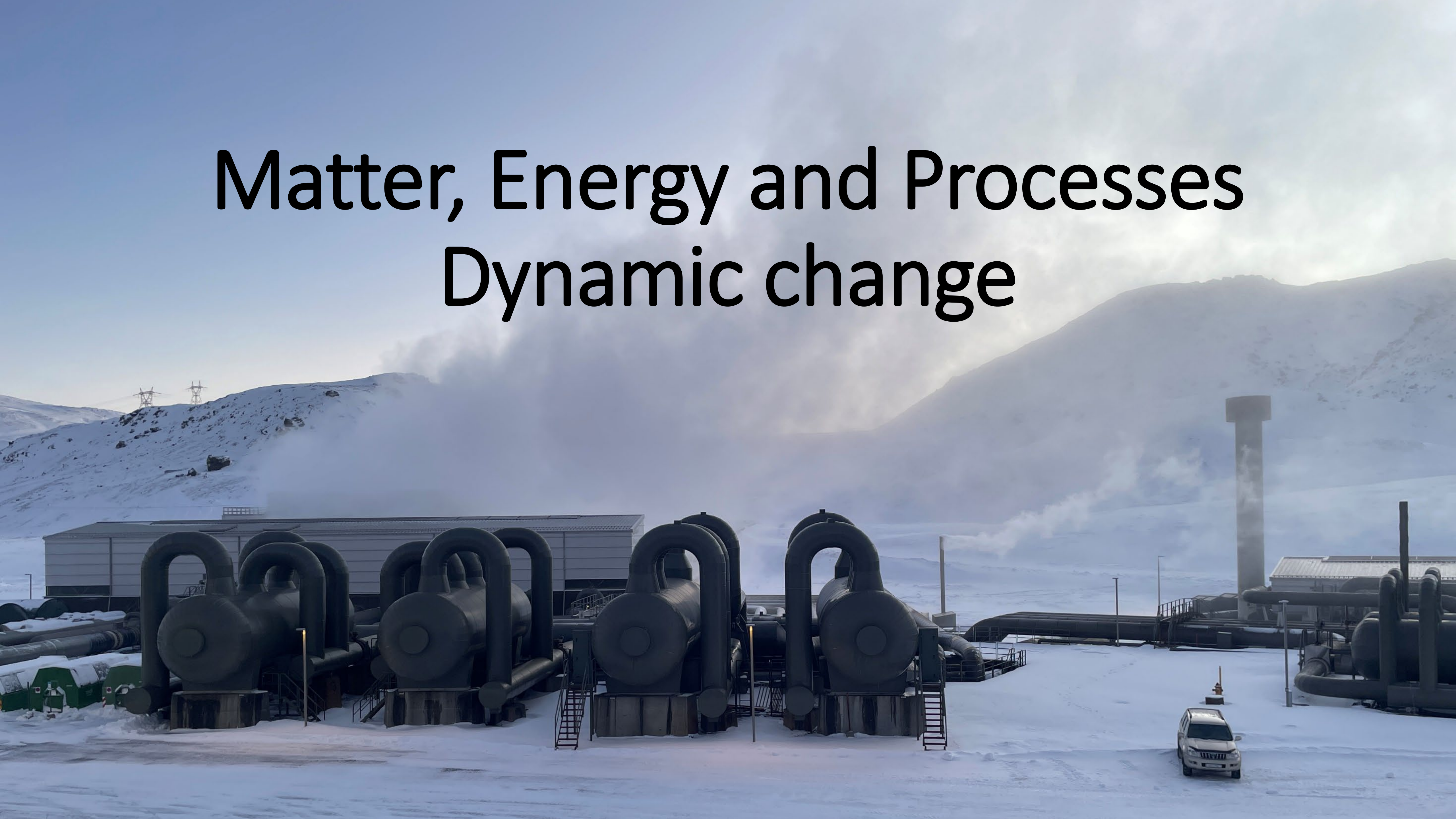
Matter, Energy and Processes
Dynamic change



Matter– rock, air & water: *Things that take up space*

- Lithosphere: Minerals, rocks, coal, oil, gas
- Atmosphere: Air, Clouds
- Hydrosphere: Water (fresh to salty), Water vapor, Ice/glaciers
- Biosphere: Animals, Birds, Insects, Plants & Anthropogenic   Infrastructure


COALATREE
THE MARTIAN CHRONICLES
RAY BRADBURY
I SUPPORT
NATIONAL PARKS
AMERICA'S BEST IDEA

Periodic Table of Elements

1 — Atomic number
H — Symbol
Hydrogen — Name

Natural elements

Synthetic elements

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

Lanthanides	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
Actinides	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Matter – takes up space

Mass – a measure of matter

Element – cannot be chemically broken down into other substances

Atom – smallest unit of an element

Proton – Positively charged particle within an atom

Electron – Negatively charged particle within an atom (no mass)

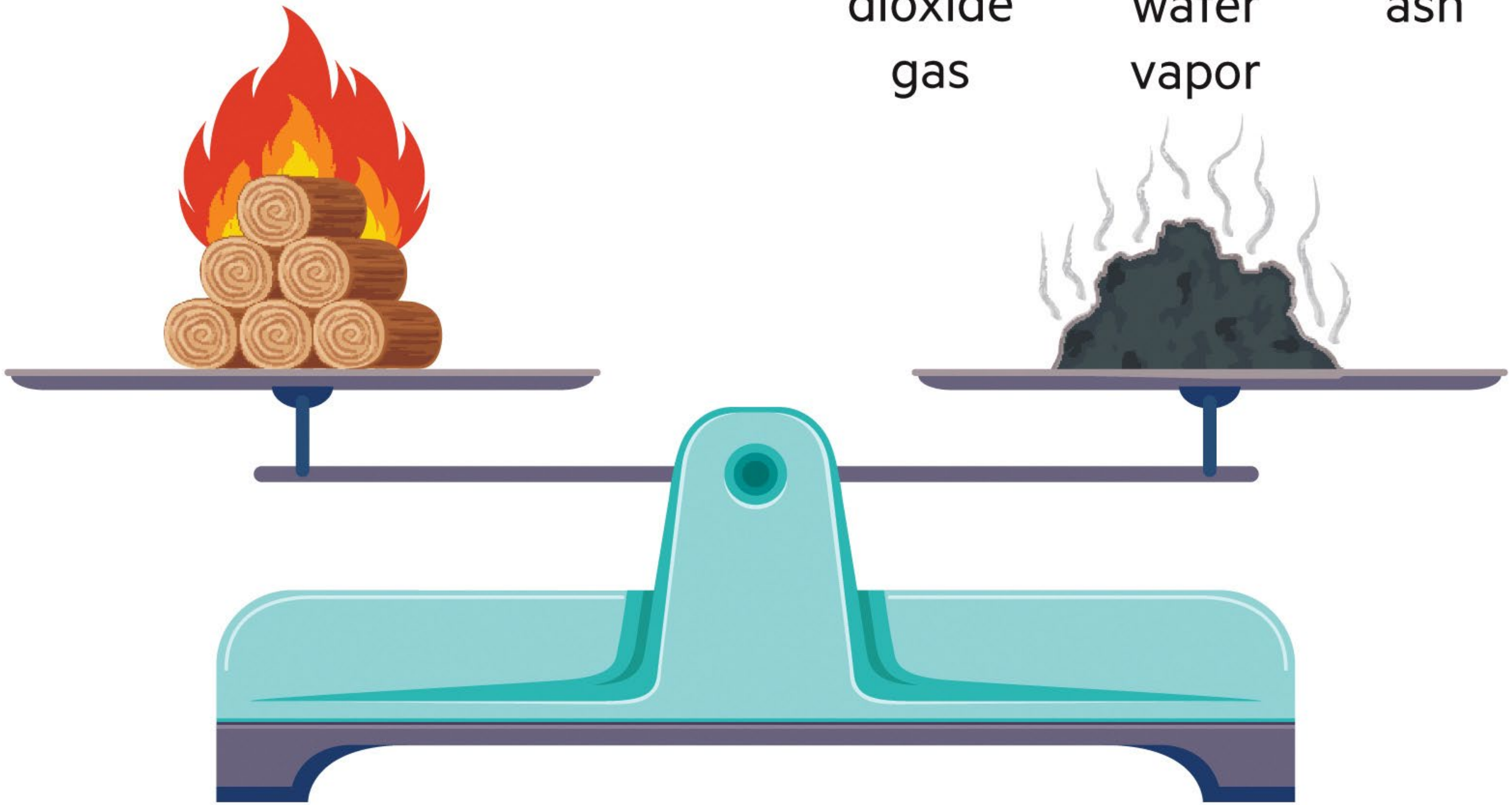
Neutron – Particle within an atom with no charge

Isotope – an atom of an element with different numbers of neutrons.

