



Rewarding Learning

ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
January 2014

## Technology and Design

### Assessment Unit AS 1

*assessing*

Product Design and  
Systems and Control

[AV111]



FRIDAY 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 Section B **or** Section C **or** Section D.

A3 pro forma answer pages are provided for Questions **11(b)(ii)** and **12(a)(i), (ii), (iii)** and **(iv)** in Section C, and for Questions **13(b)(i)** and **(ii)** and **14(d)(i)** and **(ii)** in Section D.

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

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)(iv), 11(a)(v), 12(b)(i), 13(a)(ii)** and **14(c)(ii)**.

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

Questions do not all 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** The physical and mechanical properties of a material will help a designer determine if that material is suitable for a specific product or component.

(i) Briefly explain the difference between physical properties and mechanical properties. [2]

Toughness and hardness are examples of mechanical properties.

(ii) Briefly explain what is meant by the term toughness. [1]

(iii) Briefly explain what is meant by the term hardness. [1]

**2** Woods may be classified as hardwoods or softwoods.

(i) Briefly explain the difference between hardwoods and softwoods. [2]

Beech and Mahogany are examples of hardwoods.

(ii) Briefly outline **one** main property and **one** main working characteristic associated with Beech. [2]

(iii) Give **one** specific application for the use of Mahogany and briefly outline **one** main property associated with this hardwood. [2]

**3** Polystyrene, ABS, polythene and melamine formaldehyde are used in a range of products.

(i) Give **one** specific application for the use of polythene and **one** specific application for the use of ABS. [2]

(ii) Give **one** main reason for each statement below:

- Polystyrene is used for packaging
- Melamine formaldehyde is used for table tops. [2]

- 4 Oil tanks and large hollow toys can be manufactured by the process of rotational moulding.  
With the aid of an annotated sketch, describe the rotational moulding process. [4]
- 5 (i) Give **one** specific example of a permanent method and **one** specific example of a semi-permanent method used to join plastics. [2]
- Soldering, brazing and welding are methods used to join metals.
- (ii) Briefly outline **two** main characteristics for brazing which distinguish it from soldering. [2]
- (iii) Briefly explain the process of welding. [2]
- 6 Batch production, flexible manufacturing and concurrent engineering are important terms for a company when considering the scale of production or the way manufacturing is to be organised.
- (i) Describe **two** main characteristics associated with batch production. [2]
- (ii) Describe **two** main characteristics associated with flexible manufacturing systems. [2]
- (iii) Describe **two** main characteristics associated with concurrent engineering. [2]
- 7 For a company manufacturing double glazed units for PVC windows it is important to test and inspect the glass and check tolerances.
- (i) Briefly explain the main purpose of testing and inspecting the glass. [1]
- (ii) Briefly explain why it is so important for the company to test and inspect the glass. [1]
- (iii) Briefly outline **one** specific tolerance check that the company should make when manufacturing the glass for the PVC frame and give **one** main reason why this check is so important. [2]

- 8 When manufacturing and packaging safety helmets for the cycling market companies need to take into consideration employee and consumer safety and the requirements of the Trades Description Act.
- (i) Distinguish between employee and consumer safety. [2]
- (ii) Outline **two** main requirements of the Trades Description Act that the company would need to comply with when providing information on the packaging about the product. [2]
- Quality of written communication [2]

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## 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 logic circuit using four logic gates is shown in **Fig. 9(a)**.

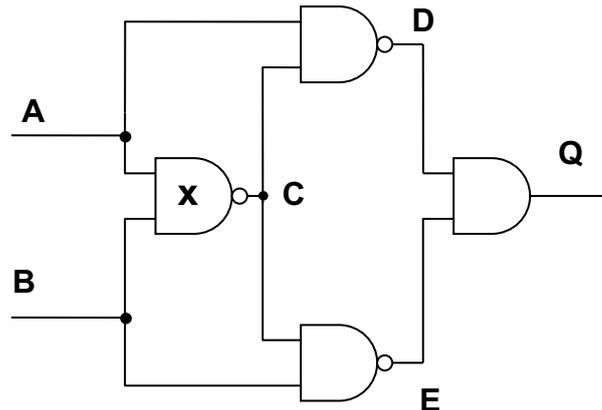


Fig. 9(a)

- (i) Name the logic gate labelled **X** shown in **Fig. 9(a)**. [1]
- (ii) Draw a truth table for all input combinations of **A** and **B** and the corresponding outputs at **C**, **D**, **E** and **Q** for the logic circuit in **Fig. 9(a)**. [4]
- (iii) Using a circuit diagram, show how 'push-to-make' switches and 'pull-up' resistors could be used as inputs to the logic circuit shown in **Fig. 9(a)**. [3]

- (b) Fig. 9(b) shows a transistor based circuit which indicates if two SPST switches have been closed.

