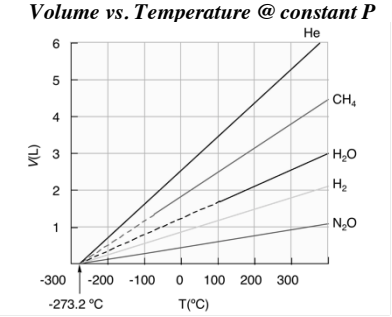
Real Gases

Dr. Ron Rusay

Real Gases

Any gas is "Real" when it does not behave "Ideally"

Volume vs. Temperature @ constant P



Real Gases

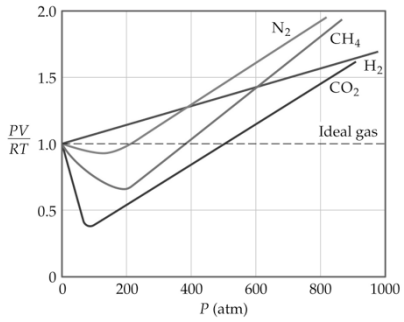
Must correct "ideal" gas pressure & volume for each respective gas when attractive forces are important: high potential & low kinetic energies

$$[P_{obs} + a\,(n/V)^2]\,(V - nb) = nRT$$

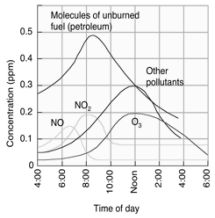
corrected pressure — corrected volume

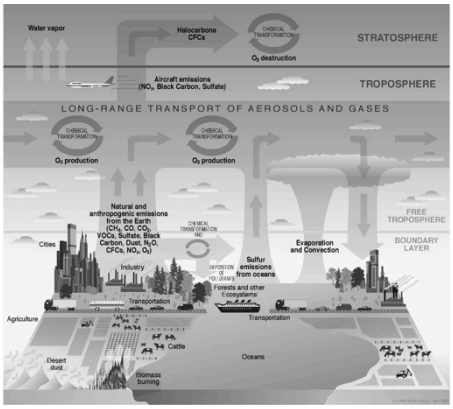
TABLE 10.3 van der Waals Constants for Gas Molecules		
Substance	***a*** **(L^2-atm/mol^2)**	***b*** **(L/mol)**
He	0.0341	0.02370
Ne	0.211	0.0171
Ar	1.34	0.0322
Kr	2.32	0.0398
Xe	4.19	0.0510
H_2	0.244	0.0266
N_2	1.39	0.0391
O_2	1.36	0.0318
Cl_2	6.49	0.0562
H_2O	5.46	0.0305
CH_4	2.25	0.0428
CO_2	3.59	0.0427
CCl_4	20.4	0.1383

"Ideal" gas conditions minimize attractive forces @ low pressure & high temperatures.



Atmospheric Gas Pollutants



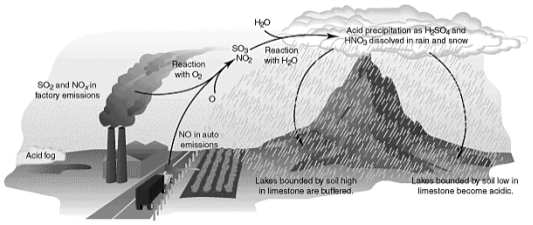


QUESTION

What time of day is it in LA?
(There is no marine layer.)

A) 8:00AM B) 4:00PM

Acid Rain



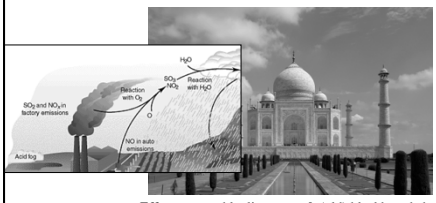
How does acid rain relate to global warming and energy policy?

Fossil fuels: coal and oil?

Acid Rain

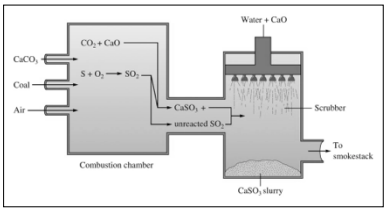
$$CO_{2\,(g)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3\,(aq)} \rightleftharpoons H_3O^+_{(aq)} + HCO_3^-{}_{(aq)}$$

$$SO_{3\,(g)} + H_2O_{(l)} \rightleftharpoons H_2SO_{4\,(aq)}$$



Effects on marble, limestone & (old) blackboard chalk, $CaCO_3$?

Atmospheric Pollutants
Acid Rain Protection



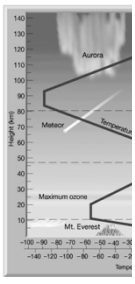
Atmospheric Pollutants?

