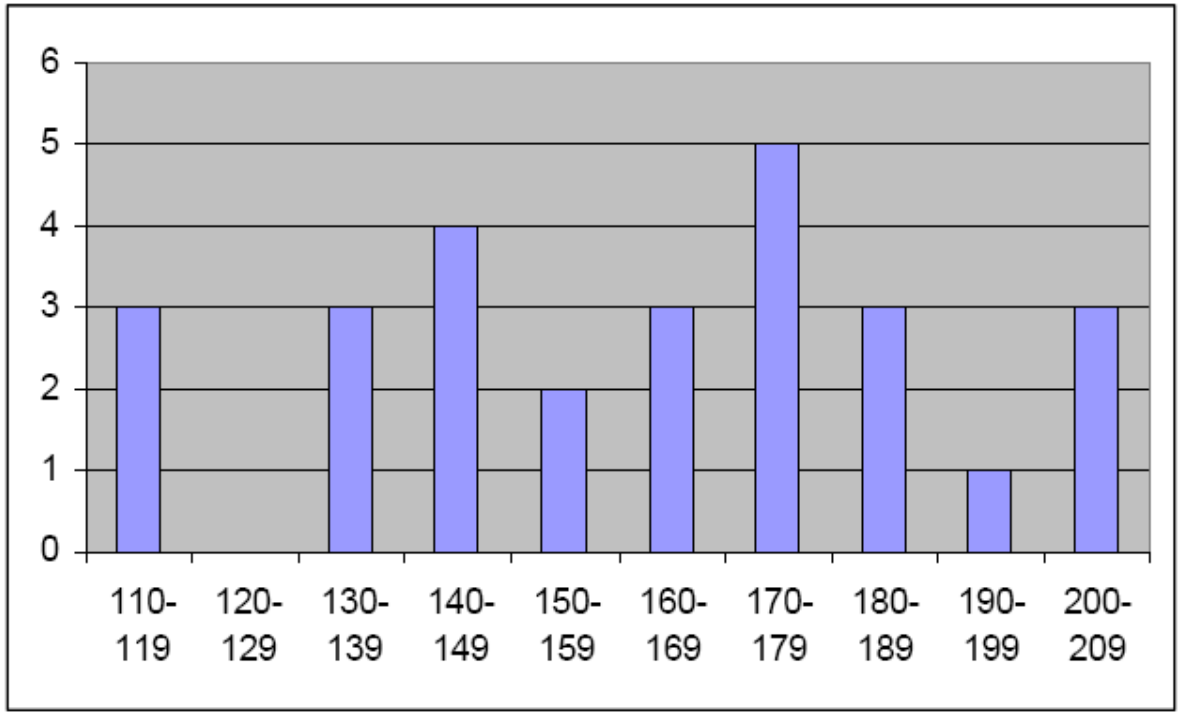
Exam 1
February 22, 2007

Statistics

Total Point Available = 200 + 20 bonus
26 Exams Scored
Average = 160
Median = 161
Standard Deviation = 27.5
High = 210
Low = 114

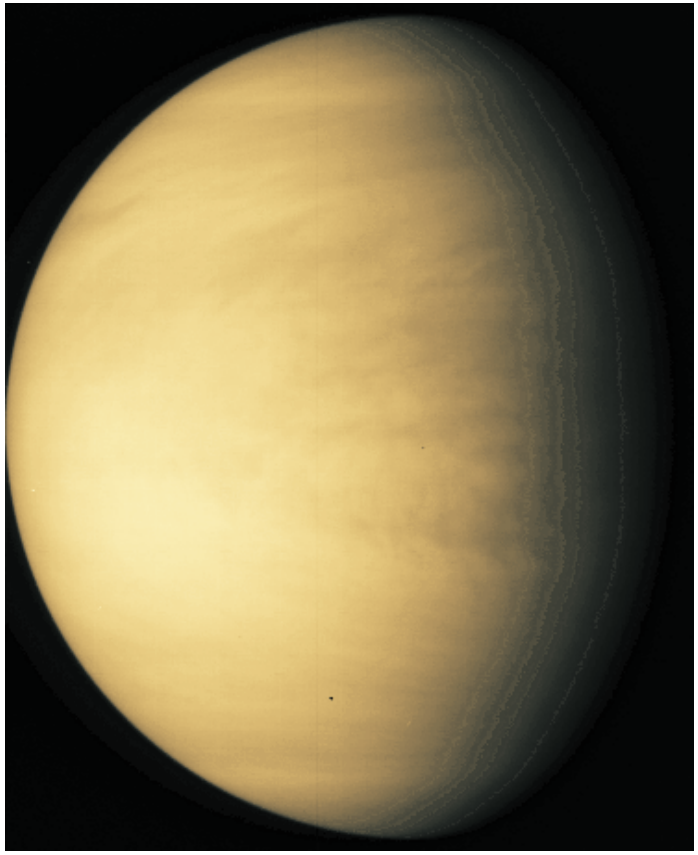


A reminder about homework:

HW will count for 10% of your final grade.

ATTEMPTING every question on a given HW assignment is worth 85% of the points.

The Chemistry of Global Warming



Venus

Average temperature 840°F

Average pressure: 90 atm

Atmosphere 96% CO_2

Clouds of Sulfuric Acid

(100°C = 212°F)

Earth

Average temperature 59°F

Average pressure: 1 atm

Atmosphere 78% N_2

Clouds of Water

(-18°C = 0°F)

Earth’s moon

- Mean surface temperature (day) 107°C
- Mean surface temperature (night) -153°C
- Maximum surface temperature 123°C
- Minimum surface temperature -233°C

http://chemincontext.eppg.com/chapter3/FiguresAlive.html

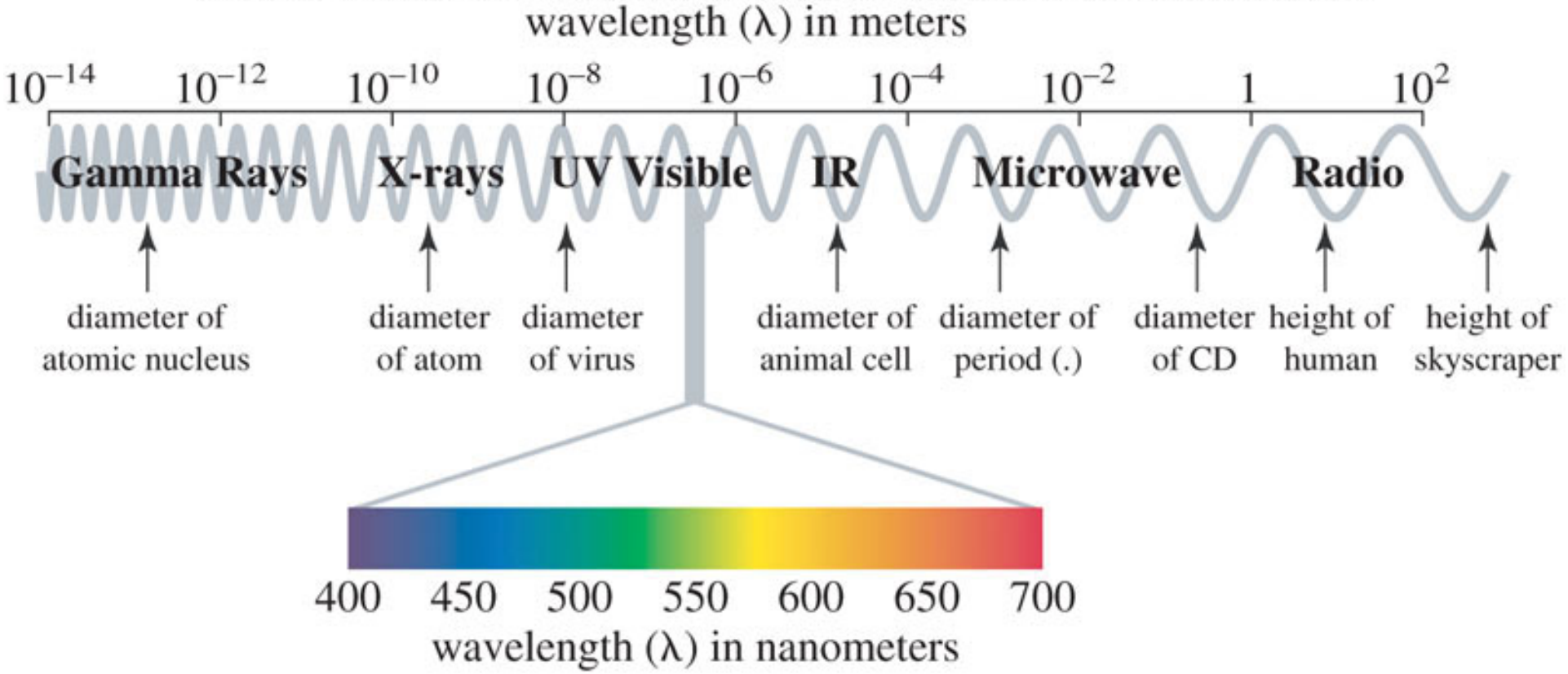
Greenhouse Effect. The trapping and build-up of heat in the lower atmosphere near a planet's surface.

