Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2016

Technology and Design

Assessment Unit AS 1
assessing
Product Design and
Systems and Control

AV111

[AV111]
FRIDAY 10 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 Question **11(b)**, Question **12(a)(iii)**, **(iv) and (v)**, Question **13(d)(i) and (ii)** and Question **14(e)(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 **6**, **9(b)(iii)**, **10(b)(ii)**, **11(a)(iii)**, **12(b)**, **13(a)(ii)** and **14(c)**.
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 Physical and mechanical properties are an important consideration when selecting a material for a component or product.

(i) State **one** specific example of a physical property. [1]

(ii) State **one** specific example of a mechanical property. [1]

The selection of a material for a component or product can also be influenced by the scale of production.

(iii) Explain how the selection of a material can be influenced by the scale of production. [2]

2 Plywood is widely used in the construction of furniture.

(i) Briefly outline **two** main properties of plywood that make it suitable for furniture. [2]

Knock down fittings may be used to join plywood when constructing furniture.

(ii) With the aid of an annotated sketch explain how knock down fittings are used to join plywood when constructing furniture. [3]

3 **(i)** Outline **two** main properties of nylon which make it suitable for clothing. [2]

(ii) Outline **two** main properties of brass which make it suitable for musical instruments. [2]

4 The methods of wasting, forming and moulding are used when processing materials.

(i) Briefly explain what is meant by each of the following methods:

- wasting
- forming
- moulding. [3]

The process of blanking may be used to manufacture washers.

(ii) With the aid of an annotated sketch describe the blanking process used to manufacture washers. [3]

5 **(i)** Explain the difference between permanent and semi-permanent methods used to join materials. [2]

Riveting is a method used to join sheets of metal.

(ii) With the aid of annotated sketches explain how rivets are used to join sheets of metal. [3]

6 A review into a company manufacturing bicycles made reference to the following terms:

- Cell production
- Factor of safety of the frame.

(i) Outline **two** main characteristics associated with cell production. [2]

(ii) Explain what is meant by the term factor of safety when applied to the frame of the bicycle. [2]

Quality of written communication [2]

7 Computer-aided design (CAD), solid modelling and virtual imaging are used in the design of products.

(i) Outline **one** main advantage associated with the use of computer-aided design (CAD). [1]

(ii) Outline **two** specific characteristics associated with solid modelling. [2]

(iii) Outline **two** specific characteristics associated with virtual imaging. [2]

8 Companies designing and manufacturing domestic products will give careful consideration to life cycle analysis and quality assurance (QA).

(i) Explain what is meant by the term life cycle analysis. [2]

(ii) Explain what is meant by the term quality assurance (QA) and give **one** main reason why a company would need to consider it. [3]

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 is shown in **Fig. 1**. The logic inputs to the circuit are provided by three push to break switches.

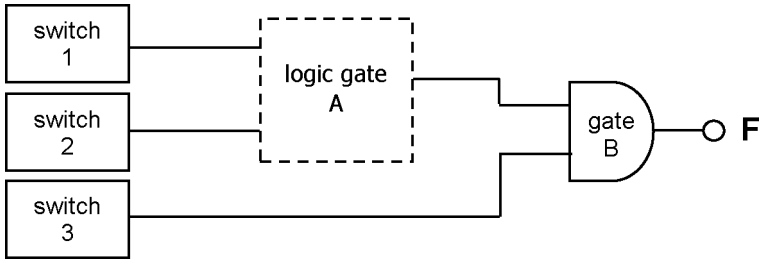

Fig. 1

(i) Logic gate A in **Fig. 1** is an exclusive NOR (ENOR) gate. Draw the symbol for this gate. [1]

(ii) Each of the push to break switches in **Fig. 1** provides a logic 0 when pressed and a logic 1 when released. With the aid of a circuit diagram show how one of the switches in conjunction with a resistor and power supply can be used to achieve this. [2]

(iii) What will be the value of output **F** for each of the following input combinations?

Switch 1	Switch 2	Switch 3
1	1	1
0	0	1
0	1	1

[3]

(b) The output from the logic circuit shown in **Fig. 1** is to be used to switch on a 12 volt heater using a thyristor when the output of the circuit is logic 1. The symbol for the heater is shown in **Fig. 2**.

