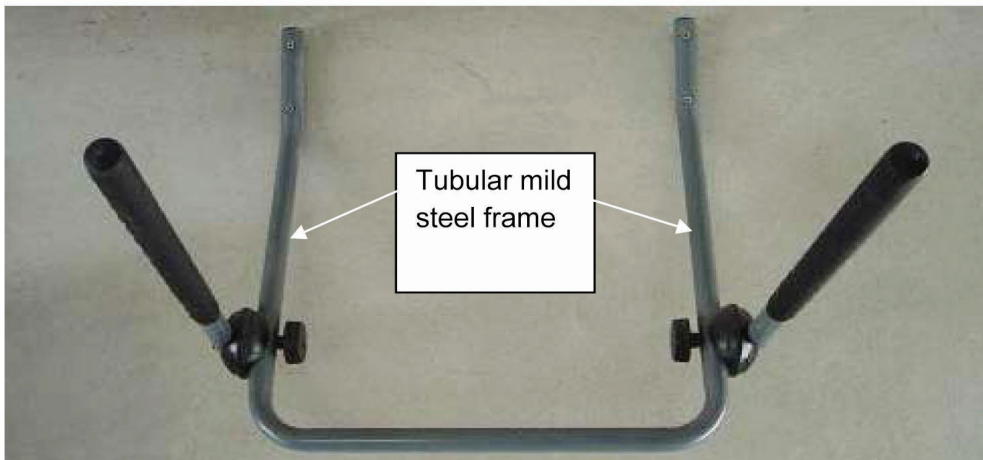


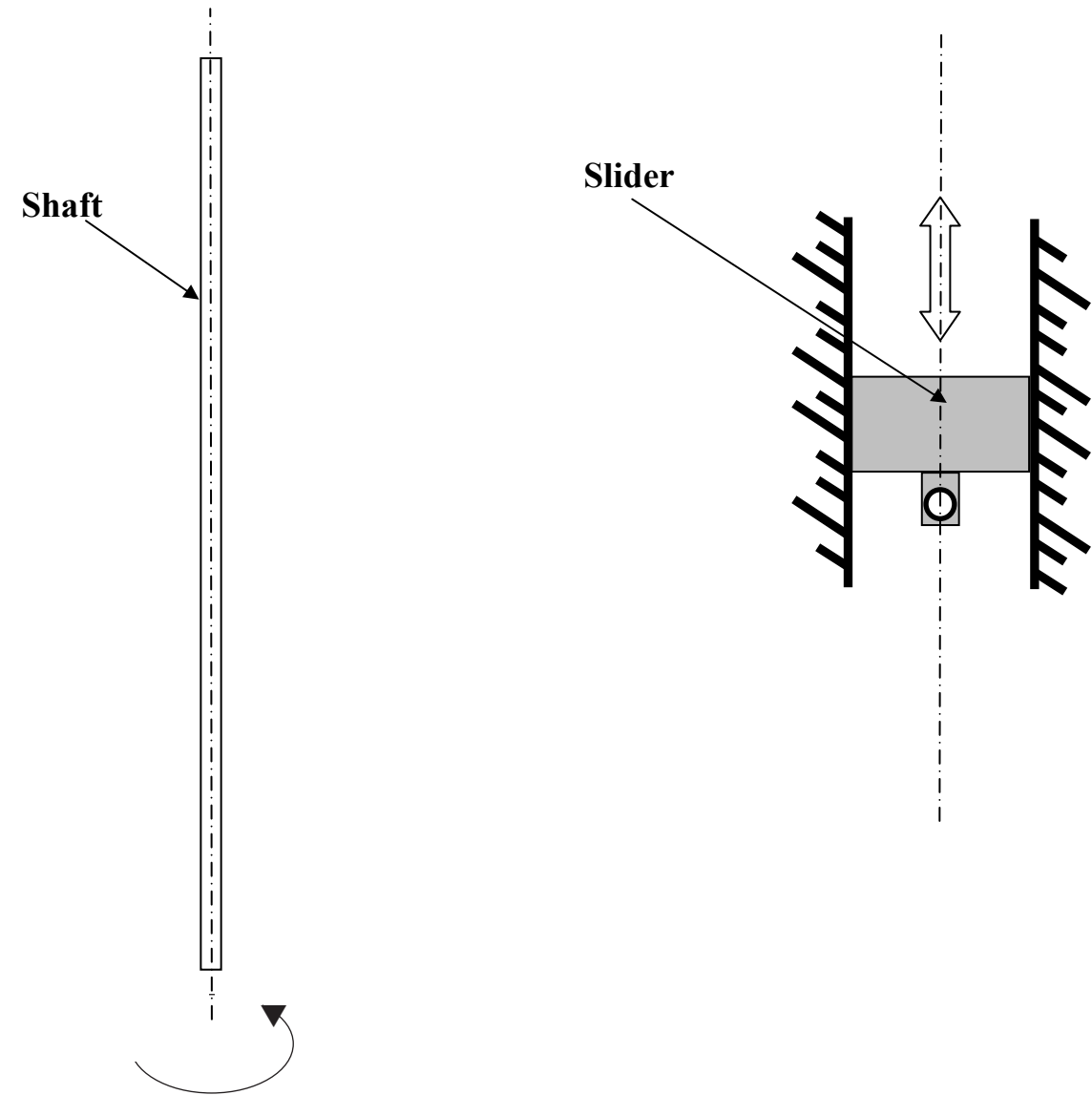
Fig. 14

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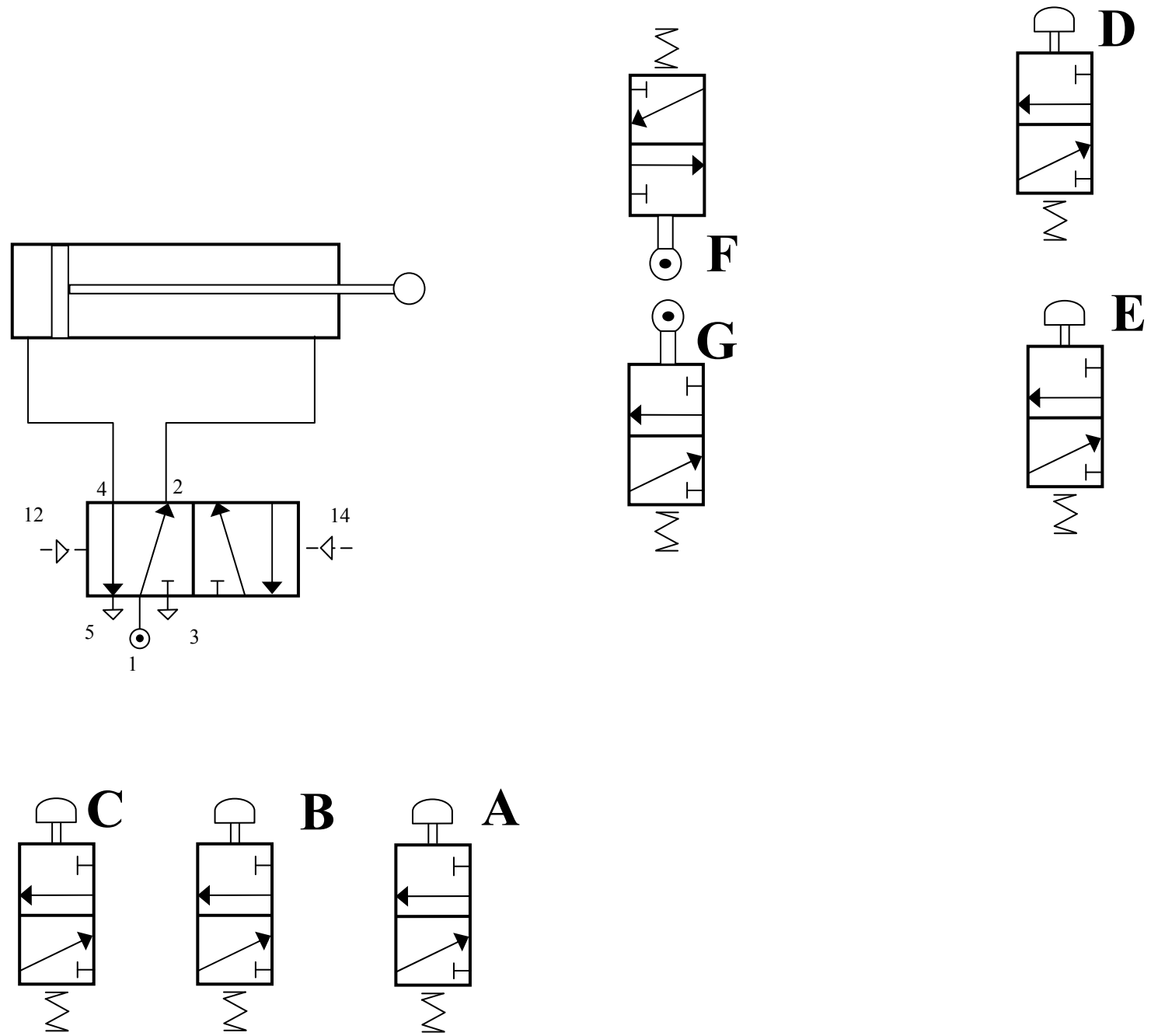
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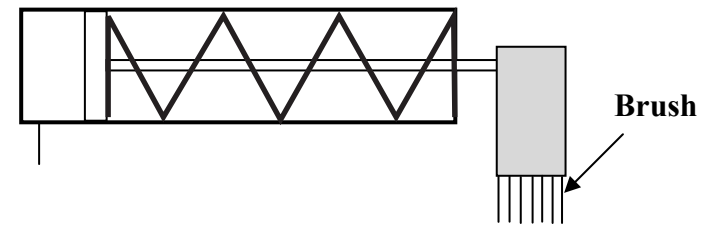
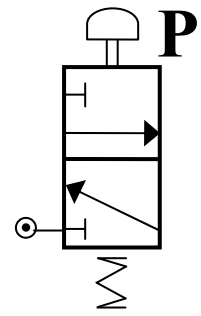
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Pro forma answer page
(answer number 11(b))



Pro forma answer page
 (answer number 12 (a)(iv) and (v))



Pro forma answer page
(answer number 12(b))

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(e)(i) and (ii)

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