Gas Laws Review

Remember:

Relationship between Volume and Temperature: direct

Relationship between Volume and Pressure: inverse

STP Values:

Standard Temperature 0°C 273 K

Standard Pressure 1 atm 760 mmHg 101.3 kPa

Formulas:

Boyles $V_1P_1 = V_2P_2$ Charles $= \frac{V_1}{T_1} = \frac{V_2}{T_2}$ > T must be in Kelvin

Combined $= \frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

Ideal Gas Law $PV = nRT$ (n = moles) $PV_m = gRT$ (m = molar mass, g = grams)

Density $D_{STP} = \frac{\text{molar mass}}{22.4L}$ ($22.4L$ = V_1) $D_{new} = \frac{\text{molar mass}}{V_2}$*

* use combined gas Law to find V_2

Dalton's Law $P_{TOTAL} = P_1 + P_2 + P_3 + \ldots$

Short answer

1. inversely
2. decreases
3. elastic
4. 0°C 273K
5. 101.3 kPa 760 mm Hg 1 atm

6. V_1 2.0L V_2 0.750L P_1 2.3 atm P_2 ?

$V_1P_1 = V_2P_2$

$(2.0L)(2.3\ atm) = (0.75L)(P_2)$

$P_2 = 6.1\ atm$

$750\ mL \times \frac{1\ L}{1000\ mL} = 0.750L$

7. $V_1 = 7.5L$ $V_2 = ?$ $T_1 = 305K$ $T_2 = 275K$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{(7.5L)}{(305K)} = \frac{V_2}{(275K)}$ $V_2 = 6.76 \rightarrow 7L$

8. $V_1 = 275mL$ $V_2 = ?$ $P_1 = 790\ mm Hg$ $P_2 = 821\ mm Hg$ $T_1 = 378K$ $T_2 = 343K$

$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

$\frac{(275mL)(790\ mm Hg)}{378K} = \frac{V_2(821\ mm Hg)}{343K}$

$V_2 = 240\ mL$

9. $V_1 = 20.0mL$ (0.778 atm) $V_2 = 40.0mL$ $P_1 = 78.9kPa$ $P_2 = 99.2\ atm$ $T_1 = 291K$ $T_2 = ?$

$78.9kPa \times \frac{1\ atm}{101.3\ kPa} = 0.778\ atm$

$\frac{(20.0mL)(0.778atm)}{291K} = \frac{(40.0mL)(99.2atm)}{T_2}$

$T_2 = 74000K$

$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

$T_2\frac{(20.0mL)(0.778atm)}{291K} = \frac{(40.0mL)(99.2atm)T_2}{T_2}$

$99.2\ atm = ?\ kPa$

$99.2atm \times \frac{101.3kPa}{1atm}$

$10049kPa$

$T_2 = \frac{(40.0mL)(99.2atm)(291K)}{(20.0mL)(0.778atm)}$

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

$PV = nRT$ (n: moles)

$PV_m = gRT$ (m: molar mass; g: grams)

10. $P = 585$ mmHg
$V = ?$
$m = 70.90$ g/mol
$g = 16.0$ g
$R = 62.4 \frac{L\ mmHg}{mol\ K}$
$T = 288$ K

$(585\ mmHg)(V)(70.90\ g/mol) = (16.0\ g)(62.4 \frac{L\ mmHg}{mol\ K})(288\ K)$

$V = 6.9\ L$

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11. $P = 800.0$ mmHg
$V = 0.75$ L
$n = ?$
$R = 62.4 \frac{L\ mmHg}{mol\ K}$
$T = 368$ K

$(800.0\ mmHg)(0.75\ L) = n(62.4 \frac{L\ mmHg}{mol\ K})(368\ K)$

$n = 0.026$ moles

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12. $P = 985$ mmHg
$V = 0.250$ L
$m = 34.09$ g/mol
$g = ?$
$R = 62.4 \frac{L\ mmHg}{mol\ K}$
$T = 323$ K

$(985\ mmHg)(0.250\ L)(34.09\ g/mol) = g(62.4 \frac{L\ mmHg}{mol\ K})(323\ K)$

$g = 0.416\ g\ H_2S$

13. $P = ?$
$V = 0.807\,L$
$m = 28.02\ g/mol$
$g = 48.3\,g$
$R = 62.4 \frac{L\,mmHg}{mol\,K}$
$T = 373\,K$

$(P)(0.807L)(28.02\ g/mol) = (48.3g)\left(62.4 \frac{L\,mmHg}{mol\,K}\right)(373K)$

$P = 49716 \rightarrow$ **49700 mmHg**

Gas Density

14. $F_2(g)$ @ STP $\quad \frac{38.00g}{22.4L} =$ **1.70 g/L**

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15. $F_2(g)$ not at STP

$V_1 = 22.4L \quad V_2 = ?$
$P_1 = 1\ atm \quad P_2 = 1.21\ atm$
$T_1 = 273K \quad T_2 = 300K$
(STP)

$\frac{(22.4L)(1\ atm)}{273K} = \frac{V_2(1.21\ atm)}{300K}$

$V_2 = 20.34L$

$D_{new} = \frac{38.00g}{20.34L} = 1.87\ g/L \rightarrow$ **1.9 g/L**

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16. $He(g)$ @ STP $\quad \frac{4.00g}{22.4L} =$ **0.179 g/L**

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17. He @ not STP

V_1 22.4L $\quad V_2 = ?$
P_1 101.3 kPa $\quad P_2 = 78.8\ kPa$
T_1 273K $\quad T_2 = 318K$

$\frac{(22.4L)(101.3kPa)}{273K} = \frac{V_2(78.8kPa)}{318K} \quad V_2 = 33.54L$

$D_{new} = \frac{4.00g}{33.54L} =$ **0.12 g/L**

$P_{TOT} = P_1 + P_2 + P_3 + \ldots$ 30% (A) 20% (B) ? (C) = 100

18. $P_{TOT} = 30\,kPa + 60\,kPa + 80\,kPa =$ **170.0 kPa**

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19. $1.52\,atm = 0.27\,atm + P_2$ **$P_2 = 1.05\,atm$**

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20. $782\,mmHg = 392\,mmHg + 230.\,mmHg + P_3$

$P_3 = 160\,mmHg$

Temperature (°C)	Vapor Pressure (mmHg)
18	15.0
19	16.5
20	17.5
21	18.7
22	19.8
23	21.1
24	22.4
25	23.8 ← H_2O
26	25.2
27	26.7
28	28.3
29	30.0

763.5 mmHg
− 23.8 mmHg
739.7 mmHg H_2

R values:

$0.0821 \frac{L\ atm}{mol\ K}$ $8.31 \frac{L\ KPa}{mol\ K}$ $62.4 \frac{L\ mmHg}{mol\ K}$