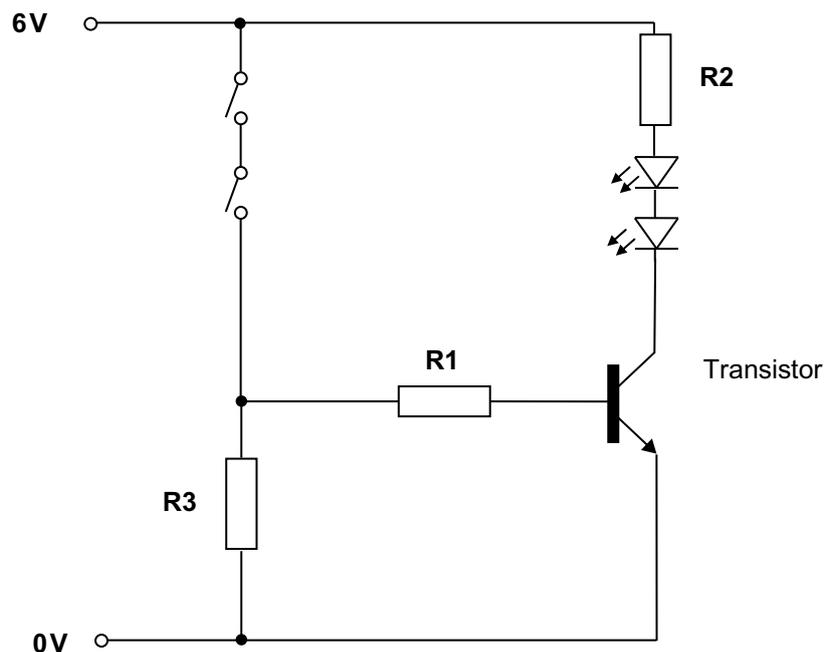


Fig. 9(b)

- (i) State the type of logic control achieved by the arrangement of the SPST switches in Fig. 9(b). [1]
- (ii) Describe the operation of the circuit shown in Fig. 9(b). [2]
- Quality of written communication [1]
- (iii) The transistor shown in Fig. 9(b) has a current gain ( $h_{fe}$ ) of 120 and a base emitter voltage ( $V_{be}$ ) of 0.6V. If the collector current is to be limited to 20 mA, calculate the required value of R1. [2]
- (iv) Calculate the required resistor value for R2 in Fig. 9(b) if the LEDs shown are each designed to operate at a forward voltage of 2.2V and a current of 20 mA. Then using your calculated value determine the power dissipated in mW by the resistor. [3]
- (v) Using an annotated circuit diagram show how the circuit shown in Fig. 9(b) could be changed so that the output is latched on when the SPST switches are closed. Your answer should include a method of resetting the circuit. [3]

- 10 (a) A circuit consisting of a power supply, thermistor R1 and a resistor R2 is shown in Fig. 10(a).

