New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Technology and Design

Assessment Unit AS 1

assessing

Product Design and
Systems and Control

[AV111]

AV111

WEDNESDAY 16 JUNE, AFTERNOON

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.
An A3 pro forma is provided for Question **12(b)**.
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 will be awarded for questions **5**, **7**, **9(b)(i)**, **10(a)(iv)**, **11(c)** and **12(c)(ii)**.
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 Hardwood such as oak and softwood such as pine are widely used for domestic purposes.

(i) Briefly explain the difference between hardwood and softwood. [1]

(ii) Briefly outline **two** main characteristics of oak which make it suitable for furniture. [2]

(iii) Briefly outline **two** main characteristics of pine which make it suitable for floorboards. [2]

2 A report focusing on a company manufacturing and assembling school lockers and filing cabinets made reference to the following terms:

- use of tolerance
- batch production
- statistical testing methods

(i) Briefly explain what is meant by each of these terms. [3]

(ii) Give **two** main reasons why this company would use common forms and sizes of materials. [2]

3 Components such as metal washers can be produced by the process of blanking.

(i) In what common form should the metal be supplied in order to be used for the blanking process? [1]

(ii) With the aid of an annotated sketch, describe the blanking process. [4]

4 ABS and polystyrene are used in a range of products.

(i) Give **two** main characteristics of ABS which make it suitable for certain parts of children's toys. [2]

(ii) Give **two** main characteristics of polystyrene which make it suitable for cups in vending machines or yoghurt pots. [2]

5 Solid modelling, virtual imaging and rapid prototyping are used in the design and manufacture of products.

(i) Outline **two** specific characteristics associated with solid modelling.

(ii) Outline **two** specific characteristics associated with virtual imaging.

(iii) Outline **two** specific characteristics associated with rapid prototyping. [6]

Quality of written communication [1]

6 There are risks associated with common manufacturing processes and appropriate procedures used to minimise them.

(i) For a specific machine manufacturing process, briefly outline **one** main associated risk and **one** method used to minimise it. [2]

(ii) For a specific hand manufacturing process, briefly outline **one** main associated risk and **one** method used to minimise it. [2]

7 Anthropometrics and aesthetics are important considerations for a designer of sports footwear.

(i) Briefly outline **two** specific examples of anthropometric data that a designer would need. [2]

(ii) Explain how texture and symmetry can influence the aesthetic appeal of sports footwear. [2]

Quality of written communication [1]

8 The challenge for designers is to incorporate the 3Rs when designing sustainable products in order to minimise their impact on the environment.

(i) Briefly explain what is meant by the 3Rs in the context of product design. [3]

(ii) Select **one** product and briefly explain how any one of the 3Rs has been incorporated into its design. [2]

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(Questions continue overleaf)

Answer the questions in **Section B** or **Section C**.

Section B

Electronic and Microelectronic Control Systems

Answer **both** questions in this section.

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

9 Two logic gates are shown in **Fig. 9(a)**.

Fig. 9(a)

(a) (i) Name the logic gates labelled **X** and **Y** in **Fig. 9(a)**. [2]

(ii) Draw truth tables for each of the logic gates shown in **Fig. 9(a)**. [2]

(b) Switches which are used to create logic functions can be incorporated into circuits as shown in the fire alarm circuit in **Fig. 9(b)**. The fire alarm circuit utilises a 555 astable circuit to control a buzzer.