Conservation of Mass

$$(C_6H_{10}O_5) + O_2 \longrightarrow CO_2 + 5\,H_2O + 5\,C$$

$(C_6H_{10}O_5)$	O_2	$\longrightarrow$	CO_2	$5\,H_2O$	$5\,C$
cellulose	oxygen	=	carbon dioxide gas	steam/ water vapor	charcoal ash



Matter cannot be created or destroyed.

Matter can be chemically rearranged, but its primary parts remain the same.

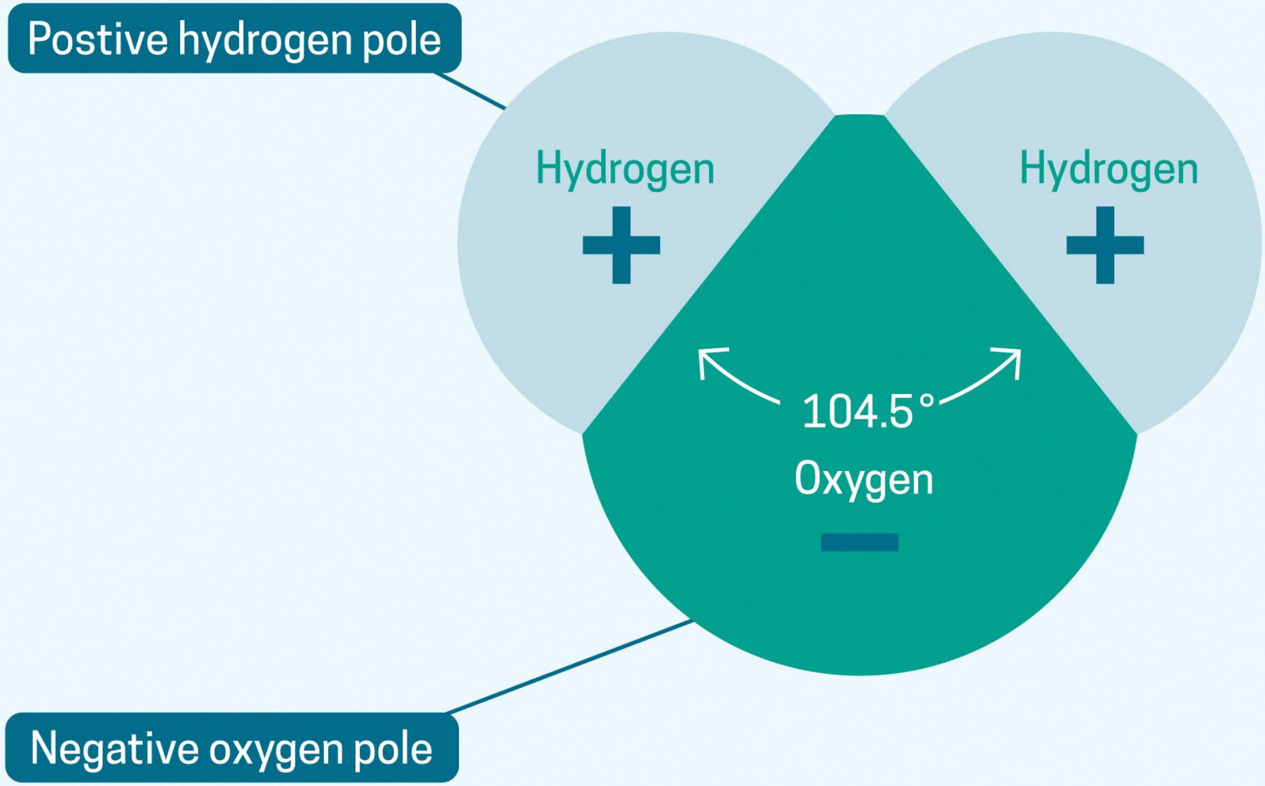
AT A GLANCE

What about Water Makes It So Important?

All life, including your own, depends on water. Not only does water cover more than two-thirds of Earth's surface, it is also present in the air we breathe and in the ground beneath us. And although less than 1% of Earth's water is accessible to us, the living cells of all organisms (including us) are largely composed of water. We humans are about 60% water by weight on average.

1 Water is a polar molecule.

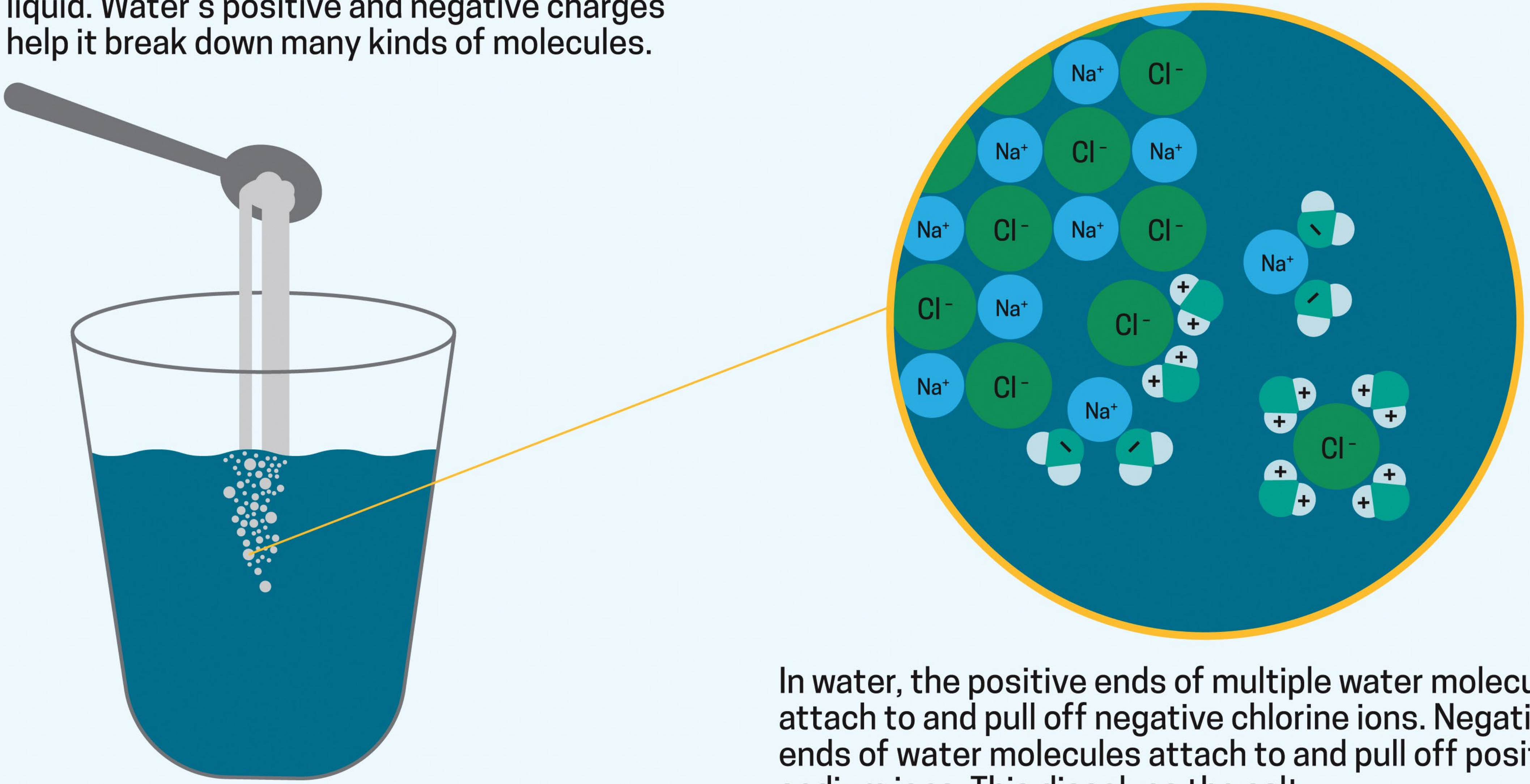
The hydrogen atoms in a water molecule are in a "mouse ear" arrangement, with a 104.5° angle between them. Each hydrogen region of the molecule has a positive charge, like the positive pole of a magnet. In contrast, the oxygen region has a negative charge, like the negative pole of a magnet. This concentration of opposite charges into different poles makes water a polar molecule.