Some of the heat flowing back towards space from the planet's surface is absorbed by water vapor, carbon dioxide, methane and other gases in the atmosphere.

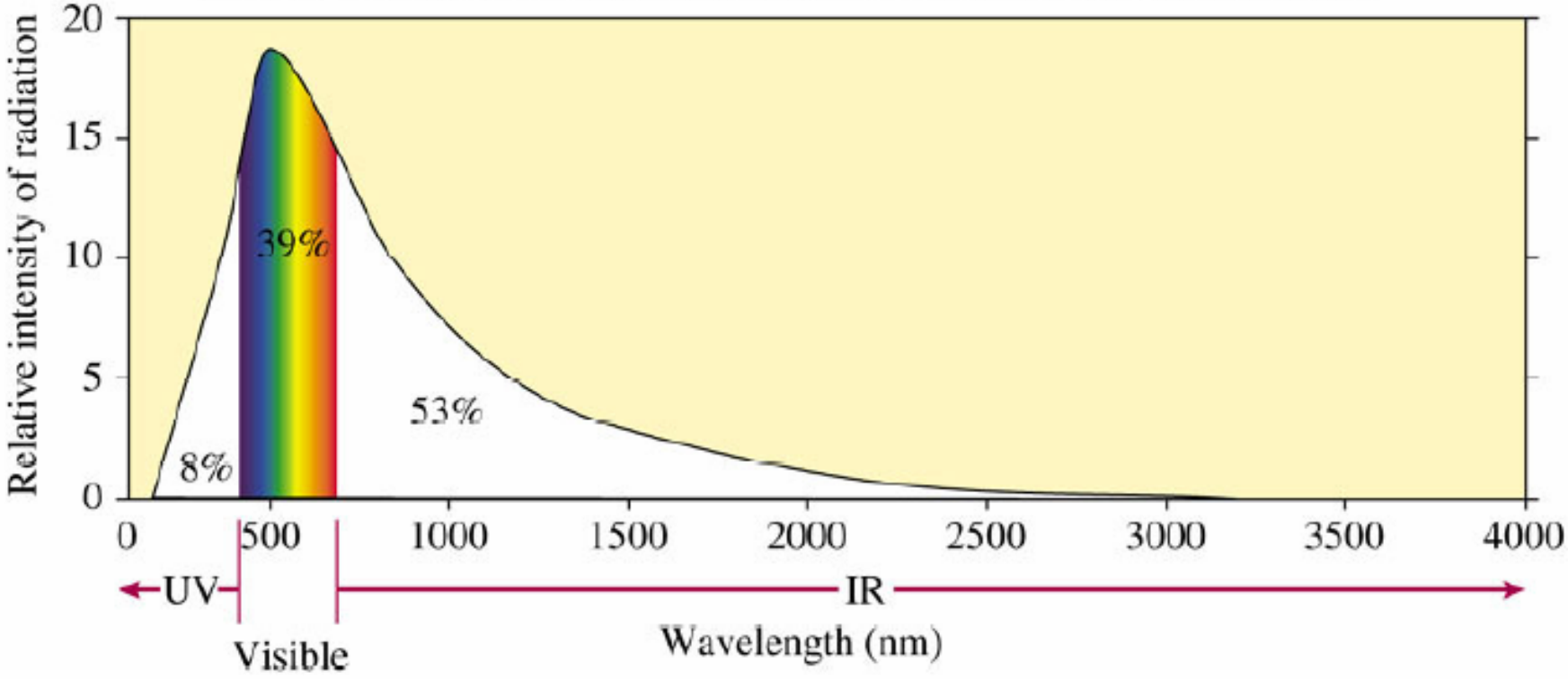
The Greenhouse Effect

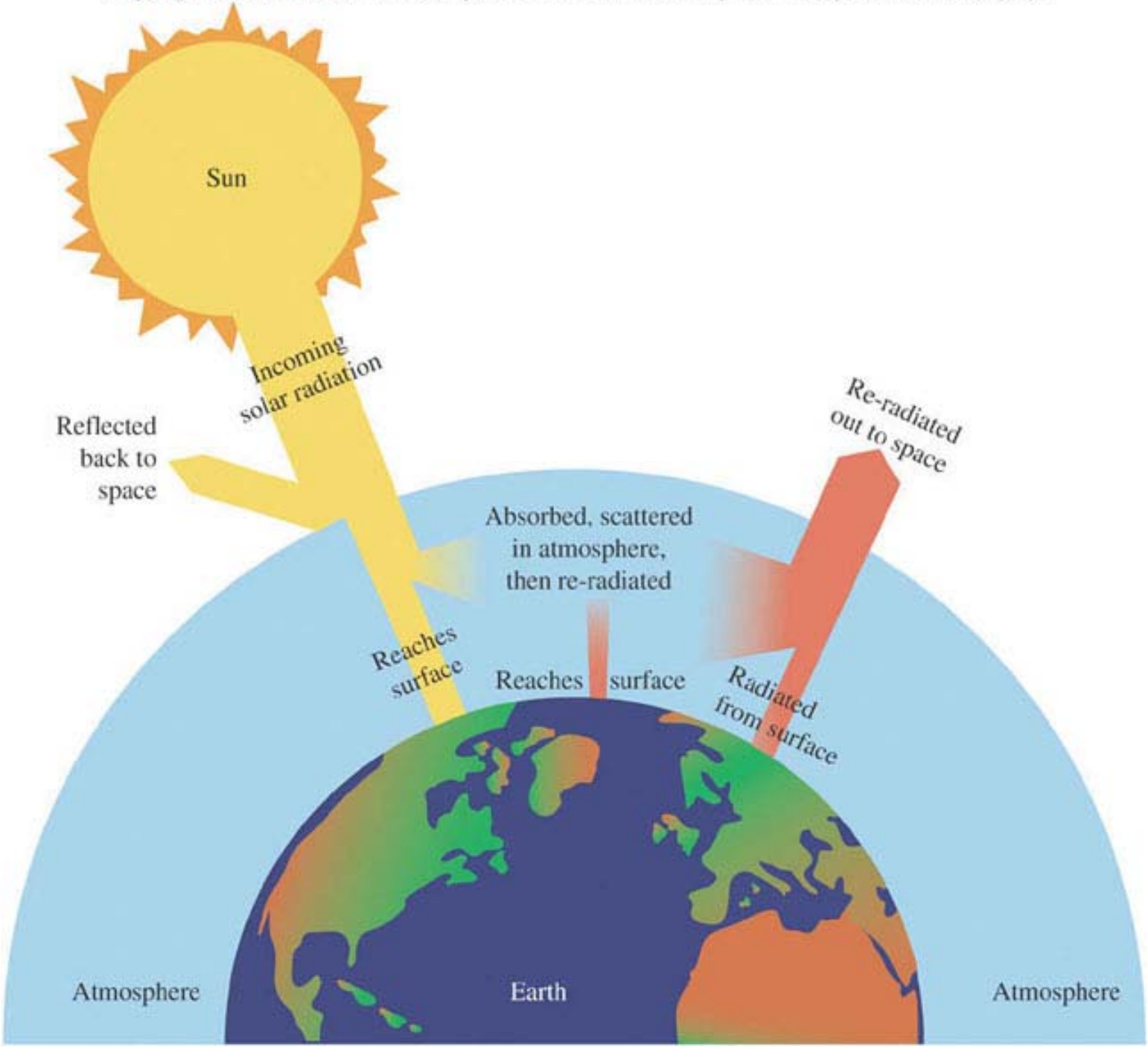
- During the day the Sun warms the Earth
- At night the Earth cools off by emitting its energy to space
- The Greenhouse Gases in the atmosphere absorb the energy emitted from the Earth and prevent the heat energy from leaving the system
- The Greenhouse Gases re-emit the energy back to Earth; they act as an **insulator** by keeping the Earth from loosing heat energy to space
- The energy being transferred in the form of heat is called infrared radiation
- The energy that is re-emitted is at **different wavelengths** than the incoming radiation!
- Think of this like a car sitting in the sun