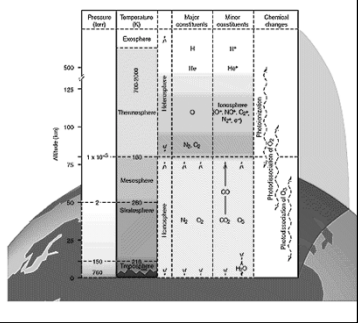
Atmospheric Composition Near Sea Level (Dry Air)*

Component	Mole Fraction
N_2	0.78084
O_2	0.20948
Ar	0.00934
CO_2	0.000345
Ne	0.000001818
He	0.00000524
CH_4	0.00000168
Kr	0.00000114
H_2	0.0000005
NO	0.0000005
Xe	0.000000087

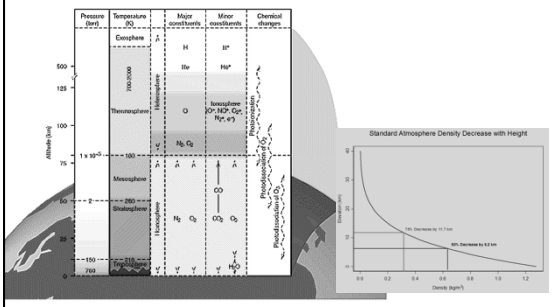
*The atmosphere contains various amounts of water vapor depending on conditions.

Air Composition / Altitude

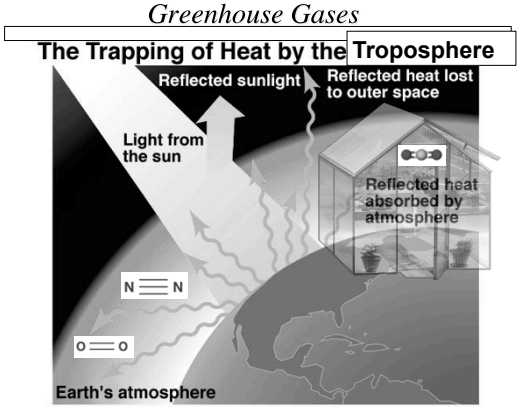




Air Composition / Altitude

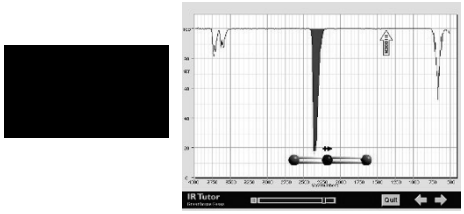


Greenhouse Gases



What is a greenhouse gas?

The sun's energy & the molecule's shape (polarity) decide.



- ***Our atmosphere (air) is 78% nitrogen and 21% oxygen. (BOTH are not polar.)***
- ***Neither are greenhouse gases. They do not absorb infrared radiation (heat).***
- ***However, CO_2 and H_2O absorb infrared energy.***
- ***Without them earth would be very chilly.***
- ***CO_2, an atmospheric pollutant?***

What is a greenhouse gas?

The sun's energy & a molecule's shape & polarity decide.

……. and a pollutant?

Chemical Composition of Air		
Name	**Symbol**	**% by volume**
Nitrogen	N2	78.084 %
Oxygen	O2	20.9476 %
Argon	Ar	0.934 %
Carbon Dioxide	CO2	0.0314 %
Neon	Ne	0.001818 %
Methane	CH4	0.0002 %
Helium	He	0.000524 %
Krypton	Kr	0.000114 %
Hydrogen	H2	0.00005 %
Xenon	Xe	0.0000087 %

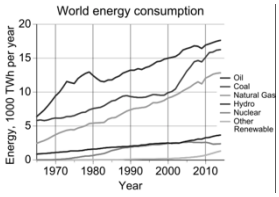
- ***Our atmosphere (air) is 78% nitrogen and 21% oxygen. (BOTH are not polar.)***
- ***Neither are greenhouse gases. They do not absorb infrared radiation (heat).***
- ***However, H_2O and CO_2 can absorb infrared energy. Without them earth would be very chilly.***
- ***……..CO_2, CH_4 atmospheric pollutants?***
- ***Governments decide.***

http://zebu.uoregon.edu/1998/es202/l13.html

Energy $\xrightarrow{\text{(Carbon)}}$ Global Warming
(CO_2)

(Carbon)
(CO_2)

Economy
Jobs



Energy $\xrightarrow{\text{(Carbon)}}$ Global Warming
(CO_2)

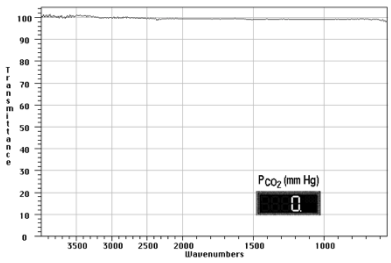
(Carbon)
(CO_2)

Economy
Jobs

https://www.co2.earth/

Infrared Spectra: CO_2 Concentration Effects

Nitrogen & Oxygen produce flat lines: 100% Transmission, 0 Absorbance



Bonus Assignment

Global Warming, Your Carbon Footprint & Your Future

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

http://chemconnections.org/Global%20Warming/

Bonus Assignment

http://chemconnections.org/general/chem108/Global%20warming%20&%20Carbon%20Footprint.2017.pdf

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Global Warming, Your Carbon Footprint & Your Future

SEE:
http://chemconnections.org/IFTVET-2016/IFVET-Global%20Warming.htm

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Globalization / Global Warming

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