N5 Pneumatics

Safety

- Wear safety goggles
- Don't blow air at anyone, not even yourself
- Don't let compressed air come in contact with your skin
- Check all connections are secure before turning on the air
- Don't leave pipes trailing along the floor

Advantages of Pneumatic System

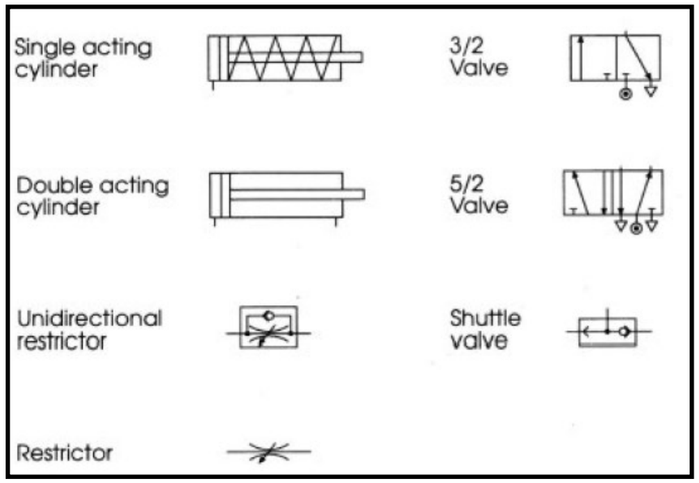
Clean - Pneumatic systems are clean because they use compressed air. If a pneumatic system develops a leak, it will be air that escapes and not oil.

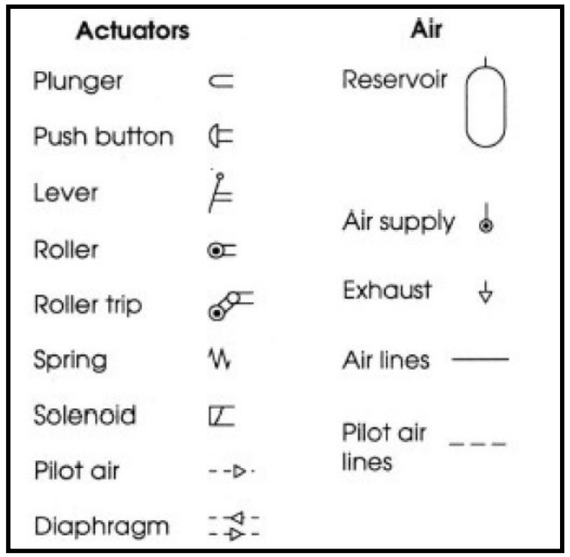
Safe - Pneumatic systems are very safe compared to other systems. We cannot, for example, use electronics for paint spraying because many electronic components produce sparks.

Reliable - Pneumatic systems are very reliable and can keep working for a long time.

Economical - If we compare pneumatic systems to other systems, we find that they are cheaper to run. This is because the components last for a long time.

Flexible - Once you have bought the basic components, you can set them up to carry out different tasks.

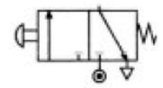




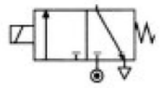
Valves should be named to give a clear indication of the type of valve and the method of operation.

