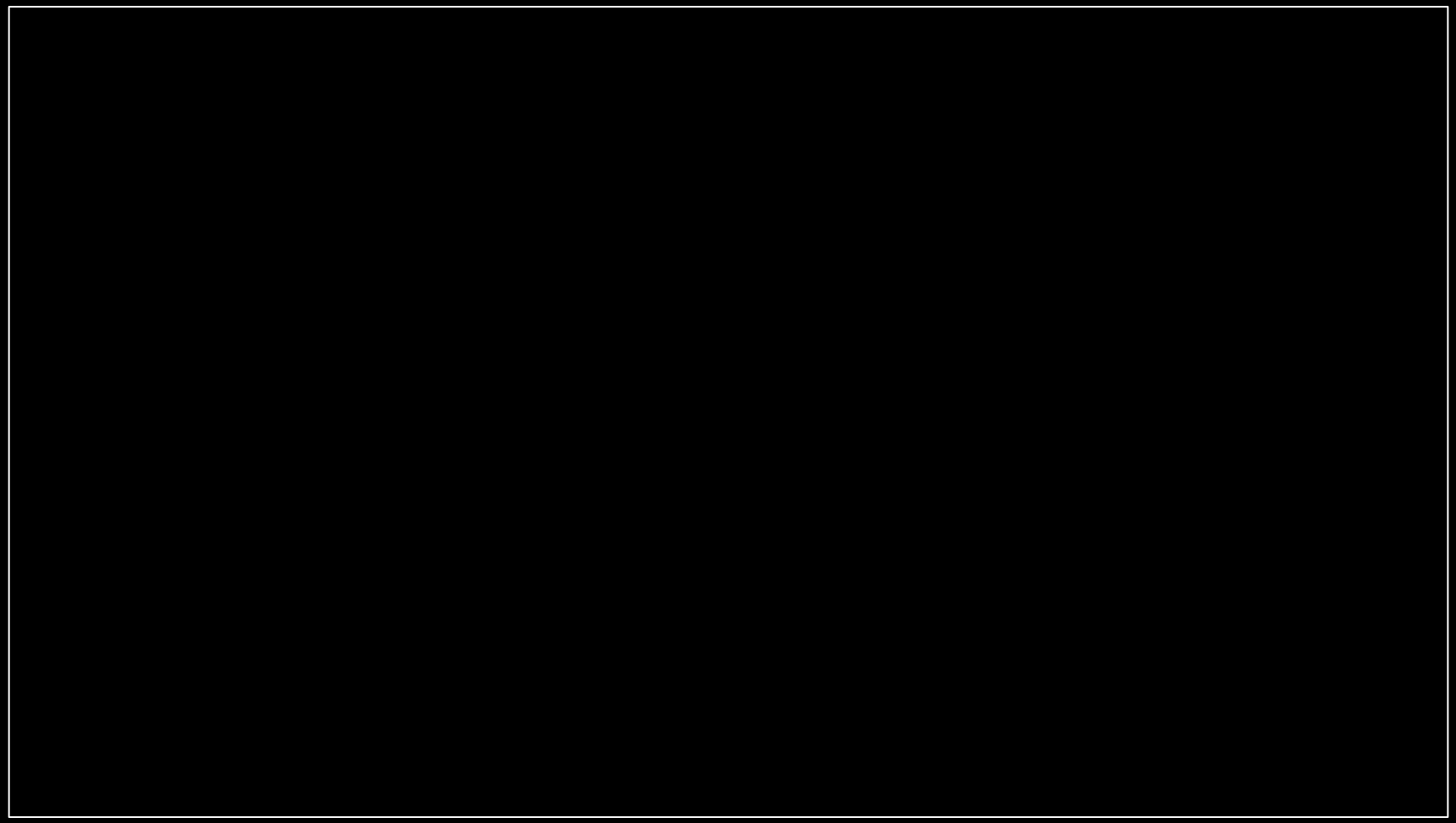
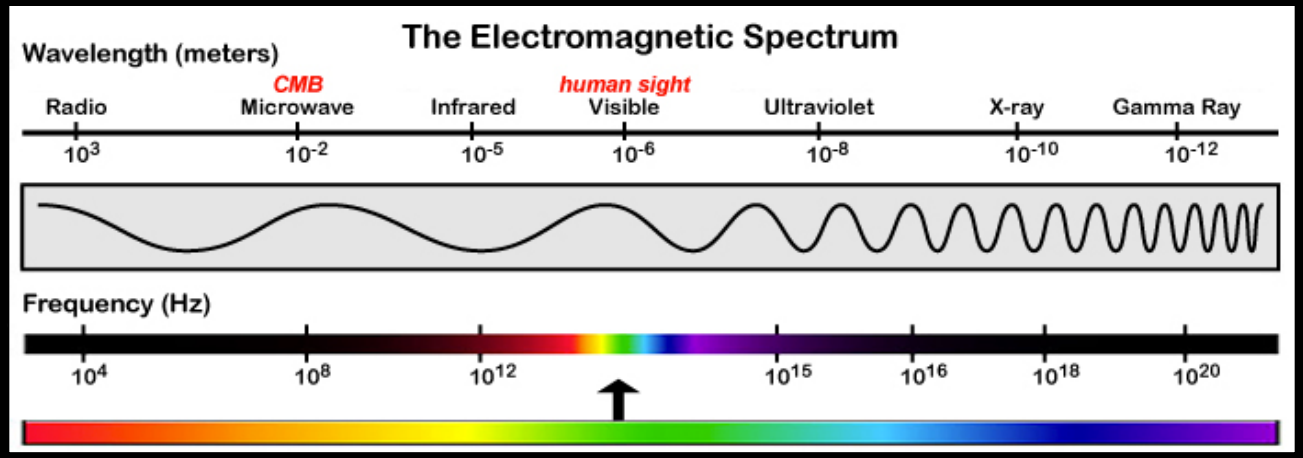
Earth as viewed by Apollo 17
Photograph courtesy NASA