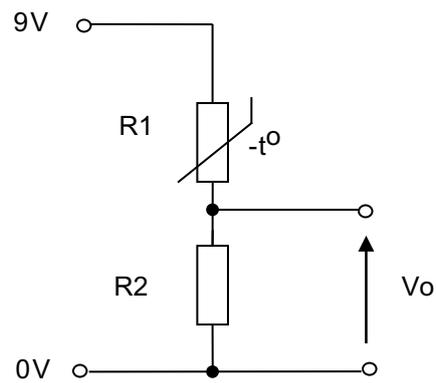
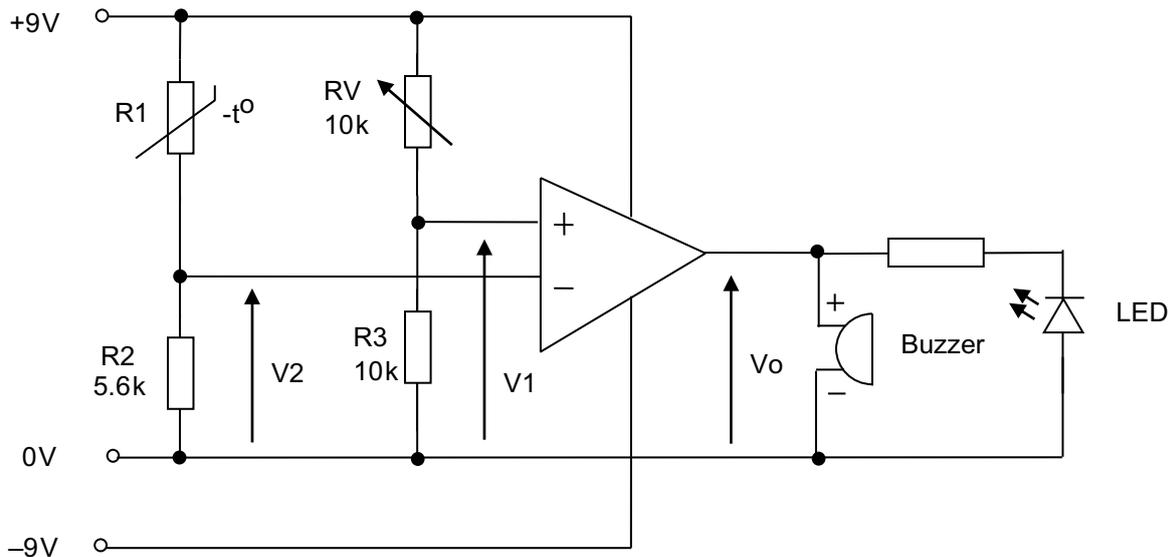


Fig. 10(a)

- (i) With the aid of a graph with labelled axes state how the voltage  $V_o$  in Fig. 10(a) varies with temperature. [3]
- (ii) Calculate  $V_o$  in Fig. 10(a) when the resistance of  $R_2$  is  $5.6\text{ k}\Omega$  and the resistance of the thermistor  $R_1$  is  $2.8\text{ k}\Omega$  at  $0^{\circ}$  centigrade. [2]

- (b) **Fig. 10(b)** shows a comparator based frost warning circuit that utilises the voltage divider circuit from **Fig. 10(a)**. The circuit has two output components, an LED and a buzzer connected as shown.



**Fig. 10(b)**

- (i) State whether the output from the comparator shown in **Fig. 10(b)** is considered as on/off or continuous and briefly justify your answer. [2]
- (ii) Explain the practical purpose of the variable resistor RV in the circuit shown in **Fig. 10(b)**. [2]
- (iii) Determine the voltage V1 when the variable resistor RV in **Fig. 10(b)** is adjusted to its mid position. [2]
- (iv) With reference to **Fig. 10(b)** explain the operation of the comparator circuit in temperatures above and below  $0^{\circ}$  centigrade. (Assume that RV is adjusted to mid position.) [4]
- Quality of written communication [1]
- (c) The circuit shown in **Fig. 10(b)** is to be modified in order to enable a high voltage heater to be operated when the temperature is less than  $0^{\circ}$  centigrade. Show, with the aid of an annotated circuit diagram, how this could be achieved. [4]

**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 various mechanical components which are to be used to create movement in a fun park attraction.

- (a) (i) Calculate the velocity ratio between **H** and **I**. [1]
- (ii) Calculate the speed in rev/min of the cam if **H** rotates at 240 rev/min. [3]
- (iii) Calculate the velocity ratio between the **Motor** and **Cam**. [4]
- (iv) Shaft **X** is attached to a cam with a roller follower to produce a reciprocating output. State **one** other method used to convert rotary motion to reciprocating. [1]
- (v) Describe the main features of the following cam followers: knife and roller. Your answer should include an explanation of why each cam follower may be chosen for an application in preference to the other. [4]
- Quality of written communication [1]

