Chapter #1: Universe and Galaxies

from the beginnings of astronomy

astronomy today

The majority of radiation that comes from space is blocked by the Earth's atmosphere. However, balloons, aircraft, and rockets all offer new possibilities for high altitude observations.

structure of the universe

1. Superclusters can spread over several 100 million light-years.
2. Light Year: 5,900,000,000,000 miles (9,500,000,000,000 km).

survey of the universe

1. If two objects radiate with the same intensity (luminosity), then the closer object will appear brighter. If a star's actual lumi nosity is of a known magnitude, then it can be used together with the observed bright ness to calculate how far away it is.
2. Redshift: However, chemical elements in the gas layers of stars absorb light of certain wavelengths. Due to the expansion of the universe, all objects are moving away from each other. This stretching of the space between objects results in wavelengths of light being stretched into longer redshifted light. The longer light travels through the universe, the more its waves are stretched.

Theory of the big bang

1. The more the universe swelled, the cooler it became, and the less energy was emitted by radiation.
2. The earliest substances in the universe were hydrogen, helium, and smaller amounts of lithium and beryllium. Heavier chemical elements were produced later by nuclear reaction in the stars

Dark matter and dark energy

1. Mysteriously, there may also be a special kind of energy accelerating the expansion of the universe.
2. The mass of a galaxy cluster can be determined by the degree of light refraction; these tend to be much greater than can be explained by their stars and gas clouds.
3. Future of Universe: Due to the unimaginably large distances be tween them, forces will no longer be effective. Time will have lost its meaning.
4. Dark Energy
5. THE ENTIRE density of the material and energy of the uni verse determines its fate, whether it will continue ex panding forever or, one day collapse.

Spirals and ellipses

Milky way system

Birth of a star

A star's mass largely determines its lifespan: the larger the mass, the shorter the star's life

Sun: 696,000 km: temp: 5800K

Diversity of stars

Meaning of color: Like iron in a forge glowing red or white hot, a star's color depends on its surface temperature. Hotter stars emit more short-wavelength light than cooler ones.

Dying Stars

1. Planets orbiting near this star will be swallowed up. The temperature in the center of a red giant can easily reach a remarkable 180 millionT (100 million°C).
2. Accretion disks around massive objects are able to release a lot of energy on their own.
3. Stars above a certain mass (approximately ten times the mass of our sun) become so dense and hot that heavier ele ments undergo fu sion.

Starry Sky

<u>Chapter #2: Solar System</u>

Disks of dust and planets

1. Due to the cen trifugal force, this cloud flattened into a disk, from which the other celestial bodies of the solar system emerged.
2. **Weak sunlight reflections on the finely spread dust of the solar system is known as zodiacal light**

Orbits of celestial bodies

Anatomy of the sun: The sun's energy is produced in its center through nuclear fusion. The energy is transported between layers by radiation and convection.

Magnetic fields and solar wind

1. The sun rotates faster near its equator than it does near its northern and southern latitudes,
2. Magnetic field lines emerge in these areas, known as sunspots, while retreating in others. Sunspots appear darker in comparison to their surroundings because the emerging magnetic fields block the rising plasma, causing patches of cooler temperature where less energy is being transported to the surface from the interior.
3. Solar wind often reaches speeds of about 250 miles per second (400 km/s), and sometimes doubles this. It creates its own magnetic fields, which deform the shape of both the sun and the Earth's magnetic fields.

Cosmic weather

1. Electrically charged particles from the sun and the Earth's upper atmosphere create circular radiation zones in the Earth's magnetic field.
2. During times of high solar activity, electrical currents in the polar regions cause the air molecules to glow, which creates auroras.
3. Geomagnetic storms Intensified particle radiation amplifies the electric currents of the Earth's magnetic field, which may overlap with the terrestrial field and cause it to fluctuate, potentially causing geomagnetically induced currents in transmission lines and transformers.

Solar Research: Dark absorption lines appear in the various spectra of light depending on the chemical composition of gases present in the photosphere or atmosphere of distant objects.