Waves of Light



Waves of Light





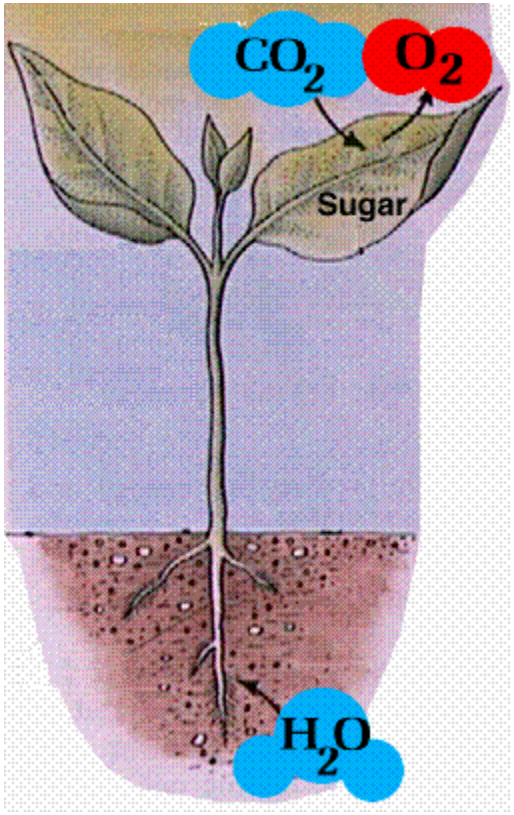
- **Greenhouse Effect.** The trapping and build-up of heat in the lower atmosphere near a planet's surface. Some of the heat flowing back towards space from the Earth's surface is absorbed by water vapor, carbon dioxide, methane and other gases in the atmosphere.
- **Enhanced Greenhouse Effect.** An increase in the natural process of the greenhouse effect, brought about by human activities, whereby greenhouse gases such as carbon dioxide, methane, chlorofluorocarbons and nitrous oxide are being released into the atmosphere at a far greater rate than would occur through natural processes.
- **Global Warming.** An increase in the average temperature of the Earth's surface. Global warming is one of the consequences of the enhanced greenhouse effect and will cause worldwide changes to climate patterns.

The Testimony of Time

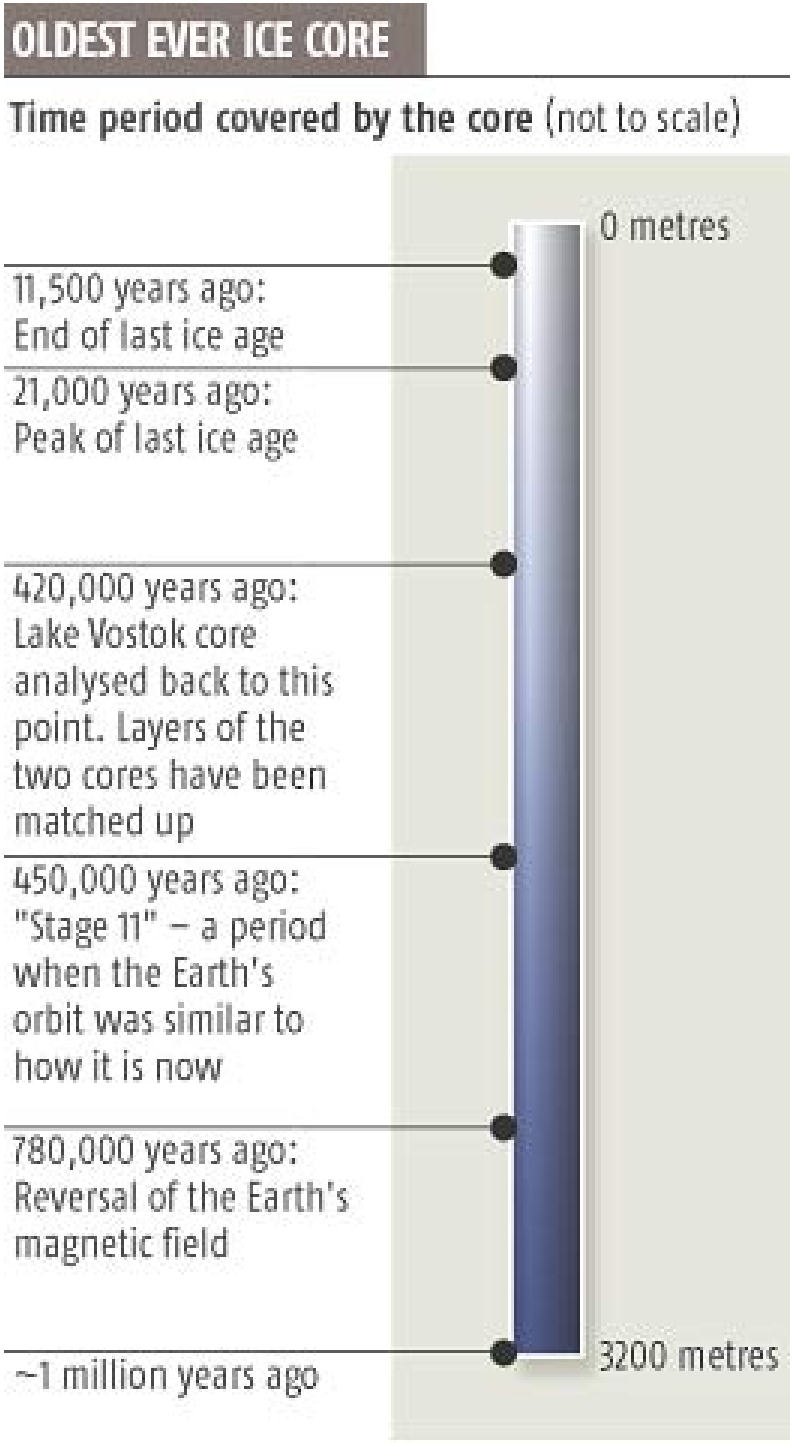
- The Earth is old – 4.5 billion years old
- In that time, its climate and atmospheric makeup have changed dramatically
- The early Earth was very much warmer than it is today
- The early atmosphere contained as much as 1000 **times** the amount of CO_2 as the modern atmosphere does
- Then something happened to remove that CO_2 and replace it with O_2.
- Life.