NATIONAL GEOGRAPHIC

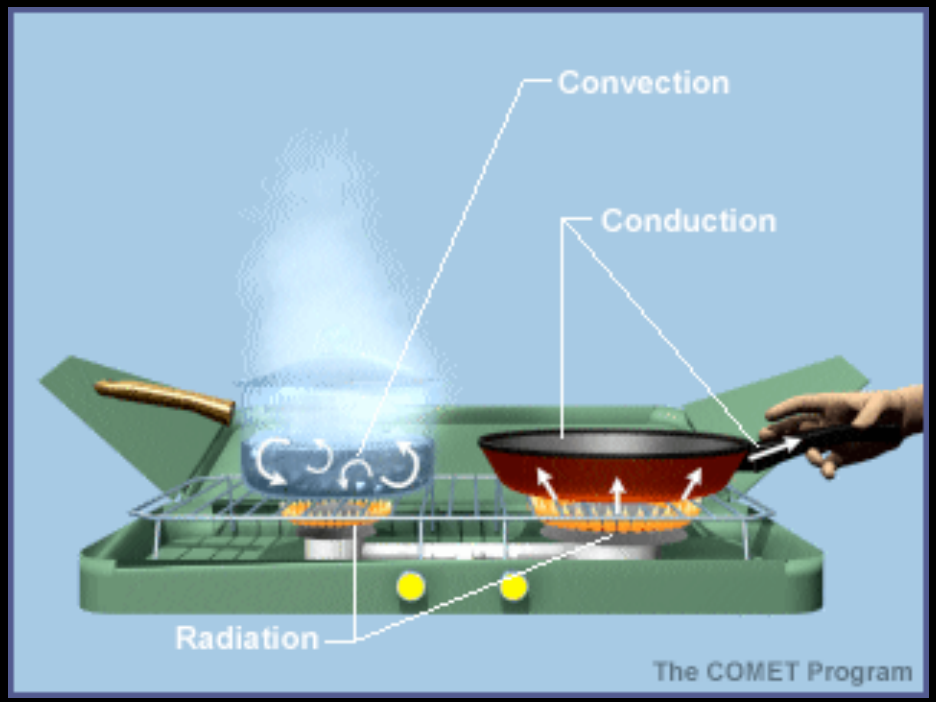


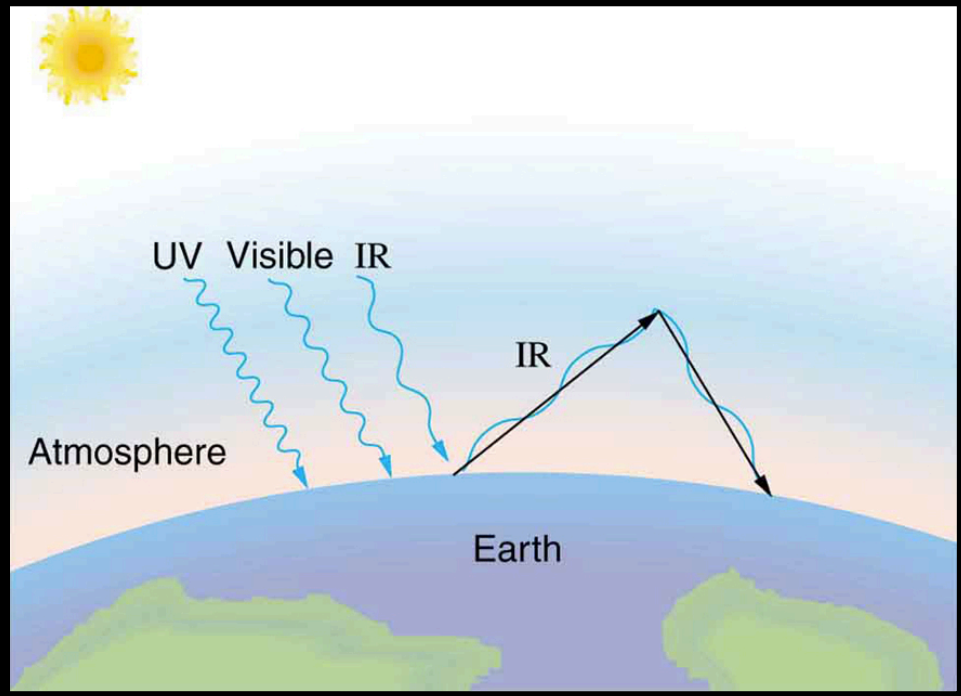
The Electromagnetic Spectrum



Kinetic Energy- Heat & Electromagnetic Radiation

- Transferred by radiation, conduction, or convection

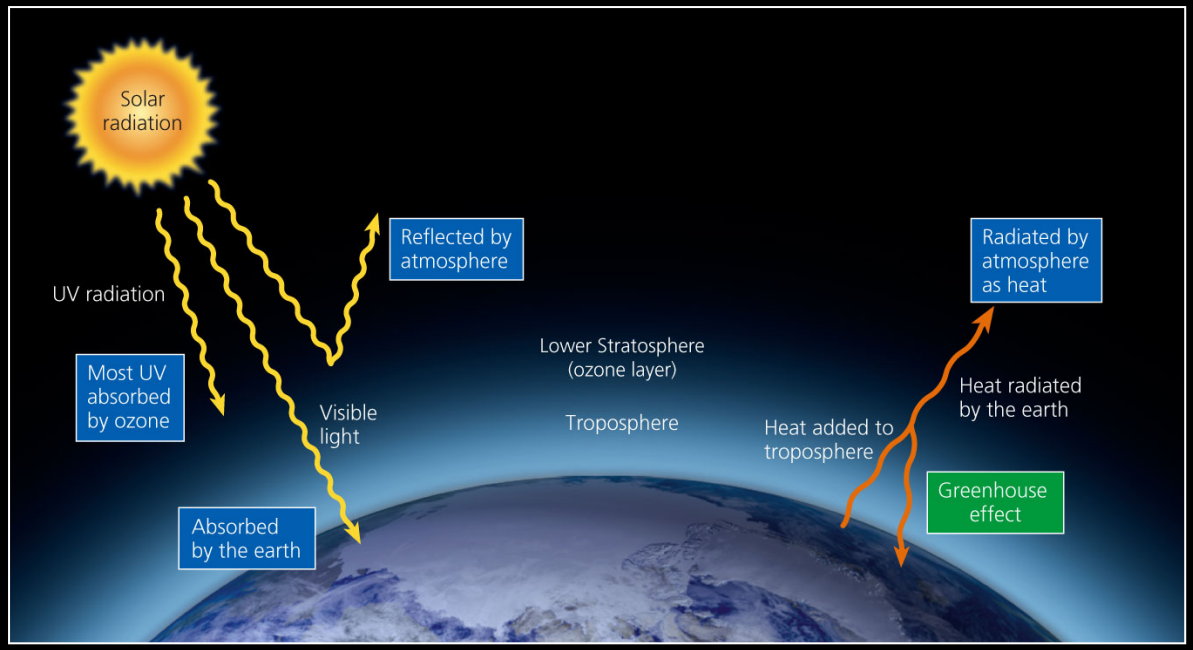


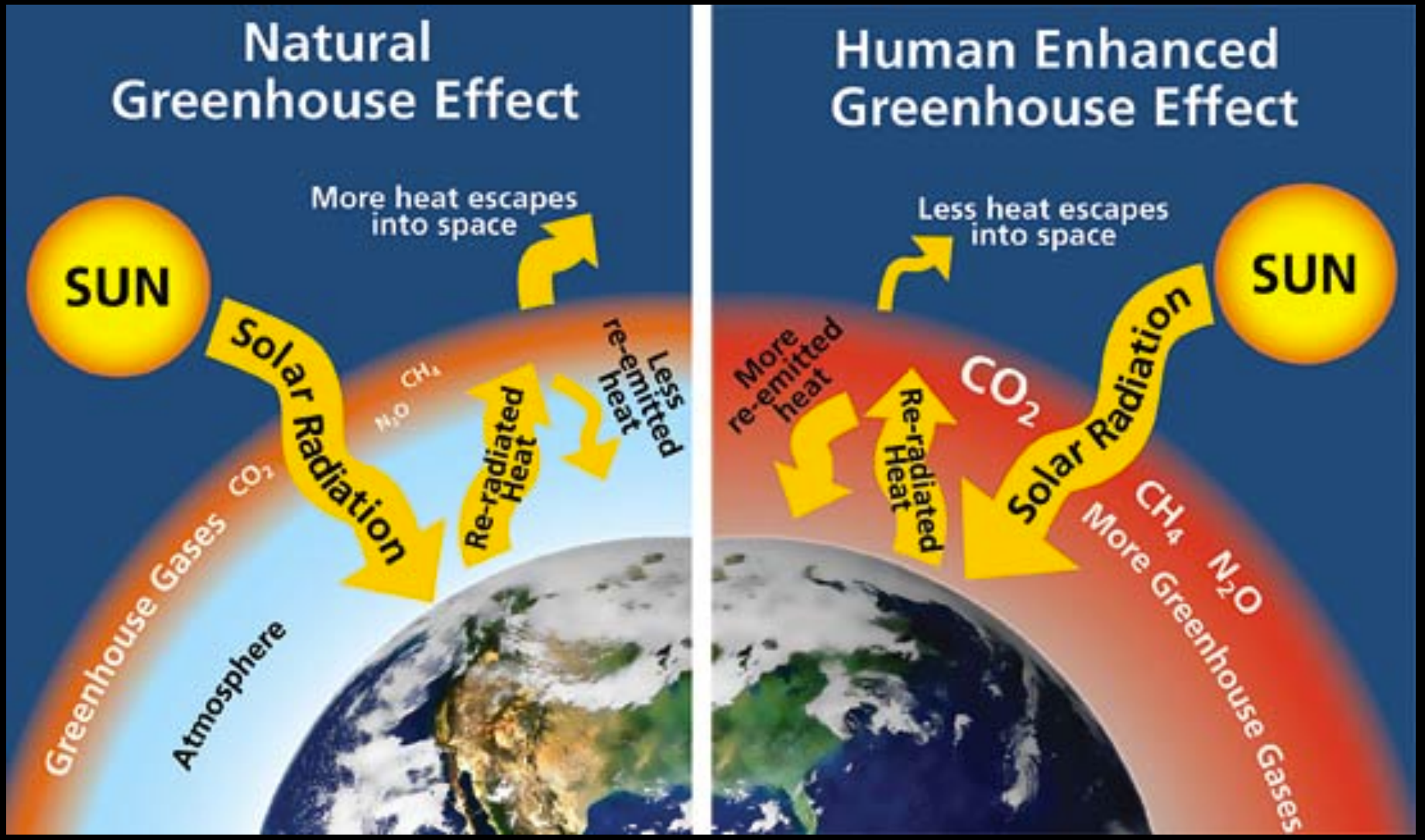


Sun, Earth, Life, and Climate