2 Water is known as the "universal solvent."

It dissolves more substances than any other liquid. Water's positive and negative charges help it break down many kinds of molecules.

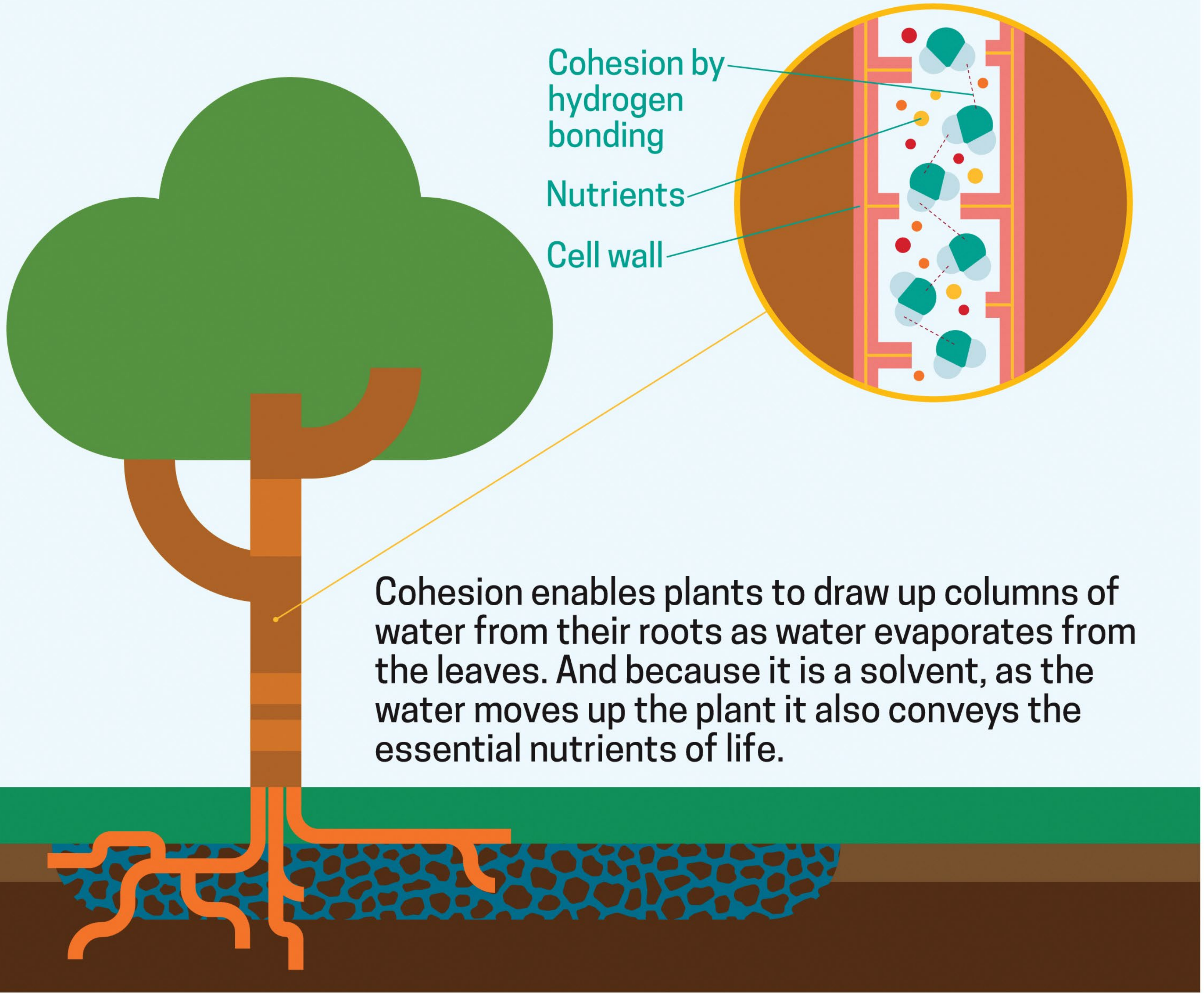
Table salt is made of alternating ions of sodium (positive charge, Na^+) and chlorine (negative charge, Cl^-).



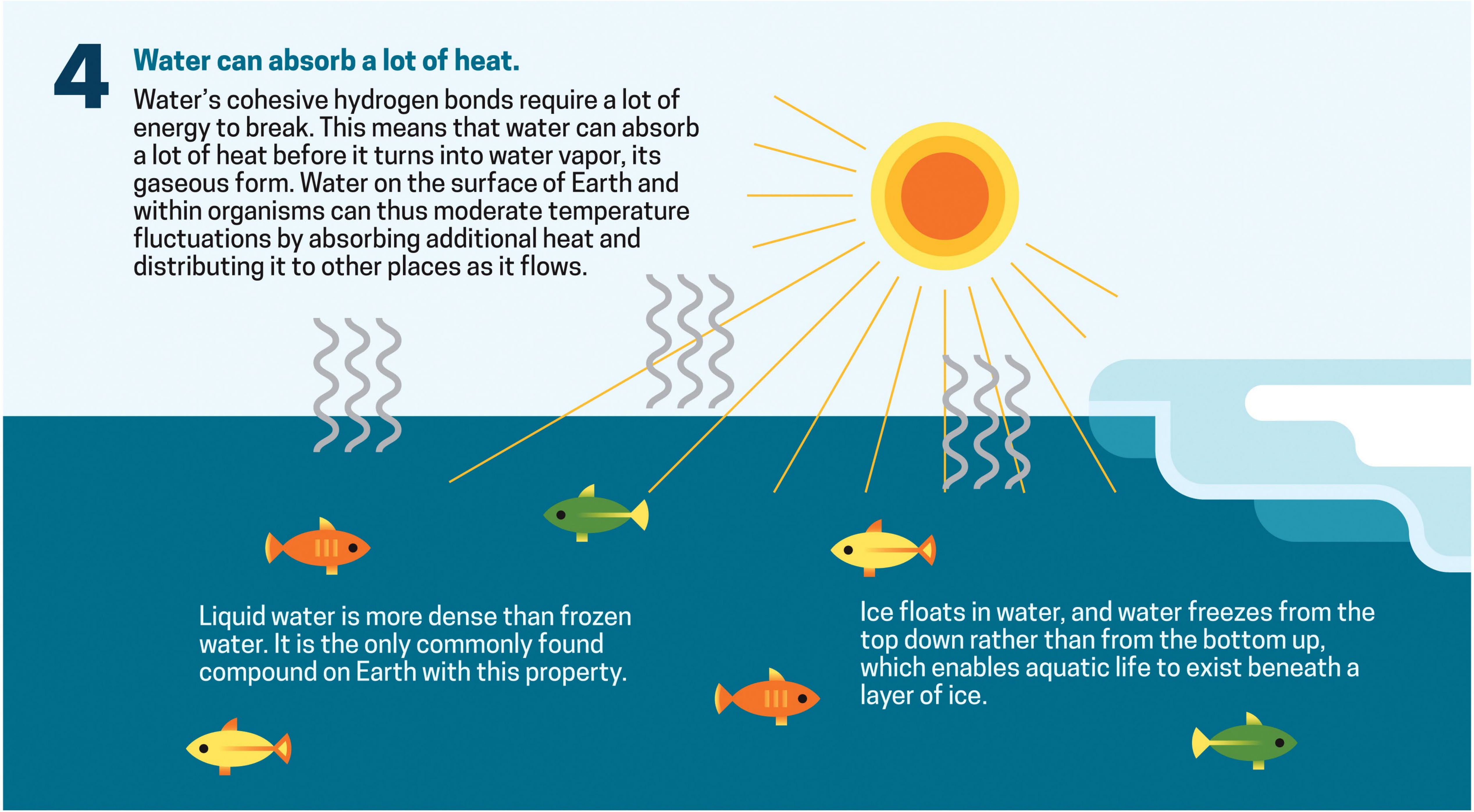
In water, the positive ends of multiple water molecules attach to and pull off negative chlorine ions. Negative ends of water molecules attach to and pull off positive sodium ions. This dissolves the salt.

