



Rewarding Learning

ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
January 2010

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## Technology and Design

### Assessment Unit AS 1

*assessing*

Product Design and  
Systems and Control

[AV111]



WEDNESDAY 20 JANUARY, MORNING

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#### 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 Questions **12(b), (c) and (d)**.

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 **7(i), 8, 10(b)(i) and (ii) and 11(e)(i) and (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** Explain what is meant by the following properties:
- Electrical conductivity
  - Thermal conductivity
  - Durability
  - Brittleness
- [4]
- 2** Metals are supplied and used in a range of forms.
- (i) State **four** different forms in which metal is available. [2]
- (ii) Drill bits can be manufactured from high carbon steel. Give **two** main reasons why high carbon steel is used. [2]
- 3** Garden hose pipes are manufactured by the process of extrusion.
- (i) State **two** main reasons why extrusion is the most suitable process for the manufacture of this product. [2]
- (ii) Suggest a suitable material for the extrusion of garden hose pipes. [1]
- (iii) With the aid of an annotated sketch describe the extrusion process. [3]
- 4** (i) Briefly explain the difference between a composite and an alloy. [2]
- (ii) Shape memory alloy and piezoelectric materials are considered smart materials.
- Briefly explain **one** main characteristic for shape memory alloy and **one** main characteristic for piezoelectric materials and give **one** specific application for each. [4]

- 5 (i) Distinguish between permanent and semi-permanent methods used in the joining of materials. [2]
- (ii) Brazing and welding are widely used methods in the joining of metals.  
Briefly outline **two** main characteristics for each of the methods above. [4]
- 6 The Trades Description Act and British Standards are important to manufacturing companies.
- (i) Briefly outline **two** main characteristics associated with the Trades Description Act. [2]
- (ii) Briefly outline **two** main characteristics associated with British Standards. [2]
- 7 Materials such as steel are produced through continuous production.
- (i) Outline **three** main characteristics associated with continuous production. [3]
- QWC [1]
- (ii) State **one** example of a material, other than steel that would be produced through continuous production. [1]
- 8 Cultural and social changes can have an influence on the design of products. With reference to the car, outline **one** main cultural change and **one** main social change and explain how these changes have influenced the design of the car. [4]
- QWC [1]

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** Fig. 9(a) shows a logic circuit which uses switches as inputs and has an LED output.

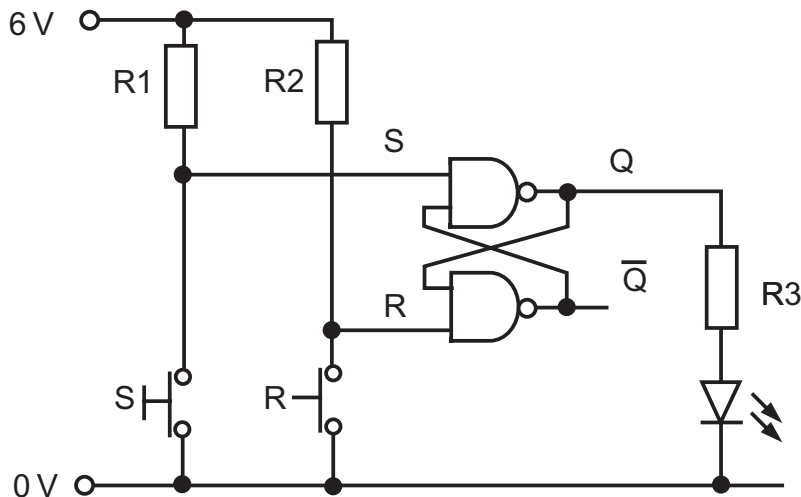


Fig. 9(a)

- (a) (i) Name the type of logic gate used in the circuit shown in Fig. 9(a). [1]
- (ii) Name the arrangement of gates shown in Fig. 9(a). [1]
- (iii) Briefly explain the function of the resistors R1 and R2 in the circuit shown in Fig. 9(a). [2]
- (iv) Draw a truth table for the circuit shown in Fig. 9(a) for the inputs S and R and the outputs Q and  $\bar{Q}$ . [5]

(b) The LED in **Fig. 9(a)** is designed to work at a forward voltage of 1.8 volts and a current of 15 mA.