Mercury and Venus

1. Venus—in contrast to Mercury—has a dense carbon dioxide atmosphere.
2. Venus glows brightly in the night sky, which has led to it being evening and morning star.
3. Venus has the densest atmosphere of all terrestrial planets: pressure on the ground is about 90 bar—the equivalent of oce being known as the evening anic pressure at a depth of
4. After one orbit around the sun. Mercury does not return exactly to its original start ing point.

Moon: Shows the different surface soil composition of the moon. Red areas generally correspond to the lunar highlands, while blue to orange shades indicate the ancient volcanic lava flow of a mare, or lunar sea. Bluer mare areas contain more titanium than the orange regions.

Earth-Moon System

1. By measuring this ash gray light, we can recog nize changes in cloud cover and the Earth's atmosphere.
2. Another consequence of the tidal interaction between the Earth and the moon is that the gravitational force of the Earth's tidal peaks pulls the moon slightly along its orbit. This causes the moon to travel faster and raise its orbit, so that the moon moves roughly 1.5 inches (3.8 cm) further away from the Earth every year.

Mars

1. Biochemical data taken by the Viking probes during the 1970s may indicate the presence of microorganisms on Mars.
2. Mars's red soil is caused by high levels of iron oxide. Large amounts of sulfur and silica have also been found in the surface.

Asteroids: Sometimes the aster oids' orbits are disturbed by collisions or gravitational forces, causing them to career off through space and possibly impact with

Comets: Comets are celestial bodies that are invisible until they near the sun. Some comets have short orbital periods and are thought to originate from the Kuiper belt, beyond the orbit of Neptune.

Jupiter and saturn: An enormous cyclonic storm has been seen in Jupiter's atmosphere since the 17th century. Known as the Great Red Spot, it could swallow up the Earth twice over

Uranus and Neptune: The dark spot visible on Neptune is an anticyclonic storm that circles the planet every 18.3 hours.

Pluto: Pluto consists of a rocky core surrounded by a mantle of ice.

Extrasolar Planets

1. The Doppler method involves measuring the wavelength of light com mg from obiects moving toward or away from the Earth.
2. The transit method is based on recording a star's small drop in brightness when a planet moves in front of it, blocking some of the light. The Doppler-or radial velocity method is based on another

effect: strictly speaking, a star and planet revolve around a common gravitational center, even if this center is located within the star itself.

3. As gases and other substances absorb particular wavelengths of radiation, scientists are able to study absorbtion lines in the spectrum of light or thermal radiation from a planet's atmosphere. In this way they can identify constituents, such as water, oxygen, or carbon dioxide.

Development of space travel

1. Astronauts from many nations work together in the International Space Station. They carry out research in the weightless environment, especially in the fields of medicine, materials science, and astrophysics.
2. In 1961 the Russian cosmonaut Yury Gagarin became the first person in space. He reached Earth's orbit and then returned safely to Earth.

Satellite technology

1. Three synchronous satellites, each rotated 120°, can reach every part of the globe except the Poles. Modern communications satellites have high-powered transmitters, whose signals can be directly received by private satellite dishes.
2. Telecommunications satellites serve as relay stations for data links and for radio, television, telephone, and fax signals. A satellite receives signals from a ground station, amplifies them, and sends them to another ground station.
3. A satellite in low Earth orbit travel at 5 miles/second (eight km/s). In a geostationary two miles per second (three km/s).

Human Beings In Space

1. The inner suit is lined with water tubes that help cool the body. Next come gas-impermeable layers. The outer layers are fireproof and rein forced against tearing. The air pressure inside is kept low to Prevent the suit from inflating.
2. The space shuttle is a manned space vehicle that can and like an airplane. Two powerful solid rocket boosters provide lift for its vertical launch.

Exploring Solar System: Space probes are unmanned spacecraft designed to gather information about the sun, planets, moons, asteroids, comets, and the space between them.

<u>Chapter #3: Earth</u>

Once upon a time, 4.56 billion years ago

1. The Earth was created-along with the sun and the other planets-about 4.6 billion years ago from an interstellar gas and dust cloud.
2. Zircon is the oldest known mineral and Is found throughout the Earth's crust.