3 Water is cohesive.

Water molecules “stick” to each other as the positively charged hydrogen atoms of one water molecule are attracted to the negatively charged oxygen atoms of other water molecules, forming hydrogen bonds. These hydrogen-bonded water molecules form a cohesive network.



Cohesion enables plants to draw up columns of water from their roots as water evaporates from the leaves. And because it is a solvent, as the water moves up the plant it also conveys the essential nutrients of life.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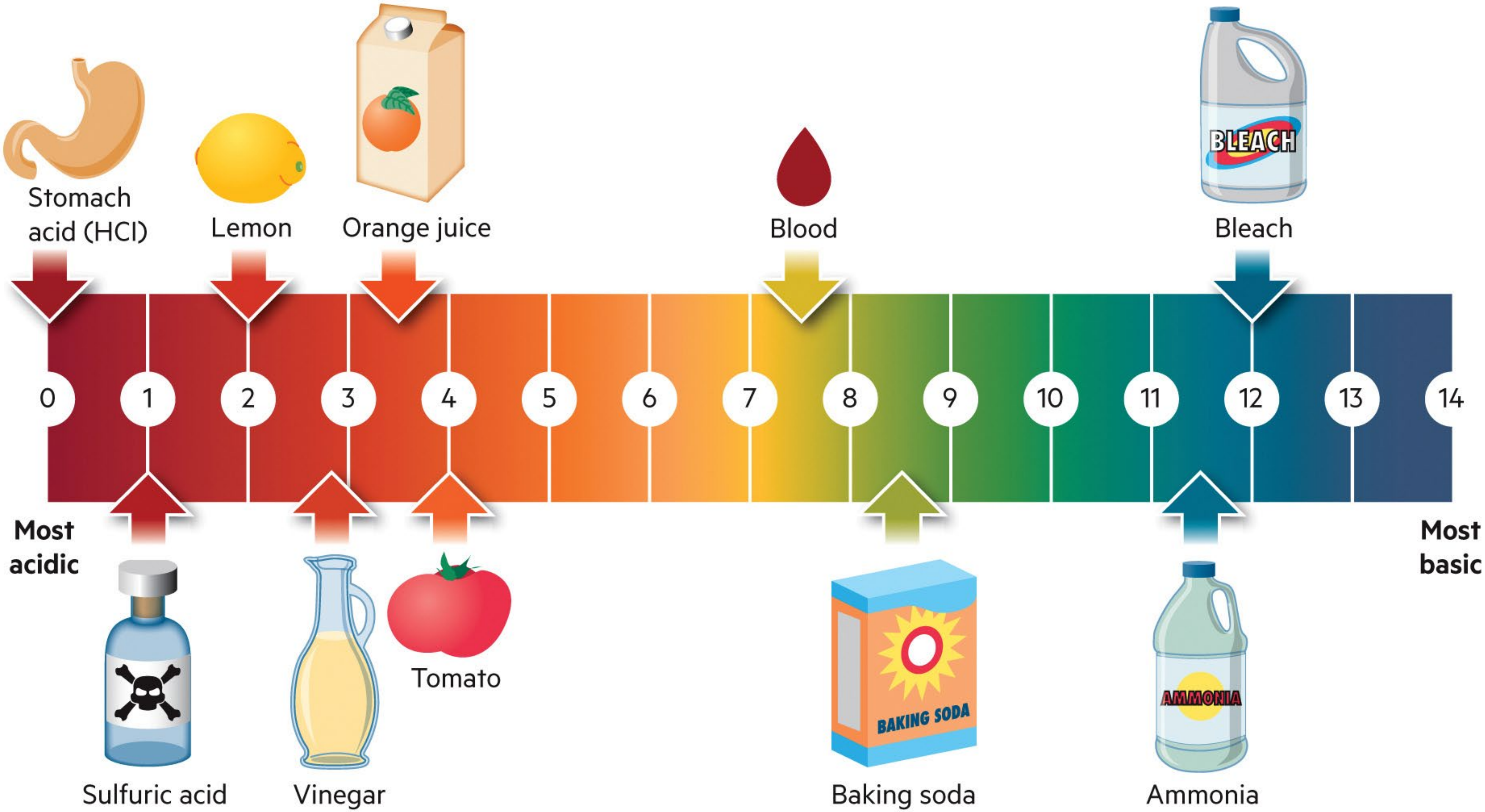
Water can absorb a lot of heat.
Water's cohesive hydrogen bonds require a lot of energy to break. This means that water can absorb a lot of heat before it turns into water vapor, its gaseous form. Water on the surface of Earth and within organisms can thus moderate temperature fluctuations by absorbing additional heat and distributing it to other places as it flows.
Liquid water is more dense than frozen water. It is the only commonly found compound on Earth with this property.
Ice floats in water, and water freezes from the top down rather than from the bottom up, which enables aquatic life to exist beneath a layer of ice.

pH

Acid – a compound that yields positively charged H^+ ions when dissolved in water.

Base – a compound that yields negatively charged OH^- ions when dissolved in water.



How matter changes…

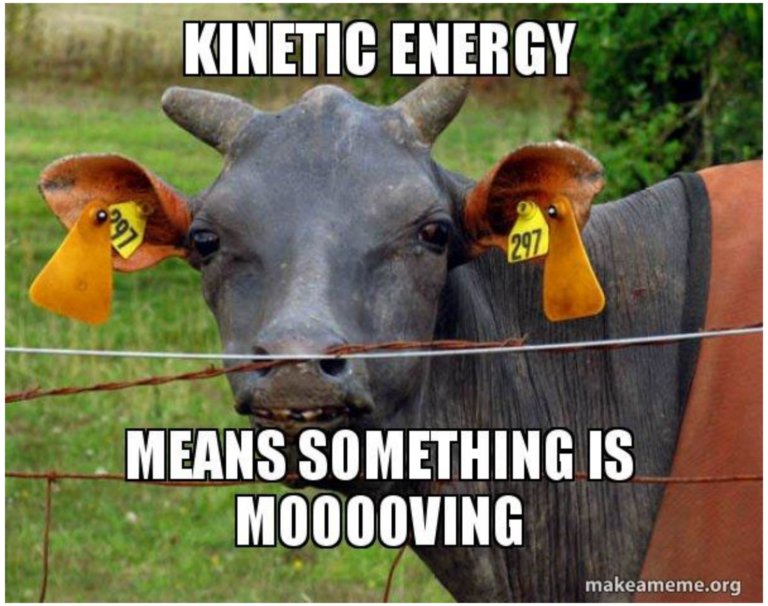
- Changes in atomic and molecular conditions may vary under dynamic heat & pressure.
- Chemical reactions can break molecules apart and new structures can form, but still balance.