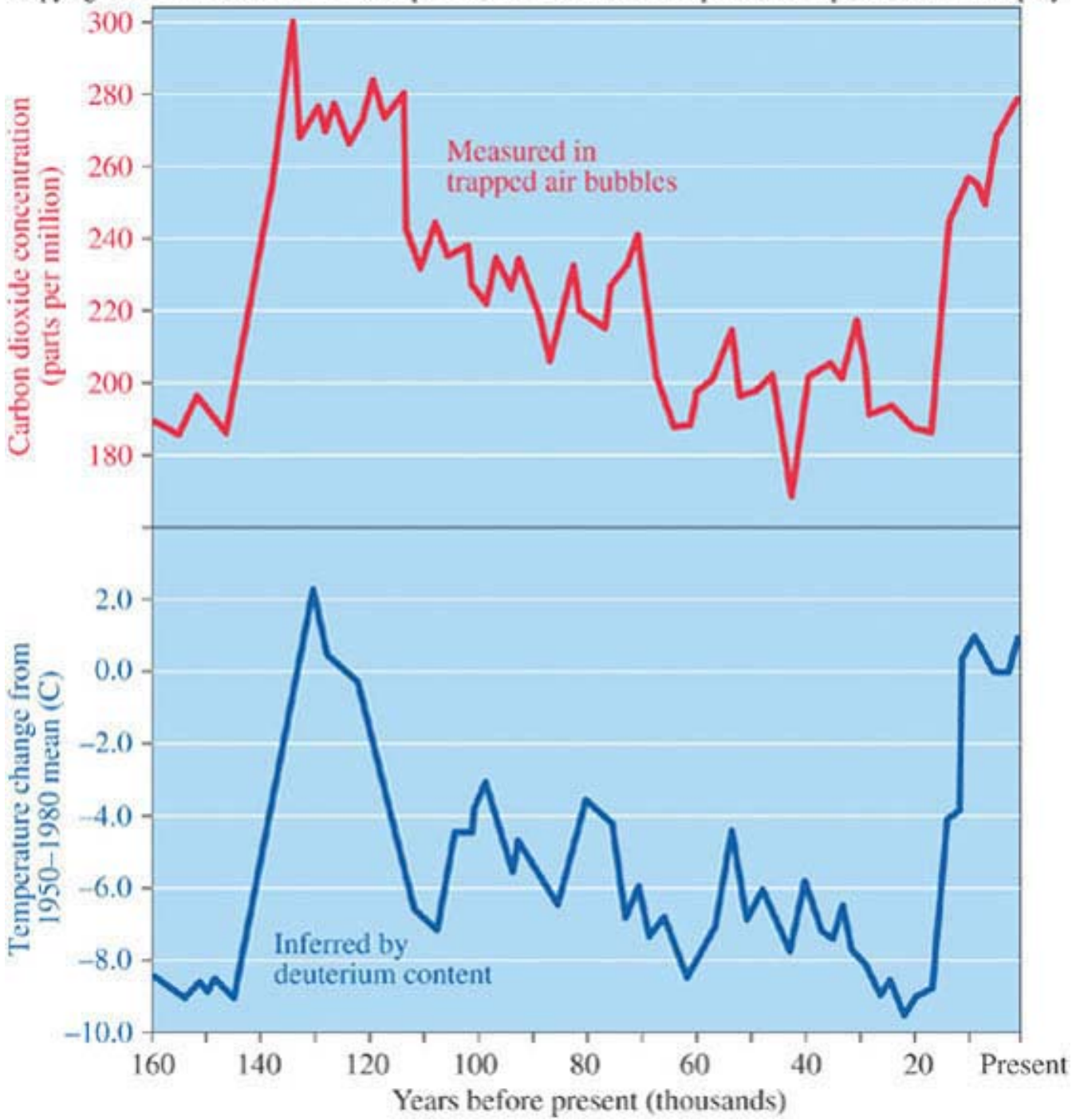
Photosynthesis

$$6H_2O + 6CO_2 \xrightarrow[light]{chlorophyll} C_6H_{12}O_6 + 6O_2$$

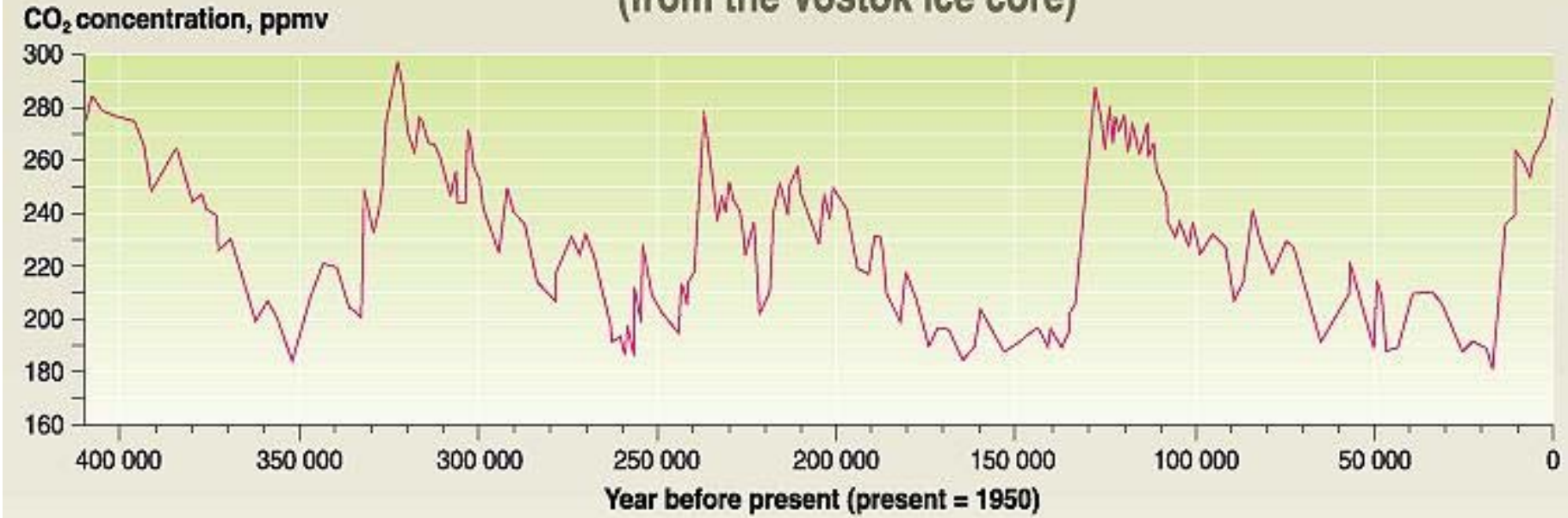


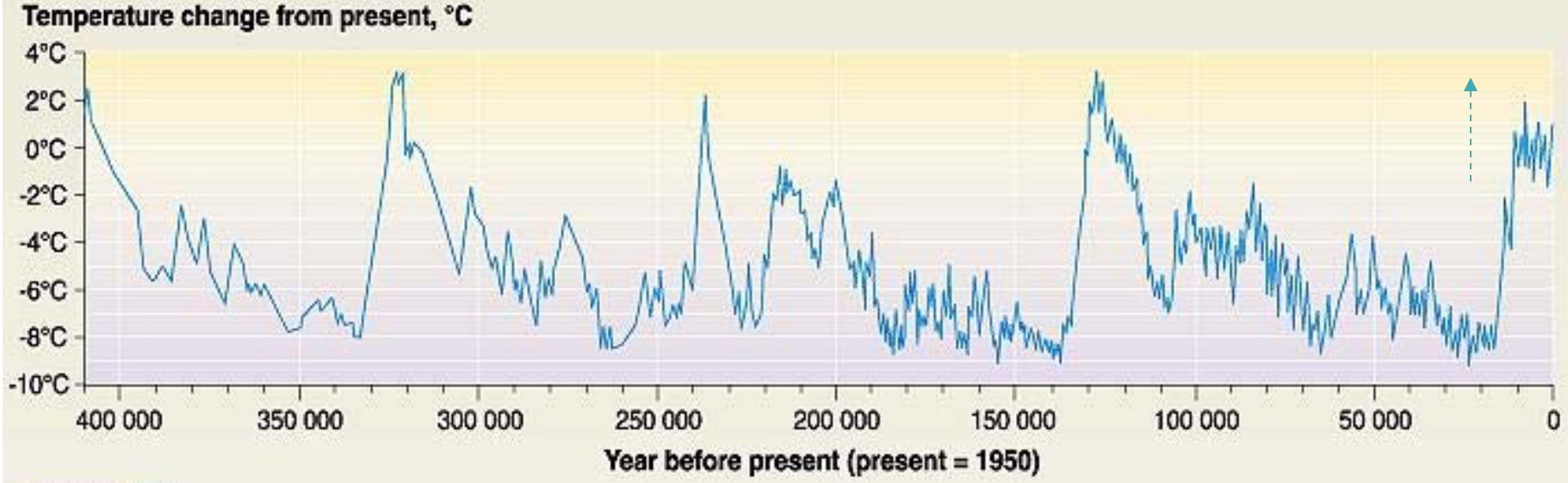
How do we know any of this about climate and the atmosphere from so long before recorded history?





Temperature and CO_2 concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)

