

Honors Chemistry – Gas Laws Worksheet Key

1. Determine the pressure in torr and kPa on a day when the pressure is .96atm.

$$\text{torr} = (.96\text{atm})(760\text{torr/atm}) = 729.6 = \mathbf{730\text{torr}}$$

$$\text{kPa} = (.96\text{atm})(101.3\text{kPa/atm}) = \mathbf{97\text{kPa}}$$

2. A reaction occurs in which a gas is produced causing the mercury column in an open-end manometer to be 125mm higher on the side of the sample gas. If the prevailing atmospheric pressure is .97atm, what is the pressure of the gas in Pascal's?

$$P_{\text{gas}} = (.97\text{atm})(760\text{mmHg/atm}) - 125\text{mmHg} = 612.2\text{torr}$$

$$612.2\text{torr}(101,300\text{Pa}/760\text{torr}) = \mathbf{8.2 \times 10^4 \text{Pa}}$$

3. Determine the pressure of a sample gas in an open-end manometer in which the mercury column is 25.0mm higher on the sample gas side and the prevailing atmospheric pressure is .97 atm. Give your final answer in Pascal's.

$$P_{\text{gas}} = (.97)(760) - 25 = 712.2\text{torr}$$

$$712.2\text{torr}(101,300\text{Pa}/760\text{torr}) = \mathbf{9.5 \times 10^4 \text{Pa}}$$

4. A gas, initially at .60atm has its volume decreased to 1/3 its original amount. Determine the final pressure in torr.

$$P_1V_1 = P_2V_2 \quad P_2 = (.60)(V_1)/(1/3 V_1) = 1.8\text{atm}$$

$$1.8\text{atm}(760\text{torr/atm}) = 1368\text{torr} = \mathbf{1.4 \times 10^3 \text{torr}}$$

5. A 1.50L container of gas, initially at 25.0°C has its temperature increased to 50.0°C. What is the final volume of the gas if P and n are held constant?

$$V_1/T_1 = V_2/T_2 \quad V_2 = (1.50)(273.15+50)/(273.15+25) = \mathbf{1.63\text{L}}$$

6. Determine the pressure of a gas in pascals if 2.00moles of that gas are sealed in a 500.mL container at 30.°C.

$$P = nRT/V = (2.00)(.0821)(303.15)/(.500) = 99.55\text{atm}$$

$$99.55\text{atm} (101,300\text{Pa}/1\text{atm}) = \mathbf{1.01 \times 10^7 \text{Pa}}$$

7. Determine how many moles of gas are contained in a sealed 650.mL container at 700. torr and 25°C.

$$n = PV/RT = (700./760)(.650\text{L})/ (.0821)(25 + 273.15) = \mathbf{.0245\text{mol}}$$

8. Determine the volume of 1 mole of a gas at STP.

$$V = nRT/P = (1)(.0821)(273.15) / (1) = \mathbf{22.4\text{L (standard molar volume)}}$$

9. How many moles of a gas are evolved in a reaction that produces 2.50L of that gas at STP?

$$n = PV/RT = (1)(2.50)/(.0821)(273.15) = .111\text{mol}$$

$$n = 2.50\text{L} / (22.4\text{L/mol}) = .111\text{mol}$$

10. Determine the identity of a monoatomic gas if 4.940g of that gas at 100.°C and 1.5atm occupies a volume of 5.00L.

$$M = mRT/PV = (4.940)(.0821)(373.15)/(1.5)(5.00) = 20.18\text{g/mol}$$

Ne

11. What is the density of diatomic oxygen gas at 95.0kPa and 30.0°C?

$$d = m/V = MP/RT = (32.0\text{g/mol})(95.0/101.3) / (.0821)(303.15\text{K}) = 1.21\text{g/L}$$

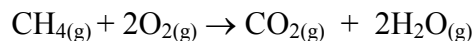
12. Determine the total pressure (in torr) of a 5.00L sealed container that has 10.0g each of He, Ne and O₂ at 10.0°C.

$$P = nRT/V = (10.0/4.003 + 10.0/20.18 + 10.0/32.0)(.0821)(283.15)/(5.00)$$

$$= 15.37\text{ atm}$$

$$15.37\text{atm} (760\text{torr}/1\text{atm}) = 11,682\text{ torr} (1.17 \times 10^4\text{ torr})$$

13. Determine the partial pressure due to carbon dioxide in the combustion of 6.25g of methane (CH₄) with sufficient oxygen in a 3.00L container at 110.°C.



$$\text{moles of methane} = 6.25\text{g} / 16.042\text{g/mol} = .3896\text{mol}$$

$$\text{moles of CO}_2 = .3896\text{mol CH}_4 (1\text{mol CO}_2 / 1\text{mol CH}_4) = .3896\text{mol CO}_2$$

$$P = nRT/V = (.3896\text{mol})(.0821)(383.15)/(3.00) = 4.09\text{ atm}$$

14. What is the mole fraction of the CO₂ in the container after the reaction?

From the Stoichiometry of the balanced equation, since CO₂ and H₂O are both gases, the moles of CO₂ will have a mole fraction of 1 out of 3 parts, or .333.