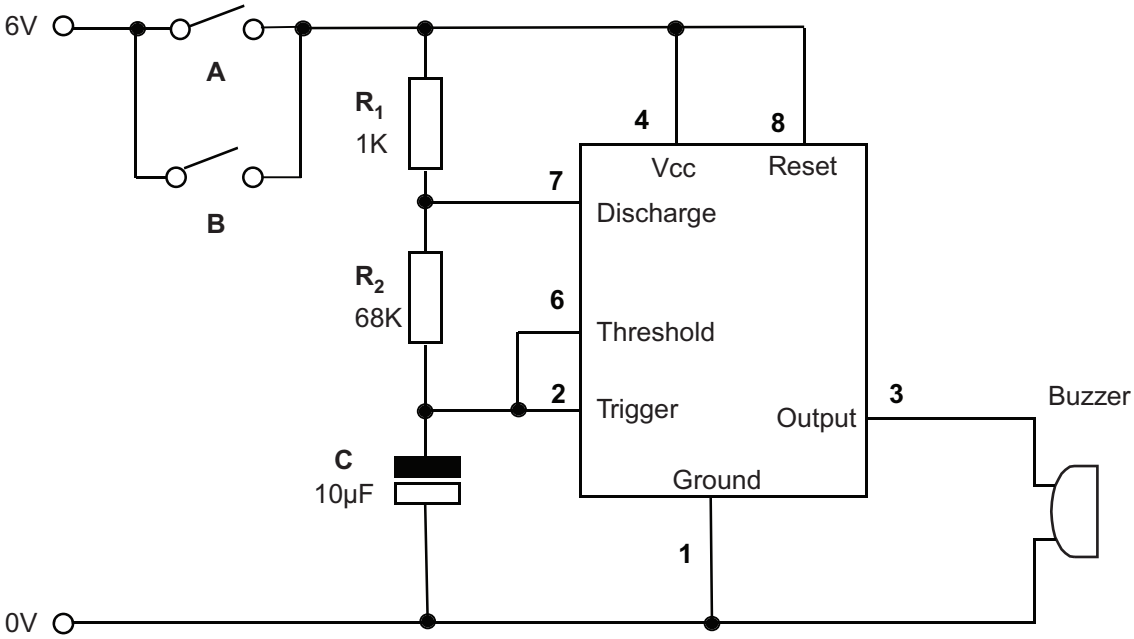

Fig. 9(b)

(i) State the logic function achieved by the arrangement of the two switches A and B in **Fig. 9(b)** and explain how this logic function is achieved. [2]

Quality of written communication [1]

(ii) Explain what is meant by the term astable when referring to 555 timers. [2]

(iii) Calculate the output frequency f of the circuit shown in **Fig. 9(b)** given that $f = 1.44/C (R1 + 2R2)$ [3]

(iv) Sketch and label the output waveform for the astable circuit in **Fig. 9(b)**. Indicate the **period**, **mark** and **space** on the waveform. [4]

(v) Design a modification to the circuit shown in **Fig. 9(b)** that will allow the frequency of the output to be adjusted. [2]

10 **Fig. 10(a)** shows a comparator circuit which is to be used as a frost warning system for a greenhouse.