(i) Calculate the value of resistor R3 in **Fig. 9(a)** required to allow the LED to function safely. Assume that the output voltage corresponding to a logic high is 6 volts. [2]

(ii) Choose a value for the resistor from the E12 preferred value series as shown below.

10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 [1]

(iii) Calculate the power dissipated by your preferred value resistor and then select the most appropriate rating from the range available. Resistors are available in 0.25, 0.5 and 0.75 watt ratings. [3]

(c) The circuit shown in **Fig. 9(a)** is to be modified to switch on a high voltage motor using a transistor and relay based circuit. Using an annotated circuit diagram show how this modification could be achieved. [4]

10 A circuit with a variable resistor and a thermistor is shown in **Fig.10(a)**.

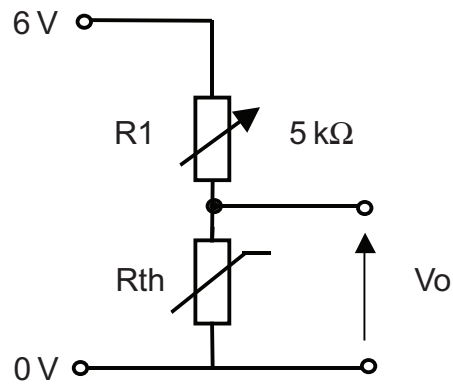


Fig. 10(a)

(a) The thermistor shown in **Fig. 10(a)** has a negative temperature coefficient.

- (i) Explain what is meant by the term negative temperature coefficient. [1]
- (ii) Draw a graph to show how the voltage  $V_o$  varies with temperature. [3]
- (iii) Calculate  $V_o$  in **Fig. 10(a)** when the resistance of the variable resistor is  $5\text{ k}\Omega$  and the resistance of the thermistor is  $2.2\text{ k}\Omega$ . [2]

(b) A 555 integrated circuit is connected to other components, including a variable resistor as shown in Fig. 10(b).

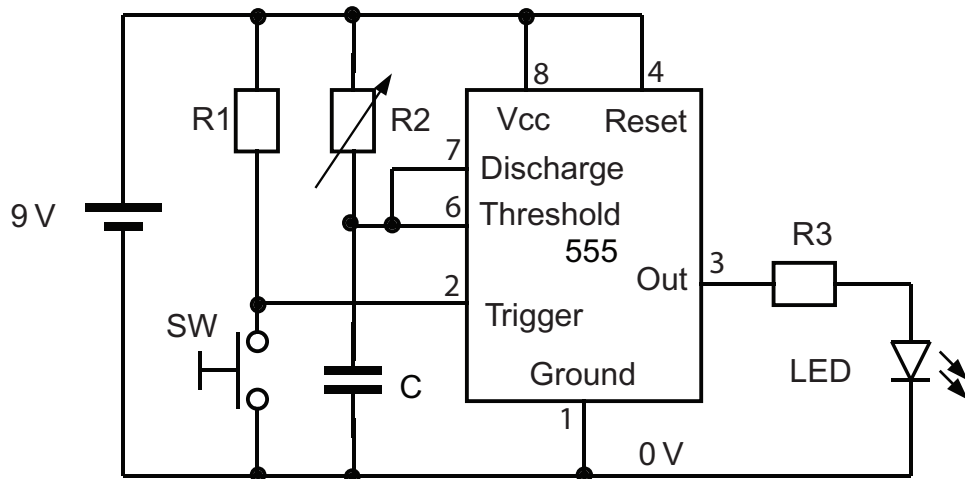


Fig. 10(b)