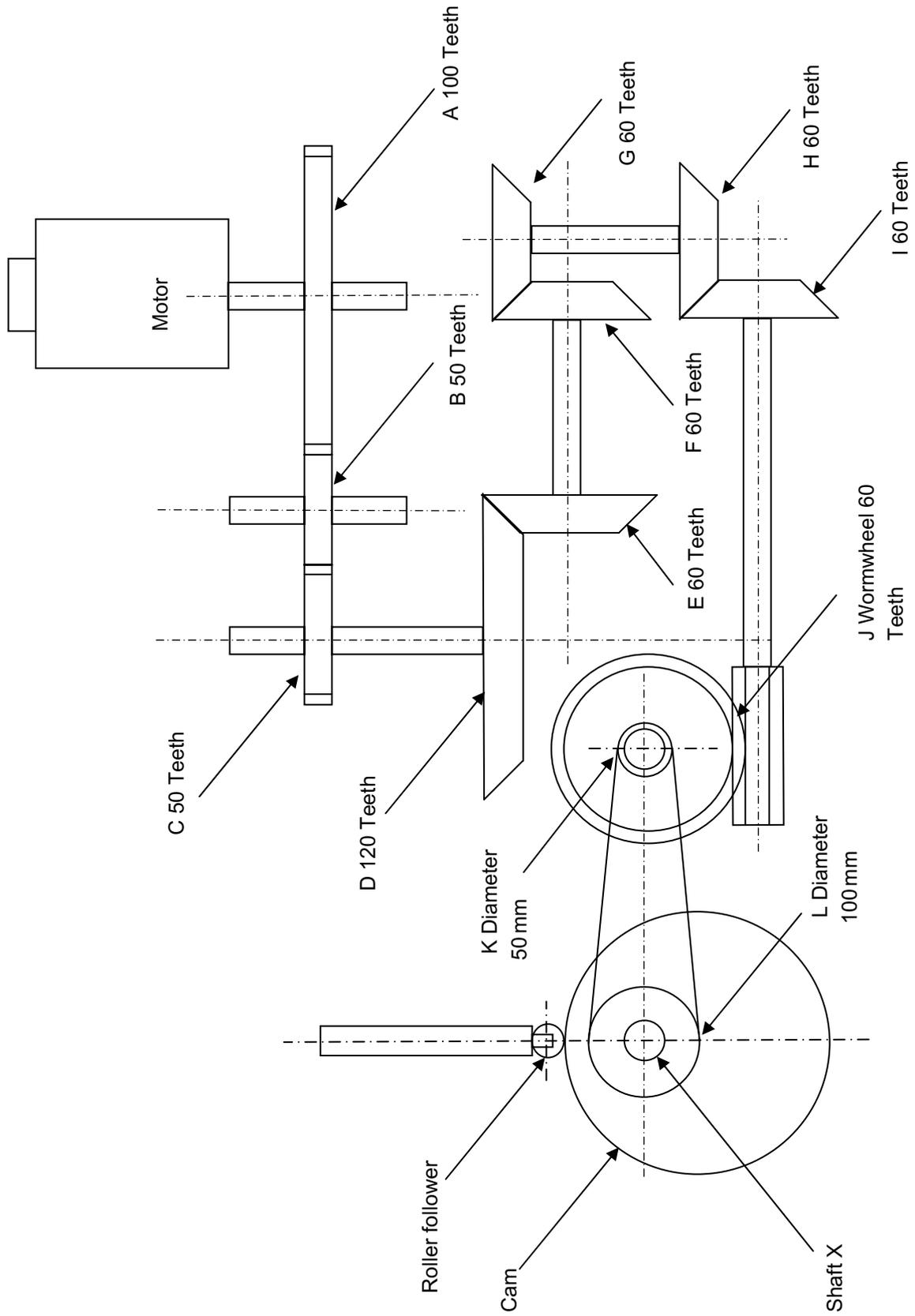


Fig. 11(a)

(b) Fig. 11(b) shows a prototype childrens' seesaw to be used as another fun park attraction.