Natural greenhouse effect

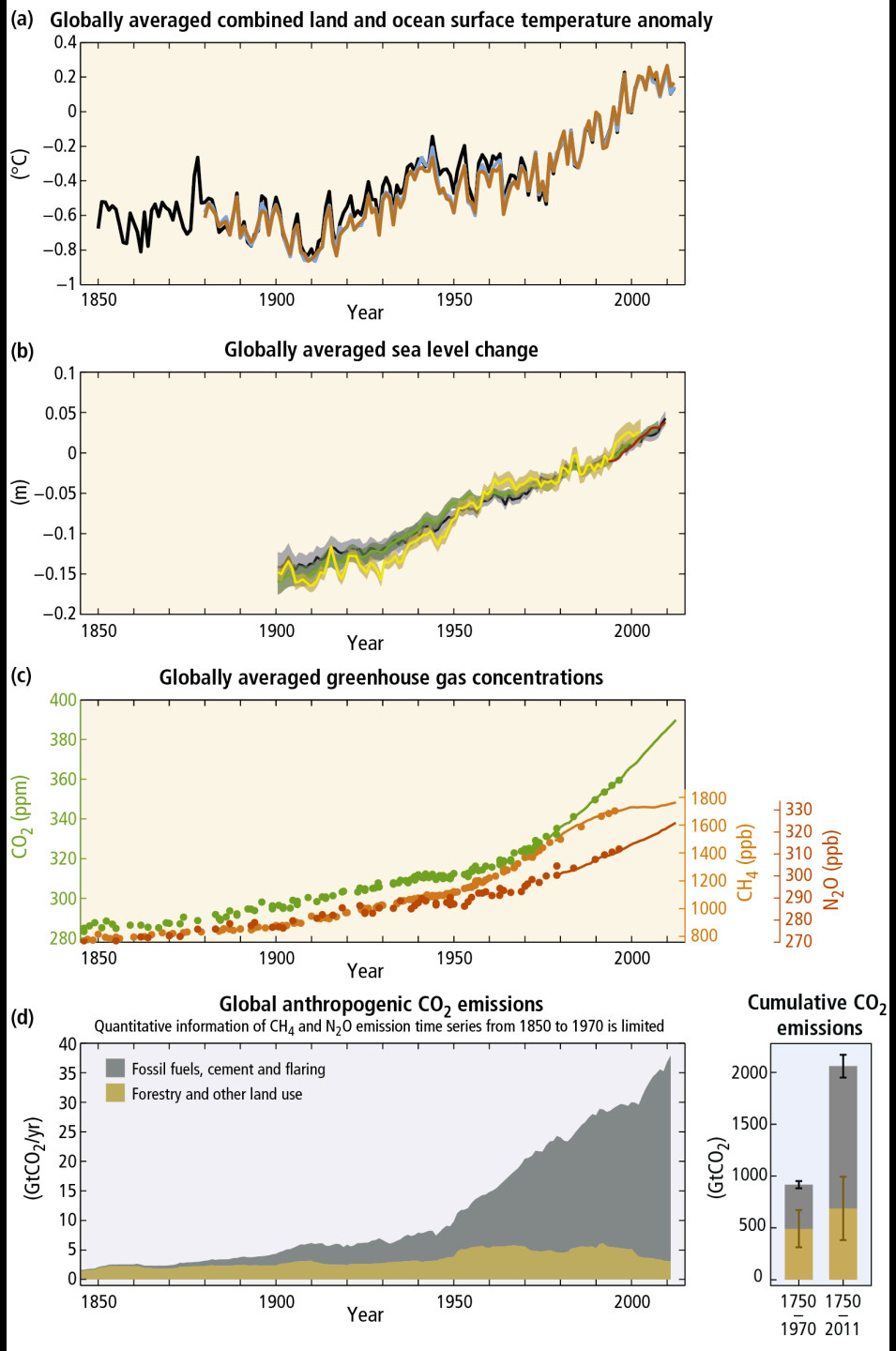
- Sun's Energy/EM Radiation includes: Ultraviolet (UV), Visible, and Infrared Radiation (IR) Electromagnetic Radiation
  - Absorbed by ozone and other atmosphere gases
  - Absorbed by the earth
  - Reflected by the earth
  - Radiated by the atmosphere as heat



