Unit 2: *Gases & Gas Mixtures*

- **Gas Basics**
- **What's in Air**
- **Some Facts About Individual Gases**
- **How Gases Behave**
- **Converting Between Depth and Pressure**
- **Calculating Partial Pressures**

Student Performance:

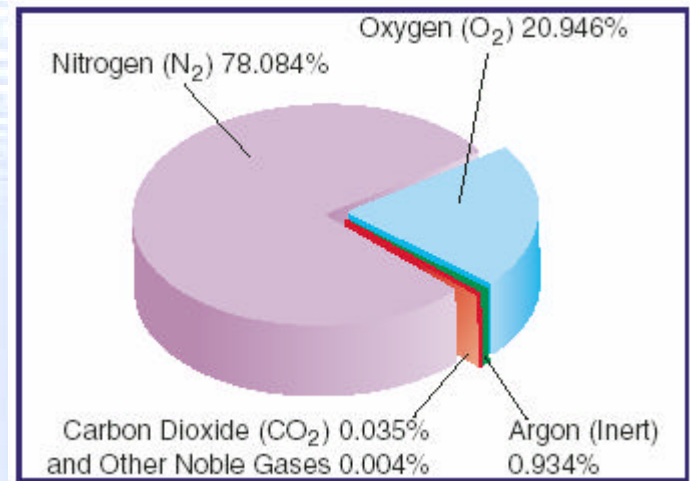**By the end of the lesson you will be able to:**

- **State the composition of air.**
- **Describe how gases behave.**
- **Explain the relationship between pressure and gas volume.**
- **Describe the solubility of gases.**
- **Explain what partial pressure is and determine various partial pressures.**
- **Determine absolute pressure at depth.**
- **Determine the partial pressure of a gas in a mixture at depth.**

Gas Basics

- **Matter**
- **Composition of a gas**
- **Gas mixtures**
- **Gas pressure**
- **Dissolved gases**

What's in Air?

- **Composition of air**
  - **Oxygen (O_2) 0.2095**
  - **Nitrogen (N_2) 0.7808**
  - **Argon (Ar) 0.00934**
  - **Carbon dioxide (CO_2) ~0.00035 (average)**
  - **Others 0.00004**
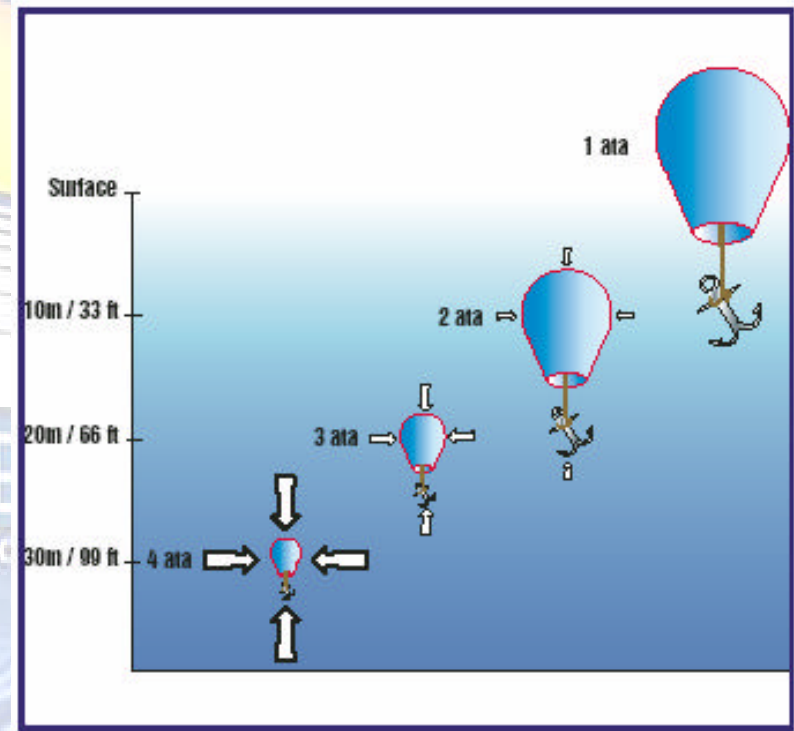- **Simplifying the numbers:**
  - 21% oxygen / 79% nitrogen

