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Avogadro's Law prep for the Ideal Gas Law Intro

Avogadro determined through careful analysis that no matter what gas was used, 1 mole of it (6,02x10^23 molecules) always occupied 22.4 liters at the standard temperature and pressure (STP) of 0c and 1atm.

1. What would the volume of 3 moles at STP be?

3 moles × 22.4 li/mole = 67.2 li

2. What would the volume of 1.5 moles at STP be?

1.5 moles × 22.4 li/mole = 33.6 li

3. What would the volume of 2/3 mole at STP be?

2/3 = 0.67 moles × 22.4 li/mole = 15.01 li

4. What would the volume of 0.125 moles at STP be?

0.125 mole × 22.4 li/mole = 2.8 li

5. How many moles of gas are there in 80 liters?

80 li / 22.4 li/mole = 3.57 moles

6. How many moles of gas are there in 15 liters?

15 li / 22.4 li/mol = 0.67 moles

7. How many moles of gas are there in 4125 milliliters?

4125 ml = 4.125 li / 22.4 li/mole = 0.18 moles

8. How many moles of gas are there in 150 milliliters?

150 ml = 0.15 li / 22.4 li/mol = 0.0067 mol

9. What would the volume of 50 grams of gaseous water at STP be?

50 g H_2O / 18 g H_2O/mole = 2.78 mol × 22.4 li/mole = 62.2

10. What would the volume of 1.2 kilograms of methane gas (CH_4) at STP be?

12+4 = 16

1.2 kg = 1200 g / 16 g/mole = 75 mole × 22.4 li/mole = 1680 li

11. If a tank held 520 liters of ammonia gas (NH_4) at STP, what mass of NH_4 would this be?

14 + 4 = 18 g/mol

520 li / 22.4 li/mol = 23.2 mol × 18 g/mol = 417.9 g

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Avogadro's Law prep for the Ideal Gas Law Worksheet

1. What would the volume of 1.70 moles at STP be?

$1.7 \text{ mole} \times 22.4 \text{ li/mol} = 38.08 \text{ li}$

2. What would the volume of 0.275 moles at STP be?

$0.275 \text{ mole} \times 22.4 \text{ li/mol} = 6.16 \text{ li}$

3. If half a mole of water vapor and 1.35 moles of methane gas were put in a balloon at STP, what would the volume of the balloon be?

$0.5 \text{ mol} + 1.35 \text{ mol} = 1.85 \text{ mol} \times 22.4 \text{ li/mol} = 41.44 \text{ li}$

4. If 1.5 moles of carbon dioxide gas and 2.5 moles of nitrogen gas were put in a balloon at STP, what would the volume of the balloon be?

$1.5 + 2.5 = 4 \text{ moles} \times 22.4 \text{ li/mole} = 89.6 \text{ li}$

5. How many moles of gas are there in 2000 liters?

$2000 \text{ li} / 22.4 \text{ li/mole} = 89.29 \text{ mole}$

6. How many moles of gas are there in 425 liters?

$425 \text{ li} / 22.4 \text{ li/mol} = 18.9 \text{ mol}$

7. How many moles of gas are there in 6.34x10^4 liters?

$6.34 \times 10^4 = 63,450 \text{ li} / 22.4 \text{ li/mol} = 2830$

8. What would the volume of 180 grams of gaseous water at STP be?

$180 \text{ g} / 18 \text{ g/mol} = 10 \text{ mole} \times 22.4 \text{ li/mole} = 224 \text{ li}$

9. What would the volume of 445 grams of ethane gas (C_2H_8) at STP be?

$2+2+8 = 32 \text{ g/mol}$

$445 \text{ g} / 32 \text{ g/mol} = 13.9 \text{ mol} \times 22.4 \text{ li/mol} = 311.5 \text{ li}$

96 + 18 = 114
6x2 + 18

10. What would the volume of 1.3 kilograms of octane gas (C_8H_{18}) at STP be?

$1300\,g / 114\,g/mol = 11.4\,mol \times 22.4\,L/mol = 255\,L$

11. If a tank held 630 liters of gaseous oxygen at STP, what mass would this be (remember oxygen gas is O_2)?

$630\,L / 22.4\,L/mol = 28.13\,mol \times 32\,g/mol = 900\,gr$

60 + 10 = 70 g/mol

12. If a tank held 1.45x10^3 liters of pentane (C_5H_{10}) at STP, what mass of C_5H_{10} would this be?

$1450\,L / 22.4\,L/mol = 64.7\,mol \times 70\,g/mol = 4531$

13. Determine the volume of occupied by 2.74 grams of carbon dioxide gas at STP.

$2.74\,g / 44\,g/mol = 0.062\,mole \times 22.4\,L/mol = 1.39\,L$

14. A sample of argon gas at STP occupies 66.2 liters. Determine the number of moles of argon and the mass in the sample.