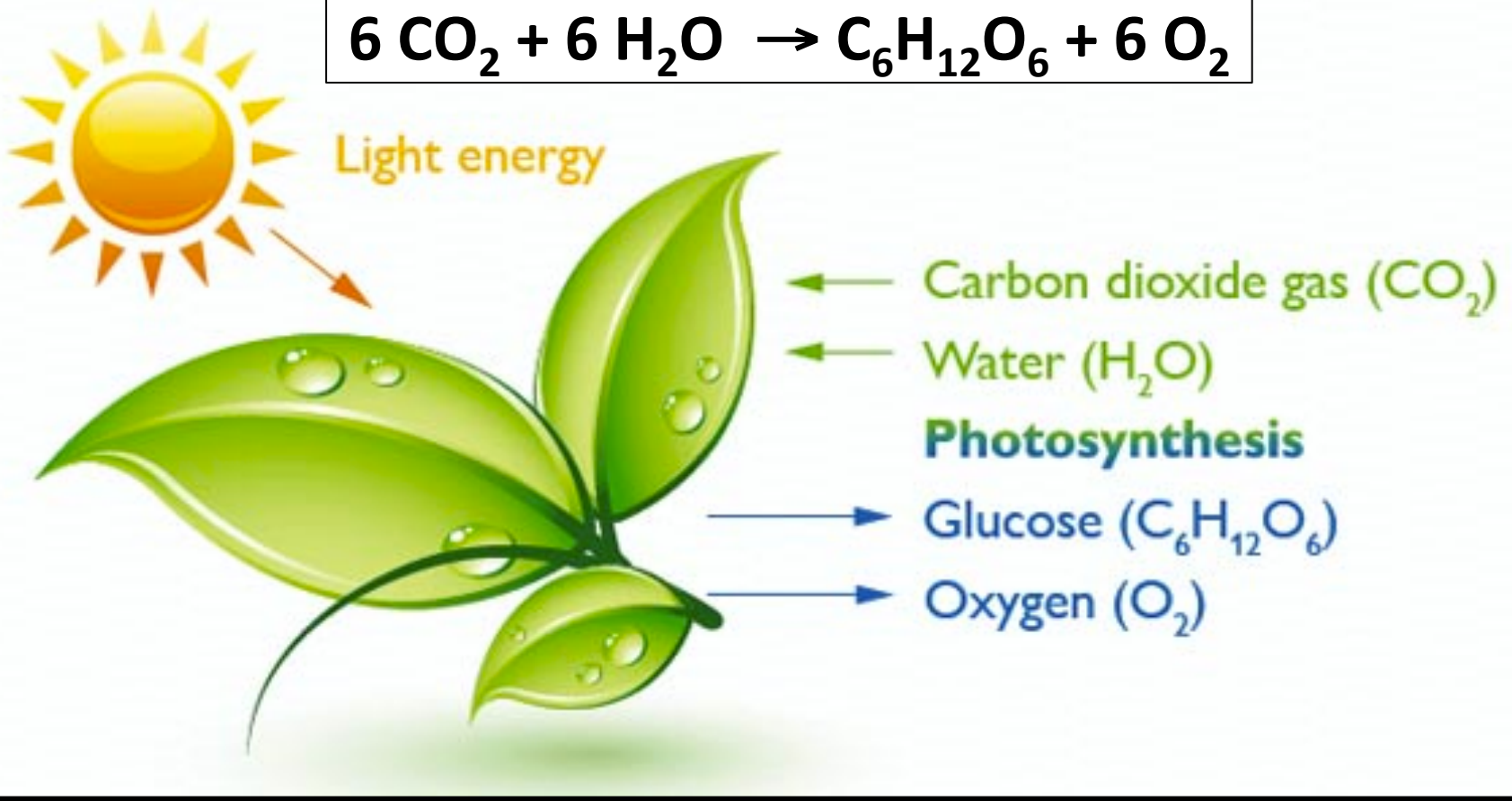

Natural
Greenhouse Effect
More heat escapes
into space
SUN
Solar Radiation
Re-radiated
Heat
Less
re-emitted
heat
CH_4
N_2O
CO_2
Greenhouse Gases
Atmosphere
Human Enhanced
Greenhouse Effect
Less heat escapes
into space
SUN
Solar Radiation
More
re-emitted
heat
Re-radiated
Heat
CO_2
CH_4
N_2O
More Greenhouse Gases

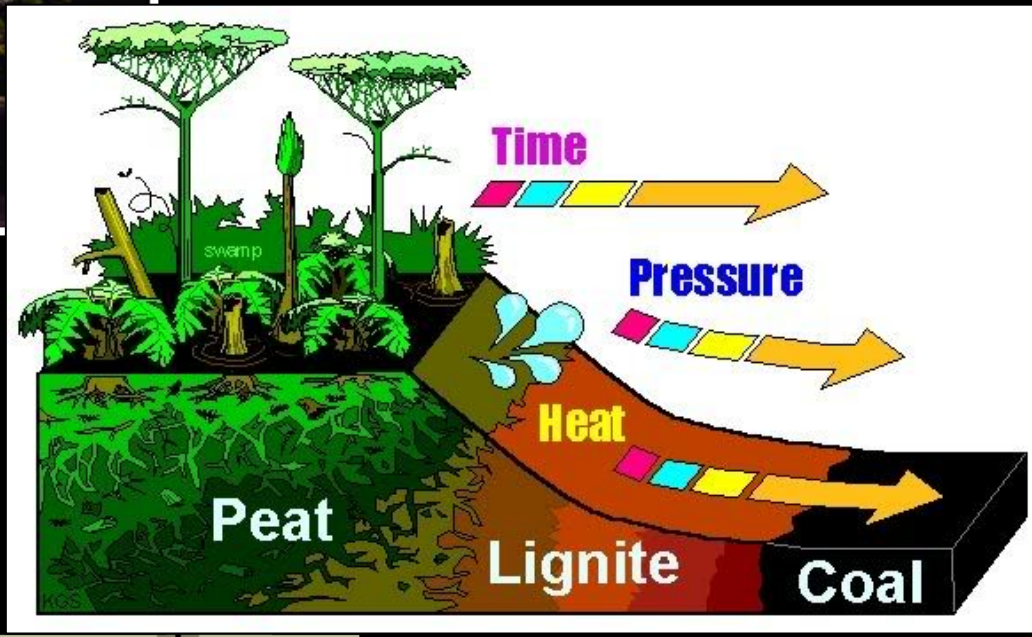
Greenhouse gases are formed by burning fossil fuels like coal to produce electricity (carbon dioxide; CO_2), burning fossil fuels like gasoline to power cars (carbon dioxide; CO_2), and raising livestock (cows) for food (Methane CH_4).

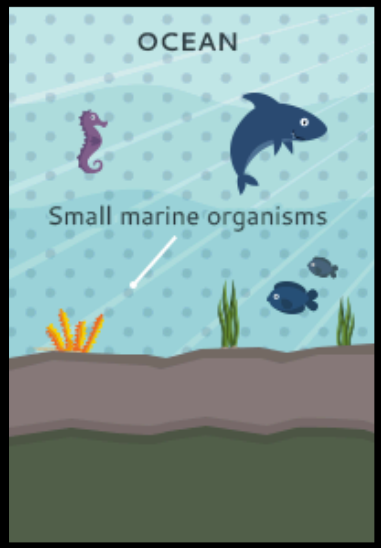


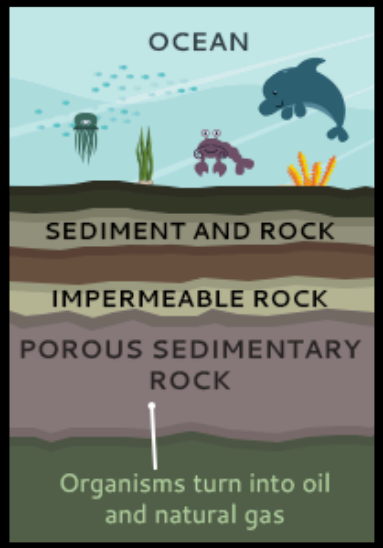

(a) Globally averaged combined land and ocean surface temperature anomaly
(°C)
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
1850
1900
1950
2000
Year
(b) Globally averaged sea level change
(m)
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
1850
1900
1950
2000
Year
(c) Globally averaged greenhouse gas concentrations
CO2 (ppm)
400
380
360
340
320
300
280
CH4 (ppb)
1800
1600
1400
1200
1000
800
N2O (ppb)
330
320
310
300
290
280
270
1850
1900
1950
2000
Year
(d) Global anthropogenic CO2 emissions
Quantitative information of CH4 and N2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
(GtCO2/yr)
40
35
30
25
20
15
10
5
0
1850
1900
1950
2000
Year
Cumulative CO2 emissions
(GtCO2)
2000
1500
1000
500
0
1750–1970
1750–2011