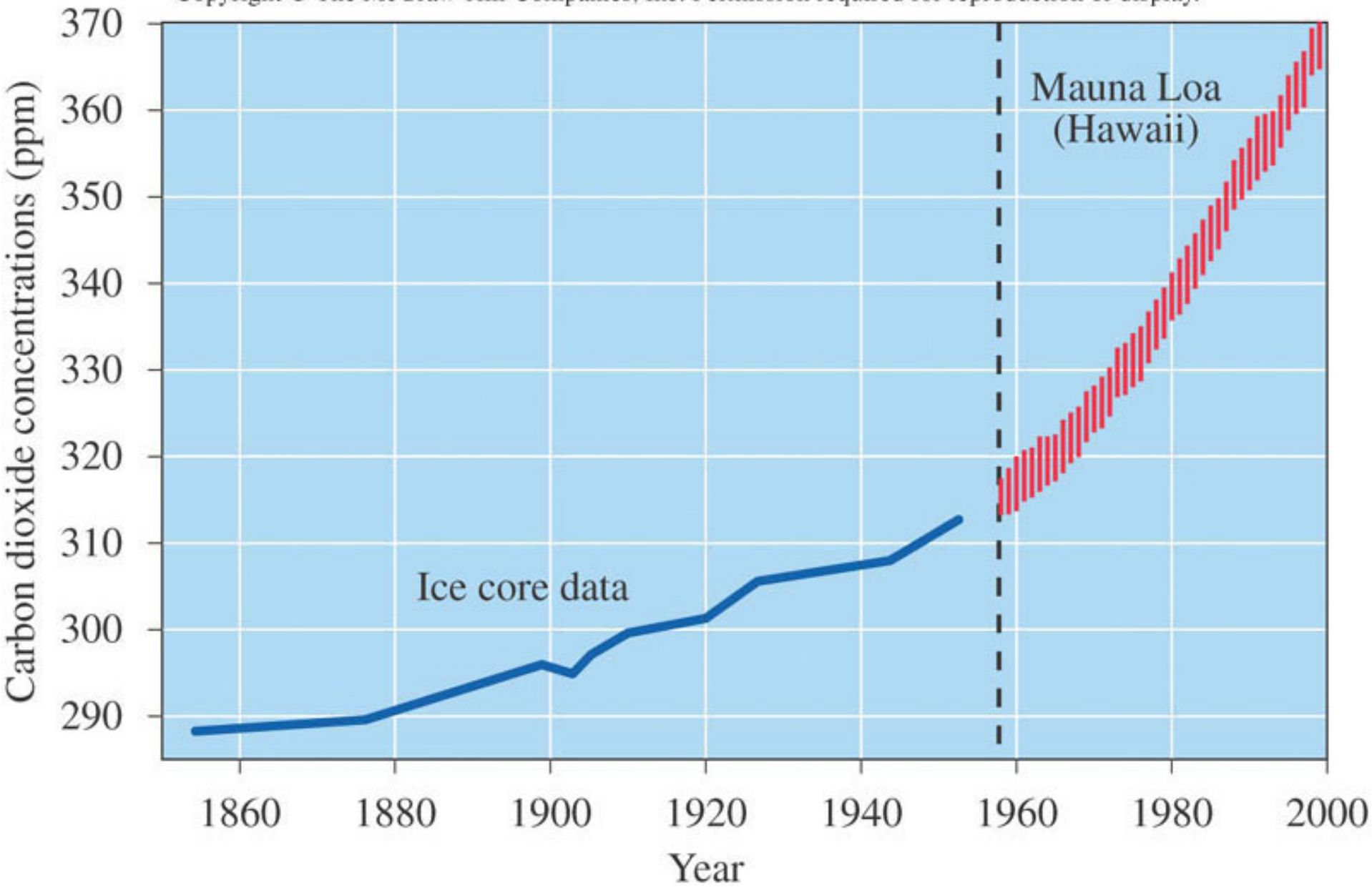




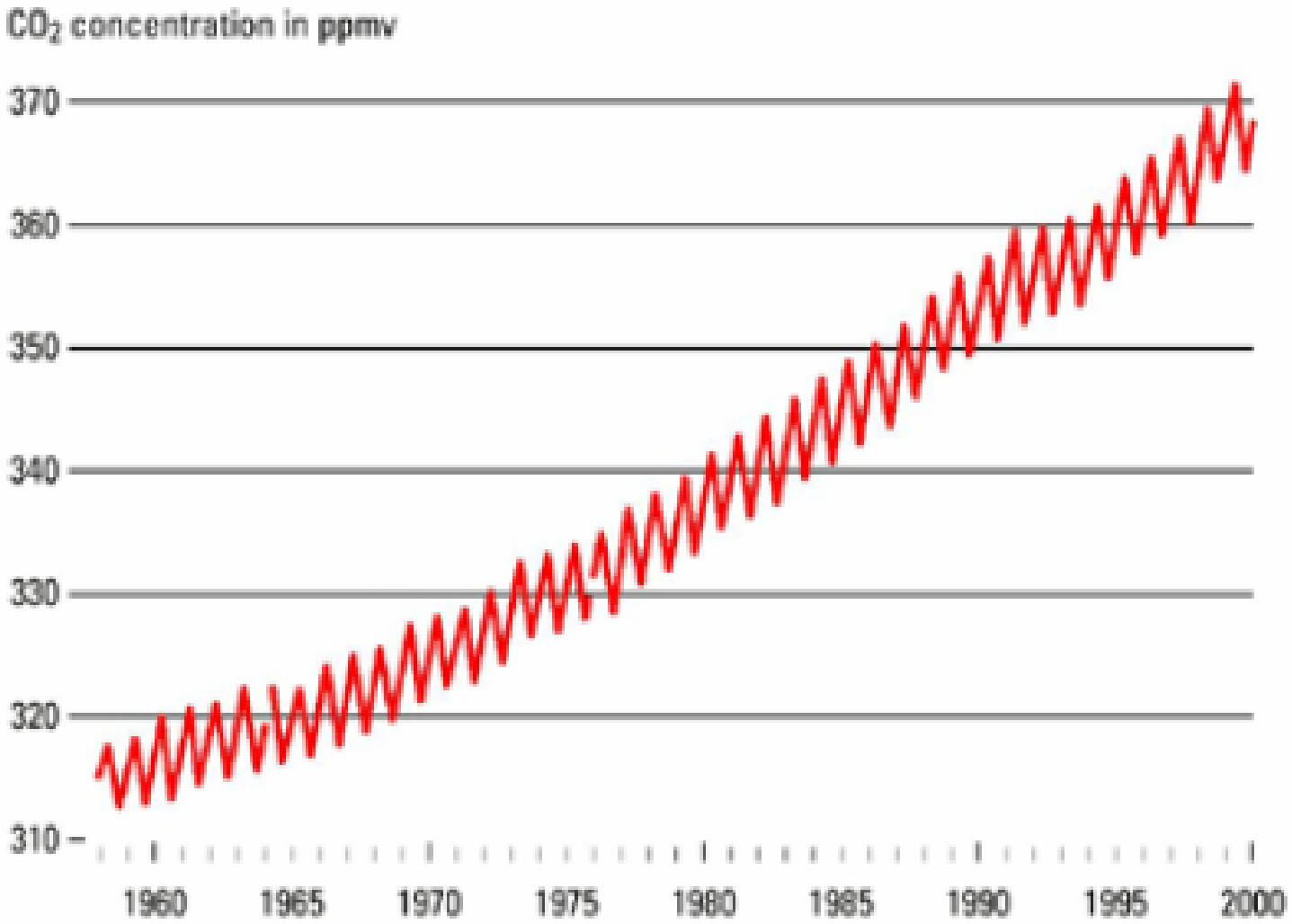
GRID Arendal UNEP

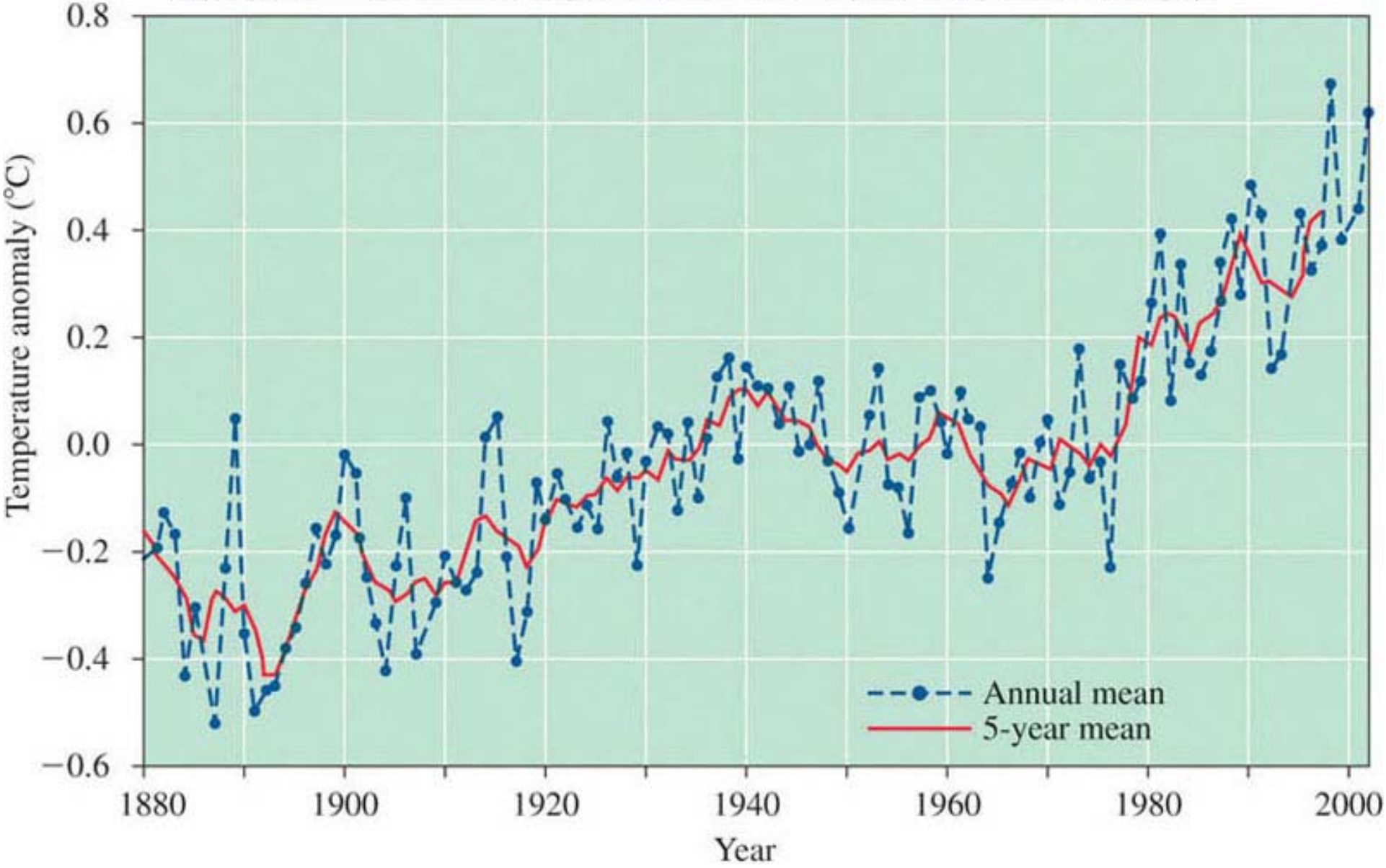
GRAPHIC DESIGN : PHILIPPE REKACEWICZ

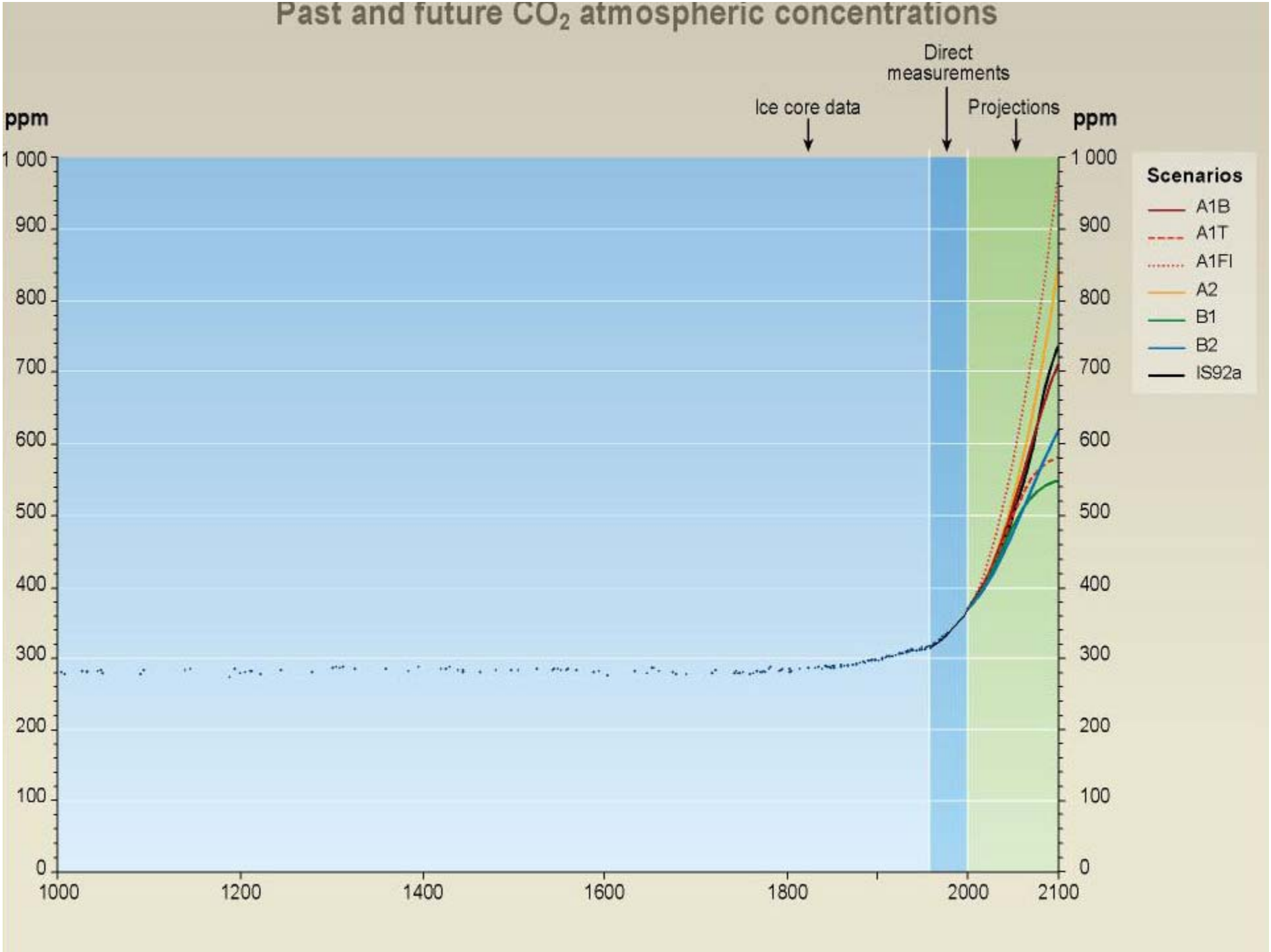
Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.



Mauna Loa CO_2 increases






Past and future CO_2 atmospheric concentrations
Ice core data
Direct measurements
Projections
ppm
ppm
1 000
900
800
700
600
500
400
300
200
100
0
1000
1200
1400