$66.2\,L / 22.4\,L/mol = 2.96\,moles \times 39.9\,g/mol$

$= 117.9\,g$

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Ideal Gas Law (PV=nRT) Problems and Molar Mass (g/mol)

1. At what temperature will 0.554 moles of neon gas occupy 13.30 liters at 1.95 atmospheres?

P = 1.95 atm
V = 13.3 L
n = 0.554 mol
R = 0.0821
T = ?

R = nRT

$T = \frac{PV}{nR} = \frac{1.95\,atm \times 13.3\,L}{0.554\,mol \times 0.0821\,\frac{atm \cdot L}{mol \cdot K}}$

= 570 K

2. A 60.6 g sample of gas occupies 42.4 L at STP. What is the molecular weight of this gas?

don't need bc STP

P =
V =
n = 60.6 g/x = n
R =
T =

$\frac{42.4\,L}{22.4\,L/mol} = 1.89\,mol$

$60.6\,g / 1.89\,mol = 32\,g/mol$ (O_2?)

3. A 20.0 g gas sample occupies 6.1 L at STP. Find the molecular weight of this gas.

STP

$\frac{6.1\,L}{22.4\,L/mol} = 0.27\,mol$ $\frac{20\,g}{0.27\,mol} = 74\,g/mol$

4. A 12.0 g sample of gas occupies 19.2 L at STP. What is the molecular weight of this gas?

STP

$\frac{19.2\,L}{22.4\,L/mol} = 0.857\,mol$ $\frac{12\,g}{0.857\,mol} = 14\,g/mol$

5. How many moles of a gas occupy 48.0 L at 700.0 mm Hg and 20.0 °C?

P = 700 mm Hg
V = 48 L
n = ?
R = 62.4 $\frac{mm\,Hg \cdot L}{mol \cdot K}$
T = 20°C = 293 K

PV = nRT

$n = \frac{PV}{RT} = \frac{700\,mm\,Hg \times 48\,L}{62.4\,\frac{mm\,Hg \cdot L}{mol \cdot K} \times 293\,K}$

n = 1.84 mol

6. How many moles of a gas occupy 28.0 L at 1.30 atm and 40.0 °C?

$P = 1.3$ atm
$V = 28.0$ L
$n =$
$R = 0.0821 \frac{\text{atm L}}{\text{mol K}}$
$T = 40^\circ\text{C} = 313$ K

$PV = nRT$

$n = \frac{PV}{RT} = \frac{1.3 \text{ atm} \cdot 28.0 \text{ L}}{0.0821 \frac{\text{atm L}}{\text{mol K}} \cdot 313 \text{ K}} = 1.42 \text{ mol}$

7. What temp would you need to hold a balloon at so that 2 moles of gas occupy 40 liters at 0.98 atm and 25 °C ?

$P = 0.98$ atm
$V = 40$ L
$n = 2$
$R = 0.0821 \frac{\text{atm L}}{\text{mol K}}$
$T = ?$

$PV = nRT$

$T = \frac{PV}{nR} = \frac{0.98 \text{ atm} \cdot 40 \text{ L}}{0.0821 \frac{\text{atm L}}{\text{mol K}} \cdot 2 \text{ mol}}$

$= 238.7$ K

8. What pressure in atm's must be exerted on a 3 mole sample of gas to compress it to a volume of 50 liters and a temperature of 22 °C ?

$P = ?$ atm
$V = 50$ L
$n = 3$ mol
$R = 0.0821 \frac{\text{atm L}}{\text{mol K}}$
$T = 22^\circ\text{C} = 295$ K

$PV = nRT$

$P = \frac{nRT}{V} = \frac{3 \text{ mol} \cdot 0.0821 \frac{\text{atm L}}{\text{mol K}} \cdot 295 \text{ K}}{50 \text{ L}}$

$= 1.45$ atm

9. What pressure in kPa must be exerted on a 10g sample of water vapor to compress it to a volume of 750 milliliters and a temperature of 0 °C ?

$P = ?$ kPa
$V = 0.75$ L
$n = 0.56$ mol
$R = 8.314 \frac{\text{kPa L}}{\text{mol K}}$
$T = 273$ K

$\frac{10 \text{ g}}{18 \text{ g/mol}} = 0.56$ mol

$PV = nRT$

$P = \frac{nRT}{V} = \frac{0.56 \text{ mol} \cdot 8.314 \frac{\text{kPa L}}{\text{mol K}} \cdot 273 \text{ K}}{0.75 \text{ L}}$

$= 1695$ kPa

10. 20.83 g. of a gas occupies 4.167 L at 79.97 kPa at 30.0 °C. What is its molecular weight?

