LECTURE 33 – INTRODUCTION TO PNEUMATICS

SELF EVALUATION QUESTIONS AND ANSWERS

1. If an empty 0.076 $m^3$ water system tank on which pressure gauge initially reads 1.38 bar is half filled with water, such as that shown in Figure, what will be the pressure reading on a gauge attached to the tank.

![Diagram of water tank](image)

0.076 $m^3$ water tank

Half filled with liquid

2. If an accumulator using dead weight ballast against an initial volume of 0.025 $m^3$ of a gas is heated from 300 K to 366 K, what volume will the heated gas occupy?

![Diagram of gas accumulator](image)

0.025 $m^3$
3. The constant volume vessel shown in Figure on which pressure gauge reads 138 bar is heated from 300 K to 395 K, what will the gauge read?

4. Gas in a 0.025 m$^3$ cylinder at 138 bar is reduced in volume to 0.016 m$^3$. While heated from 297 K to 395 K, what is the final gauge pressure in the cylinder?

5. A fixed quantity of gas, at constant pressure, occupies a volume of 8.50 L and has a temperature of 29 ℃. (a) What volume will the gas occupy if the temperature is increased to 125 ℃? (b) At what temperature will the volume be 5.00 L?
Q1 Solution:

Since the temperature is constant, we can use Boyle’s Law

\[
p_1V_1 = p_2V_2
\]

\[
p_2 = p_1 \times \frac{V_1}{V_2}
\]

\[
p_2 = 2.38 \times \frac{0.076}{0.076/2} = 4.76 \text{ bar(absolute)}
\]

\[
p_2 = 3.76 \text{ bar(gauge)}
\]

Q2 Solution:

Since the pressure is constant, From Charles law, we have

\[
\frac{V_1}{T_1} = \frac{V_2}{T_2}
\]

\[
T_1 = \text{temperature in Kelvin} = 300 \text{ K, } T_2 = 366 \text{ K}
\]

\[
\frac{0.025}{300} = \frac{V_2}{366}
\]

Solving we get, \( V_2 = 0.0305 \text{ m}^3 = 30500 \text{ cm}^3 \)

Q3 Solution

Since the volume is constant, by applying Gay –Lussac’s law, we get,

\[
p_1 = 138 \text{ bar (gauge)} = 138 + 1 = 139 \text{ bar(absolute)}
\]

\[
T_1 = \text{temperature in Kelvin} = 300 \text{ K, } T_2 = 395 \text{ K}
\]

\[
\frac{p}{T} = \text{constant or } \frac{p_1}{T_1} = \frac{p_2}{T_2}
\]

\[
\frac{139}{300} = \frac{p_2}{395}
\]

Solving we get, \( p_2 \approx 183 \text{ bar(absolute)} = 182 \text{ bar(gauge)} \)
Q4 Solution

Using General gas law

\[ \frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} \]

\[ \frac{139 \times 0.025}{297} = \frac{p_2 \times 0.016}{395} \]

Solving we get, \( p_2 = 288.85 \text{ bar (absolute)} = 287.85 \text{ bar (gauge)} \)

Q5 Solution

Part a

Since the pressure is constant, From Charles law, we have

\[ \frac{V_1}{T_1} = \frac{V_2}{T_2} \]

\( T_1 = \text{temperature in Kelvin} = 29 + 273 = 302 \text{ K}, \ T_2 = 125 + 273 = 398 \text{ K} \)

\[ \frac{8.5}{302} = \frac{V_2}{398} \]

Solving we get, \( V_2 = 11.2 \text{ L} = 11200 \text{ cm}^3 \)

Part b

Again rearranging the gas law for constant pressure term, we get

\[ \frac{8.5}{302} = \frac{5}{T_2} \]

Solving we get, \( T_2 = 177.65 \text{ K} \)