- (i) State if the circuit shown in Fig. 10(b) is an example of an open loop or closed loop system and briefly justify your choice. [2]  
QWC [1]
- (ii) Describe the operation of the circuit shown in Fig. 10(b) making reference to the components that control the timing. [4]  
QWC [1]
- (iii) Calculate the range of the variable resistor R2 to illuminate the LED in Fig. 10(b) for the periods ranging from 1 second to 5 seconds when  $C = 100\ \mu\text{F}$  given that the Time Period  $T = 1.1 \times C \times R2$  seconds. [4]
- (c) A programmable system such as a PIC could be employed to achieve the same function as the hard-wired circuit shown in Fig. 10(b). List **two** advantages and **one** disadvantage of using a programmable system over a hard-wired system. [3]

## 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 incorporating a motor, pulley and gears.
- (a) (i) Name a belt type which can be used on pulleys which are at 90 degree angles to each other. [1]
- (ii) State the direction of rotation at **G** if **A** rotates in an anticlockwise direction. [1]
- (b) (i) Calculate the overall velocity ratio between **A** and **K**. [2]
- (ii) Calculate the overall velocity ratio between **A** and **I**. [3]
- (iii) Calculate the difference in output speeds between **D** and **K** if the motor rotates at 240 rev/min. [3]
- (c) (i) Pulley **A** is attached to the motor shaft using a key and keyway. Using an annotated sketch outline the main features of this arrangement. [2]
- (ii) Name **one** other method of attaching pulleys to shafts apart from a key and keyway or grub screw. [1]
- (d) Occasionally the heavy motor needs to be raised and lowered from the ground to aid pulley belt replacement. Using an annotated sketch name and draw a linkage system which could keep the motor base level with the ground. [3]
- (e) The mechanical system is to be attached to a cam and follower. Describe the following terms:
- (i) Dwell. [1]
- QWC [1]
- (ii) Stroke length. [1]
- QWC [1]