1600
1800
2000
2100
Scenarios
A1B
A1T
A1FI
A2
B1
B2
IS92a

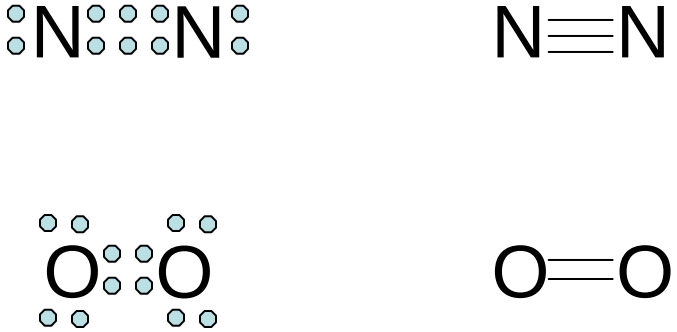
A1. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies).

A2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1. The B1 storyline and scenario family describes a convergent world with the same global population, that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

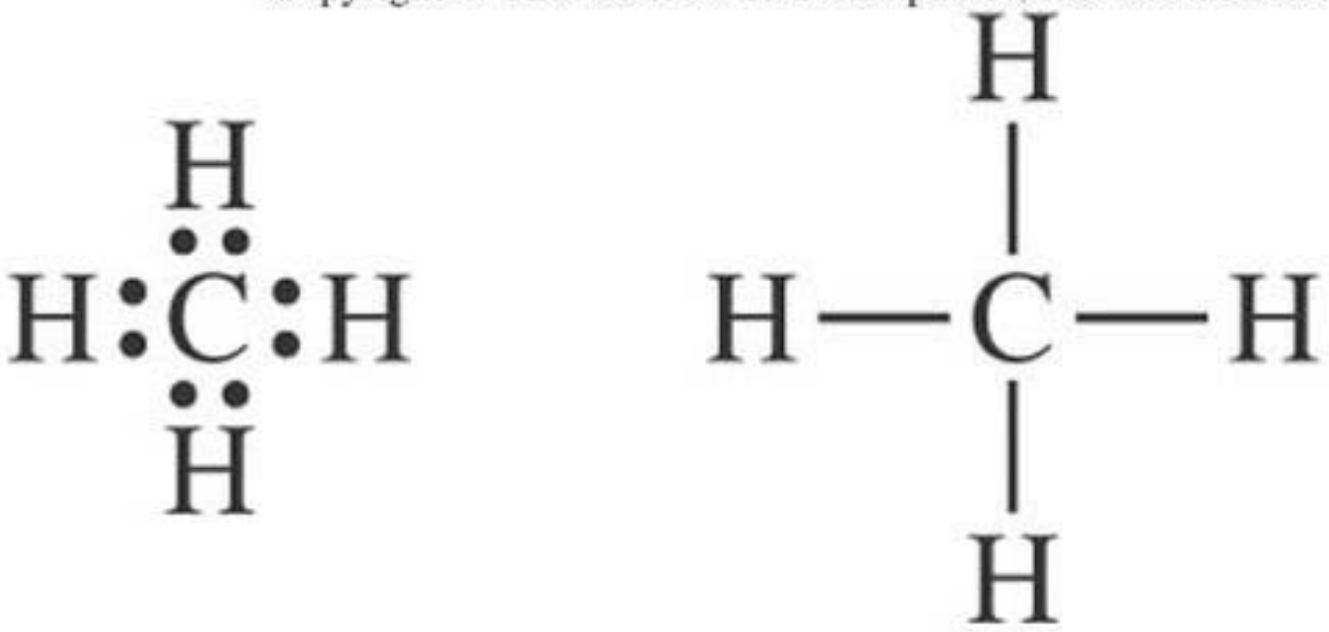
B2. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