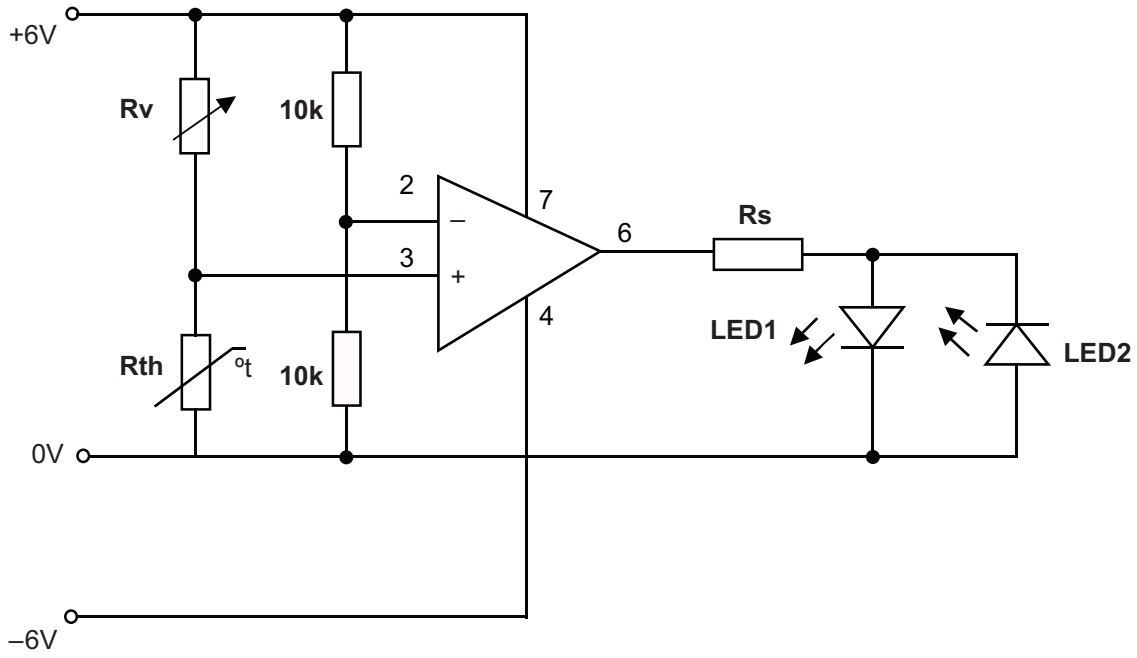

Fig. 10(a)

(a) **(i)** The circuit shown in **Fig. 10(a)** can be analysed in terms of input, control and output. Draw a systems block diagram for the circuit, inserting the names of the appropriate components in each of the blocks. [3]

(ii) State whether the circuit shown in **Fig. 10(a)** is an on/off or continuous control system and briefly justify your answer. [2]

(iii) Name component Rv and state its function in the circuit shown in **Fig. 10(a)**. [2]

(iv) With reference to both hot and cold input conditions, describe the operation of the circuit shown in **Fig. 10(a)**. [4]

Quality of written communication [1]

(v) Calculate the required value of resistor Rs if the LEDs shown in **Fig. 10(a)** are designed to work at a forward voltage of 1.2 V and a current of 10 mA. [2]

(b) The frost warning circuit shown in **Fig. 10(a)** is to be modified so that it will switch on a high voltage heater using a transistor and relay-based circuit. A table showing the available transistors is shown in **Fig. 10(b)**.

Transistor	Vbe	Ic(max)	hFE
Type 1	0.7	1A	40
Type 2	0.6	800 mA	100
Type 3	0.6	400 mA	200

Fig. 10(b)

(i) Explain what is meant by the term Ic (max) when referring to transistors. [2]

(ii) Show, with the aid of a diagram, how a transistor and relay-based circuit can be used to enable the circuit shown in **Fig. 10(a)** to turn on a high voltage heater. [4]

(iii) If a transistor with a supply voltage of 6 volts requires a base current of 8 mA to operate a relay with a coil resistance of 10 ohms, calculate the gain required for the transistor and choose an appropriate transistor from the table shown in **Fig. 10(b)**. [2]

Answer the questions in **Section B** or **Section C**.

Section C

Mechanical and Pneumatic Control Systems

Answer **both** questions in this section.

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

11 **Fig. 11** shows a mechanical system which includes a motor, chain and sprockets, pulleys, gears and shafts.

(a) **(i)** Name the mechanical system which could join shaft **P** with shaft **Q** providing a substantial transmission speed reduction. [1]

(ii) State the direction of rotation at shaft **R** if **A** rotates in an anticlockwise direction. [1]

(iii) Calculate the overall velocity ratio between **A** and **G**. [3]

(iv) Calculate the output speed at **G** if **B** rotates at 120 rev/min. [2]

(v) Calculate the input speed of the motor if there is a reduction between shafts **P** and **Q** by a factor of 20 and **F** rotates at 120 rev/min. [4]

(b) Shaft **R** is attached to pulley **G** using a grub screw. Using an annotated sketch, outline the main features of this fixing method. [2]

(c) The belt between pulleys **F** and **G** increasingly suffers from slippage. Draw and name a system to prevent this increasing slippage problem and describe how it achieves this. [3]

Quality of written communication [1]

(d) Using an annotated sketch, name and draw a system which would convert the rotary motion of shaft **R** into reciprocating motion of **Component 1**. [3]

