1. Air flows through a nozzle of diameter 1.3 mm having a discharge coefficient of 0.95, from a pressure of 5 atm to a pressure of 1 atm at 25 °C. Density of air will be:
   A) 5.930 g/cm³
   B) 59.30 kg/cm³
   C) 0.593 kg/m³
   D) None

   Ans (A)

   \[
   \rho = \frac{pM}{RT} = \frac{5 \times 101325 \times 29}{8314 \times 298} = 5.93 \text{ kg/m}^3
   \]

2. For Q. 1 Maximum velocity will be:
   A) 3.15 m/s
   B) 2.95 m/s
   C) 0.315 km/s
   D) 3150 m/s

   Answer (C)

   Now, upstream pressure is 5 times greater than that of downstream pressure. Hence pressure ratio is at critical condition

   \[
   v_0 = \sqrt{\frac{2\gamma p}{(\gamma - 1)\rho} \left[1 - \left(\frac{p_0}{p}\right)^{\frac{\gamma - 1}{\gamma}}\right]}
   \]

   \[
   = \sqrt{\frac{2 \times 1.4 \times 5 \times 101325}{(1.4 - 1) \times 5.93} \left[1 - \left(0.528^{\frac{1.4 - 1}{1.4}}\right)\right]}
   \]

   \[
   = 315.83 \text{ m/s} = 0.315 \text{ kms}^{-1}
   \]

3. For Q. 1 Mass flow rate will be:
   A) 669\times10^{-6} \text{ kg/s}
   B) 24.09 \text{ Kg/h}
   C) Both A&B
   D) None of these

   Ans. (A)
4. Methane is being pumped through a 50.0 cm ID pipeline for a distance of $1.0 \times 10^5$ m at a rate of 2.0 Kg Mole/s. Mass density of methane is
   a) 40.746 kg/m$^2$.s
   b) 162.984 kg/m$^2$.s
   c) 1273.31 kg/m$^2$.s
   d) 5093.25 kg/m$^2$.s
   Ans. (b)

   \[ G = 2.0 \times \frac{\text{Kg Mole}}{s} \times 16 \times \frac{\text{Kg}}{\text{Kg Mole}} \times \frac{1}{\pi \frac{D^2}{4} \text{m}^2} = \frac{2 \times 16 \times 4}{3.1416 \times 5^2} = 162.984 \text{ kg/m}^2 \text{.s} \]

5. For adiabatic flow, $PV^\gamma = C$ where $\gamma$ is
   a) $\gamma$ is the ratio of heat capacities at constant pressure and at constant volume respectively.
   b) $\gamma$ is the ratio of heat capacities at constant volume and at constant pressure respectively.
   c) $\gamma$ is always 1
   d) None
   Ans. (a)

   $\gamma = \frac{C_P}{C_V}$

6. Discharge through nozzle is maximum when,
   a) $P/P_o = 0.528$
   b) $P_o/P = 0.528$
   c) $P/P_o < 0.528$
   d) All of the above
   Ans. (b)

7. A nozzle of 1 mm dia with a coefficient of discharge of 0.92 is to deliver air from 4 atm pressure to 3 atm pressure at 35 $^\circ$C. Density of air:
   a) 4.59 kg/m$^3$
   b) 3.44 kg/m$^3$
c) 4.59 g/m³

d) 3.44 g/m³

Ans. (a)

\[ \rho = \frac{pM}{RT} = \frac{4 \times 101325 \times 28.97}{8314 \times 308} = 4.59 \text{ kg/m}^3 \]

8. In Q. 8 Velocity of air
   a) 260.15 m/s
   b) 220.85 m/s
   c) 220.85 cm/s
   d) None

Ans. (b)

\[ \text{We know that, } v_0 = \sqrt{\frac{2\gamma p}{(\gamma - 1)\rho} \left[1 - \left(\frac{p_0}{p}\right)^{\frac{\gamma - 1}{\gamma}}\right]} \]

\[ v_0 = \sqrt{\frac{2 \times 1.4 \times 4 \times 101325}{(1.4 - 1) \times 4.59} \left[1 - \left(\frac{3}{4}\right)^{\frac{1.4 - 1}{1.4}}\right]} \]

=220.85 m/s

9. In Q. 8 Mass flow rate
   a) 2.48 kg/h
   b) 2.15 kg/h
   c) 2.48 kg/s
   d) 2.15 kg/s

Ans. (b)

\[ A_0 = \frac{\pi D^2}{4} = \frac{\pi \times 0.01^2}{4} = 7.85 \times 10^{-7} \text{ m}^2 \]

Now, we know that
\[ W = C_D A_0 \sqrt{\frac{2 \gamma p \rho}{(\gamma - 1)}} \left( \frac{P_0}{P} \right)^{\frac{2}{\gamma}} - \left( \frac{P_0}{p} \right)^{\frac{\gamma+1}{\gamma}} \]

\[ W = 0.92 \times 7.85 \times 10^{-7} \sqrt{\frac{2 \times 1.4 \times 4 \times 101325 \times 4.59}{(1.4 - 1)} \left[ \left( \frac{3}{4} \right)^{2/1.4} - \left( \frac{3}{4} \right)^{1.4+1/1.4} \right]} \]

= 0.000597 Kg/s = 2.15 Kg/h

10. In Q. 8 Maximum velocity of air
   a) 370.89 m/s
   b) 321.20 m/s
   c) 260.15 m/s
   d) 220.85 m/s

      Ans. (a)

      At critical pressure ratio, i.e., \( p_0/p = 0.528 \), the velocity will be maximum

\[ v_0 = \sqrt{\frac{2 \gamma p \rho}{(\gamma - 1) \rho}} \left[ 1 - \left( \frac{P_0}{P} \right)_{cr}^{\frac{\gamma-1}{\gamma}} \right] \]

11. In Q. 8 Maximum mass flow rate is
   a) 2.594 kg/h
   b) 3 kg/h
   c) 2.48 kg/h
   d) None

      Ans. (b)

      At critical pressure ratio, i.e., \( p_0/p = 0.528 \), the discharge will be maximum

12. The unit of rate of mass discharge from the nozzle “W” will be
   a) kg/hr
b) kg-hr  
c) kg-m/s  
d) None of the above  

Ans. (a)

13. The expression for the Bernoulli’s equation is  
   a) \( \frac{p}{\rho} + \frac{v^2}{2} + gz = \text{constant} \)  
   b) \( \frac{p}{\rho} + \frac{v^2}{2g} + gz = \text{constant} \)  
   c) \( \frac{p}{\rho g} + \frac{v^2}{2g} + gz = \text{constant} \)  
   d) None of the above  

Ans. (a)

14. For adiabatic flow  
   a) \( pV^\gamma = C \)  
   b) \( pV = C \)  
   c) \( pV^{\gamma-1} = C \)  
   d) None of the above  

Ans. (a)