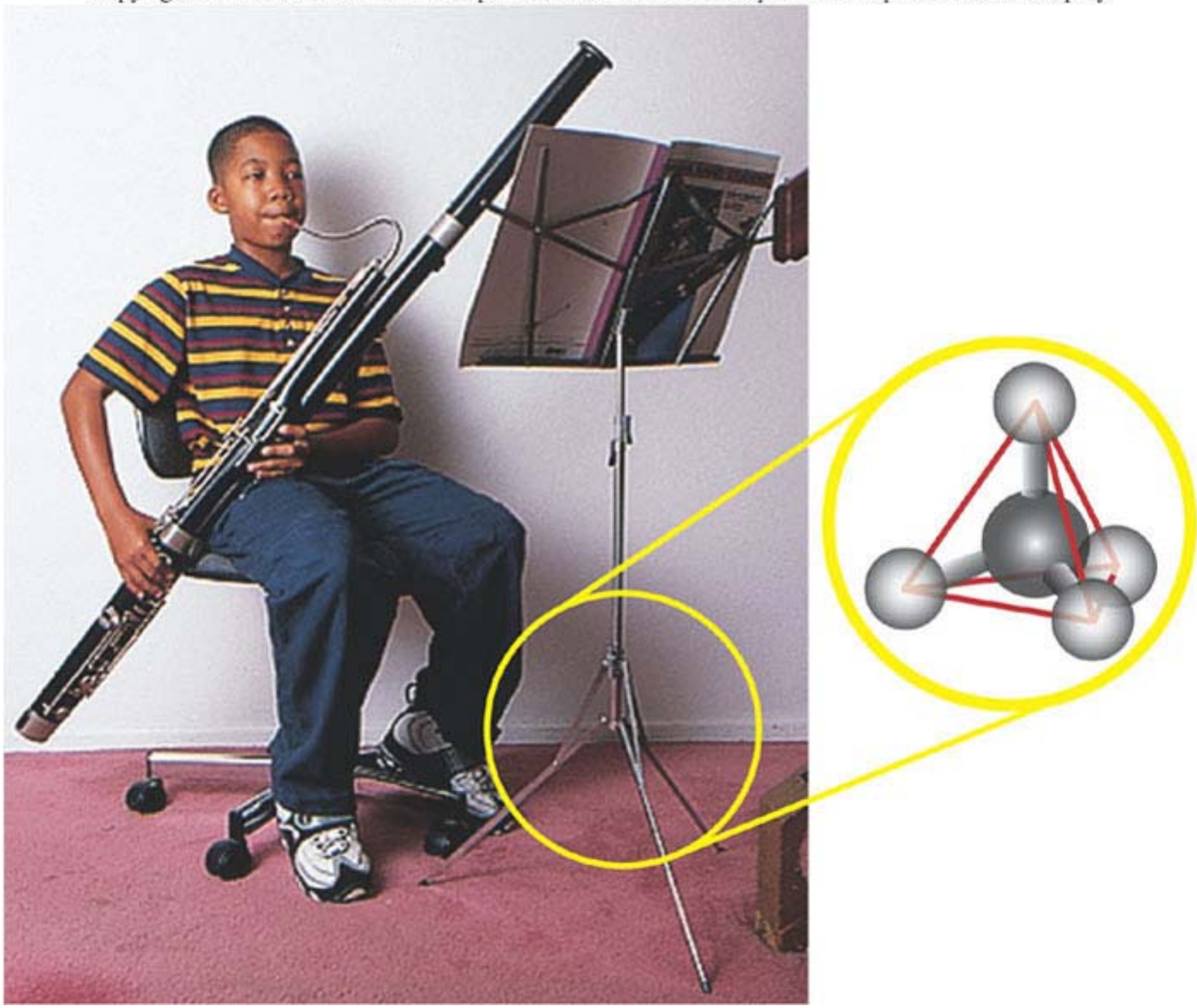
- Greenhouse Gases
  - H_2O, CO_2, CH_4
- Not Greenhouse Gases
  - N_2, O_2, Ar
- Molecular Structure
- Molecular Shape

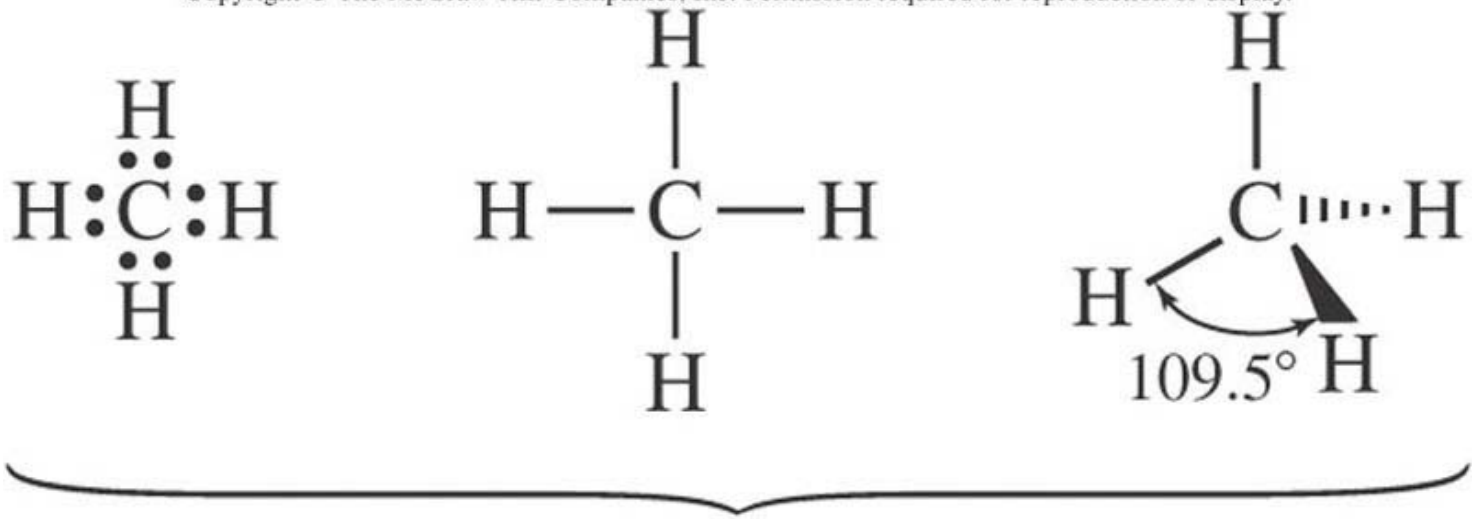


Methane, CH_4

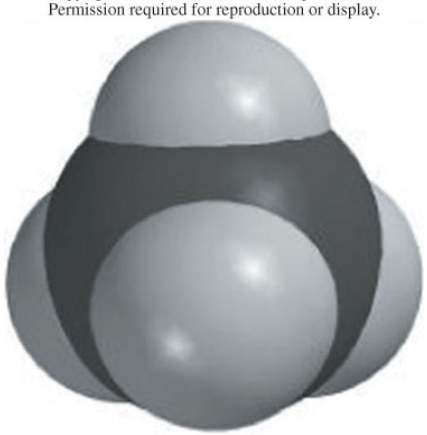
N=	8+2+2+2+2	=16
A=	4+1+1+1+1	=8
S=	N-A	8 e^- shared 4 bonds

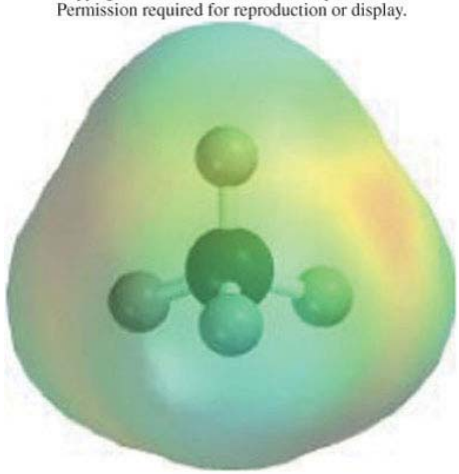






(a)



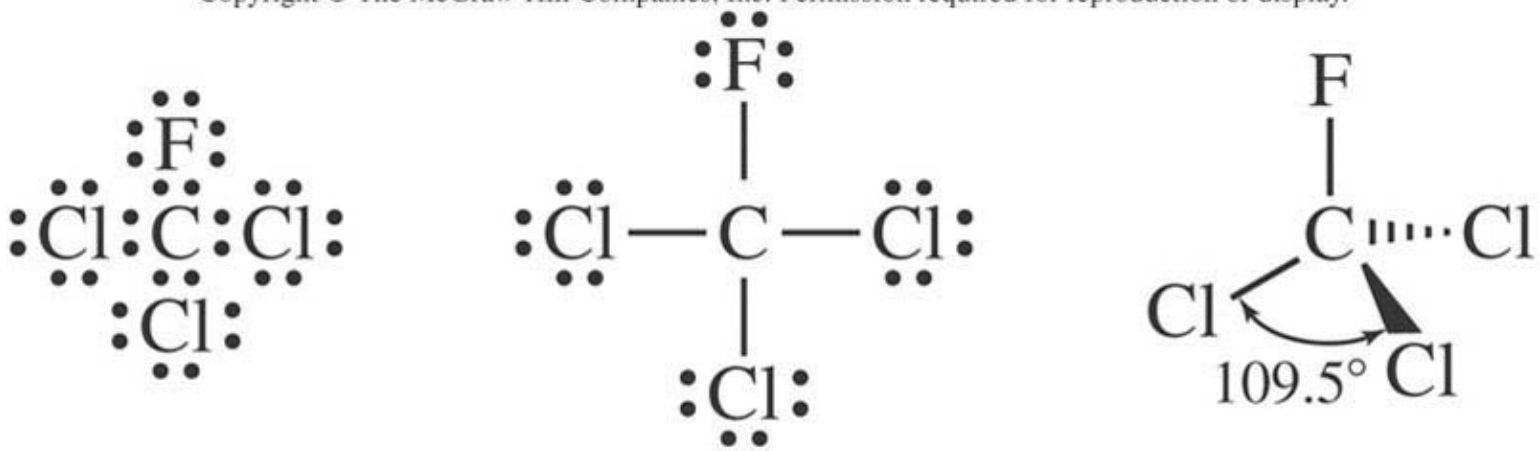


tetrahedron

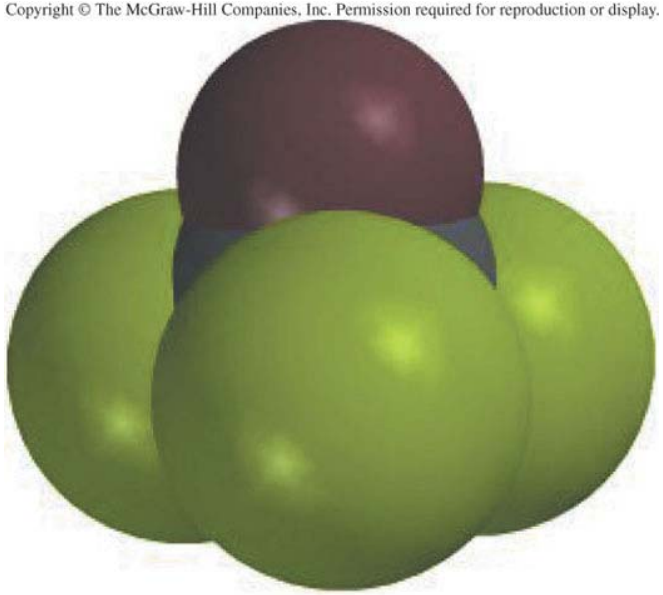
(b) (c)