Origins of life

1. However, due to the high temperature and low gravi tational forces this atmosphere simply escaped back into space.

2. Clouds discharge electricity through lightning.

Shape of the earth

1. The speed that the Earth rotates depends on the respective latitude.
2. These high-speed revolu tions cause centrifugal forces to develop, with the effect that the Earth is not strictly a sphere.
3. The rule is: force of gravity (weight) equals the mass multiplied by the acceleration of Earth.

Magnetic field of the earth

1. The Earth's magnetic field is like a gigan tic bar magnet tilted at 11° to the rotational axis of the Earth.
2. Solidified magma, which is created on the seafloor at mid-ocean ridges in the process of plate tectonics, indicates that the magnetic field of the Earth can reverse.
3. The origin of the magnetic field lies in the interior of the Earth and is produced by enormous convection currents within the liquid outer core of the Earth. At depths between 1,800 to 3,200 miles (2,900 to 5,150 km), liquid iron churns around the solid iron inner core of the Earth. This movement creates an electric field, and thus the accompanying magnetic field-a phenomenon also referred to as a geodynamo.
4. Auroras are light phenomenons that occur near Earth's poles as a result of the magnetic field.
5. The last time the magnetic north and south poles changed their position was about 780,000 years ago.

Core and mantle of the earth

Convection currents in the outer core also create the Earth's magnetic field (p. 57). High pressure causes the liquid outer core to become solid at a depth of 3,200 miles

Structure of the earth's crust: The highlands of Tibet: the result of colliding continental plates.

Minerals: formation: Igneous minerals, Sedimentary minerals, Metamorphic minerals, Weathered minerals

Minerals: structure: Quartz is the most common mineral found in the Earth's crust

Sedimentary rocks: Sedimentary rocks are categorized into three groups: clastic, chemical, and bio genic.

Earth in motion: One consequence of continental drift and the movement and collision of continental plates was the creation of mountain ranges and the deepening of the ocean floor.

Plate boundaries:

1. The greater the angle of descent, the faster subduction takes place, creating an oceanic trench close to the is land arc.
2. The slower the drift of an oceanic plate, the cooler and heavier it becomes. When plates collide, the heavier plate is subducted
3. When two continental plates collide, however, subduction does not take place. Instead the plates push against each other and buckle upward, forming mountains at the point where they meet.

Reconstruction: Specialized laser satellites are used to measure vertical changes at the edges of the plates.

Primeval continents

Causes

1. The point of origin of an earthquake is called the hypocenter. Typically, the hypocenter of an earthquake occurs at a depth of less than 37 miles (60 km) below the surface of the Earth.
2. Not all earthquakes are caused by tectonic changes, some are caused by volcanic eruptions.
3. Humans can also be the direct cause of earthquakes, for example by collapsing mines and tunnels or by conducting underground atomic bomb tests.

Measurement and consequences

1. Early in the 20th century, volcanologist Giuseppe Mercalli created a scale catego rizing earthquakes based on damage in curred.
2. Seismographs, used to measure vibra tions of an earthquake, come in a wide variety.
3. The stronger the earthquake, the greater the amplitude.

Faults

1. Faults are ruptures or cracks in rock that often extend for miles along the upper layer of the Earth's crust where two crustal sections are displacing one another.
2. However, strong shearing forces are at work at the edges of the converging plates, which can lead to the formation of faults.

Prediction and safety: Rock deformations cause changes in the active plate boundaries of Earth's crust.

Anatomy of volcanoes:

1. Approximately 5 miles (8 km) beneath Yellowstone Na tional Park in the United States. If this volcano erupted again, could cause earthquakes and tsunamis, as well as catastrophic effects on the Earth's climate.
2. The higher the magma rises, the greater the amount of degasification that

Volcanic eruptions: Mount Etna is one of the most active volcanoes in the world and is in an almost constant state of eruption.

life with volcanoes

1. Over 80 percent of today's active volcanoes are located on the "ring of fire"-subduction zones of several tectonic plates around the Pacific Ocean.
2. Laser-equipped mea suring devices, able to measure volcanoes at very high degrees of precision, record surface deformations. Such devices mea tions. If sure the dilation (expansion) of volcanoes' magma chambers, a phenomenon directly related to increases of pressure within magma chambers, which can cause eruptions.