Nitrogen (N_2) 78.084%

Oxygen (O_2) 20.946%

Carbon Dioxide (CO_2) 0.035% and Other Noble Gases 0.004%

Argon (Inert) 0.934%

Unit 2 - Gases & Gas Mixtures

Some Facts About Individual Gases

- **Oxygen (O_2)**
- **Nitrogen (N_2)**
- **Argon (Ar)**
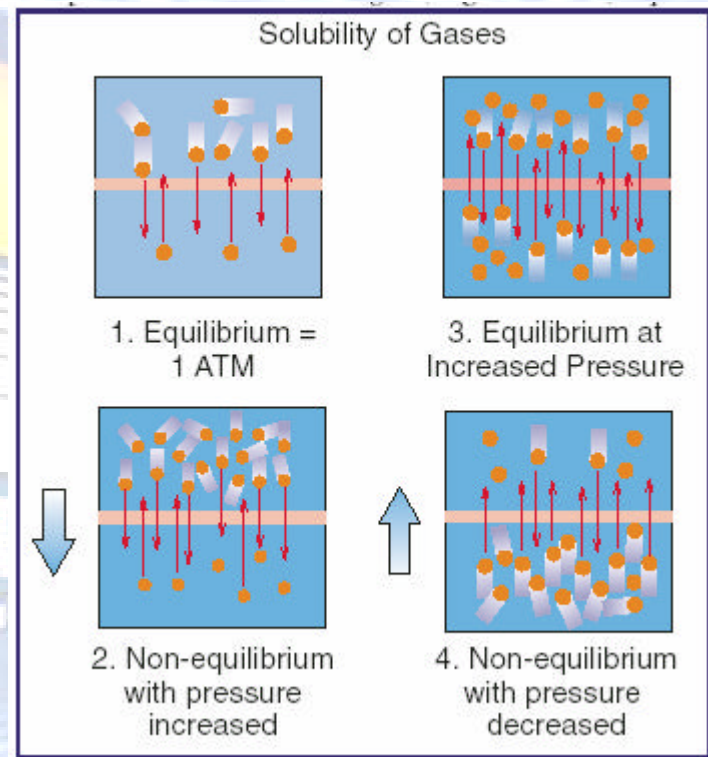- **Carbon Dioxide (CO_2)**
- **Helium (He)**
- **Neon (Ne)**

How Gases Behave

Boyle's Law: Pressure, Volume, and Density

How Gases Behave continued

Henry's Law: The Solubility of Gases

Solubility of Gases

1. Equilibrium = 1 ATM
2. Non-equilibrium with pressure increased
3. Equilibrium at Increased Pressure
4. Non-equilibrium with pressure decreased

How Gases Behave continued

Dalton's Law: Partial Pressure in Gas Mixtures

NITROGEN
OXYGEN
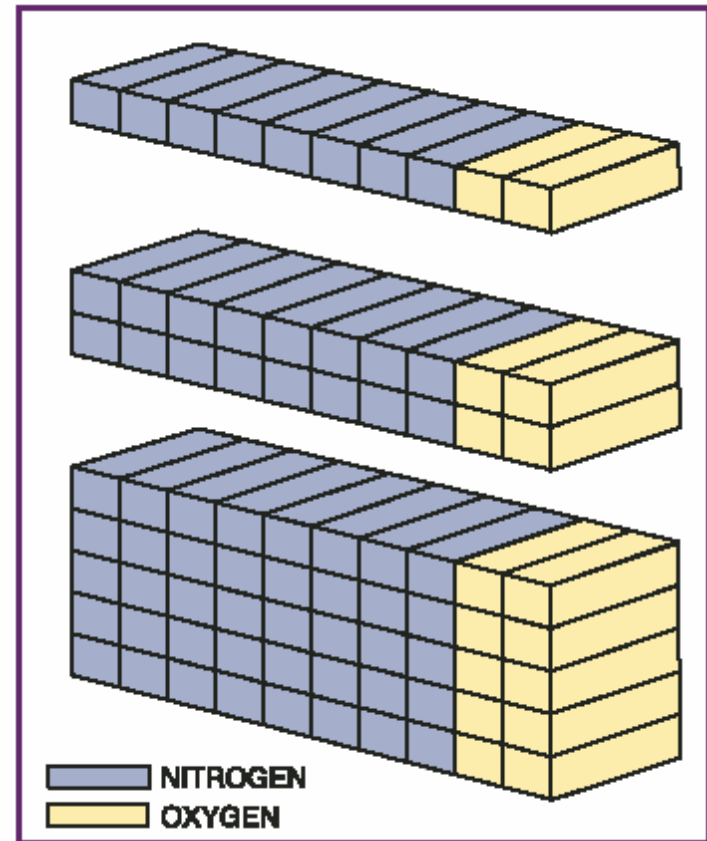
Converting Between Depth and Pressure