Freon-11, CCl_3F

N=	8+8+8+8+8	= 40
A=	4+7+7+7+7	= 32
S=	N-A	8 e^- shared 4 bonds

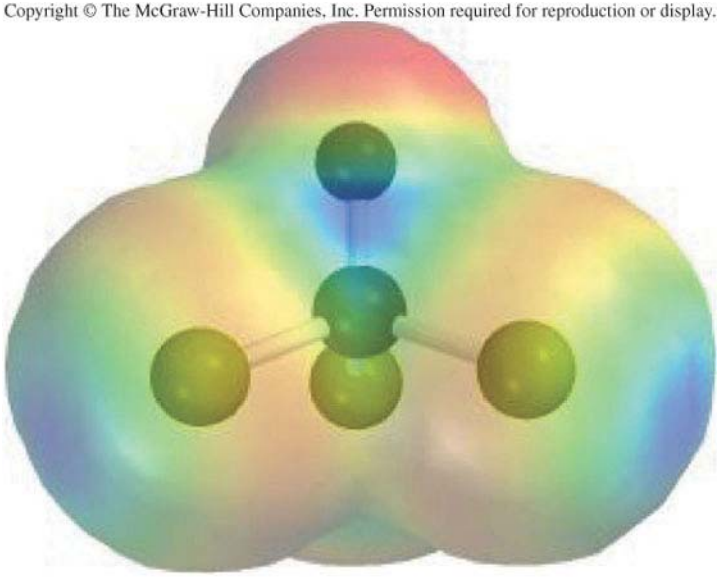


(a)



(b)

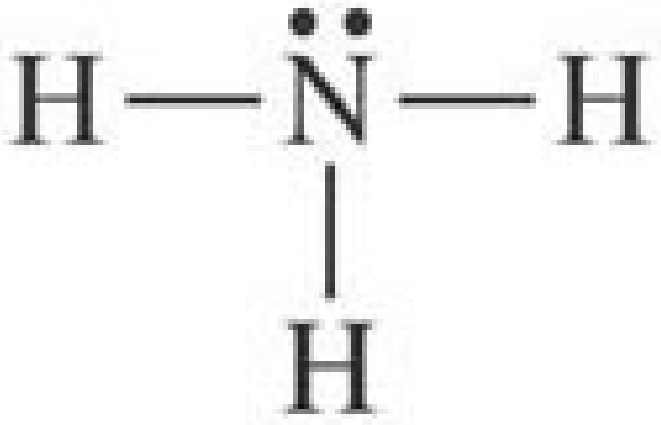
tetrahedron

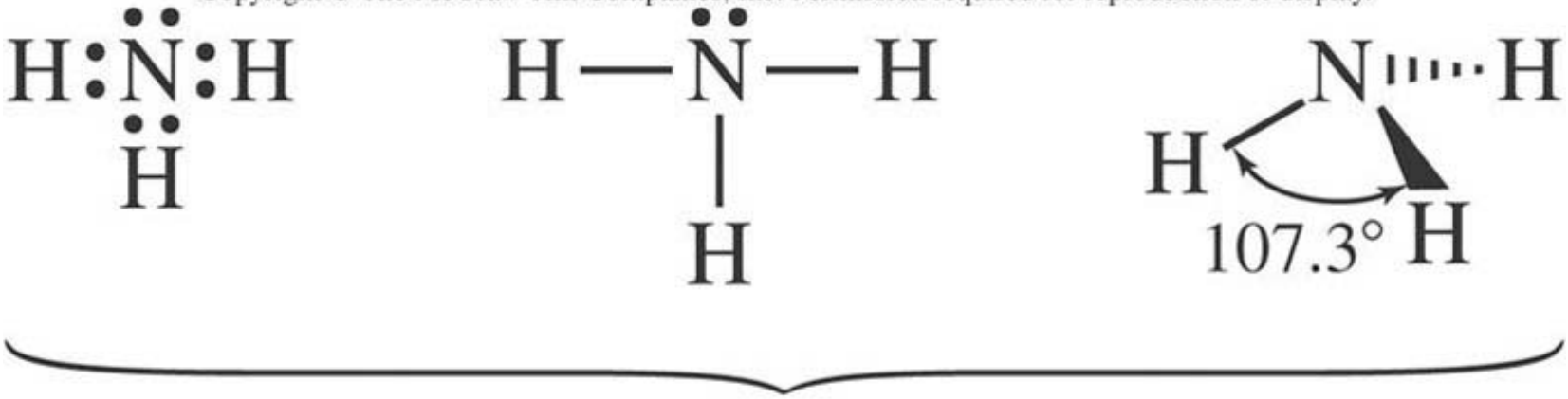


(c)

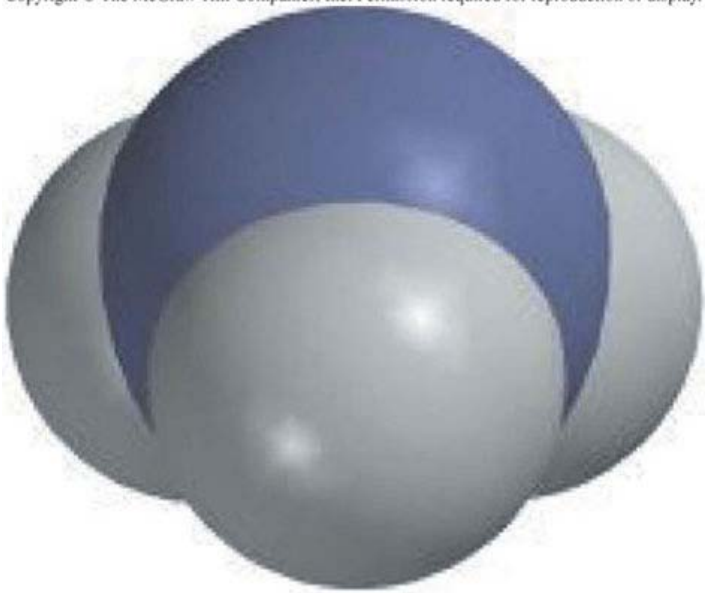
Ammonia, NH_3

N=	8+2+2+2	= 14
A=	5+1+1+1	= 8
S=	N-A	6 e^- shared 3 bonds





(a)



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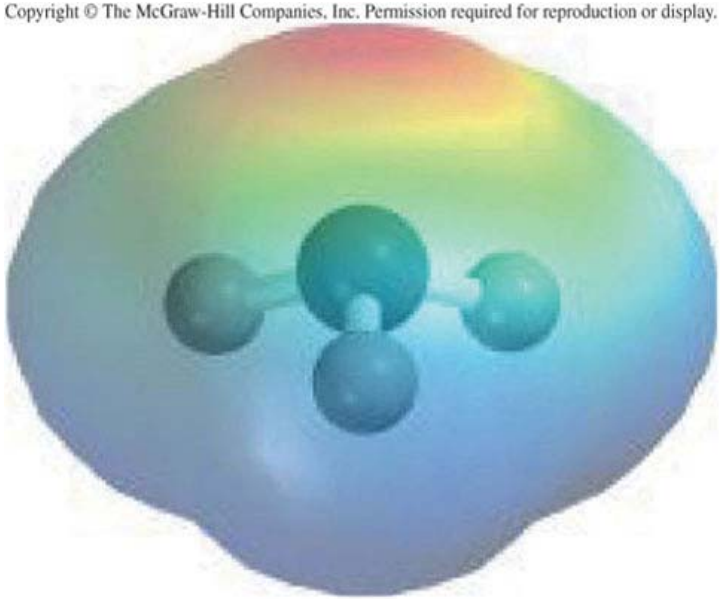

(c)

pyramid