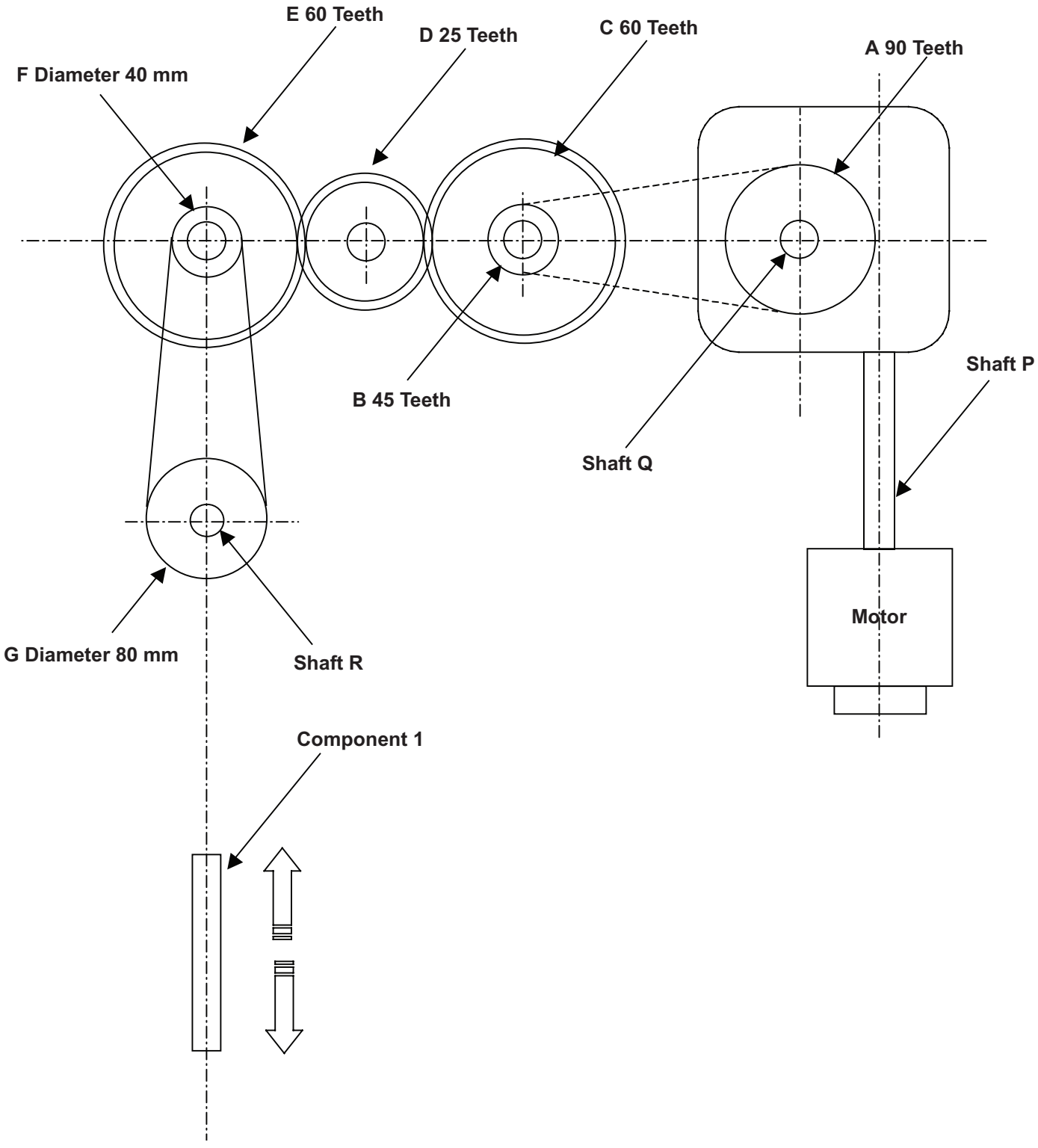

Fig. 11

12 **Fig. 12** shows part of an incomplete pneumatic system which includes two identical double acting cylinders.

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

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

(iii) Briefly explain the purpose component **C** has in the circuit. [2]

(b) The start valve activates the 5PV to produce an outstroke of cylinder **X**.