- Phase changes
  - To solids, liquids, gases
- Temp. and Pressure differences

Energy

- Capacity to do work
  - Work = Applied force to move matter.

- Kinetic
  - Energy within matter in motion



- Potential
  - Energy in matter that has yet to be released

Processes – Moving matter around

Earth's dynamic interior and exterior

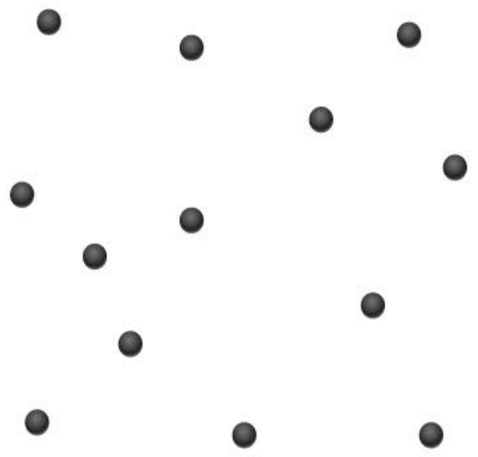
- Movements/changes in
    - A. Air circulation
    - B. Water circulation to Ice flows
    - C. Gravity
    - D. Organisms/life – e.g. photosynthesis, respiration
    - E. Fire
    - F. Weather/climate
    - G. Plate Tectonics

Thermodynamics

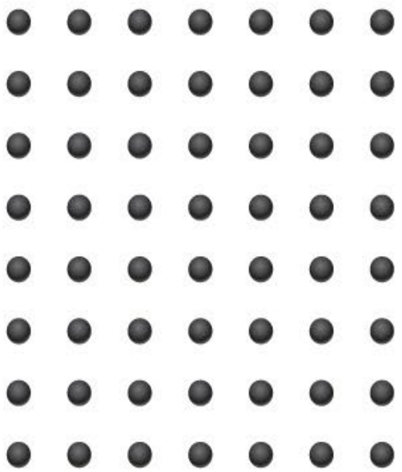
- **First Law**: Energy is conserved – It cannot be created nor destroyed it just changes form…

- **Second Law**: With each transformation or energy transfer, some energy is degraded/wasted in the production of heat
  - Isolated systems tend to become disordered/chaotic over time do to a lack of energy = High Entropy.

What Is Entropy?

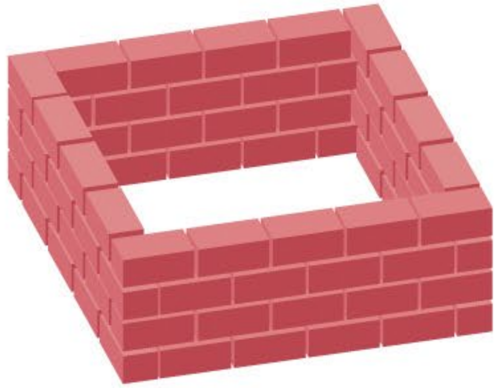


High entropy



Low entropy

Bricks thrown in a pile will likely fall in a disordered pile. This pile has high entropy.



It takes energy to order these in a chimney. This finished chimney has low entropy.

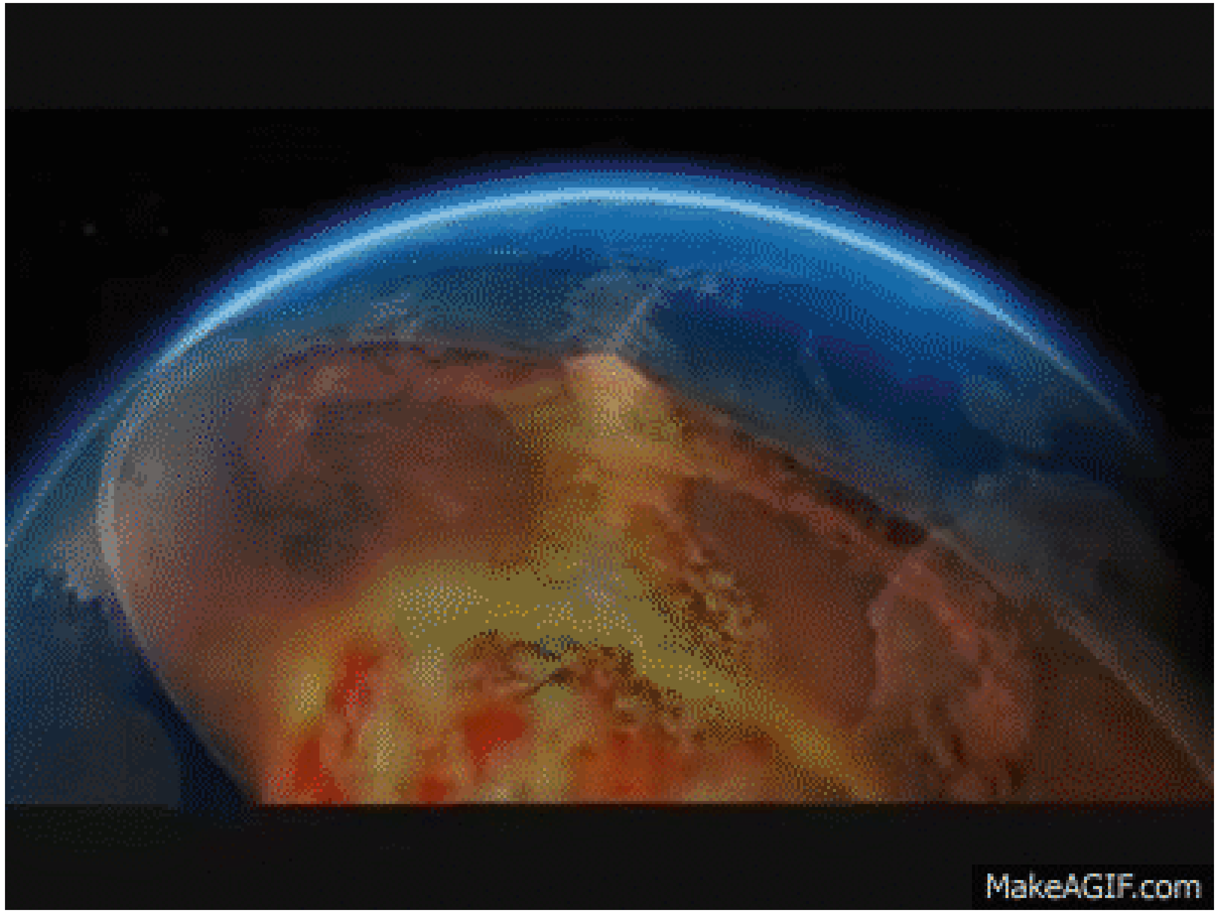
Ian Hubball/Alamy Stock Photo

Over time, without upkeep, the chimney will crumble. It will tend back toward a state of high entropy.