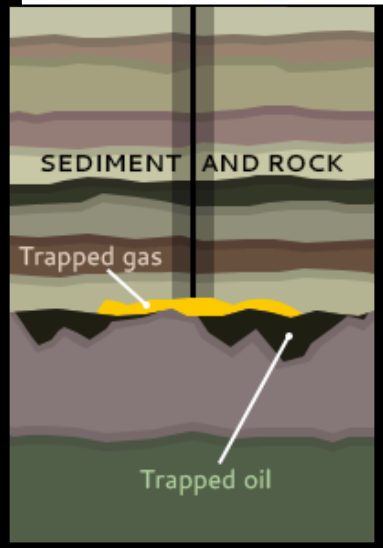
$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$

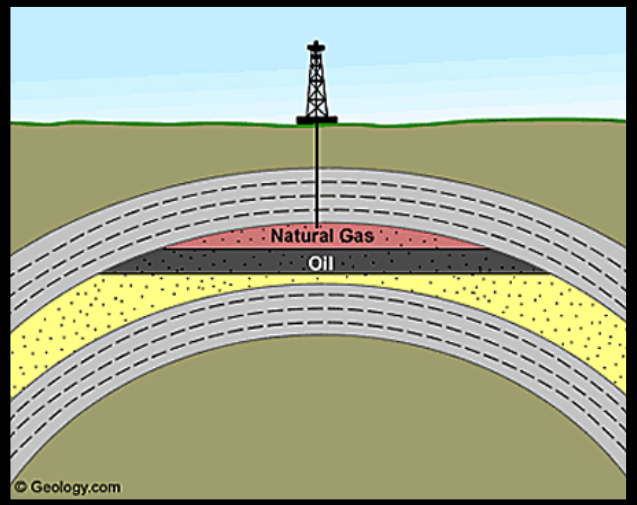



Time
swamp
Pressure
Heat
Peat
Lignite
Coal


OCEAN
Small marine organisms


OCEAN
SEDIMENT AND ROCK
IMPERMEABLE ROCK
POROUS SEDIMENTARY ROCK
Organisms turn into oil and natural gas