- **Absolute vs. gauge pressure**

DEPTH FEET	DEPTH METERS	WATER PRESSURE	ABSOLUTE PRESSURE
0	0	0	1 ata
33	10	1 atm	2 ata
66	20	2 atm	3 ata
99	30	3 atm	4 ata
132	40	4 atm	5 ata

Converting Between Depth and Pressure **continued**

- **Converting by formula**
- **To find absolute pressure:**

  P *ata* = (D *fsw* / 33 *fsw/atm*) + 1 *atm*

  = (D *fsw* + 33 *fsw*) / 33 *fsw/atm*

- **To find depth:**

  D fsw = (P ata − 1 atm) x 33 fsw/atm

Converting Between Depth and Pressure continued

- **Converting by table**

Absolute Pressure at Depth		
Depth (fsw)	Depth (msw)	Pressure (ata)
0	0	1
10	3	1.3
20	6	1.6
30	9	1.9
40	12	1.2
50	15	2.5
60	18	2.9
70	21	3.1
80	24	3.4
90	27	3.7
100	30	4.0
110	34	4.4
120	37	4.7
130	40	5.0
140	43	5.3
150	46	5.6

Calculating Partial Pressures

- **If you know the absolute pressure:**
  - The basic formula:

  $$P_g = F_g \times P_{total}$$

  - Using a graphical figure
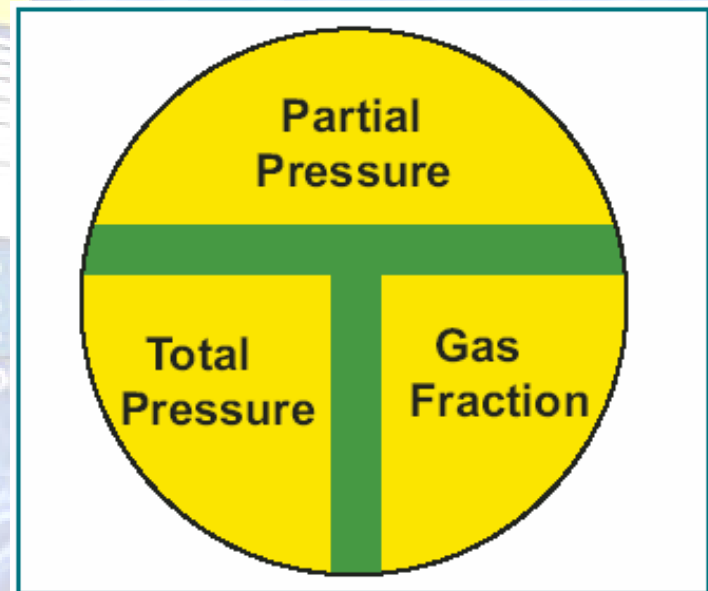
Calculating Partial Pressures **continued**

- **Moving between partial pressure and depth using formulas:**
- **Depth to partial pressure**
  - First find the absolute pressure at depth.
  - Then find the partial pressure of the component gas at that absolute pressure.
- **Partial pressure to depth**
  - First find the absolute pressure of the gas mixture from the partial pressure and fraction of the component gas.
  - Then find the depth for that absolute pressure.

Calculating Partial Pressures **continued**

Using a table

Oxygen Partial Pressure (in atmospheres absolute) at Depth											
FO$_2$		Air	0.24	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.40
Depth (fsw)	Depth (msw)										
40	12	0.46	0.53	0.58	0.62	0.66	0.71	0.75	0.80	0.84	0.88
50	15	0.53	0.60	0.65	0.70	0.75	0.80	0.86	0.91	0.96	1.01
60	18	0.59	0.68	0.73	0.79	0.85	0.90	0.96	1.01	1.07	1.13
70	21	0.66	0.75	0.81	0.87	0.94	1.00	1.06	1.12	1.19	1.25
80	24	0.72	0.82	0.89	0.96	1.03	1.10	1.16	1.23	1.30	1.37
90	27	0.78	0.89	0.97	1.04	1.12	1.19	1.27	1.34	1.42	1.49
100	30	0.85	0.97	1.05	1.13	1.21	1.29	1.37	1.45	1.53	1.61
110	33	0.91	1.04	1.13	1.21	1.30	1.39	1.47	1.56	1.64	1.73
120	36	0.97	1.11	1.21	1.30	1.39	1.48	1.58	1.66	1.76	1.85
130	40		1.19	1.28	1.38	1.48	1.58	1.68	1.77	1.88	1.98

Unit 2 - Gases & Gas Mixtures

End of Unit 2
Gases & Gas Mixtures

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