(i) Using an annotated sketch design a suitable mechanical system which will enable unequal weights at either end of the seesaw to be balanced. [3]

(ii) Another attraction in the fun park involves children pulling vertically (in a reciprocating motion) on a pull rope which would swing a knocker (in an oscillating motion) to ring an overhead bell. On the pro forma provided (answer number **11(b)(ii)**) draw a suitable linkage arrangement which could be used to ring the bell when the rope is pulled vertically. [3]

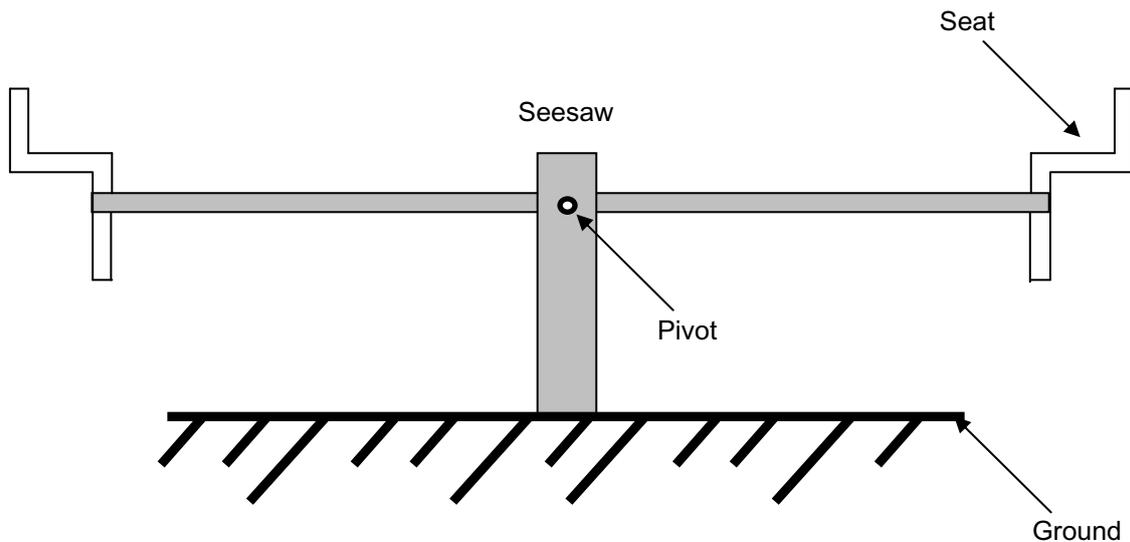


Fig. 11(b)

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12 Fig. 12 shows part of an incomplete pneumatic circuit.