SEDIMENT AND ROCK
Trapped gas
Trapped oil


Natural Gas
Oil
© Geology.com

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

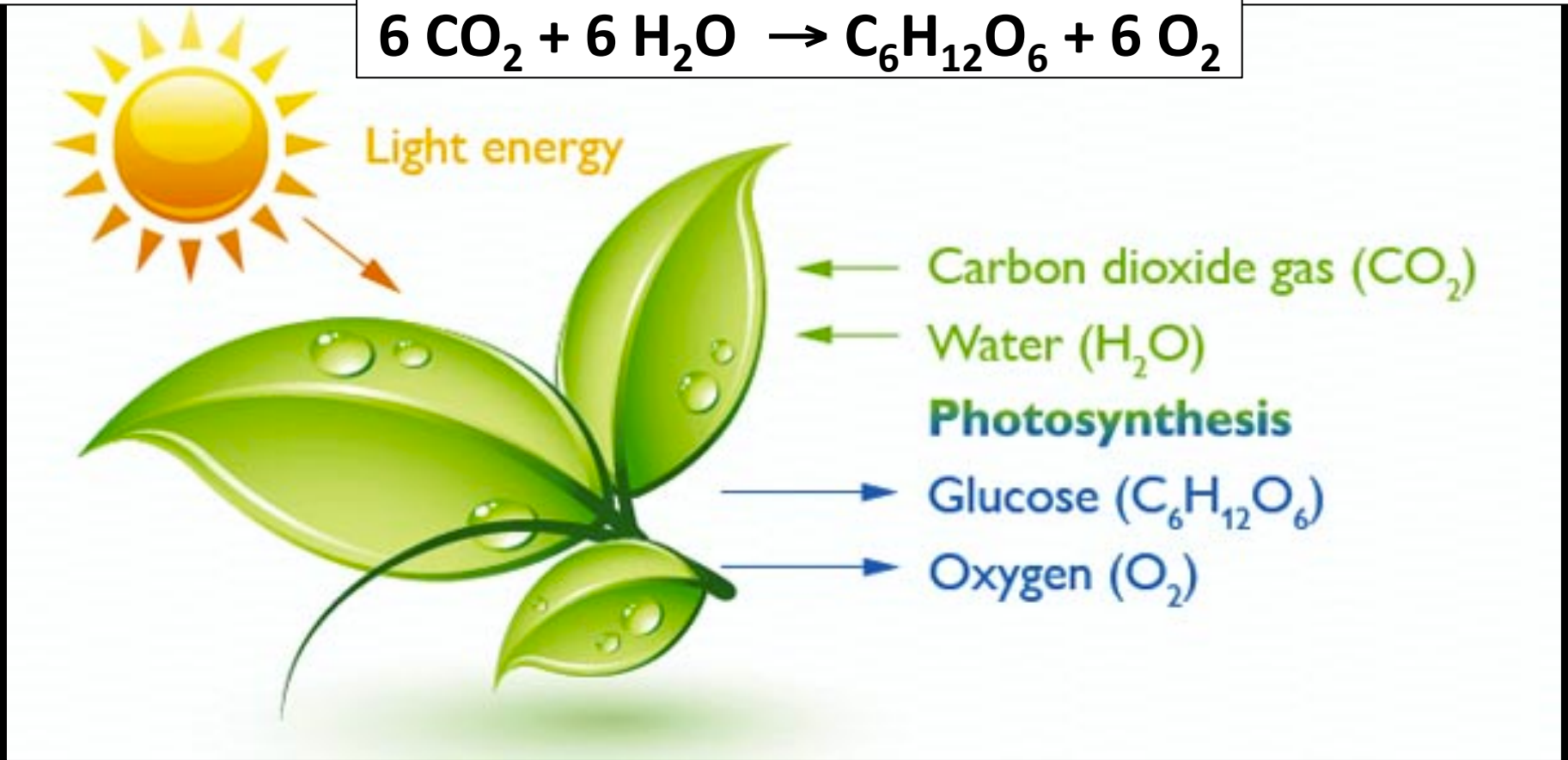
CH_4 methane

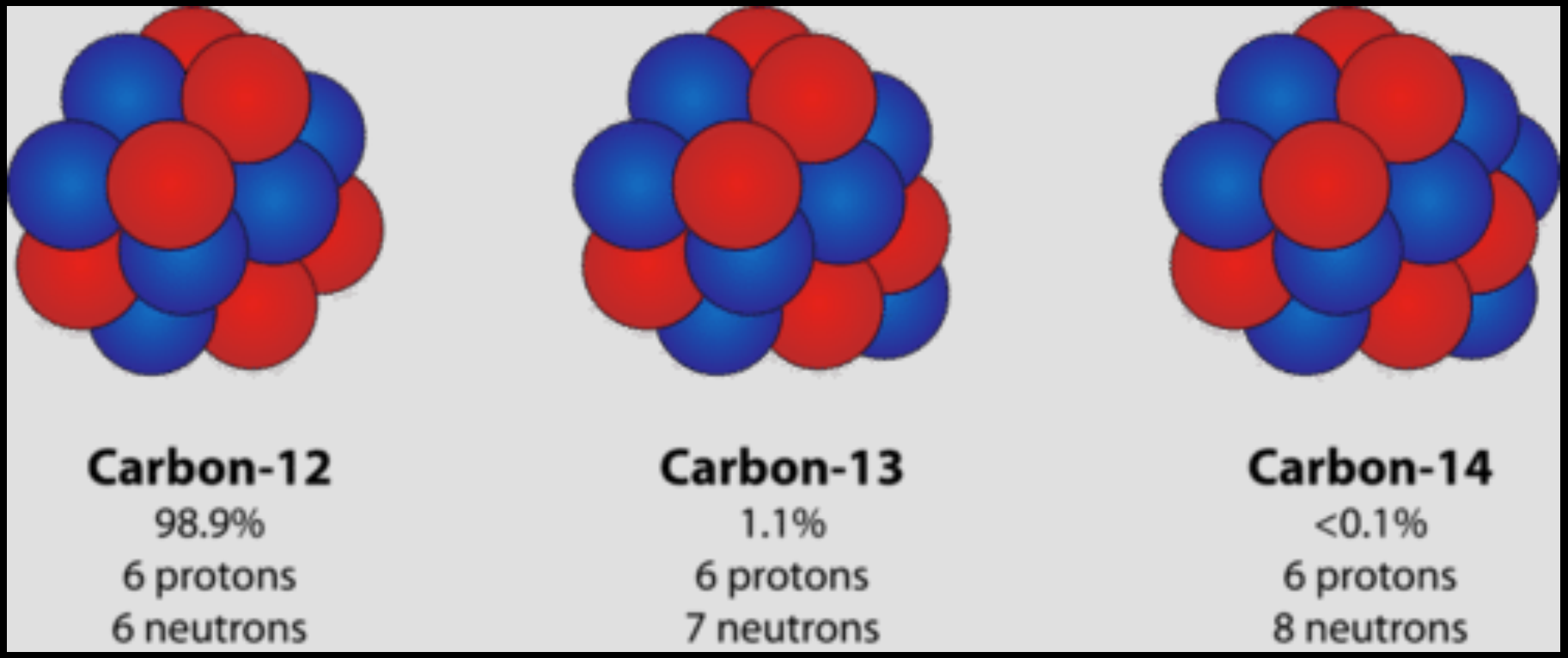
$2O_2$ oxygen

CO_2 carbon dioxide

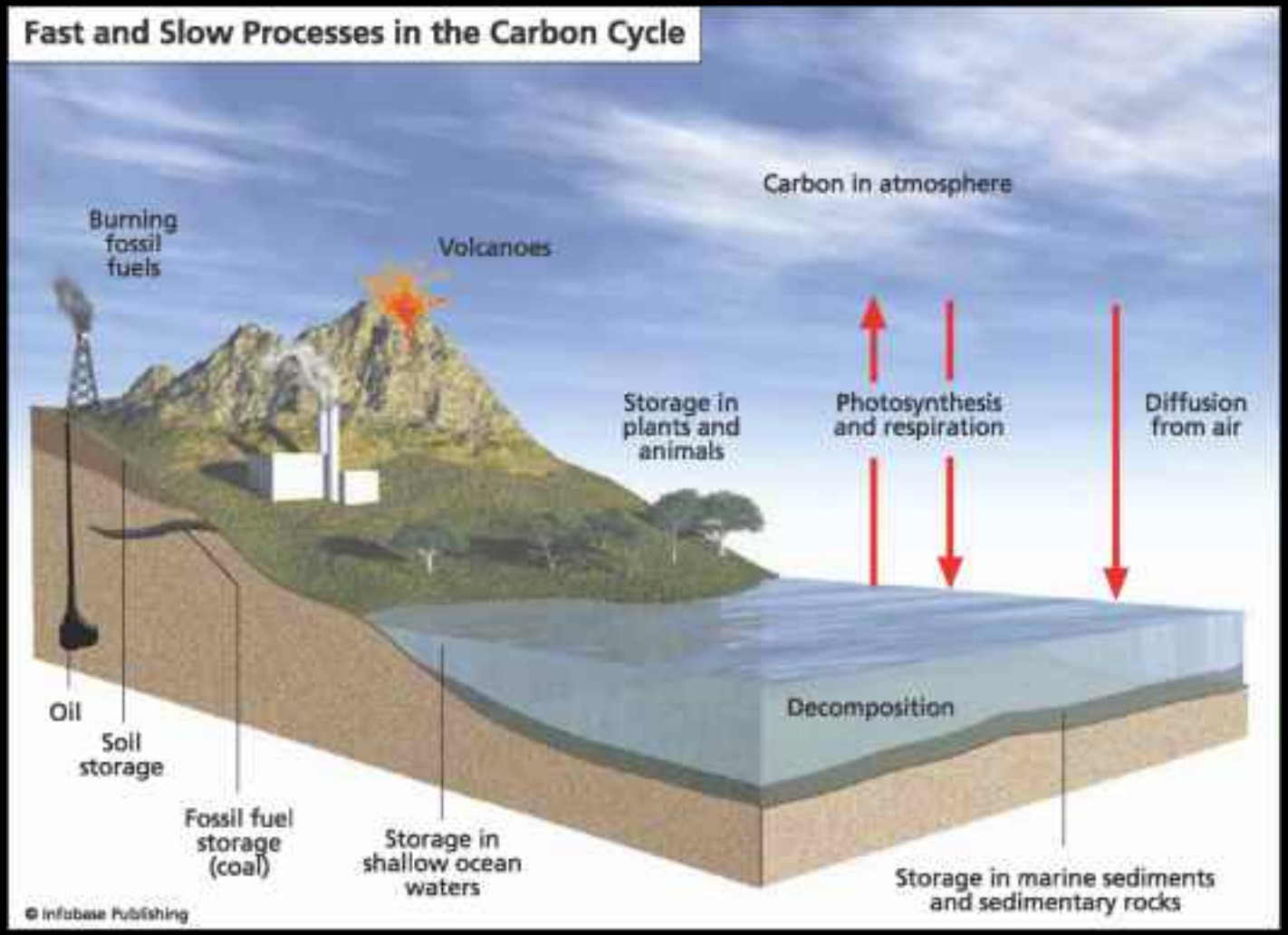
$2H_2O$ water

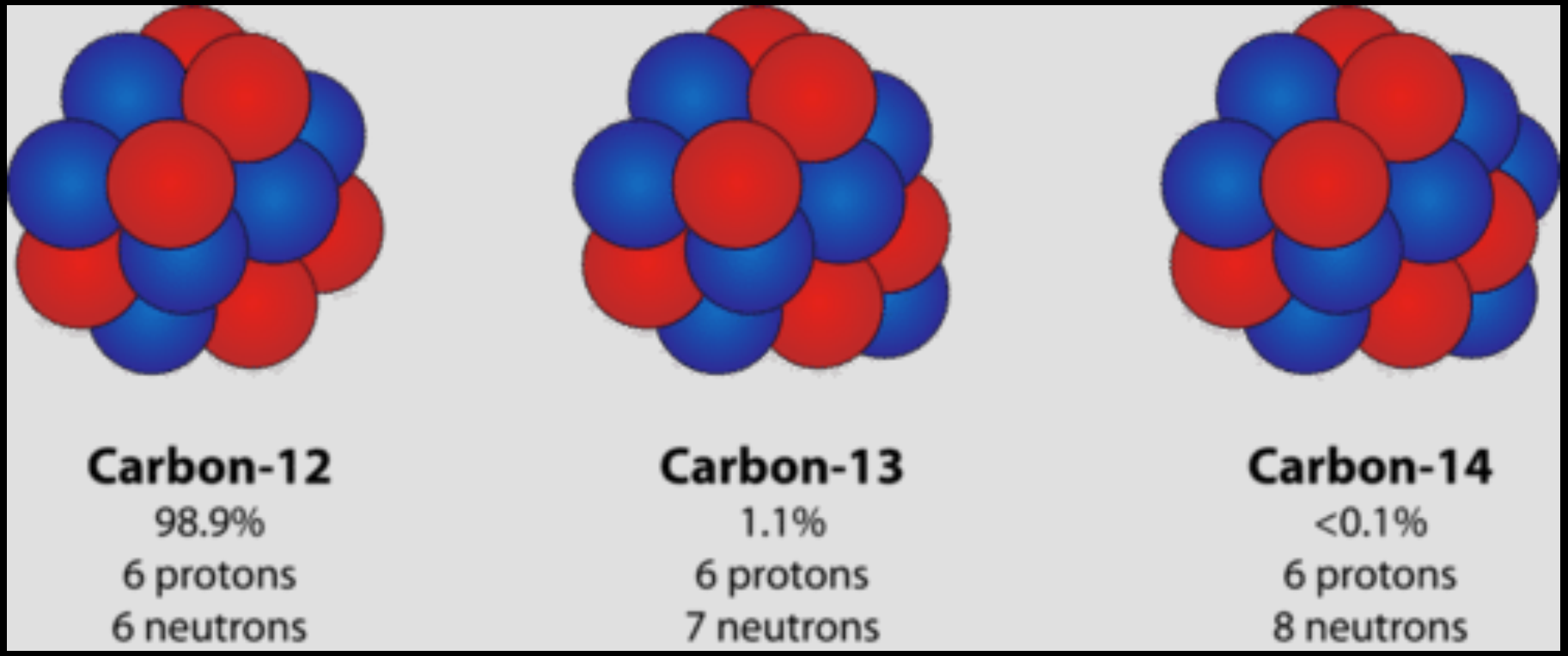
$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$





Isotope: forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass


Fast and Slow Processes in the Carbon Cycle
Carbon in atmosphere
Burning fossil fuels
Volcanoes
Storage in plants and animals