$P = 79.97$ kPa
$V = 4.167$ L
$n = ?$
$R = 8.314 \frac{\text{kPa L}}{\text{mol K}}$
$T = 303$ K

$PV = nRT$

$n = \frac{PV}{RT} = \frac{79.97 \text{ kPa} \cdot 4.167 \text{ L}}{8.314 \frac{\text{kPa L}}{\text{mol K}} \cdot 303 \text{ K}} = 0.132$ mol

$MM = \frac{g}{\text{mol}} = 20.83 \text{ g} / 0.132 \text{ mol} = 157.8$ g/mol

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Ideal Gas Law and Avogadro's Concept Quiz

1. What volume of gas at standard temperature and pressure would 1.2 kg of propane (C_3H_8) take up?

$3\times12+8 = 44\ g/mol$

$V = ?$ $\quad m = 1.2\ kg = 1200\ g \div 44\ g/mol = 27.27\ mol$

$27.27\ mol \times 22.4\ l/mol = 611\ l$

2. If you could condense the water vapor from 400 two liter soda bottles, how much grams of water would you get if it were under 760mmHg pressure and 273k?

$H_2O = 18\ g/mol$ $\quad V = 400\times2 = 800\ l$ $\quad$ ← STP!! →

$2+16$

$800\ l \div 22.4\ l/mol = 35.7\ mol \times 18\ g/mol = 642.9\ g$

3. If you let 350 moles of dihexylpentane evaporate from a liquid to a gas at STP, what would the volume of the gas?

$350\ mol \times 22.4\ l/mol = 7840\ l$

4. A 180.0 g gas sample occupies 56.0 L at STP. Find the molecular weight of this gas.

$56.0\ l \div 22.4\ l/mol = 2.5\ mol$ $\quad 180\ g \div 2.5\ mol = 72\ g/mol$

5. At what temperature will 830 grams of argon gas occupy 120 liters at 5.95 atmospheres?

$PV = nRT$

$T = ?$

$m = 830\,g / 39.94\,g/mol = 20.78\,mol$ (n)

$V = 120\,L$

$P = 5.95\,atm$, $R = 0.0821\ \frac{atm\,L}{mol\,K}$

$T = \frac{PV}{nR} = \frac{5.95\,atm \times 120\,L}{0.0821\ \frac{atm\,L}{mol\,K} \times 20.78\,mol} = 418.5\,K$

$(145^\circ C)$

6. If you heated 120 g of methane (CH_4) to 100 C at 1.12 atmospheres of pressure, what volume would this gas expand to?

$PV = nRT$

$120\,g / 16\,g/mol = 7.5\,mol$

$T = 373\,K$

$P = 1.12\,atm$

$R = 0.0821\ \frac{atm\,L}{mol\,K}$

$V = \frac{nRT}{P} = \frac{7.5\,mol \times 0.0821\ \frac{atm\,L}{mol\,K} \times 373\,K}{1.12\,atm}$

$= 205.1\,L$

7. What pressure in mmHG would 55 moles of ether gas in a 20 liter tank at room temperature (about 25 C) be?

$PV = nRT$

$P_{mmHg} = ?$

$n = 55\,mol$

$V = 20\,L$

$T = 298\,K$

$R = 62.4\ \frac{mmHg\,L}{mol\,K}$

$P = \frac{nRT}{V} = \frac{55\,mol \times 62.4\ \frac{mmHg\,L}{mol\,K} \times 298\,K}{20\,L}$

$P = 51{,}136.8\,mmHg$

$(P_{atm} = 67.3\,atm)$

8. If a lighter loses 0.201 grams when it releases 150ml of gas at 1.1 atm and 250k, what is the molar weight of the gas? (extra credit – if this gas contains only carbon and hydrogen, suggest a possible formula for it)

$m = 0.201\,g$

$V = 150\,ml = 0.150\,L$

$P = 1.1\,atm$

$T = 250\,K$

$R = 0.0821\ \frac{atm\,L}{mol\,K}$

$n = \frac{PV}{RT} = \frac{1.1\,atm \times 0.15\,L}{0.0821\ \frac{atm\,L}{mol\,K} \times 250\,K}$

$n = 0.0080\,mol$

$\frac{0.201\,g}{0.0080\,mol} = 25.125\,g/mol$

C_2H

CH_{13}