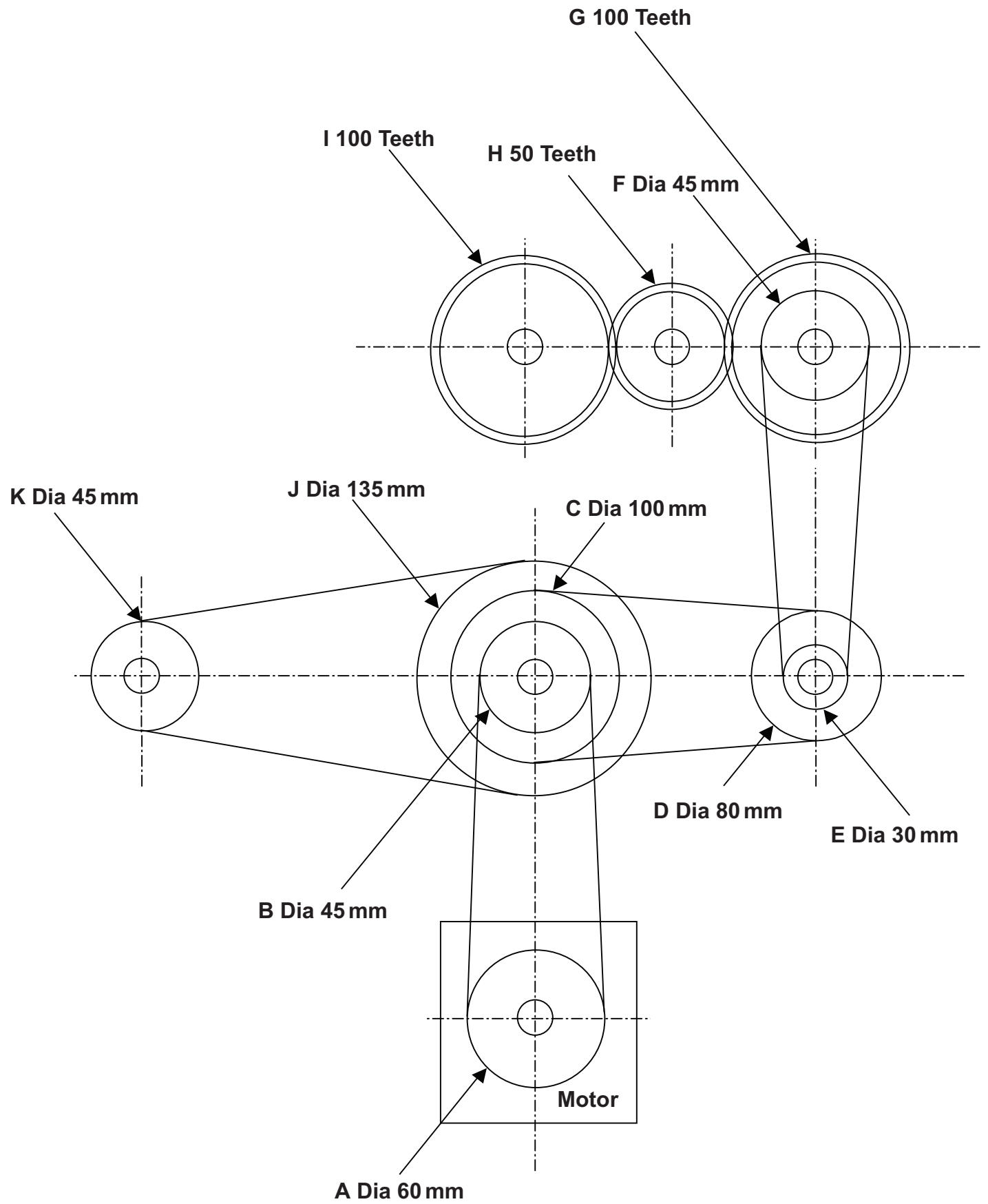


Fig. 11

**12 Fig. 12** shows part of an incomplete pneumatic system incorporating a single and double acting cylinder.

- (a) (i) Name the activation method at valve **A**. [1]
- (ii) Name the activation method at valve **C**. [1]
- (iii) Name the activation method at valve **X**. [1]
- (iv) Draw an airbleed showing how it is used to activate a single three port valve. [2]
- (b) On the pro forma provided (**answer number 12(b), (c) and (d)**) complete the circuit enabling the double acting cylinder to outstroke if 3 port valves **A and B and C or D** are activated. [4]
- (c) On the pro forma provided (**answer number 12(b), (c) and (d)**) complete the circuit enabling the single acting cylinder to outstroke slowly as the double acting cylinder instrokes. [3]
- (d) On the pro forma provided (**answer number 12(b), (c) and (d)**) complete the circuit enabling the double acting cylinder to instroke after a delay in time following an outstroke. [4]
- (e) The double acting cylinder is supplied with an air pressure of  $0.5 \text{ N/mm}^2$  and produces a force during the outstroke of 235.12 N and 210 N during the instroke. Calculate the piston rod diameter. Please assume  $\pi = 3.14$ . [4]