Photosynthesis and respiration
Diffusion from air
Oil
Soil storage
Fossil fuel storage (coal)
Storage in shallow ocean waters
Decomposition
Storage in marine sediments and sedimentary rocks
© Infobase Publishing



1. What do carbon isotope ratios have to do with burning fossil fuels and carbon dioxide emissions?
2. How have scientists learned about carbon isotope ratios over the past 10,000 years?
3. What has happened to carbon isotope ratios over the last 150 yrs?
4. How does this provide evidence to support the claim that the atmospheric CO_2 increase over the last 150 years is caused by human activity?

AP Environmental Science

Section I: Multiple Choice

- ✧ 1 hour 30 minutes (90 minutes)
- ✧ 100 questions
- ✧ Approximately 54 seconds per question
- ✧ 60% of final test grade (not class grade)

Section II: Free Response

- ✧ 1 hour 30 minutes (90 minutes)
- ✧ 4 questions
  - ➢ Document Based Question
  - ➢ Data-Set Question
  - ➢ Synthesis & Evaluation
  - ➢ Synthesis & Evaluation
- ✧ Approximately 22 minutes per question
- ✧ 40% of final test grade (not class grade)

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

CH_4 methane

$2O_2$ oxygen

CO_2 carbon dioxide

$2H_2O$ water

$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$