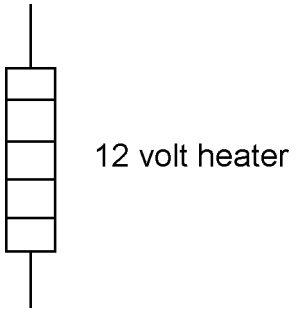

Fig. 2

(i) Draw a circuit diagram to show how the output from the logic circuit shown in **Fig. 1** can be used to switch on the heater shown in **Fig. 2** using a thyristor. The circuit diagram should include a means of resetting the thyristor. Assume that the output from the logic circuit is 5 volts when logic 1. [4]

(ii) If the heater shown in **Fig. 2** has a resistance of 60 ohms, calculate the power dissipated by it when operating at 12 volts. [2]

(iii) The logic circuit shown in **Fig. 1** could be replaced by a circuit based on a PIC. Explain **two** advantages (excluding cost) of using a PIC based circuit to replace the logic circuit shown in **Fig. 1**. [2]

Quality of written communication [1]

(c) Another logic circuit based on logic gates is shown in **Fig. 3**. The circuit which is constructed using NAND gates is known as an SR flip flop with Q and $\overline{Q}$ outputs.

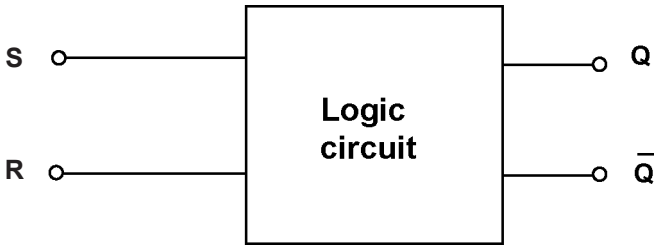

Fig. 3

(i) State the logic for Q and $\overline{Q}$ when S is logic 1 and R is logic 0. [2]

(ii) With the aid of a circuit diagram (and with reference to S, R, Q and $\overline{Q}$), explain how the arrangement of NAND gates in an SR flip flop achieves a latching action. [3]

10 **(a)** A thermistor with a negative temperature coefficient is shown in **Fig. 4**.

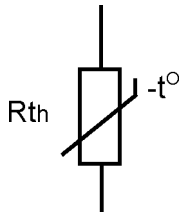

Fig. 4

(i) State what is meant by the term 'negative temperature coefficient' when referring to a thermistor. [1]

(ii) Sketch a graph with labelled axes to show how the resistance of the thermistor shown in **Fig. 4** changes with temperature. [2]

(b) A 555 timer circuit that utilises the thermistor from **Fig. 4** is shown in **Fig. 5**.

The timer circuit is to be used to control a UV light unit used in an industrial chemical process. The chemicals (depending on the temperature) are exposed to UV light for a time period. The time period T is given by T = 1.1 x Rth x C.

