SAMPLE CALCULATIONS for STP and RTP ANSWER KEY

Watch your sig figs!

1. How many moles of ozone occupy a volume of 3.36 L at STP?

$3.36\ L \times \frac{1\ mol}{22.4\ L} = 0.150\ mol$ Did you know that Ozone is O_3?

0.150 mol (mol is the short form for mole or moles) ☺

2. What is the mass of 575 L of ammonia gas at RTP?

$575\ L \times \frac{1\ mol}{24.5\ L} \times \frac{17.031\ g\ NH_3}{1\ mol} = 399.707\ g$

= 400. g or 4.00×10^2 g (3 sig figs)

3. What is the volume occupied by 0.125 g of H2S gas at STP?

$0.125\ g \times \frac{1\ mol}{34.082\ g\ H2S} \times \frac{22.4L}{1\ mol} = 0.0822\ L$

4. What mass of carbon dioxide occupies a volume of 1.05 L at RTP?

$1.05\ L \times \frac{1\ mol}{24.5\ L} \times \frac{44.009\ g\ CO2}{1\ mol} = 1.89\ g$

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5. How many oxygen atoms are present in 0.12 L of nitrogen dioxide gas at STP?

.12L L NO_2 X $\frac{1 \text{ mol}}{22.4 \text{ L}}$ X $\frac{6.02X10^{23} \text{ molecules } NO_2}{1 \text{ mol}}$ X $\frac{2 \text{ "O" atoms}}{1 \ NO_2 \text{ molecule}}$

= $6.4 X10^{21}$ O atoms

The question asks for # of atoms, yet gives the original volume of the MOLECULES.

This is why we need that final multiplication factor in our calculation

6. What is the density of chlorine gas at RTP?

We know that Cl_2 is 70.906 g / mol and we know that RTP is 24.5 L/ mole

Arrange these two pieces of information so that the units will cancel:

$\frac{70.906 \text{ g}}{1 \text{ mol}}$ X $\frac{1 \text{ mol}}{24.5 \text{ L}}$ = 2.89 g/L

Density is measured as MASS over VOLUME. Units are g / L (sometime g / mL)

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7. What is the density of acetylene gas (C_2H_2) at 0°C and 760 mmHg?

We know that 0°C is the temperature condition for STP
Also, 760 mmHg is equivalent to 1 atm (1 atmosphere) which is also equivalent 101.3 kPa (the pressure condition for STP)
We can also calculate the molar mass of C_2H_2 to be 26.238 g/mol
Arrange these two pieces of information so that the units will cancel:

$$\frac{26.038\ g\ C_2H_2}{1\ mol} \times \frac{1\ mol}{22.4\ L} = 1.16\ g/L$$

8. Identify the gaseous element with a density of 1.63 g/L at RTP.

Arrange these two pieces of information so that the units will cancel:

$$\frac{1.63\ g}{1\ L} \times \frac{24.5\ L}{1\ mol} = 39.9\ g/mol$$ THIS IS ARGON GAS!

9. Calculate the number of carbon atoms in 35 L of C_3H_8 (propane) gas at RTP.

$$35\ L \times \frac{1\ mol}{24.5\ L} \times \frac{6.02 \times 10^{23}\ molecules\ C_3H_8}{1\ mol} \times \frac{3\ C\ atoms}{1\ C_3H_8\ molecule}$$

$= 2.6 \times 10^{24}$ C atoms

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10. What if question 9 asked for sodium bicarbonate instead of C3H8?
Would the question be done differently if it was an ionic "compound" versus a covalent molecule?
No, the question would not be done differently. You calculate the number of atoms in the same regardless of an ionic compound or covalent molecule.

$$\frac{\#\text{ atoms}}{\text{ionic cpd}} \quad \text{OR} \quad \frac{\#\text{ atoms}}{\text{covalent molecule}}$$

11. What volume will 5.25×10^{22} molecules of methane occupy at STP?

$$5.25 \times 10^{22}\text{ molecules} \times \frac{1\text{ mol}}{6.02\times10^{23}\text{ molecules}} \times \frac{22.4\text{ L}}{1\text{mol}} = 1.95\text{ L}$$

12. Gold has a density of 19.30 g/mL. If your brick of gold occupies a volume of 645 cm^3, how many atoms of gold are in your brick?
Keep in mind that $1cm^3 = 1mL$.

$$645\ cm^3 \times \frac{1\text{ mL}}{cm^3} \times \frac{19.30\text{ g}}{\text{mL}} \times \frac{1\text{ mol}}{196.967\text{ g Au}} \times \frac{6.02\times10^{23}\text{ Au atoms}}{1\text{ mol}}$$

$$= 3.80 \times 10^{25}\text{ Au atoms}$$

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13. The density of oxygen gas at STP is 1.43 g/L. If you have 7.8 g of the gas, how many molecules of oxygen gas are in your sample?

$$7.8\ g \times \frac{1\ L}{1.43\ g} \times \frac{1\ mol}{22.4\ L} \times \frac{6.02 \times 10^{23}\ O_2\ molecules}{1\ mol}$$

$= 1.5 \times 10^{23}$ molecules

14. A sealed container holds 5.0 L of a gas. The gas has a mass of 6.25g. What is the molar mass of this gas at STP?

$$5.0\ L \times \frac{1\ mol}{22.4\ L} = 0.22\ moles$$

Now I am stuck. I got to the MOLE but where do I go now?

Well, they told me I have 625 g, and I have figured out that 5.0 L is also equivalent to 0.22 moles

WAIT! Isn't grams divided by moles just the molar mass? Then I could just take the given mass and divide by the moles I calculated:

6.25g / 0.22 moles

IN other words

$\frac{6.25\ g}{0.22\ moles} = 28$ g/ mole ….which would be N_2 gas!