Energy

Dynamic Earth **Trinity**: Structure, Processes, Time

Work



Matter

Actions

=

Change

Time and equilibrium

- short
- intermediate
- deep/long

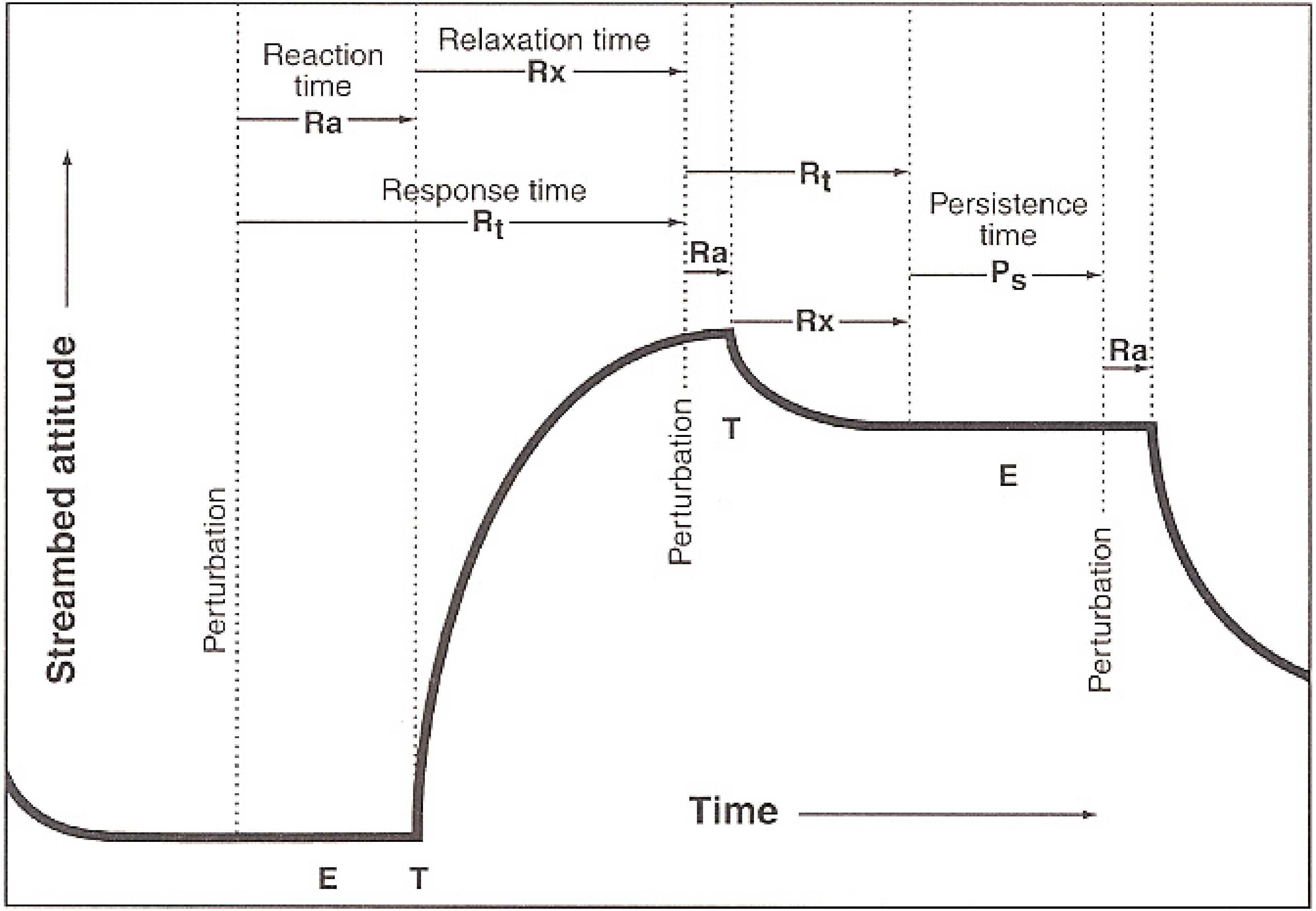
Concept 1: Energy drives processes that change the Earth's systems over variable time

Concept 2: Equilibrium – Conditions placed on systems where competing influences are balanced.

Stream E.g.

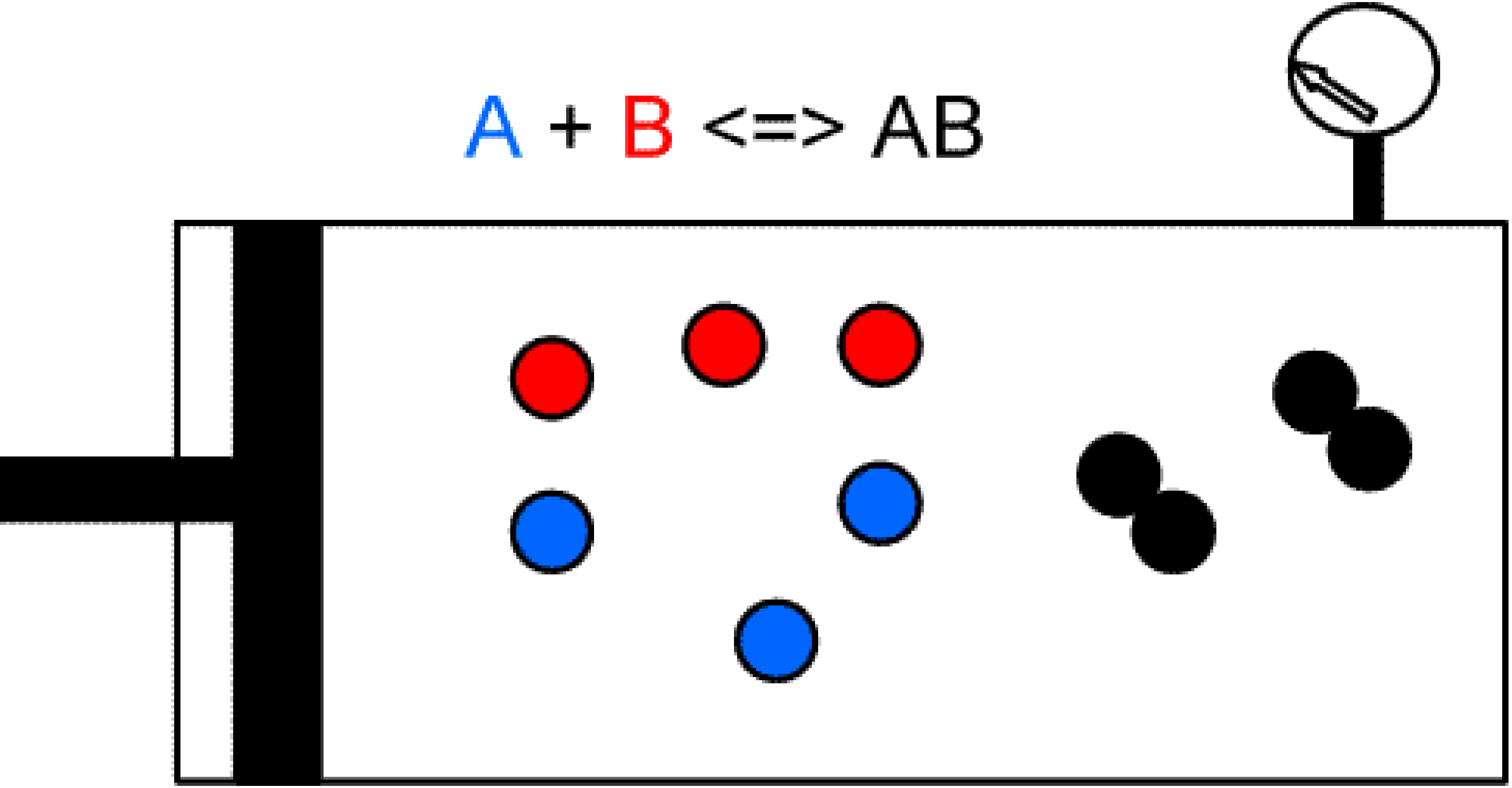
Complex Changes

A) Perturbation (P)
B) Reaction time (Ra)
C) Equilibrium (E)
D) Threshold (T)
E) Relaxation time (Rx)
F) Response time (Rt)
G) Persistence time (Ps)



Le Chateleir (1884)

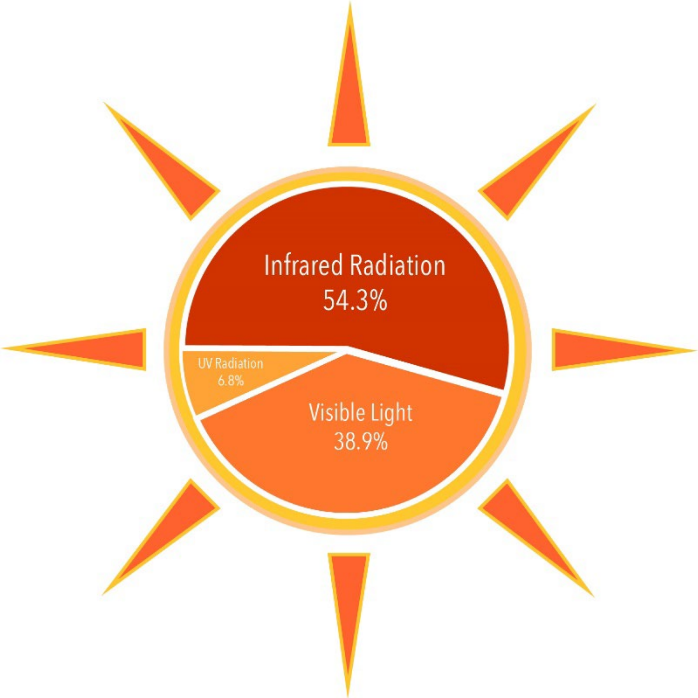
“A change in any of the variables governing the equilibrium of a chemical system will cause a compensating change among other variables that will seek to re-establish stability within the system.”