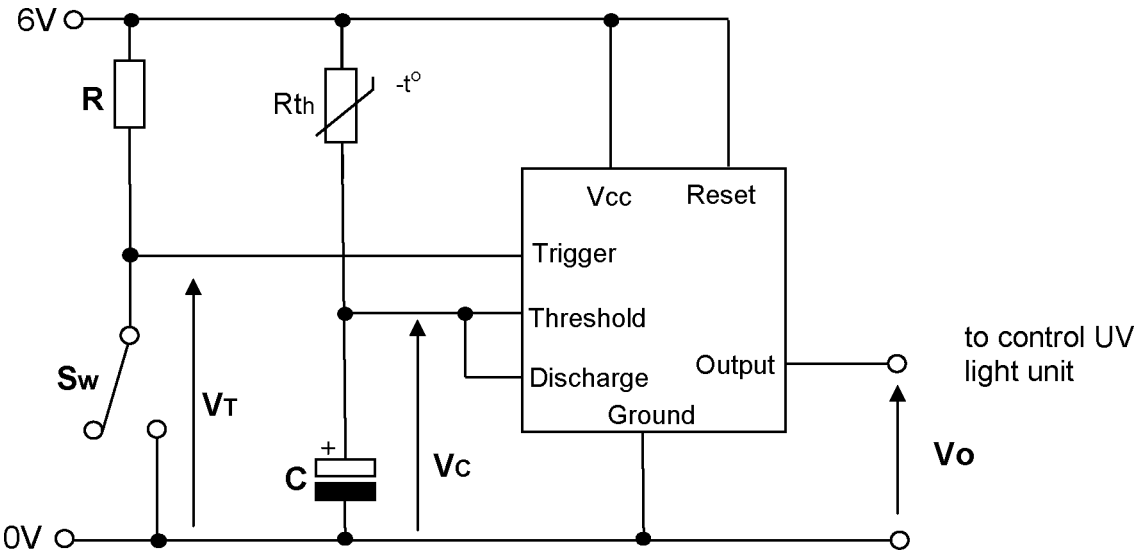

Fig. 5

(i) The timer circuit in **Fig. 5** can be viewed as an open loop system.

State the main difference between open loop and closed loop systems. [1]

(ii) With reference to the circuit shown in **Fig. 5** explain the change in time period caused by an increase in temperature. [2]

Quality of written communication [1]

(iii) For the circuit shown in **Fig. 5** sketch and label the following graphs on the same axes:

- Voltage V_T against time when the microswitch Sw is momentarily closed and opened. [2]
- Voltage Vc against time when the microswitch Sw is momentarily closed and opened. [2]

(iv) Calculate the time period for the circuit shown in **Fig. 5** if Rth has a resistance of 5.6 kΩ and the capacitor C has a value of 1000 μF. [2]

(c) The output from the timer circuit shown in **Fig. 5** controls a 12 volt UV lamp using a transistor and 6 volt SPDT relay arrangement. The electronic symbols for these components are shown in **Fig. 6**.

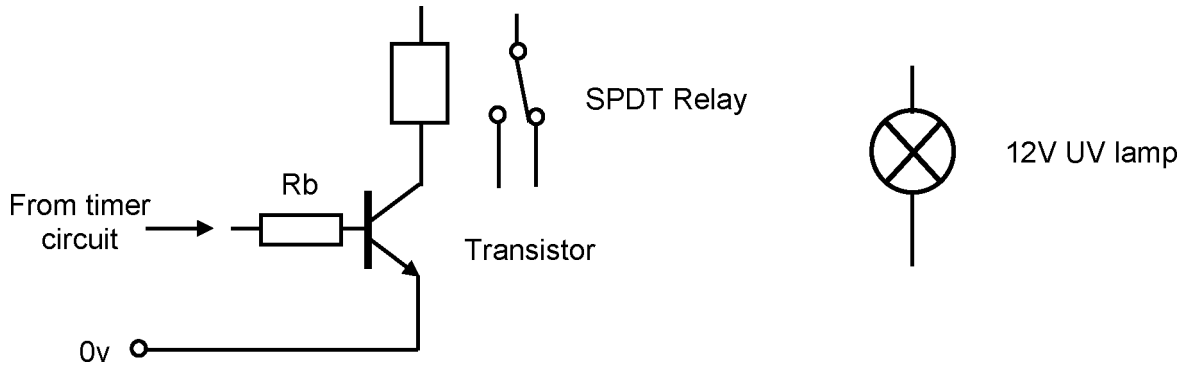

Fig. 6

(i) Calculate the value of base resistor Rb required if the gain (hfe) of the transistor in **Fig. 6** is 120, the Vbe is 0.7 V and the Ic max is 200 mA. Assume that Vo from the timer circuit is 6 volts. [3]

(ii) Show, using a circuit diagram, how the transistor/relay arrangement in **Fig. 6** can be used to control the 12 V UV lamp, drawing any additional components required. [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. 7** shows a prototype mechanical system.

(a) **(i)** Compare the direction of rotation at **A** with the direction of rotation of **F**. [1]

(ii) Sprocket **K** is attached to shaft **W** using a grub screw. Using an annotated sketch outline the main features of a grub screw attachment method. [2]

(iii) **K** and **J** are connected using a chain and sprocket system.

