Question 1

On a day when atmospheric pressure is 75.83 cmHg, a pressure gauge on a tank of gas reads a pressure of 258.5 cmHg. What is the absolute pressure (in atmospheres and kPa) of the gas in the tank?

A) 334.3 cm Hg = 4.399 atm = 445.7 kPa
B) 182.7 cmHg = 2.40 atm = 243.2 kPa
C) 334.3 cmHg = 4.398 atm = 445.6 kPa
D) 258.5 cmHg = 3.40 atm = 345 kPa

cm Hg

$P = 75.83 + 258.5 = 334.33$

$P = \frac{334.33}{76} \times 1.013 \times 10^2 \text{ kPa}$

$= 445.6 \text{ kPa}$

Question 2

A certain mass of an ideal gas occupies a volume of 4.00 m^3 at 758 mmHg. Compute its volume at 635 mmHg if the temperature remains unchanged.

A) 3.55 m^3
B) 0.298 m^3
C) 1.19 m^3
D) 4.77 m^3

$P_1 V_1 = P_2 V_2 \rightarrow V_2 = \frac{P_1 V_1}{P_2} = \frac{(758)(4 m^3)}{635}$

$V_2 = 4.77 m^3$

Question 3

A given mass of ideal gas occupies 38 mL at 20° C. If its pressure is held constant, what volume does it occupy at a temperature of 45° C?

A) 86 mL
B) 35 mL
C) 17 mL
D) 41 mL

$\frac{V_1}{V_2} = \frac{T_1}{T_2} \rightarrow V_2 = V_1 \frac{T_2}{T_1} = (38) \frac{45+273}{20+273}$

$V_2 = 41 \text{ mL}$

Question 4

A tank of ideal gas is sealed off at 20° C and 1.00 atm pressure. What will be the pressure (in kPa and mmHg) in the tank if the gas temperature is decreased to -35° C?

A) 125 kPa = 9.35 x 10^2 mmHg
B) 82 kPa = 1.08 mmHg
C) 1.75 kPa = 13 mmHg
D) 82 kPa = 6.2 x 10^2 mmHg

$\frac{P_1}{P_2} = \frac{T_1}{T_2} \rightarrow P_2 = P_1 \frac{T_2}{T_1}$ atm

$P_2 = (1.00) \frac{273 - 35}{20 + 273} = 0.812 = 82 \text{ kPa}$

$\simeq 620$ mm Hg

Question 5

Given 1000mL of helium at 15° C and 763 mmHg, determine its volume at -6° C and 420 mmHg.

A) 1.68 x 10^3 mL
B) 7.27 x 10^2 mL
C) 1.97 x 10^3 mL
D) 5.08 x 10^2 mL

$\frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2} \rightarrow V_2 = \frac{P_1 V_1}{P_2} \frac{T_2}{T_1}$

Question 6

A 5000-cm3 tank contains an ideal gas (M=40 kg/kmol) at a gauge pressure of 530 kPa and a temperature of 25° C. Assuming atmospheric pressure to be 100 kPa, what mass of gas is in the tank?

A) 0.051 kg

$PV = nRT$

$((530 + 100) \times 10^3 \text{ Pa})(5000 \times 10^{-6} m^3) = n(8.31)(273+25)$

$\Rightarrow n = 1.27 \text{ mole} \Rightarrow m = (1.27)(0.04)$

$= 0.051 \text{ kg}$

B) 0.61 kg
C) 51 kg
D) 5.1 x 104 kg

bubble near the surface: $P_2 = P_{atm} \simeq 100$ kPa

Question 7
An air bubble of volume V0 is released near the bottom of a lake at a depth of 11.0 m. What will be its new volume at the surface? Assume its temperature to be 4.0° C at the release point and 12° C at the surface. The water has a density of 1000 kg/m3, and atmospheric pressure is 75 cmHg.
A) 1.1 Vo
(B) 2.1 Vo
C) 2.0 Vo
D) 6.2 Vo

$P_1 = \left(\frac{75}{76} \times 1.013 \times 10^5 \text{ Pa}\right) + (1000 \times 9.8 \times 11)$

$P_1 = 207.8$ kPa

$P_1 V_1 = P_2 V_2 \rightarrow V_2 = \frac{(207.8)(V_0)}{100 \text{ kPa}} \simeq \boxed{2.1 V_0}$

Question 8
Find the mass of a neon atom. The atomic mass of neon is 20.2 kg/kmol.
A) 3.36 kg
B) 3.36 x 10^{-23} kg
(C) 3.36 x 10^{-26} kg
D) 2.98 x 10^{-27} kg

$m = \frac{0.0202 \text{ kg/mol}}{6.02 \times 10^{23} \text{ atoms/mol}} = \boxed{3.36 \times 10^{-26} \text{ kg}}$

Question 9
At what temperature will the molecules of an ideal gas have twice the rms speed they have at 20° C?
A) 586 K = 313° C (approximately)
(B) 1172 K = 899° C (approximately)
C) 414 K = 141° C (approximately)
D) 73 K = -200° C (approximately)

$V_2 = 2V_1 \Rightarrow$

$\sqrt{\frac{3kT_2}{m}} = 2\sqrt{\frac{3kT_1}{m}} \Rightarrow T_2 = 4T_1$

$T_2 = 4(20+273) = \boxed{1172 \text{ K}}$

Question 10
An object must have a speed of at least 11.2 km/s to escape from the Earth's gravitational field. At what temperature will urms for H2 molecules equal the escape speed? Repeat for N2 molecules. (MH2=2.0 kg/kmol and MN2=28 kg/kmol.)
(A) 1.0 x 10^4 K; 1.4 x 10^5 K
B) 5.0 x 10^3 K; 7.0 x 10^4 K
C) 1.0 x 10^7 K; 1.4 x 10^8 K
D) 3.0 x 10^4 K; 4.2 x 10^6 K

$V = 11.2 \times 10^3 \text{ m/s} = \sqrt{\frac{3kT}{2 \times 1.66 \times 10^{-27} \text{ kg}}}$

Solving for T $\Rightarrow$

$\boxed{T = 1.0 \times 10^4 \text{ K}}$

for N_2, $m \rightarrow 28 \times 1.66 \times 10^{-27}$ kg $\Rightarrow$

$T = 1.4 \times 10^5$ K