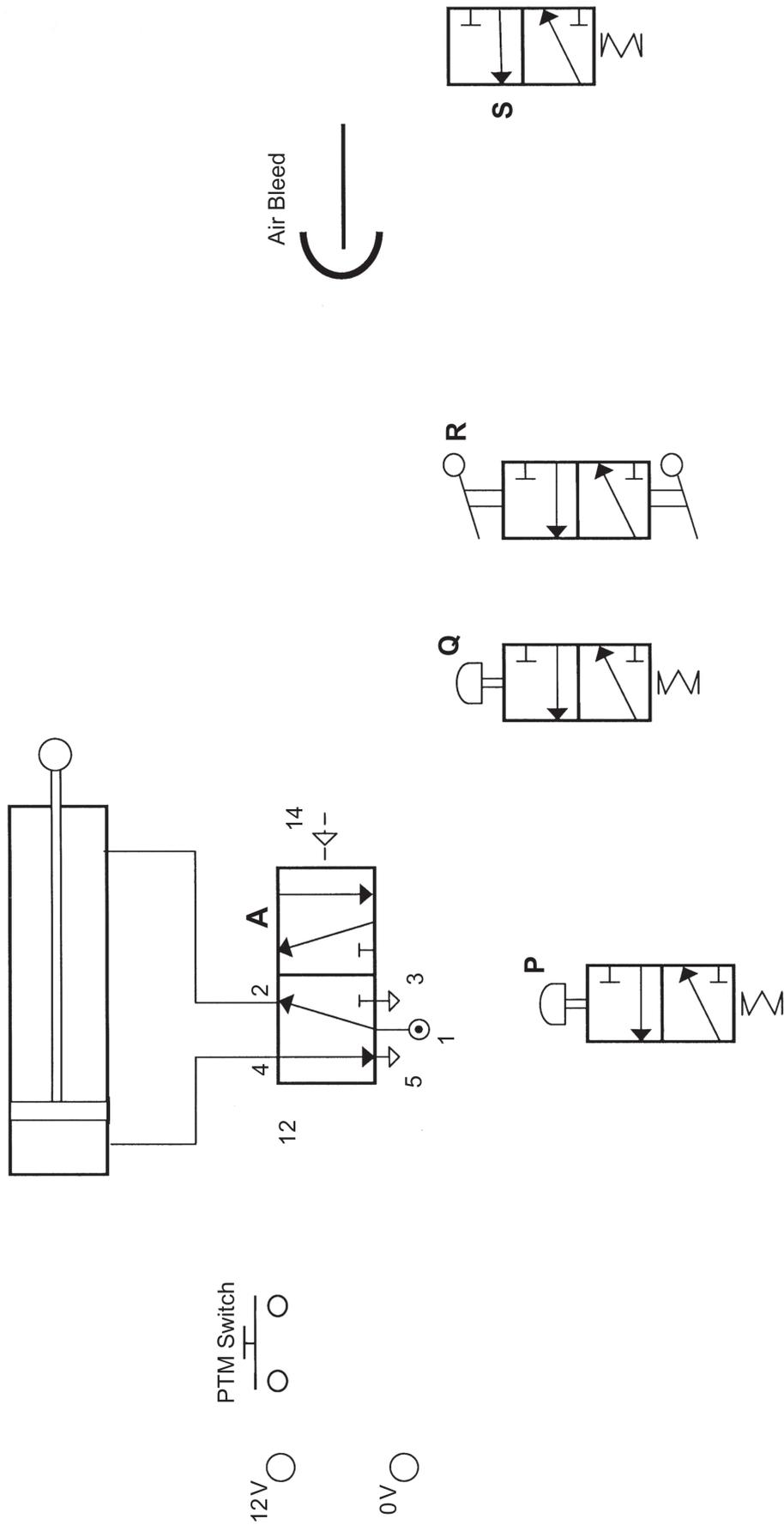


Fig. 12

- (a) (i) Valve **S** is to be activated using an airbleed. On the pro forma provided (answer numbers **12(a)(i)**, **(ii)**, **(iii)** and **(iv)**) complete the airbleed circuit adding any necessary additional components to enable **S** to be activated. [2]
- (ii) On the pro forma provided (answer numbers **12(a)(i)**, **(ii)**, **(iii)** and **(iv)**), complete the circuit adding any necessary additional components to enable the double acting cylinder to instroke once the **PTM Switch** has been activated. [2]
- (iii) On the pro forma provided (answer numbers **12(a)(i)**, **(ii)**, **(iii)** and **(iv)**) complete the circuit adding any necessary additional components to enable the double acting cylinder to outstroke once **P or S** or alternatively **Q and R** have been activated. [6]
- (iv) As a safety feature on the pro forma provided (answer numbers **12(a)(i)**, **(ii)**, **(iii)** and **(iv)**) design a method of disengaging the main air supply leading into five port valve **A**. Make any modifications to the existing circuit which are necessary. [3]
- (b) (i) Explain how a time delay can be included in a pneumatic circuit. Your answer should outline how the delay in time can be varied. [3]
- Quality of written communication [1]
- (ii) A double acting cylinder is supplied with an air pressure of  $0.5 \text{ N/mm}^2$  and produces a force during the outstroke of  $325.12 \text{ N}$  and  $300 \text{ N}$  during the instroke. Calculate the piston rod radius. 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)** With reference to **Fig. 13** on the insert sheet of the electric toothbrush:
- (i) Briefly outline **two** specific performance criteria that the user would require from the product. [2]
  - (ii) For the product shown in **Fig. 13** evaluate **two** different aesthetic aspects of the product which may make it suitable for a teenage male target audience. [2]
- Quality of written communication [1]
- (iii) With reference to **Fig. 13** outline **two** main criteria that the designer would need to consider when selecting a material for the housing. [2]
  - (iv) With reference to **Fig. 13** suggest a suitable manufacturing process for the housing and outline **one** main reason why the manufacturer would select this process for this product. [2]
  - (v) Analyse the product shown in **Fig. 13** and briefly outline **one** example of anthropometric data that the designer would have required when designing the product. [1]
  - (vi) With reference to **Fig. 13** evaluate the following:
    - **one** positive environmental issue in relation to the use of materials
    - and **one** negative environmental issue in relation to the housing. [2]