Explain **two** reasons why this has been used by the designer. [2]

Quality of written communication [1]

(iv) Calculate the velocity ratio between **A** and **F**. [3]

(v) Calculate the speed of rotation at the worm shaft if **E** rotates at 260 rev/min. [2]

(vi) Calculate the number of teeth on sprocket **K** to enable it to rotate at 5 rev/min if the motor rotates at 3200 rev/min. [4]

(b) On the pro forma provided (answer number **11(b)**), sketch and label a mechanical system to enable anti-clockwise rotations on shaft **W** (also shown on **Fig. 7**) to raise block **X** and alternatively lower it with clockwise rotations.

Explain how your solution fulfils its function. [5]

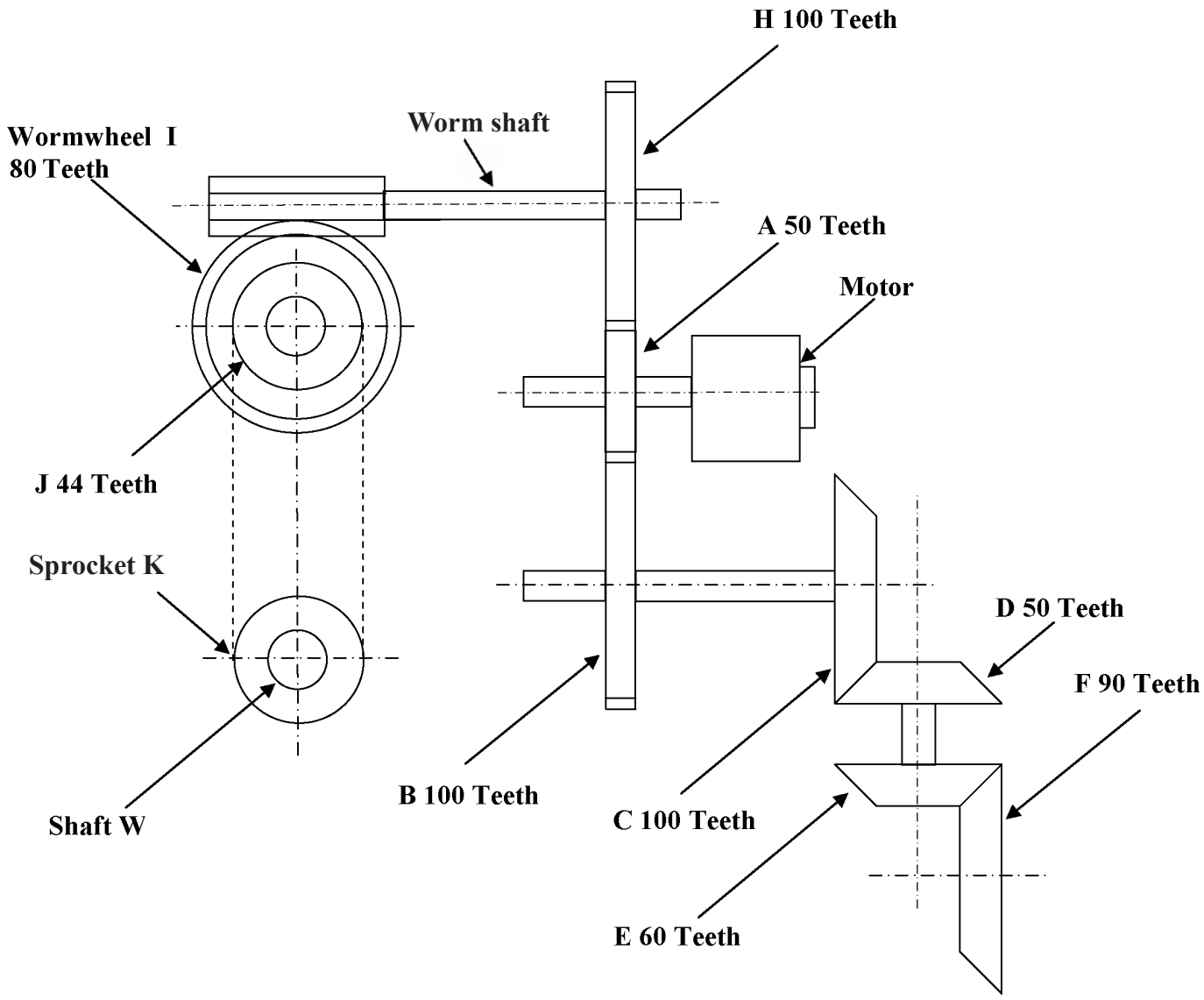

Fig. 7
Components **not** drawn to scale

12 **(a)** The pro forma provided (answer number **12(a)(iii)**, **(iv)** and **(v)**) shows an incomplete pneumatic system.