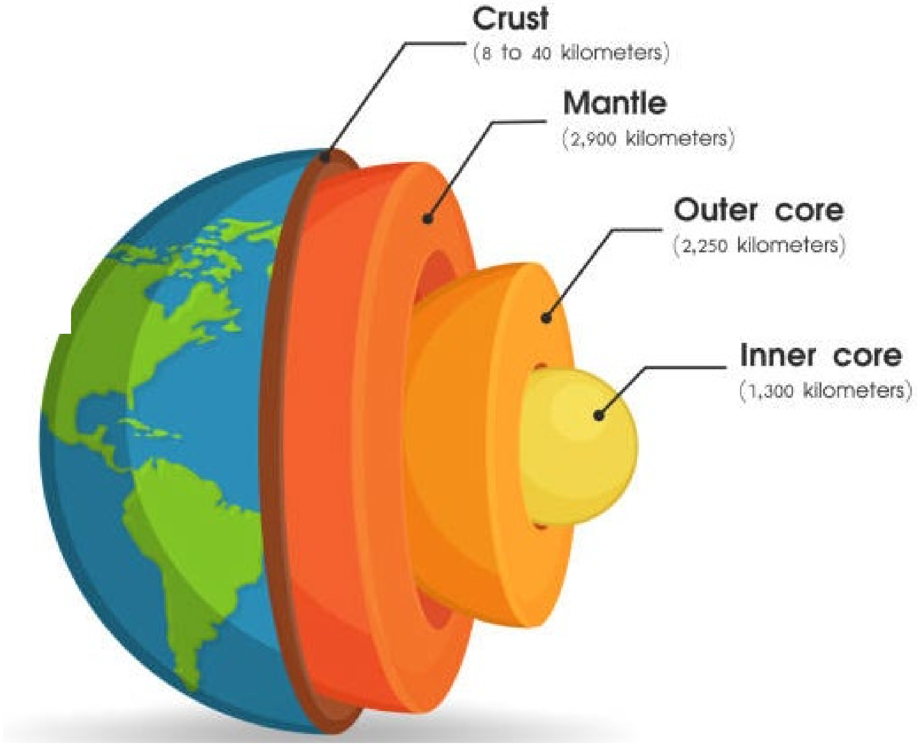


Volume decrease, increases pressure of the system

Sources

- External – Solar radiati(



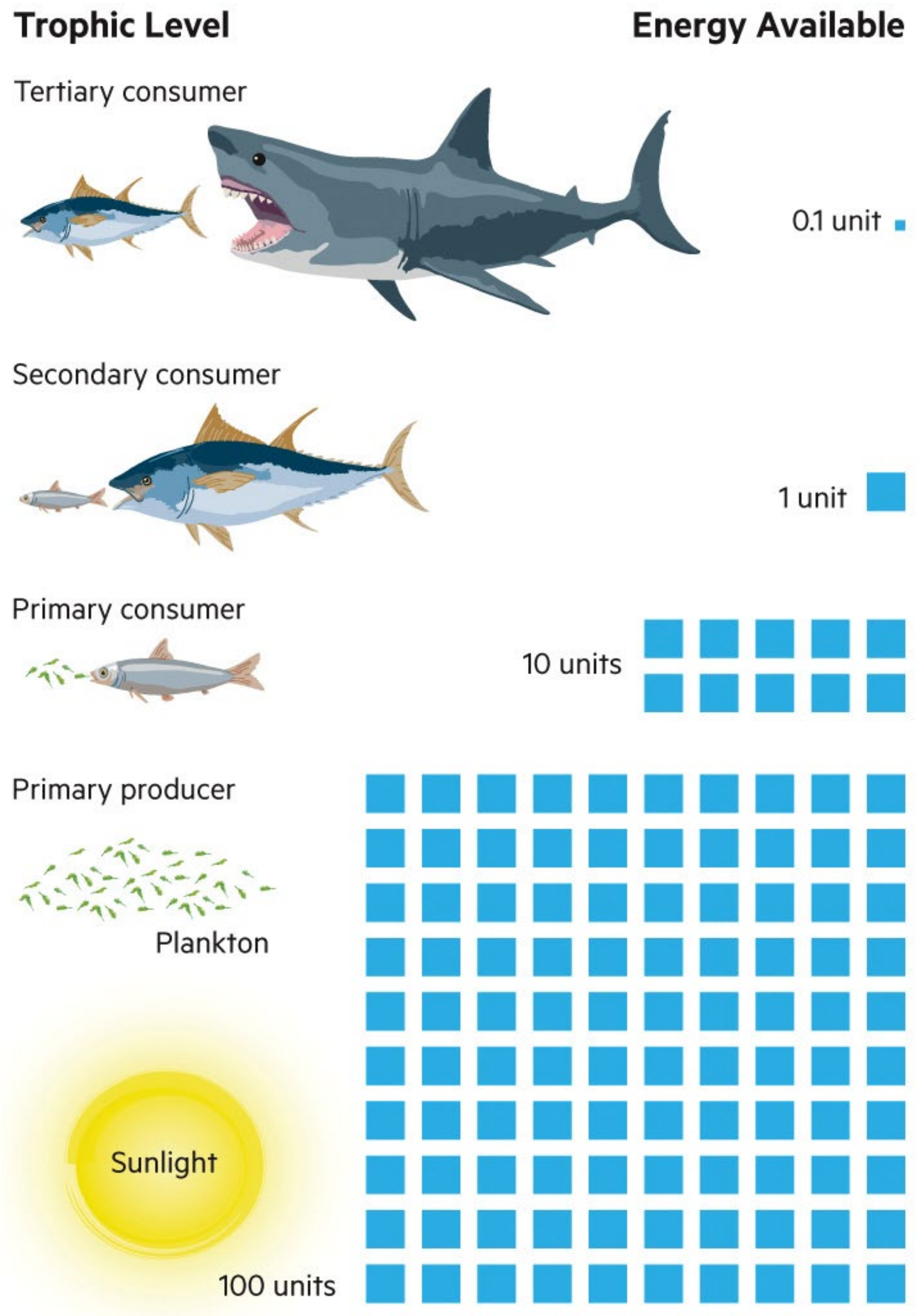


- Internal – Earth’s core

- Human – Energy Concentration and intensification

Energy and the Biosphere

- Food chain
- Trophic level = position in food chain
- Primary producers Vs consumers
- **10% Law:** Every step up the tropic level only 10% of the available energy leads to the creation of biomass…
  - There is a significant energy cost associated with each transformation up the food chain.