Thermal springs and geysers

1. Geysers are spectacular and demonstrate the immense energy stored in the interior of the Earth.
2. Black smokers are hot springs at the bottom of the ocean.

Mountain formation

1. Of the once mighty Caledonians, only the Norwegian coastal plateau, the highlands of Scotland and Greenland, and the Appalachians remain today.
2. The world's highest mountain ranges known today originated during this phase: the Alps in Europe, the Andes in South America, and the Himalaya in Asia.
3. The most common high mountain forma tions are fold mountains, which emerge when two crustal plates come together.
4. Mountains can form through sub duction. which occurs when two plates meet and one sinks beneath the other

Mountain ranges

Fracture tectonics

mountain summits

types of deserts: A lack of cloud cover leads to ex treme daily temperature fluc tuations. Temperatures reach up to 175T (80°C) during the day as the sun heats the ground unimpeded.

surviving drought conditions

types of forests

forests as habitats and economic areas

saltwater wetlands

freshwater wetlands: In the arid center of southern Africa, the Okavango River flows into a maze of lagoons, swamps, and savanna.

temperate grassland: steppe and prairie

tropical grassland: savanna: As the distance from the Equator to the tropics grows, the number of dry months increases from less than four to about ten months and the amount of average precipitation decreases three- to sixfold

Weathering: Pressure and temperature variations play a large role in physical weathering by causing mechani cal destruction of rocks.

Erosion

Deposition: If the speed of the flow decreases, erosion is no longer possible and large fields of rubble build up.

Mass movements

world's oceans: Hence, the meridian running through Cape Agulhas at 20° east longi tude separates the Atlantic Ocean from the Indian Ocean. The meridian running through the South East Cape of Tasmania at 147° eastern longitude is the boundary between the Indian Ocean and the Pacific Ocean. The southern boundary between the Pacific and the Atlantic Oceans passes through Cape Horn at 68° west lon gitude to the Bering Strait, which defines the northern boundary.

physical characteristics

1. The giant Pacific octopus lives in the deep ocean, which has low temperatures, high pressure, and no light
2. The hotter and dryer the climate is, the greater the rate of evaporation and the greater the salinity of the water.
3. Therefore, sound travels at four times the speed it travels through air.
4. MARINE ANIMALS AT RISK Several marine animals including sharks, whales, and dolphins -rely on sound for orientation as the visibility is limited. However, they are severely affected by noise from engines, sonar, and military and industrial activi ties. These animals lose their orientation and risk getting too close to shore where they can get stranded and die

ocean currents

1. Ocean currents, dependent upon the winds and varying salt concentrations, drive huge masses of water over long distances.
2. Prevailing winds drive the ocean's surface currents, circulating warm water away from the Equator and circulating cold water toward the Equator by the currents created by the cir culating trade winds.
3. Deep ocean currents around the world: A knowledge of currents is vital to the shipping industry, as it can help to save on fuel costs.
4. While surface currents are driven by winds, deep currents are driven by density and temperature gradients.

tides, coasts, and waves

1. Waves like these are surface waves that occur in the upper layer of the ocean and are caused by the wind.
2. Waves and currents move large amounts of sand along shallow and sandy shore lines, thereby creating sandbanks that constantly change position.

oceanic crust

The Mediterranean is predicted to shrink, while the Atlantic is growing.

islands and atolls

Earth's largest island is Greenland,

coral reefs: underwater forests

Coral polyps share a sym biotic existence with the zooxanthellae algae embed ded in their skin. Through photosynthesis, the algae turn carbon dioxide and water into oxygen and sugar that is used by the polyps, which in return provide nutri tion and protection for the algae.

deep sea

catchment areas and stream courses

The sediment load of the river is reduced and dissolved as sediment is carried to the ocean in larger amounts during periods of high water flow.

high and low courses

Origins

Circulation

glacier formation

ice of the poles and high mountains

The Greenland ice sheet has been shrinking. The Arctic could be ice-free almost certainly by 2050.

