Properties of the Noble Gases

Noble Gases – E.g.

Element→	He	Ne	Ar	Kr	Xe	Rn
# of electrons in outer shell	2	8	8	8	8	8
Atomic radius (Å)	0.93	1.12	1.54	1.69	1.90	2.20
Critical Temperature (°C)	-267.9	-228.7	-122.3	-63.8	-16.6	105
Boiling Point	Lowest	→→→→→→→→→→→→				Highest
Melting Point	Lowest	→→→→→→→→→→→→				Highest

Review -- Update

- Freezing Point: is the temperature at which a liquid becomes a solid at normal atmospheric pressure.
- Melting Point: is the temperature at which a solid becomes a liquid at normal atmospheric pressure.
- Boiling Point: the temperature at which a pure solvent's or solution's vapor pressure = atmospheric pressure
- Flash Point: is the lowest temperature at which a liquid can form an ignitable mixture in air near the surface of the liquid. The lower the flash point, the easier it is to ignite the material.
- Critical Temperature: is the temperature above which a substance can not be liquified REGARDLESS how much pressure is applied.
- Critical Pressure: is the pressure required to liquify a gas at its critical temperature.

Common Substance	Critical Temperature (K)	Critical Pressure (atm)
H_2 - [1]	33.24	12.8
N_2	126	33.5
O_2	154.3	49.7
CO_2	304.2	73.0
NH_3	405.5	111.5
H_2O - [2]	647.1	217.7
SO_2	430.3	77.7

[1] -- has weak intermolecular forces; [2] - has high intermolecular forces. Note the differences these forces make between critical temperatures and pressures between the two related substances.

Composition of the Atmosphere

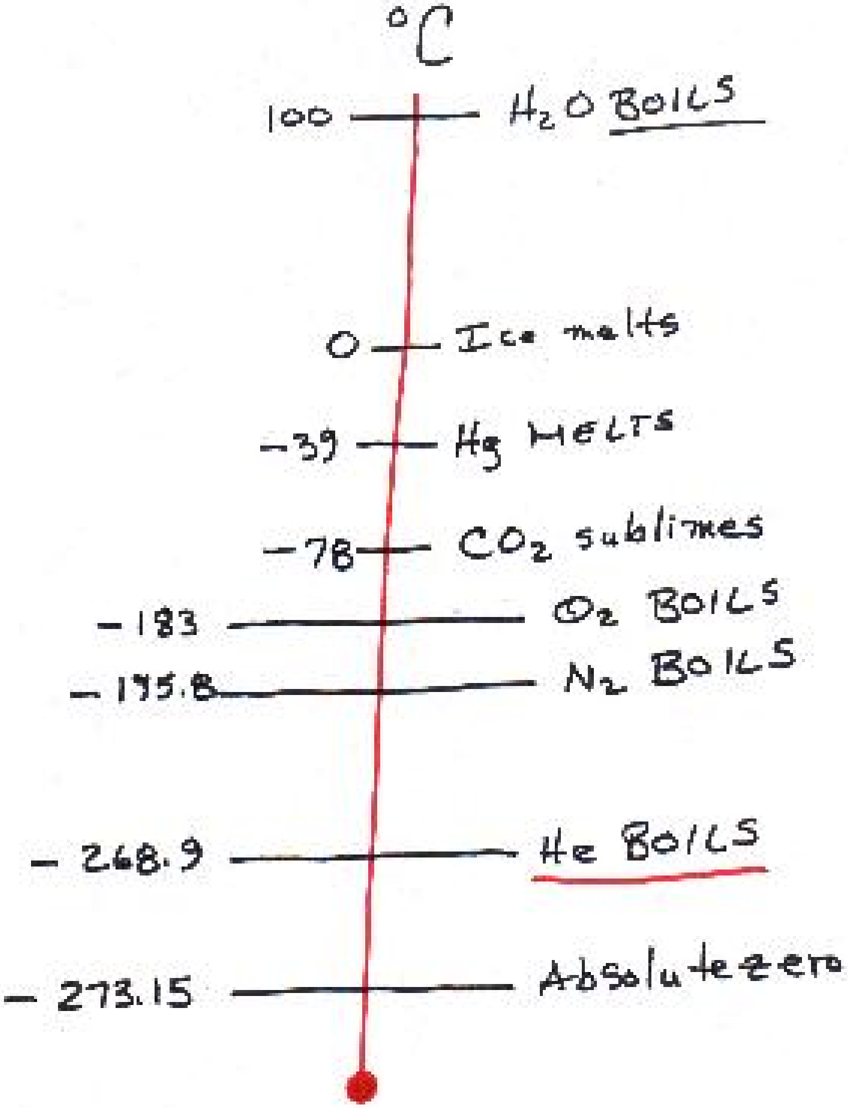
- This topic, I believe is of importance as our atmosphere does contain noble gases.
- The table, following slide, summarizes the composition of our atmosphere.
- Keep in mind that as altitude increases, the per cent composition does not vary - the PRESSURE does, e.g.,
  - at sea level, atmospheric pressure is 760 mm Hg;
  - at 15000 feet, 400 mm Hg;
  - at 10 miles, 40 mm Hg and
  - at 30 miles, 0.1 mm Hg.