_alisang/EyeEm/Getty Images

Lions

- Organisms at high trophic levels are less abundant

- Compose far less mass per unit area than lower than those trophic levels (e.g. grass)

- Do humans follow this trend?
- Depends on food consumption.
  - Plants – Primary consumers
  - Meat – Secondary or tertiary consumers

Box Models

Characterizing complex systems

environmental

Inputs

Outputs

Feedbacks

positive

negative

Carrying capacity

Residence time

USEFULNESS…

Input , Output Analysis – Calculating change

1. Input = Output

Use UNI to explain this concept

2. Input > Output

Use UNI to explain this concept

3. Input < Output

Use UNI to explain this concept

Box models - *simplified versions of complex systems*

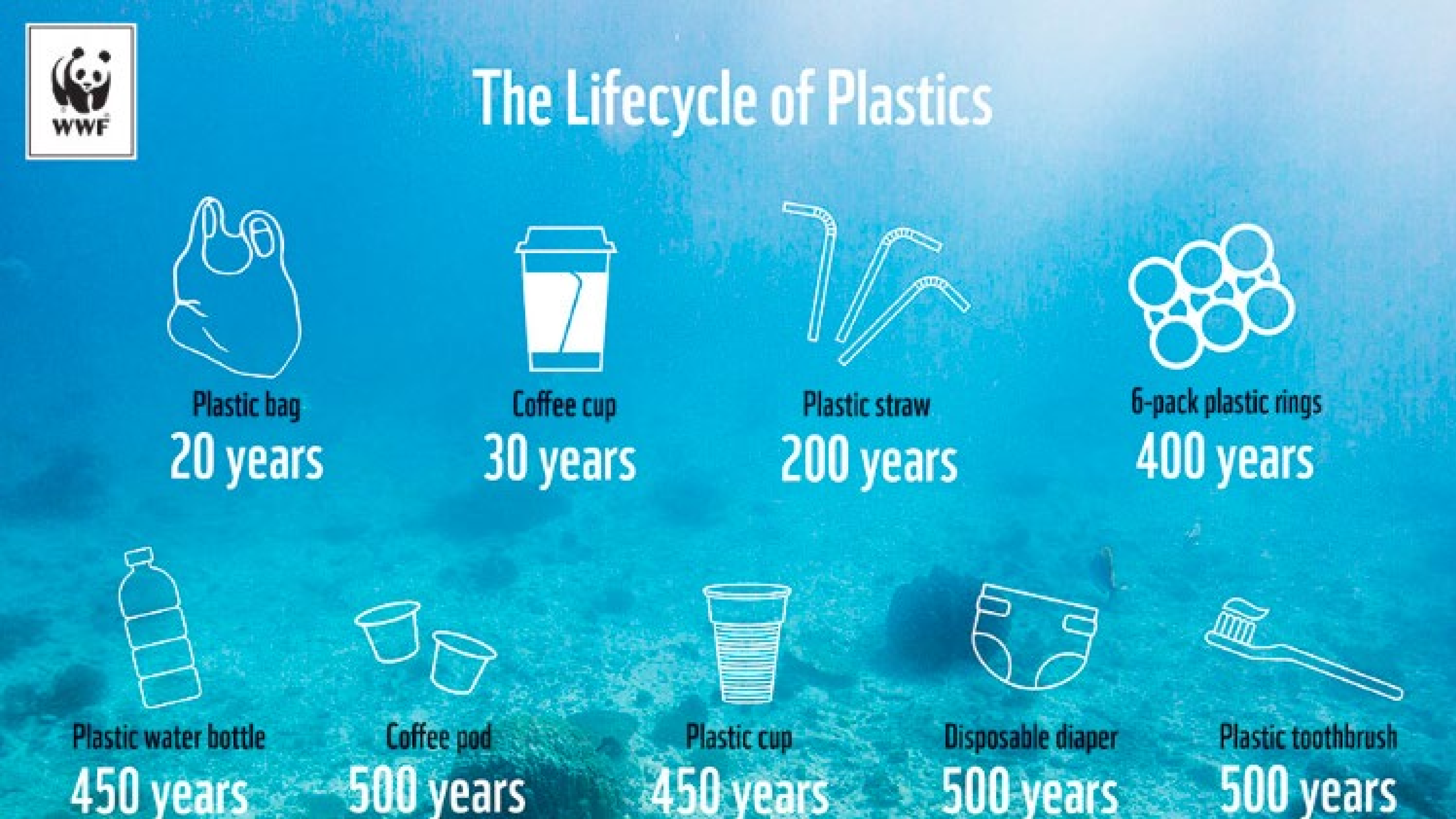
Provide opportunities to…

- Consider all problem variables (*collaborate* & *brainstorm*)
- Investigate interactions between variables (*feedbacks, residence times, carrying capacities*)
- Interpret potential outcomes
- Work on and implement solutions

Everything goes somewhere!

- Single use plastics: Goods made primarily from fossil fuels and meant to be disposed of right after use, *seconds to minutes.*

Examples


WWF
The Lifecycle of Plastics
Plastic bag
20 years
Coffee cup
30 years
Plastic straw
200 years
6-pack plastic rings
400 years
Plastic water bottle
450 years
Coffee pod
500 years
Plastic cup
450 years
Disposable diaper
500 years
Plastic toothbrush
500 years

9 REASONS TO REFUSE SINGLE-USE PLASTIC

1. Made from fossil fuels
2. Huge carbon footprint
3. Will still be here in hundreds of years
4. Only a tiny percentage is recycled
5. Leaches toxins into food & drink
6. Causes hormone disruption & cancers
7. Pollutes our oceans
8. Kills marine animals and birds
9. Enters our food chain

LESS PLASTIC.

WWW.LESSPLASTIC.CO.UK

9 TIPS FOR LIVING WITH LESS PLASTIC

1. Bring your own shopping bag
2. Carry a reusable water bottle
3. Bring your own cup
4. Pack your lunch in reusable containers
5. Say no to disposable straws & cutlery
6. Skip the plastic produce bags
7. Slow down and dine in
8. Store leftovers in glass jars
9. Share these tips with your friends

LESS PLASTIC.

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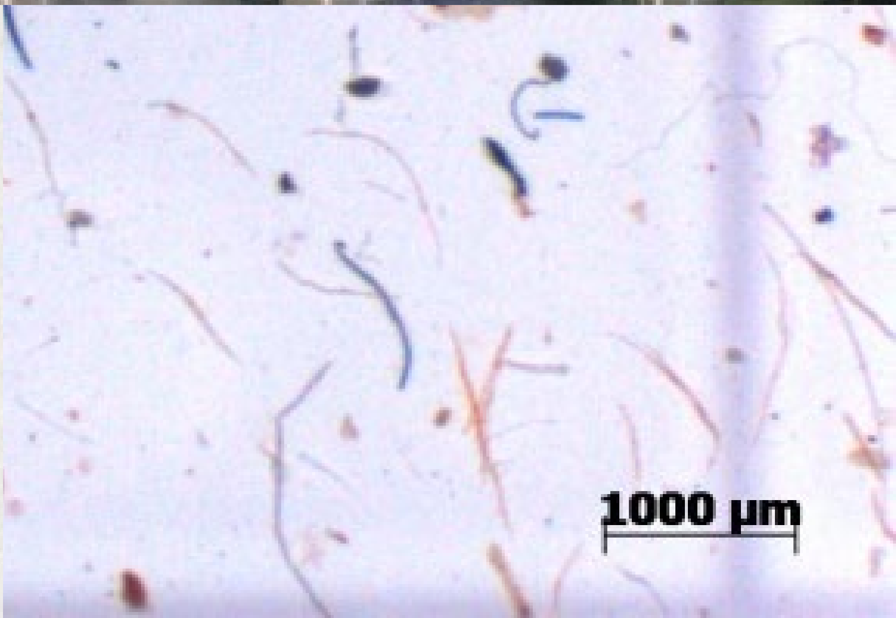
NEUTROGENA
DEEP CLEAN
Neutrogena
Clean & Clear
daily pore
cleanser
Aveeno
positively radiant


1000 µm


DANGER TRAIL FROM LAUNDRY TO PLATE
1 When your fleece is washed, hundreds of tiny polyester fibres are released
2 The fibres are too small to be caught by washing machine filters and flow into sewage system, ending up in the sea
3 Fish mistake these fibres for food, putting them at risk of suffocation
4 They could even cause damage to humans if they are eaten by tuna, crabs or other creatures that end up in the supermarket

How microplastics are generated