(b) With the aid of detailed annotated sketches, using the blank A3 pro forma answer page (answer numbers **13(b)(i)** and **(ii)**), suggest for each of the following:

(i) An appropriate innovative design for a wall mounted holder for the electric toothbrush (**Fig. 13**). [4]

(ii) An appropriate bar chart that could be printed on the packaging of the product to represent the data for battery type A, B and C from the table shown below.

Battery type	Speed of head	Type of use	Battery duration approx
Battery type A	Speed 1 (low)	Soft brushing	120 minutes
Battery type B	Speed 2 (medium)	Medium brushing	90 minutes
Battery type C	Speed 3 (high)	Hard brushing	60 minutes

[4]

**14 Fig. 14** on the insert page shows a photograph of a game based on a column or tower structure of wooden blocks. The aim is for each player to remove a block one by one from the body of the tower, placing this on the top of the tower whilst avoiding the collapse of the remaining structure.

(a) When designing this game designers from the games company carried out extensive primary and secondary research in order to determine what was on the market and what the needs of the user might be. Additional research was also carried out in order to assist the creation of a trademark.

(i) Briefly explain the difference between primary research and secondary research. [2]

(ii) Briefly outline **two** main characteristics associated with trademarks. [2]

(b) In order to extend the client base the games company has decided to customise the shape of the wooden blocks using a CNC router.

Explain **three** different ways in which the CNC router could be used to customise the shape of the wooden blocks. [3]

- (c) The wooden game is to be packaged using corrugated board which will not only have high quality graphics printed onto it, but will also make use of holograms.
- (i) Briefly outline **two** main characteristics associated with corrugated board. [2]
- (ii) Explain **two** main benefits to the company of using holograms on the packaging. [2]
- Quality of written communication [1]
- (d) On the blank A3 pro forma answer page (answer numbers **14(d)(i)** and **(ii)**) use detailed annotated sketches to produce one possible solution for each of the following:
- (i) rendered pictorial sketches to explain to the user that:
- To construct the tower three wooden blocks are set side by side to form a layer.
  - Each layer is then alternated to be perpendicular (at right angles) to each other until all sixteen layers of the tower are complete. [4]
- (ii) an appropriate rotating platform to enable a player to rotate the column structure of wooden blocks before deciding which block they wish to try to remove. [4]