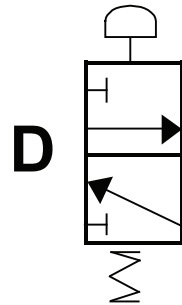
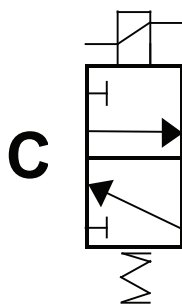
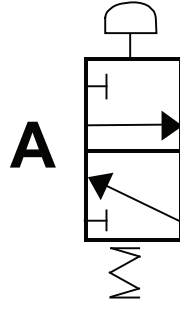
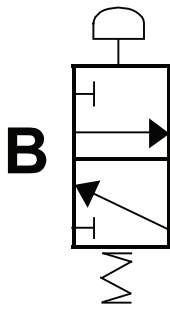
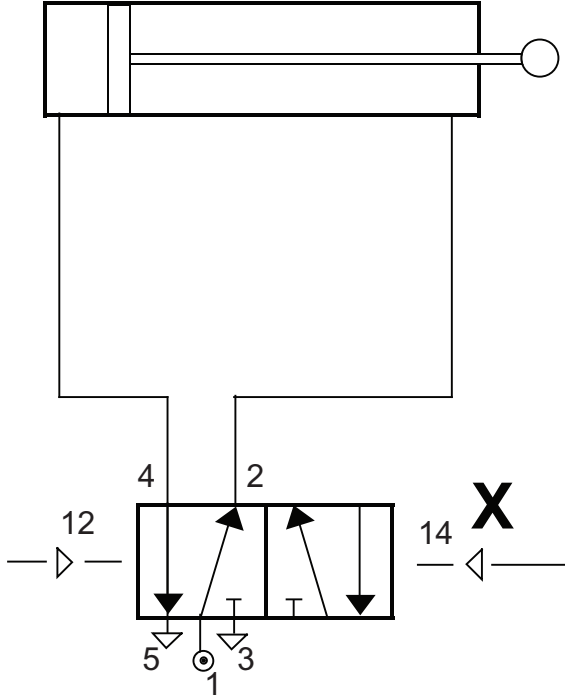
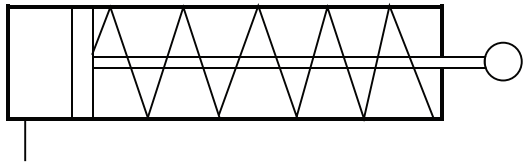
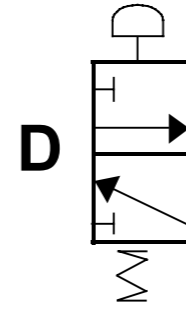
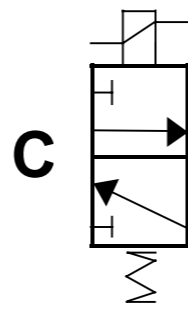
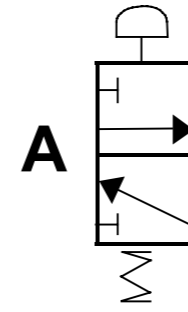
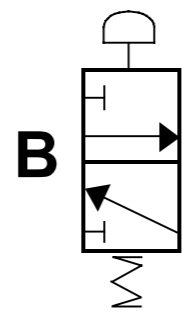
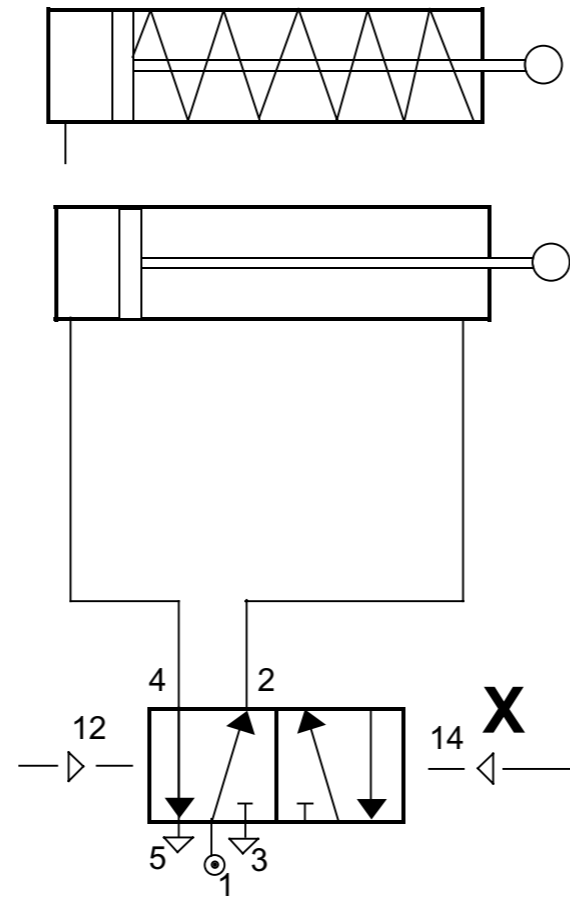


Fig. 12





Pro forma answer page  
 (answer numbers 12(b), (c) and (d))