For example

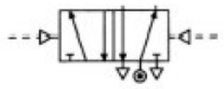
3/2 valve Push button Spring return



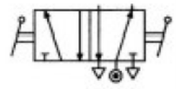
3/2 valve Solenoid Spring return



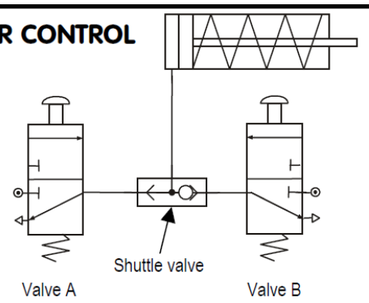
5/2 valve Pilot Pilot



5/2 valve Lever Lever

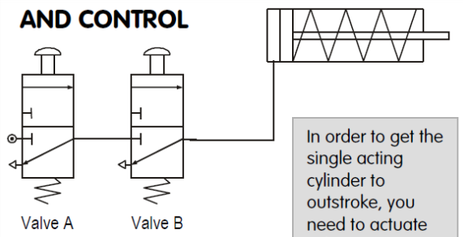


OR CONTROL

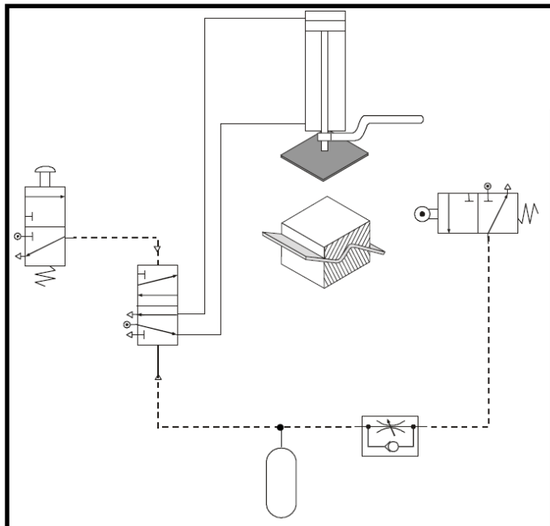


The cylinder will outstroke if valve A OR valve B is actuated.

AND CONTROL



In order to get the single acting cylinder to outstroke, you need to actuate valve A AND valve B.



Could you describe how this circuit works?

ANSWER

When the push button is pressed, the 5/2 valve changes state and the cylinder outstrokes. As it outstrokes, it pushes the former together and the hot plastic sheet is pressed into shape. As this happens it also actuates the roller. Air now flows through the restrictor and starts to fill up the reservoir. Once the reservoir is full, the 5/2 valve changes state and the cylinder instrokes, ready for the process to begin again.

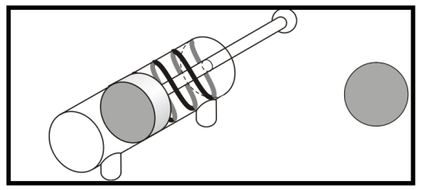
Force, Pressure, Area Calculations

$$Area = \pi r^2 = \pi \frac{d^2}{4}$$

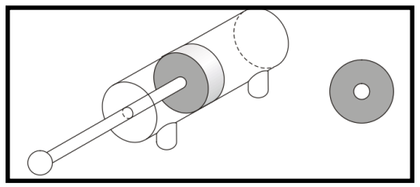
$$Force = Pressure \times Area$$

where force is measured in newtons (N), pressure is measured in Nmm^{-2} and area is measured in mm^2

Outstroke area of a piston



Instroke area of a piston



Effective area = piston area – piston rod area

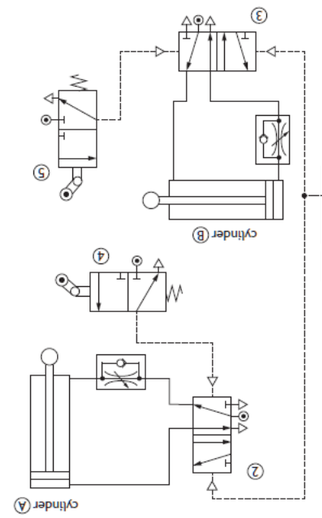
Describing circuits

(a)		*When a signal is received from the microcontroller ...* valve 1 actuates and pilot air switches valve 2 and piston A outstrokes. ..piston A actuates valve 4 which sends pilot air to reset valve 2 causing piston A to instroke. valve 1 actuates and pilot air switches valve 3 and piston B outstrokes. ..piston B actuates valve 5 which sends pilot air to reset valve 3 causing pistion B to instroke. Piston A outstrokes slowly and piston B instrokes slowly.	5	Descriptive response. 1 mark for valve 1/2 causing piston A to outstroke. 1 mark for valve 4 and 2 to cause piston A to instroke. 1 mark for valve 1/3 causing piston B to outstroke. 1 mark for valve 5 and 3 causing piston B to instroke. 1 mark for piston A outstroking slowly and piston B instroking slowly. If response describes valve 1 (or both 5/2 valves) causing both pistons to outstroke then 2 marks can be awarded. Instroking conditions must clearly link both named valves to the correct cylinder.

9. (continued)

(a) Describe the operation of the circuit shown opposite. 5

When a signal is received from the microcontroller . . .



The pneumatic circuit used to arrange the bottles is shown below.

9. A pneumatic circuit is used to arrange bottles ready for packaging in a production line.

Pressure, Force & Area Calculations

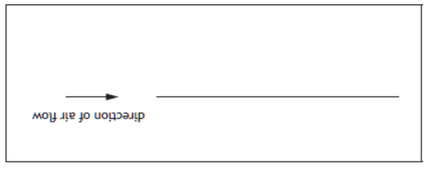
(a)			5	Pipe connections must be port to port. 1 mark for ANDing valve (1) to valve (2) and piping pilot actuator on top of the 5/2 valve. 1 mark for piping up valve (3) to pilot actuator on the bottom of 5/2 valve. 1 mark for a pilot air line type for given piping into the 5/2. 1 mark for top pipe to DAC from 5/2 valve. 1 mark for bottom pipe to DAC from 5/2 valve. Allow FTE if incorrect 5/2 state outputs port are used. 1 mark max for DAC piping.
(b)			2	1 mark for correct symbol of a uni-directional restrictor. 1 mark for correct orientation of by-pass route. Symbol need not be drawn on the given pipe.