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

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

(iii) On the pro forma provided (answer number **12(a)(iii)**, **(iv)** and **(v)**) complete the relevant section of the circuit to enable an activation at **A or B or C or D** to outstroke cylinder **H**. Please note that **C** requires a solenoid activation method. [4]

(iv) On the pro forma (answer number **12(a)(iii)**, **(iv)** and **(v)**) complete the relevant section of the circuit to enable cylinder **H** to instroke automatically following the outstroke, which activates **two** airbleeds. Draw two airbleeds in your answer and note that both airbleeds need to be activated to allow the instroke to occur. [5]

(v) On the pro forma provided (answer number **12(a)(iii)**, **(iv)** and **(v)**) complete the relevant section of the circuit to enable cylinder **H** to outstroke slowly. Please note that the piping connecting cylinder **H** to the five port valve must not be used. [2]

(b) Describe what determines the outstroke and instroke forces in single and double acting cylinders. [3]

Quality of written communication [1]

(c) A double acting cylinder has a piston rod diameter of 8 mm and is supplied with an air pressure of 1.0 N/mm^2. It produces a force of 420 N during the instroke. Calculate the piston diameter. Please assume π = 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. 8** on the insert page shows photographs of a child's bicycle seat.

(i) For the product shown in **Fig. 8** explain **one** way in which the designer has taken into consideration the safety of the user. [1]

(ii) Briefly outline **two** specific ways in which the designer has incorporated aesthetic appeal into the design of the child's bicycle seat shown in **Fig. 8**. [2]

Quality of written communication [1]

(iii) With reference to **Fig. 8** briefly outline **two** main criteria that would influence the selection of the material to be used for the shell of the child's bicycle seat. [2]

(iv) With reference to **Fig. 8** briefly outline **two** main criteria that would influence the manufacturing process to be used for the moulded shell of the child's bicycle seat. [2]

(b) To improve the product the use of reflective films is to be considered.

Briefly outline **two** main characteristics associated with reflective films which would make them suitable for this product. [2]

(c) The child's bicycle seat is to be packaged using corrugated board and bio-degradable plastic.

(i) Briefly outline **one** main characteristic associated with corrugated board which makes it suitable for the packaging. [1]

(ii) Briefly outline **one** main characteristic associated with bio-degradable plastic which makes it suitable for the packaging. [1]

(d) With the aid of detailed sketches, using the blank A3 pro forma answer page (answer number **13(d)(i)** and **(ii)**), complete each of the following:

(i) An appropriate design of a pictogram that will be printed onto the packaging for the child's bicycle seat to remind the user that this product is suitable for a child whose weight is between 9 and 22 kg. [4]

A waterproof covering can be purchased for this specific bicycle seat. It is intended that when the covering is tightly rolled up it will form a cylindrical shape.

(ii) Produce an appropriate annotated design of a product to store the waterproof covering on the back of the bicycle seat when it is rolled up. Your design must allow the user to easily and quickly store, remove or replace the covering as required. You must show how the product you have designed is attached to the back of the bicycle seat. [4]

14 **Fig. 9** on the insert page shows photographs of an ice cream scoop.

(a) When generating ideas for products such as the ice cream scoop, designers place a great importance on the design and manufacturing specification.

Distinguish between a design specification and a manufacturing specification. [2]

(b) In an attempt to produce a more innovative range of ice cream scoops the company's design team have employed the technique of lateral thinking.

(i) Outline **two** main characteristics associated with lateral thinking. [2]

One design idea generated from the technique of lateral thinking resulted in the company's design team applying for a registered design.

(ii) Explain **two** main characteristics associated with a registered design. [2]

(c) In order to determine the suitability of the material for the ice cream scoop a range of chemical cleaning products was used during testing. When using these cleaning products the company consulted with COSHH regulations.