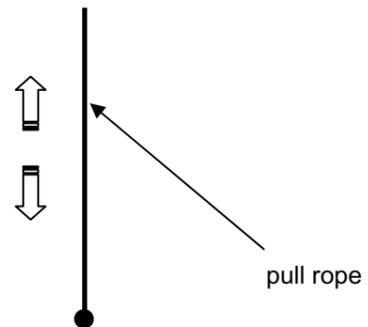
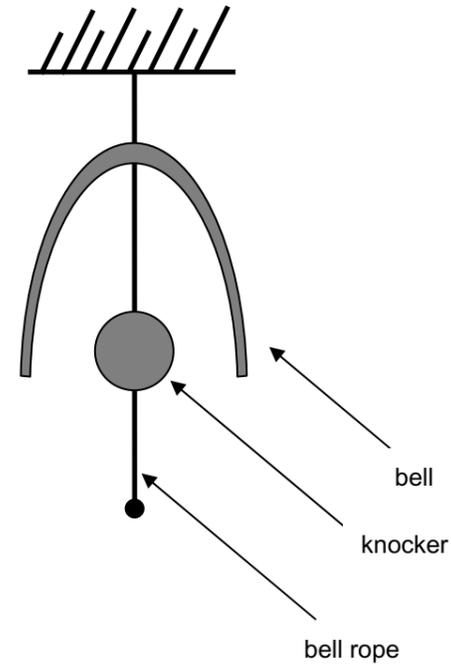
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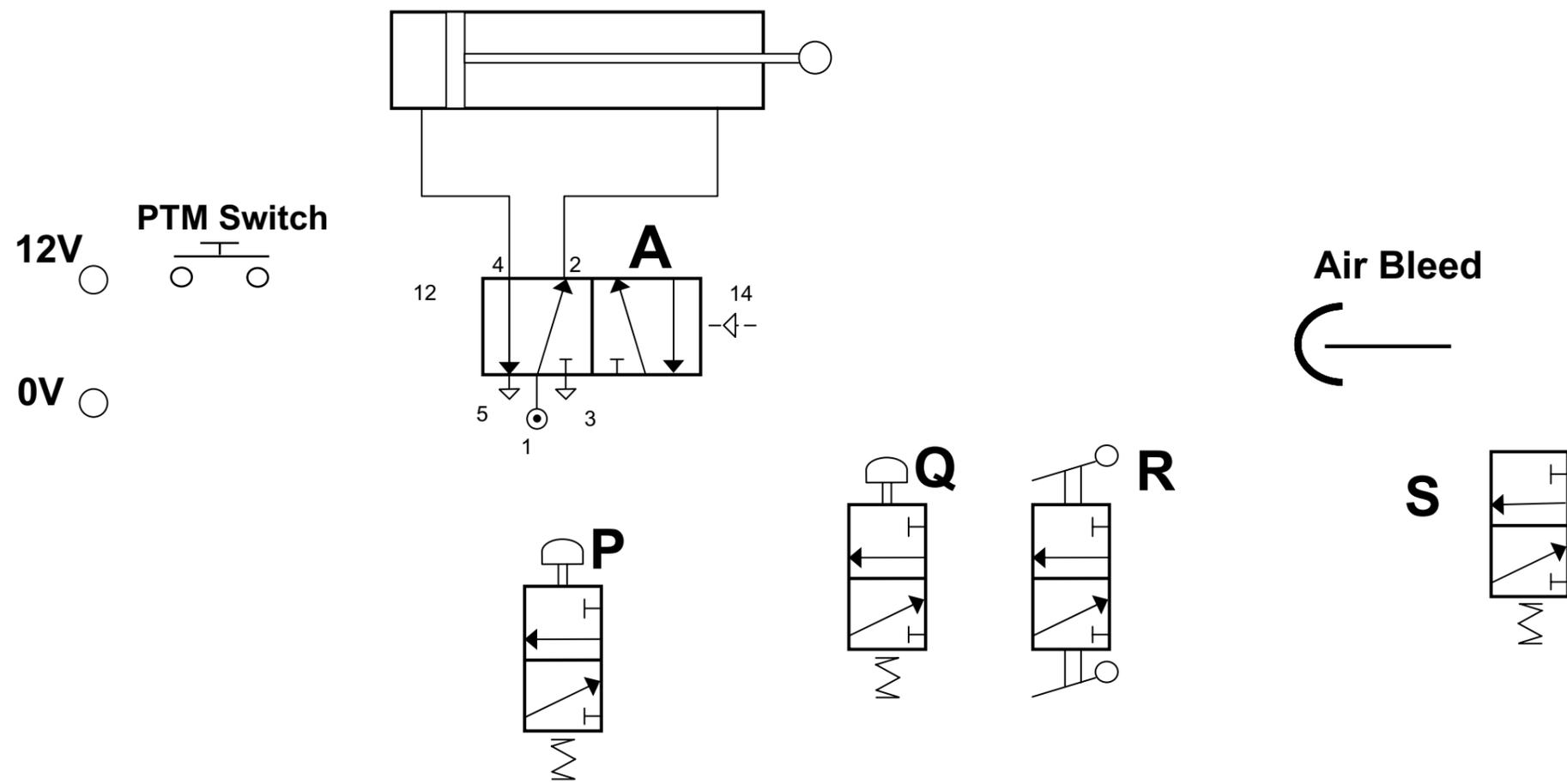
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**Pro forma answer page  
(answer number 11(b)(ii))**



Pro forma answer page  
 (answer numbers 12(a)(i), (ii), (iii) and (iv))

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

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

Question No. 14(d)

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**2014**

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Candidate Number

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

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Assessment Unit AS 1 January 2014

(for use with Question 13)

Do not write your answers on this insert

Rechargeable electric toothbrush



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Fig. 13

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**(for use with Question 14)**

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**Fig. 14**