ATMOSPHERE

structure of the atmosphere

atmospheric processes

1. While a black body absorbs all radiation and does not reflect anything, a white body produces the opposite effect.
2. In order to balance the uneven energy distribution on Earth, global wind systems circulate in the atmosphere while oceanic currents transport energy from the lower latitudes to the higher latitudes.
3. At sunset the low position of the sun causes increased scattering of light, with only longwave red and orange light reaching the ground.

high- and low-pressure weather fronts

1. The sun acts as an engine of the weather system. Its energy moves enor mous air masses which travel as currents throughout the lower atmosphere. The daily change in weather usually results from events at the boundaries.
2. Air masses from high-pressure areas move into low-pressure areas in order to equalize differences in pressure. In temperate zones, the weather is determined by the interaction of cold and warm air masses. When air masses of different temperatures collide, a front forms. If lighter, warmer air slides above the cold air, a warm front is created.
3. Jet streams are created where very cold air collides with very warm air masses resulting in an extreme pressure drop and an exceptionally fast wind. Jet streams may reach speeds of up to 370 mph (600 km/h) at a height of 5.6 to 7.5 miles (9 to 12 km).
4. The process where a cold and warm front merges is called occlusion.
5. Differences in air pressure are balanced by strong westerly winds. Hot tropical air and cold air from the Poles create a boundary called the polar I where major air turbulences result.

meteorology and weather observations

precipitation and clouds: The colder the air temperature, the less water vapor it can retain.

wind, storms, and anomalies

1. Wind is air in motion originating from air pressure gradients in the atmosphere. always blows from an area with high air pressure into an area with low air pressure. The greater the difference in air pressure, the stronger the wind.

2. Warm air expands near the Equator and rises, causing a low pressure belt called the intertropical convergence zone. This zone is also known as the doldrums. While the rising air cools expands toward slowly, it the Earth's Poles, creating convection currents.
3. Winds do not blow across the globe in a straight line; they are diverted from the west to the east by the rotation of the Earth, causing the distinctive spiral effect. Atik. K> mm r This rotation causes the rising warm air masses from the Equator to the Poles to shift to ward the right and the descending cold air masses from the Poles to the Equator to shift toward the left.

the global climate

What determines climate?: Primary climatic factors include a region's latitude, its elevation, and the features of its terrain, as well as the amount of solar radiation it receives. From these primary factors arise secondary climatic factors, such as ocean currents, wind systems, and other natural cycles.

natural climate phenomena

1. This cold current from the deep pacific creates an extended high-pressure zone and a dry climate in western South America.
2. Conversely, in Southeast Asia, warm waters produce sustained low-pressure zones regularly resulting in heavy monsoon rains in Australia and Indonesia.
3. Because ice preserves air particularly well, polar analyses are some of the most accurate and valuable sources of past climate data.
4. When rising pressure differences between South America and Southeast Asia allow the trade winds to gain strength, the circulation pattern resumes and the still original conditions return. This is known as La Nina

tropical climates

1. The key characteristics of the tropical belt are continuously high solar radiation and consistently high tempera tures.
2. The annual rainfall decreases the farther away from the Equator an area is located, while the number of dry months increases.

subtropical climates

climate of the temperate zone

subpolar and polar climate: Distinct seasons occur within the polar circles. However, during the winter, the sun never fully rises and in the extreme cases of the North and South Poles, the polar night and polar day last half a year each.

climate change: In 1920, Milutin Milankovitch, a Serbian astronomer and mathematician, realized that astronomical forces have a cyclical influence on the intensity of solar radiation reaching the earth.

climate factor mankind

global warming

the effects of climate change

ENVIRONMENTAL PROTECTION

polluted air
water at risk
soil pollution and erosion
loss of species diversity
environmental consciousness
think globally, act locally
environmental concerns in everyday life
ecologically friendly consumption

Biology

Chapter #1: Evolution
the first biological molecules
According to this theory, the first components of life, and life itself, originated around heat sources in the sea.
first living cells
cell organelles
differences: plant and animal cells
genetic information: dna