15. A gaseous compound is known to be 30.45% nitrogen and 69.55% oxygen by mass. A 1.11g sample of the gas at 30.0°C in a 2.00L container has a pressure of 114 torr. Determine the molecular formula of the compound.

$$M = mRT/PV = (1.11\text{g})(.0821\text{Latm/molK})(303.15\text{K}) / (.15\text{atm})(2.00\text{L})$$

$$M = 92.09\text{g/mol (molar mass)}$$

$$\text{mass of nitrogen} = .3045(92.09) = 28.04\text{g}$$

$$\text{moles of nitrogen} = 28.04\text{g} / 14.01\text{g/mol} = 2\text{ mol N}$$

$$\text{mass of oxygen} = .6955(92.09) = 64.05\text{g}$$

$$\text{moles of oxygen} = 64.05\text{g} / 16.00\text{g/mol} = 4\text{ mol O}$$

molecular formula is: N₂O₄

16. A sealed container has 2.0g of Argon, 3.0g of helium and 2.0g of nitrogen gas.

a) What is the mole fraction of the nitrogen?

b) What is the pressure of the nitrogen at STP?

c) What is the volume of the container under STP conditions?

- a) Moles of N_2 : $2.0\text{g}/(28.02\text{g/mol}) = .0714\text{mol } N_2$
Total moles = $(2.0\text{g}/39.95\text{g/mol}) + (3.0\text{g}/4.003\text{g/mol}) + (2.0\text{g}/28.02\text{g/mol})$
= .8709mol
Mole fraction of nitrogen = $.0714/.8709 = .0820$
- b) At STP the total pressure is 1 atmosphere
The pressure of N_2 is $(1\text{atm})(.0820) = .0820\text{atm}$
- c) At STP, 1 mole is 22.4Liters (standard molar volume). Therefore
 $V = .8709\text{mol} (22.4\text{L/mol}) = 19.51\text{L}$

17. A cube of metal (2.425cm per side) that is sitting on an equal arm balance (see-saw) is exactly balanced by a spherical balloon of xenon gas sitting on the other side. If the radius of the balloon is 1.00dm and the prevailing conditions are 30.0°C and 760.torr of pressure for the gas, determine the identity of the metal from the following choices (assume the mass of the skin of the balloon is negligible).

(Density (g/cm^3): Al, 2.698; Zn, 7.133; Fe, 7.874; Ag, 10.49; Mg, 1.738; Ca, 1.550)

$$V = 4/3 \pi r^3 = 4/3 \pi (1.00\text{dm})^3 = 4.18879\text{L}$$

$$m = MPV/RT = (131.3\text{g/mol})(1.00\text{atm})(4.18879\text{L}) / (.0821\text{Latm/molK})(303.15\text{K}) = 22.098\text{g}$$

$$d_{\text{metal}} = 22.098\text{g} / (2.425\text{cm})^3 = 1.55\text{g}/\text{cm}^3 = \text{Calcium}$$

18. A person wishes to use a helium balloon to give people rides into the air. The combined mass of the balloon material and basket is 475kg and the volume of helium is $3.35 \times 10^5\text{L}$. If the average density of air is 1.920g/L, what is the maximum mass of people (in kg) that the balloon will be able to lift off the ground? (Assume standard pressure and 22.0°C)

$$F_{\text{net}} \propto \text{mass}_{\text{air}} - \text{mass}_{\text{balloon} + \text{He}}$$

$$\text{Mass}_{\text{air}} = (1.920\text{g/L})(3.35 \times 10^5\text{L}) = 643,200\text{g} = 643.2\text{kg}$$

$$\text{Mass}_{\text{balloon}} = 475\text{kg}$$

$$m = MPV/RT$$

$$\text{Mass}_{\text{He}} = [(4.003\text{g/mol})(1.00\text{atm})(3.35 \times 10^5\text{L}) / (.0821\text{Latm/molK})(295.15\text{K})] (1\text{kg} / 1,000\text{g}) = 55.34\text{kg}$$

$$643.2\text{kg} - 475\text{kg} - 55.34\text{kg} = 112.859\text{kg}$$

Mass must be less than 113kg