N_2	78%
O_2	20.99%
Ar ←	0.94%
CO_2	0.035-0.04%
H_2	0.01%
Ne ←	0.0012%
He ←	0.0005%
Kr ←	0.0001%
O_3	0.00006%
Xe ←	0.000009%

← All noble gases

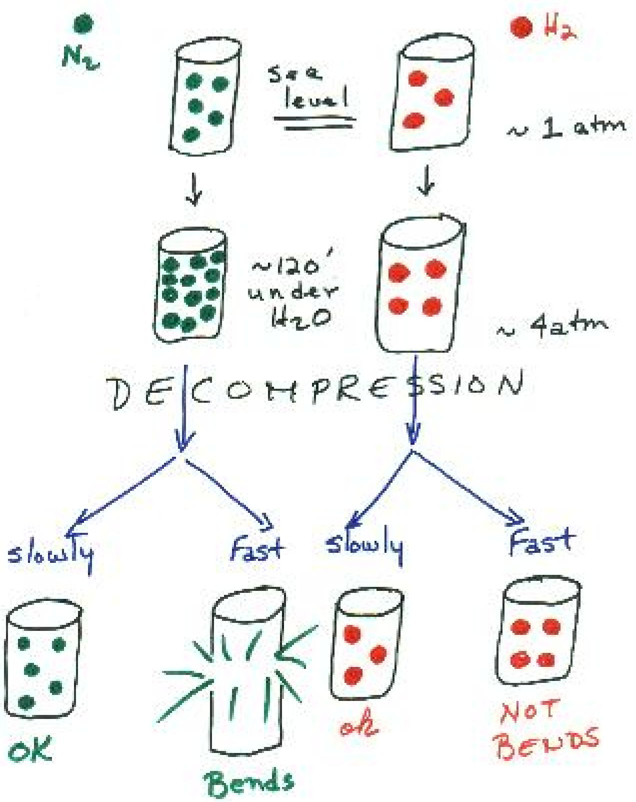
General Comments Regarding Noble Gases

- Some of the more common temperatures in chemistry.
- The one to emphasize is that of the boiling point of He: -268.9° C.



- He is an unusual noble gas.
- One form of $^{4}He_2$ has no electrical resistance.
- It has zero viscosity, i.e., it flows up and over the edges of the container until the levels of He inside and outside the container are level.
- That it has no electrical resistance makes it useful as a super conductor.
- He, also has no triple point, unlike water.
- He is used in arc welding, to fill weather balloons, to fill blimps/dirigibles (it's non-flammable).

- He is also used in deep-sea diving:
- In general, He is much less soluble in water than are either oxygen or nitrogen.
- At the high pressures of deep sea diving, LOTS of nitrogen (N_2) dissolves in water, blood and cerebrospinal fluid.
- If decompression is attained appropriately, there is no problem.
- If, however, decompression is too rapid, the person develops the bends.
- In this part of the country, this is usually fatal as there is no decompression chamber at Tahoe, any more and the closest one is at Davis, I believe.
- OTOH, if He is substituted for the N_2, even rapid decompression is not as deadly as it is for nitrogen-containing gas mixtures.
- This means that for long term deep-sea diving, the likelihood of developing the bends is greatly reduced.



- Ar is cheaper than He.
- We use about $1.5*10^9$ pounds per year.
- It is used in incandescent bulbs to prevent bulb "burn out". Ne, Ar and Xe are often coupled with Kr in "neon lights".
- The color of the light is dependent upon the composition of the gases.
- Pure Ne gives an orange-red light; pure Xe gives a blue light.

- Xenon is water soluble and has found some use in compounds as an anesthetic.
- Xe is capable of attaining one of three hybridizations: sp, dsp^2 or d^2sp^3.
- The following reactions illustrate these hybridizations:

1. sp hybridization:
   - Xe(xs g) + F_2(g) + >250° C + High Pressure $\rightarrow$ XeF_2(s)
2. dsp^2 hybridization:
   - Xe(g) + $2F_2$(g) + 400° C + 6 atm $\rightarrow$ XeF_4(s)
3. d^2sp^3 hybridization:
   - Xe(g) + $3F_2$(g) + >250° C + >50 atm $\rightarrow$ XeF_6(s)

- Xe and Kr have many compounds.
- These compounds are generally involved with fluorine, oxygen and nitrogen, which are the most electronegative elements on the periodic table.
- While He and Ne have no known compounds, recently, reports have been coming out about new compounds with Ar.