1. HUMAN GENOME PROJECT
2. Each nucleotide has three components: one sugar (deoxyribose), one phosphate, and one of the four bases adenine (A), cytosine (C), guanine (G), and thymine (T).
3. GENETIC FINGERPRINT

Chromosomes
mitosis: replication of cells
Meiosis
general cell metabolism
further metabolic processes: The lactic acid produced during lactic acid fermen tation gives plain yogurt its sour taste.
fossils and fossilization:
other fossils and living fossils: Besides fossil animals, there are also fossilized plants like this tree in Yellowstone National Park.
Stratigraphy
paleozoic era
mesozoic era
cenozoic era
the evolution of plants

the evolution of animals
evolution of humankind: the beginning
homo sapiens
Selection: Organisms that are particularly well adapted to their environment generally have better chances of survival and reproduction, therefore prevailing over other individuals. This development is referred to as natural selection.
the evolution of new species
Systematics
evolutionary trees

Chapter #2: Microorganisms

structure and metabolism of bacteria
harmful and useful bacteria: Bacterial fermentation is used for preservation, for example when pickling olives, cucumbers, or saurkraut. Products such as yogurt, acid curd cheese, or soy sauce are all made with the help of metabolically active lactic acid bacteria.
the virus
viruses as pathogens
heterotrophic single-celled organisms
autotrophic single-celled organisms

Chapter #3: Plants and Fungi

anatomy of higher plants
Photosynthesis: To capture enough light to power photosynthesis, leaves usually grow toward the sun, a habit known as phototropism.
water and nutrient transport
secondary plant compounds
Algae: Kelp forests throughout the temperate and polar coastal oceans provide one of Earth's most productive ecosystems for a multitude of marine organisms.
mosses
whisk ferns, club mosses, and horsetails
Ferns
Gymnosperms
Angiosperms: They are equipped with various mechanisms to attract and catch prey, mainly insects. These techniques can include sticky traps (e.g., sun dew), jaw traps (e.g., Venus flytrap), and pit fall traps (e.g.. pitcher plants).
pollination, fertilization, fruit, and seed dispersal
habitat specialists

the fungi kingdom

useful and harmful fungi: People put the highly sensitive noses of pigs to use to help them locate buried truffles. Disease-causing fungi There are a number of fungi that can be dangerous for humans; these in available for use by other organisms and returned into the cycle of nature. include Cryptococcus neoformans, which can cause meningitis and is especially dangerous to people with a weakened immune system.

Chapter #3: Animals

Sponges

Cnidarians: The poisons of jellyfish may act on the nervous system (neurotoxins) and paralyze the victim. Some species are extremely poisonous to humans, while others cause only mild skin irritations or burns.

Worms: About 200 to 400 million people worldwide are estimated to suffer from this parasitic infection. Humans can also be infested by any roundworms, such as the Trichinella spiralis, carried by their pets.

Insects:

crustaceans and spiders

Mollusks

Fish

Amphibians

Reptiles

aves

mammals: common features

mammals: diversity: When danger approaches armadillos can protect themselves by quickly rolling into an armored ball. The humps in camels serve as fat and energy reservoirs

monotremes and marsupials: Koalas feed almost exclusively on eucalyptus leaves. The leaves contain a poison, which the koalas are able to tolerate to a certain extent. The concentration of poison is lower in older leaves.

rodents and lagomorphs

Ungulates

elephants and sea cows

sea mammals: Dolphins have a larger brain than humans and a fourth brain ventricle that allows them to remain mobile 24 hours a day. They relax by switching off half their brain for short periods. The other half takes over the duties of watching for danger and con trolling their swimming and breathing.