15. A pneumatic circuit is used in part of a manufacturing process. MARKS

(a) Complete the piping of the pneumatic circuit below to outstroke the piston in cylinder (A) when valve (1) and valve (2) are actuated. The piston will instroke when valve (3) is actuated. 5

The speed of the piston movement needs to be slowed down.

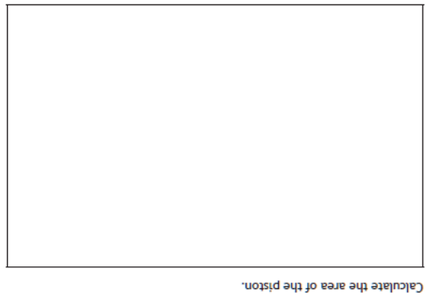
(b) Draw the symbol for a uni-directional restrictor to slow the air flow in the direction shown. 2



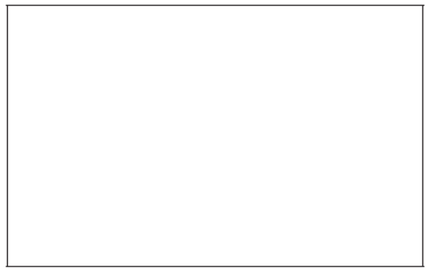
9. (continued)

Air at a pressure of 0.32 N mm^{-2} is supplied to cylinder (B). This results in an outstroking force of 620 N.

(b) (i) Calculate the area of the piston. 3



(ii) Calculate the diameter of the piston. 3

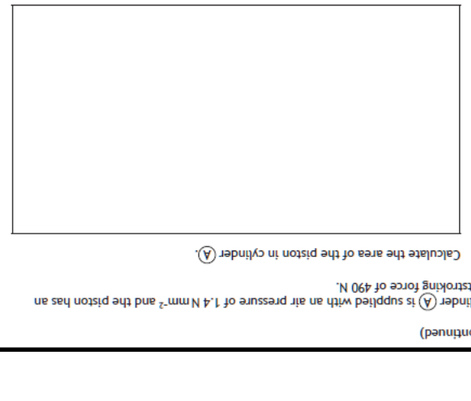


(b)	(i)	$P = \frac{F}{A}$ $0.32 = \frac{620}{A}$ $A = \frac{620}{0.32}$ A = 1937.5 A = 1900 mm^2 (2 sf)	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
(b)	(ii)	$A = \frac{\pi d^2}{4}$ $1900 = \frac{\pi d^2}{4}$ $d = \sqrt{\frac{1900 \times 4}{\pi}}$ d = 49.1849 d = 49 mm (2 sf)	3	1 mark for substitution. Allow FTE from (b)(i). 1 mark for transposition. 1 mark for correct answer from given working with unit. If radius is given as the final answer then max 2 marks.

15. (continued)

Cylinder (A) is supplied with an air pressure of 1.4 N mm^{-2} and the piston has an outstroking force of 490 N.

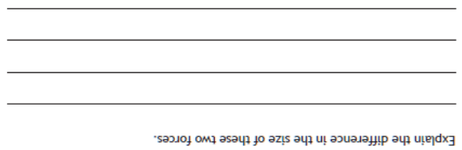
(c) Calculate the area of the piston in cylinder (A). 3



An engineer compared the size of the outstroke force and the instroke force of a double-acting cylinder when supplied with the same air pressure.

The result of the test showed that there was a difference in the size of the two forces.

(d) Explain the difference in the size of these two forces. 2



(c)		Pressure = $\frac{\text{Force}}{\text{Area}}$ $1.4 = \frac{490}{\text{Area}}$ $A = \frac{490}{1.4}$ A = 350 mm^2 (2 sf)	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.
(d)		The area on the instroke is smaller (due to the piston rod), ...resulting in the instroking force being smaller The area on the outstroke is larger (due to no piston rod), ...resulting in the outstroking force being larger The two areas are different ... therefore the outstroke force is larger	2	1 mark for cause (difference in area - stated or inferred). 1 mark for effect (specific effect on difference in force in/outstroke). Do not accept size in place of area. Do not accept forces will be different. Allow FTE.