1. A control valve is to be used to control water flow at a maximum rate of 120 US gallons per minute. If the maximum pressure drop across the valve is 100 psi, determine the valve size required for this particular application. The table below relates C_V and valve size.

C_V	*Valve size (inches)*
0.3	$\frac{1}{4}$
3	$\frac{1}{2}$
14	*1*
35	$1\frac{1}{2}$
55	*2*
108	*3*
174	*4*
400	*6*
725	*8*

TABLE 1

2. FIGURE 1 shows the valve characteristics of three different types of valve trim.

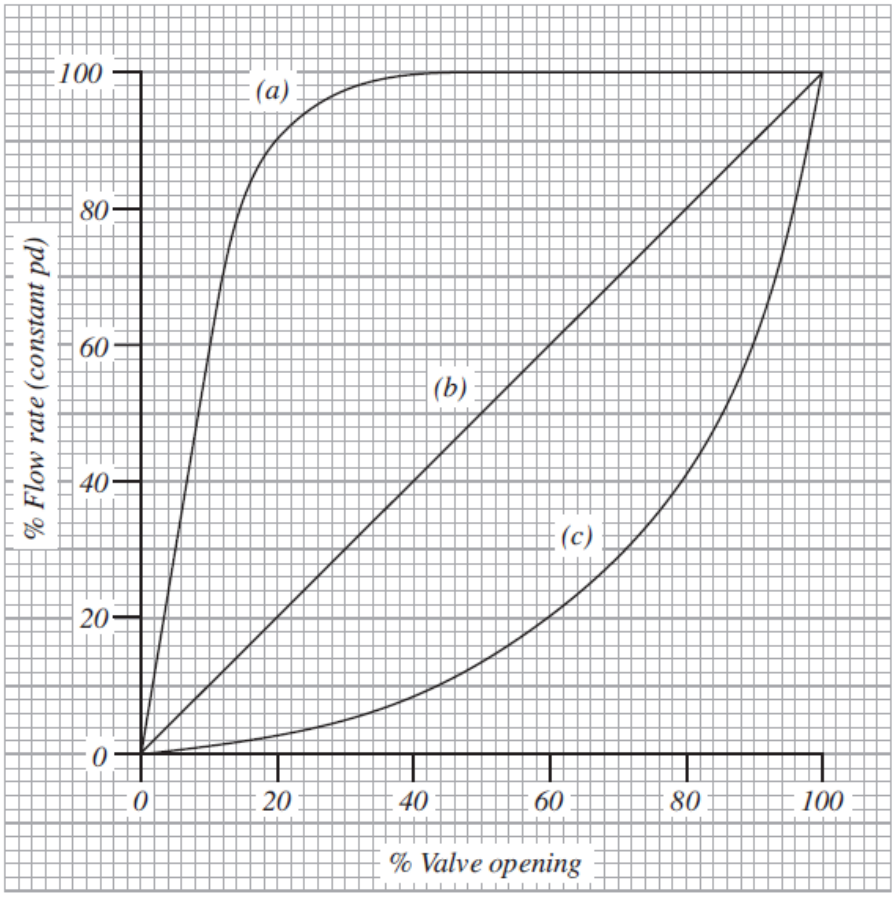

FIG. 1

(i) Identify each of the three characteristics.

(ii) State, with reasons, a typical type of application for each of the three types of valve trim.

6. The purpose of the arrangement shown in FIGURE 4 is to mix the two liquid products A and B in a fixed mass ratio. Product A, which is itself a mixture, is a 'wild' flow, whilst product B, a pure compound, is controlled. As the mixture leaves the tank the transmitter ρTX measures its density.

(a) Complete the diagram to show how the arrangement could be controlled by the method of 'variable ratio control'.

(b) Identify which transmitter provides 'feedforward'.

(c) Describe how the control system responds to a disturbance caused by a variation in the density of product A.

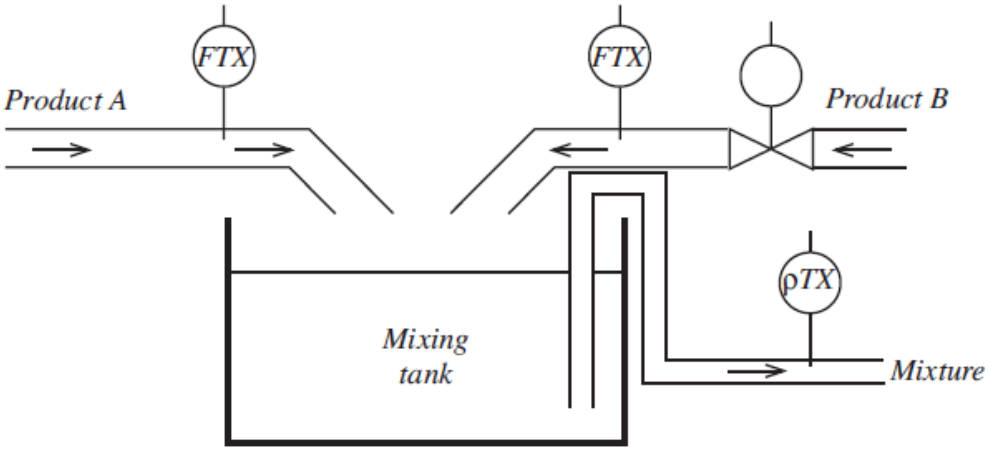

FIG. 4

7. FIGURE 5 shows a partially completed diagram of a flow control system. The flow controller is **reverse acting** and has a 0.2 to 1.0 bar pneumatic output signal which will supply both control valves V_1 and V_2.

The small range control valve, V_2, only needs to operate on the first 25% output change of the controller output signal. For larger flow rates the small range valve will remain fully open and control will be achieved by operation of the large range valve. Note the differing air failure action of the two valves.

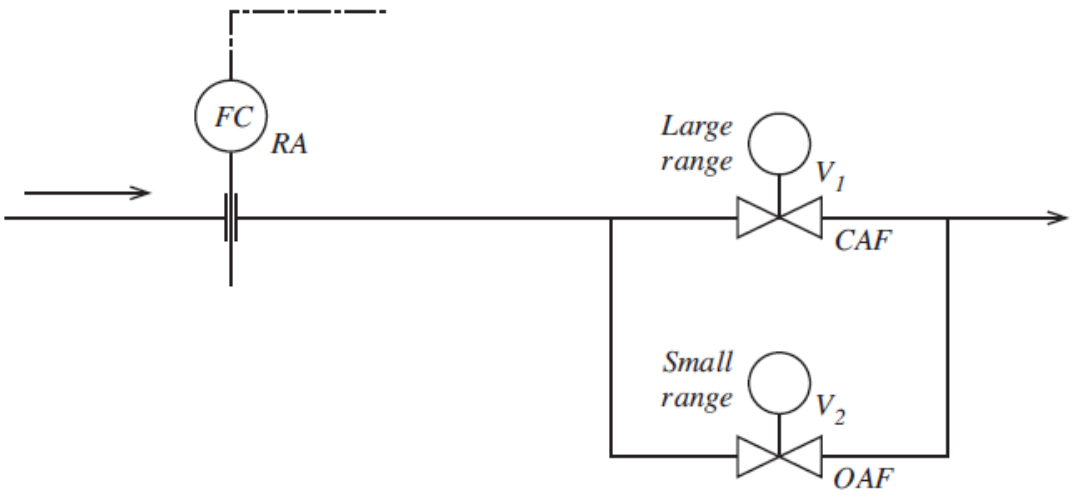

FIG. 5

Design a system utilising valve positioners which will meet the prestated specifications.