Outline **three** main characteristics associated with COSHH regulations. [3]

Quality of written communication [1]

(d) To assist in the planning for manufacture of the ice cream scoop shown in **Fig. 9** a Gantt chart is to be used.

Briefly explain **two** main characteristics associated with a Gantt chart. [2]

(e) On the blank A3 pro forma answer page (answer number **14(e)(i)** and **(ii)**), use detailed annotated sketches to produce **one** possible solution for each of the following:

(i) An appropriate design for the head of the shaft which would enable the user to quickly remove the scoop and replace it securely with different sized scoops as required. [4]

(ii) A suitable design of a covering that could be secured onto the existing body of the scoop by the customer to allow for colour preferences outlining any modifications that might be needed to the ice cream scoop in order to accommodate this covering. [4]

THIS IS THE END OF THE QUESTION PAPER

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Question No. 11(b)

ADVANCED SUBSIDIARY (AS) TECHNOLOGY AND DESIGN
Assessment Unit AS1 Unit 1
Summer 2016

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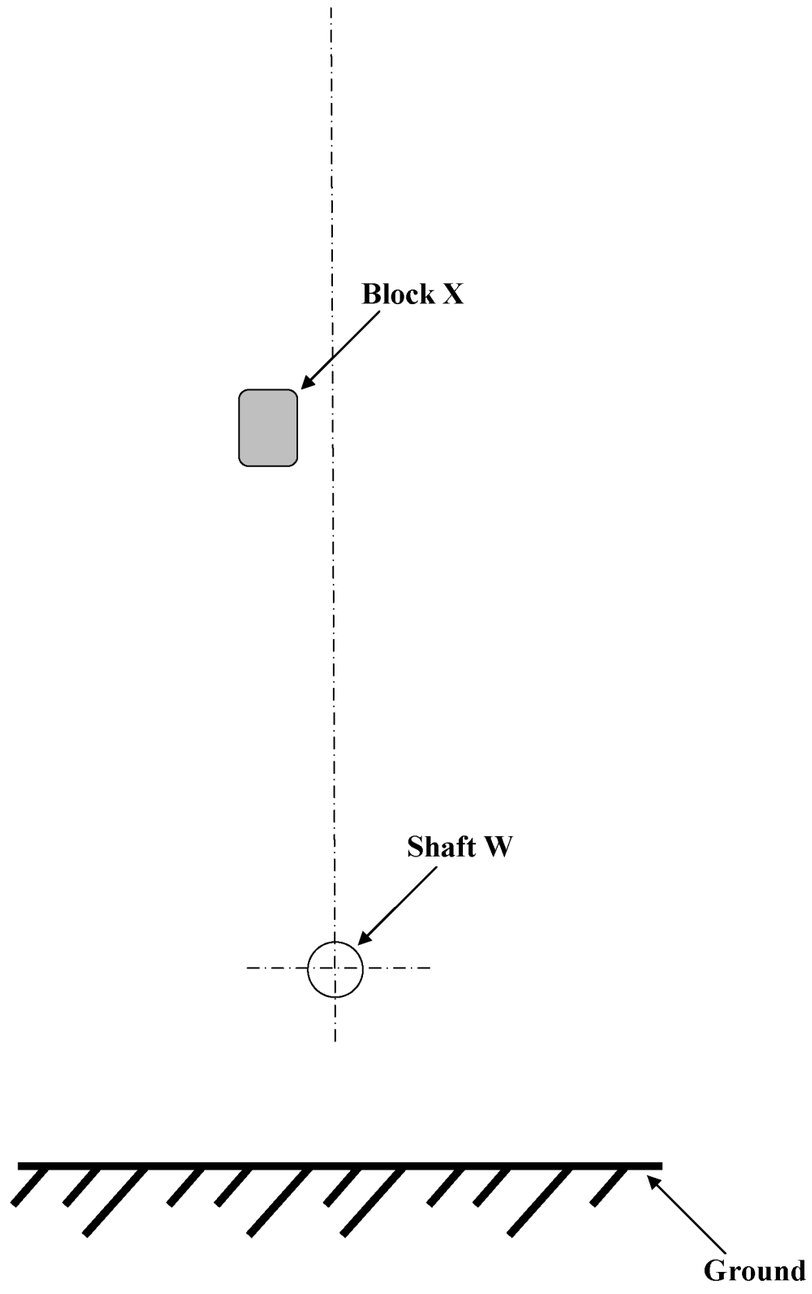