(i) On the pro forma provided (answer number **12(b)**), complete the circuit enabling an outstroke of cylinder **X** to be followed by an outstroke from cylinder **Y** which in turn enables cylinder **X** to instroke. [4]

(ii) On the pro forma provided (answer number **12(b)**), complete the circuit enabling double acting cylinder **Y** to instroke after a delay in time following the instroke of cylinder **X**. [4]

(c) **(i)** The two identical double acting cylinders produce a combined force during the outstroke of 706.5 N. Calculate the piston diameter if the air pressure is supplied at 0.5 N/mm^2. Assume $\pi = 3.14$. [4]

(ii) Describe what causes the difference in force during the outstroke and instroke for a double acting cylinder with a single air pressure. Discuss how this differs with the forces produced with a single acting cylinder. [3]

Quality of written communication [1]

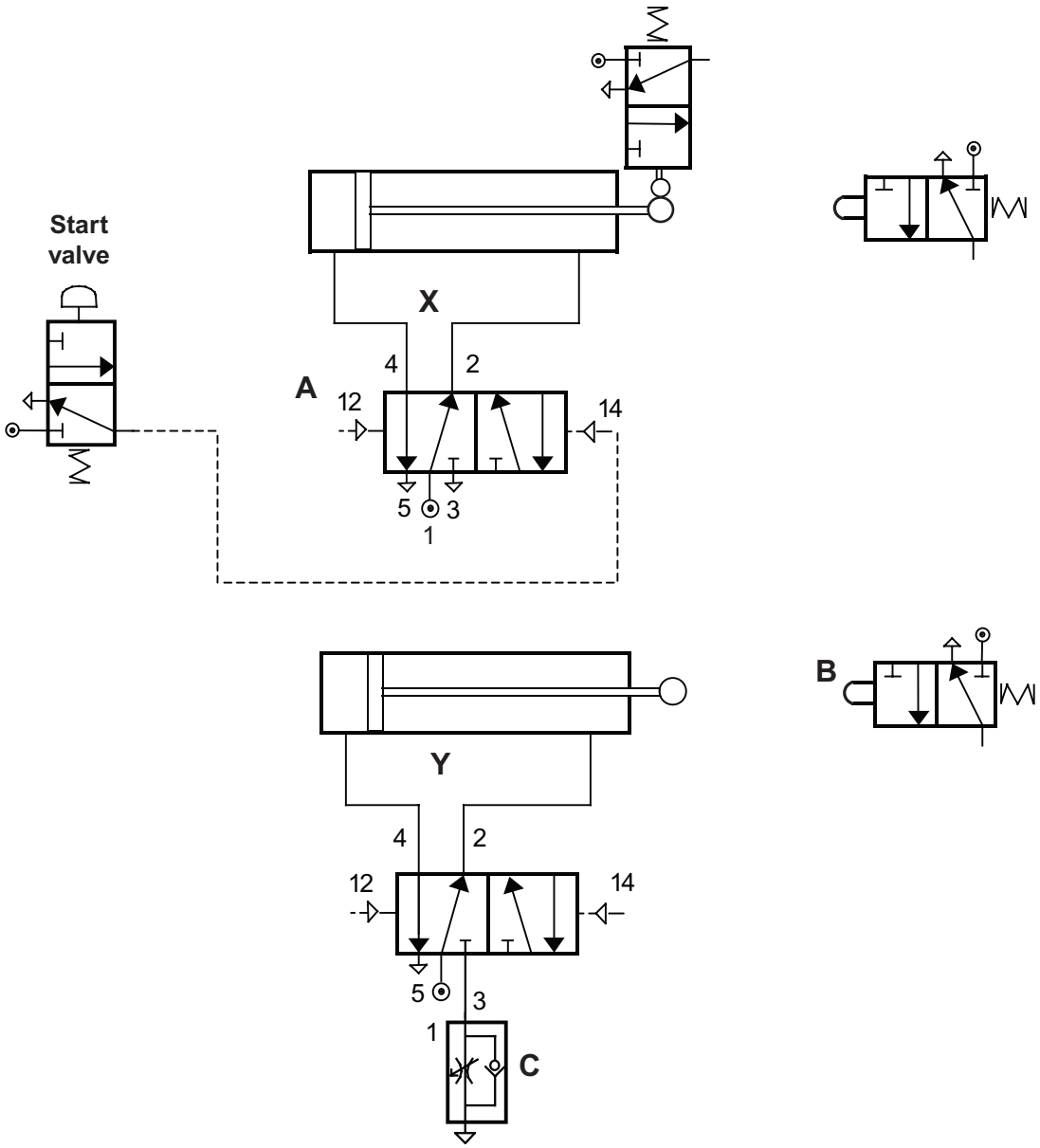

Fig. 12

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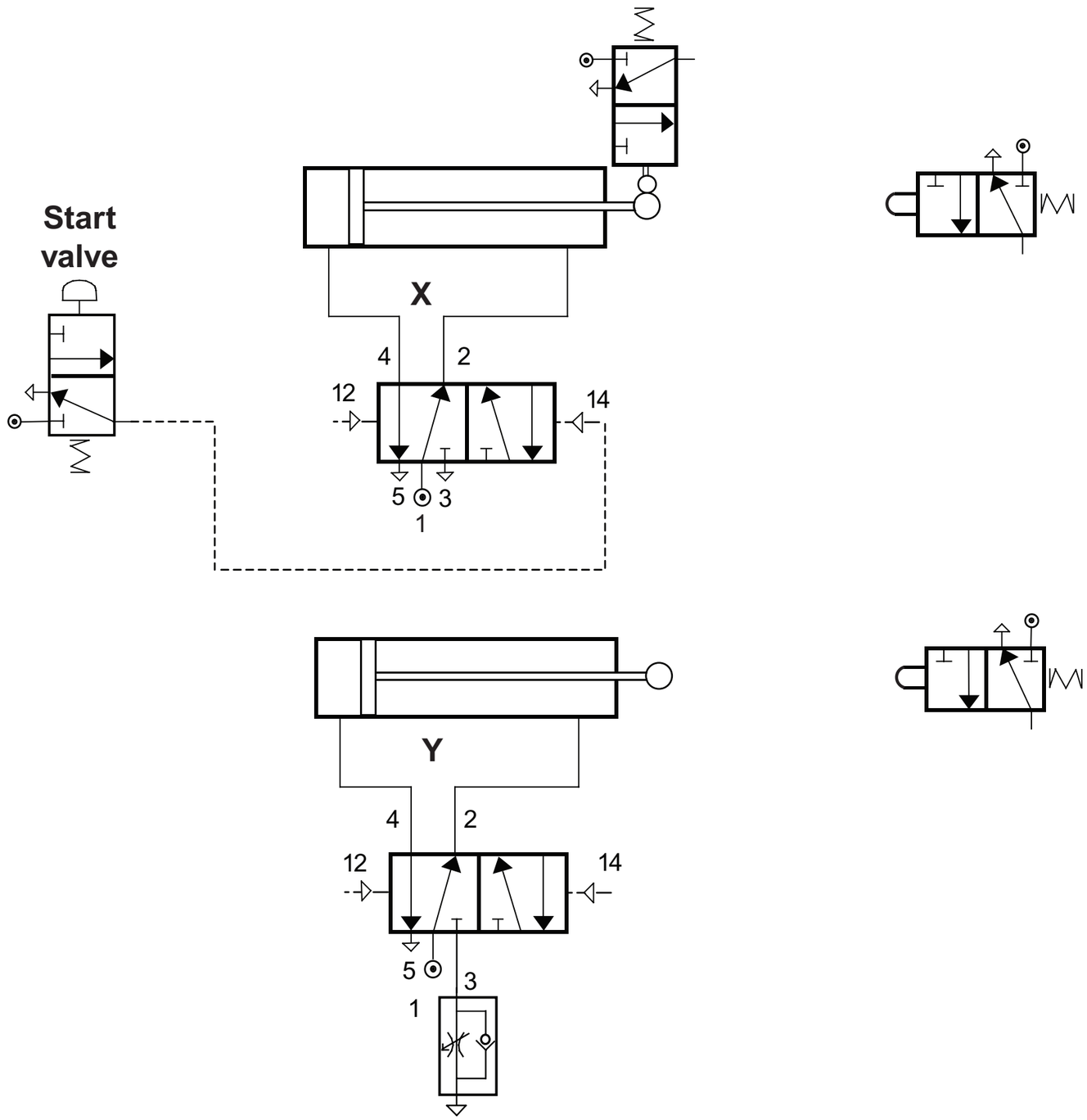
Question No. 12(b)

ADVANCED SUBSIDIARY (AS) TECHNOLOGY AND DESIGN
Assessment Unit AS 1 Unit 1
2010

Centre Number

71

Candidate Number



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

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