Pro forma answer page
(answer number 11(b))

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Assessment Unit AS1 Unit 1
Summer 2016

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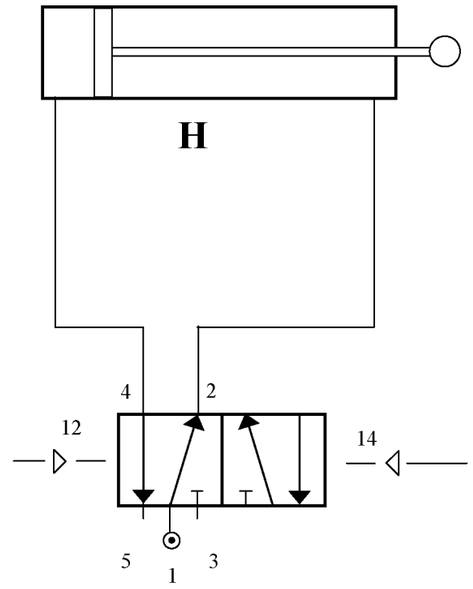
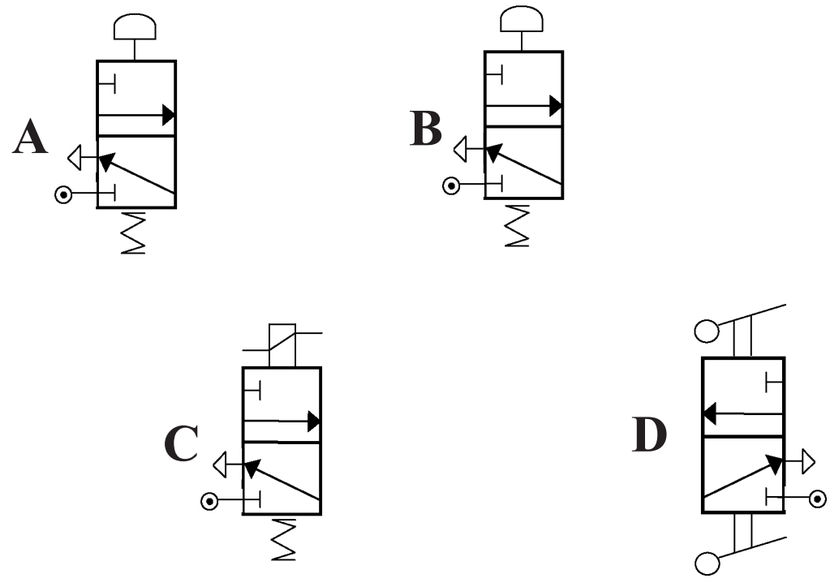
Candidate Number





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

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Summer 2016

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Candidate Number

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

ADVANCED SUBSIDIARY (AS) TECHNOLOGY AND DESIGN
Assessment Unit AS1 Unit 1
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Pro forma answer page
(answer number 14(e)(i) and (ii))

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(for use with Question 13)

Do not write your answers on this insert

Fig. 8

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(for use with Question 14)

Do not write your answers on this insert

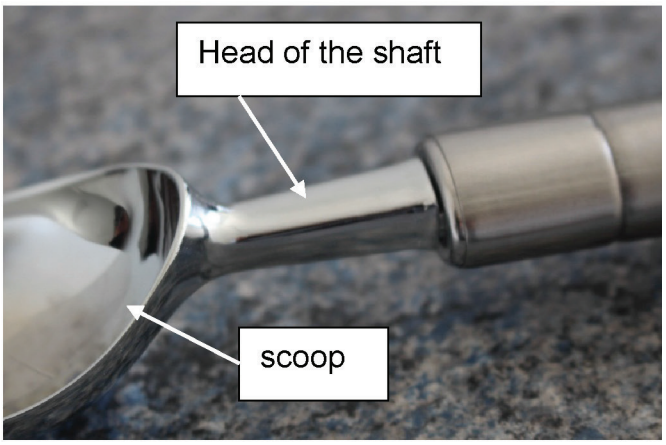

Fig. 9