Insectivores

Predators

night fliers: Most bats, especially insectivorous bat species, use echolocation (a biological sonar) for navigating and hunting at night. Bats emit ultrasounds of frequen cies between 10 and 200 kHz. Humans are unable to hear these sounds. Potential prey items or obstacles bounce back these sound waves for the

animals to detect with their extremely sensitive hearing. The waves are then converted by the brain into an image of the environment. This allows bats to hunt even in complete darkness. A bat produces ultrasound through its lar ynx and emits it through the nose or mouth.
Primates

Chapter #5: Humans

reproductive organs, reproduction, embryogenesis, puberty and aging, tissues and organs, respiration and the lungs, skeletal system: bones, joints, muscles, and tendons, heart and circulation, blood, nutrition, digestion, water and the kidneys, hormones, nerve cells and signal transfer, brain and spinal cord, the eye, the ear, nose and tongue, skin
cell types and the lymphatic system, immune response to disease,

Chapter #6: Genetics and Heredity

Genes, hereditary rules, feature characteristics: transcription, feature characteristics: translation, mutations, hereditary diseases, cloning, stem cell research

Chapter #7: Ethology

What is behaviour? instinctive behavior courtship, mating, and care of the young, feeding and social behavior, agonistic behavior, communication, the biological clock, learned behavior,

Chapter #8: Ecology

abiotic factors: light,
abiotic factors: temperature and water: According to Bergmann's Rule, homeo thermic animals of a species and of related species grow larger in cold climates than they do in warmer regions (relative to volume, larger animals have a smaller surface area, which is advantageous for heat strongly temperature can affect an organ balance). Allen's Rule (proportional rule) stipulates that individuals of a species (and related species) in colder climatic zones have smaller body appendages (e.g., ears) than those in warmer regions, in order to conserve heat.
growth and regulation, competition: Varying neck lengths Ducks and geese are able to share a pond habitat since all acquire food differently. allow sPecies to reach different depths.
mutual benefit, **parasitism, biocenosis and biotope**, **energy flow and food chains, carbon cycle and nitrogen cycle, phosphorus cycle and water cycle, agricultural ecosystems, cities**

Chapter #9: Inorganic Chemistry

from matter into elements, atoms: the building blocks of nature, **the periodic table, the power of chemical bonds, new substances are formed**: Boats and ships are highly susceptible to rust due to constant exposure to salty water and harsh weather.

from test tube to reactor, **with retorts and computers, searching for clues** (A Total Ozone Mapping Spectrometer (TOMS) image showing ozone depletion over Antarctic and a spectrometer used in the optics industry.), **semiconductors**, **materials of tomorrow**

Chapter #10: Organic and Biochemistry

carbon: an extremely versatile element, carbohydrates: the world of sugars, **nucleic acids: molecular building blocks, lipids and fatty acids, amino acids, enzymes: active catalysts, origin and development, modern biotechnology,**

chemistry and nutrition : Commonly used preservatives include sorbic acid, nitrites, vitamin C, and vitamin E, which prevent the multiplication of pathogens.

medicinal drugs and cosmetics; Sodium laureate sulfate makes shampoo foam.

Plastics: MOST PLASTICS melt when heated. This is because their threadlike mo lecular chains are held together only by weak molecular forces. Nonplastics w o CO co such as rubber can withstand higher temperatures.

Nanotechnology, economy, accidents,

Physics and Technology

Chapter #1: Physics

energy and matter, forces, fields, interactions, rest and motion, of apples and planets, vibrating systems, waves everywhere, waves in the air,

Ultrasound: Dolphins orient themselves using ultrasound, emitting calls and then interpreting the echoes. Their teeth are arranged in a way that works as an array or antenna to receive the incoming sound, and the lower jaw transmits the waves to the middle ear. Ultrasound cleaning devices use the energy produced by these waves to loosen dirt particles. In medicine, doctors use the same principle to break up gall bladder or kidney stones.

heat and temperature, **order and disorder,**

Electricity: Amber is mineralized resin from ancient trees. Thanks to its high electrical resistance it serves as a good insulator. By rubbing, however, it is possi ble to transfer electrons onto a piece of amber, thus giving it an electrical charge.

mysterious magnetism: According to speculative theories attempting to unify all of the fundamental forces, how ever, these magnetic monopoles could have been pres ent shortly after the big bang. In complex experiments, scientists are currently attempting to demonstrate their existence—so far without success.

Light, **from microscope to optoelectronics, the new physics,**

quantum effects in our daily lives: The magnetic field of a superconducting continuous current keeps the superconductor suspended in the field of another magnet.

quarks, electrons, and co., fundamental forces, everything is relative,
space, time, and mass: The more massive a body is, the more it warps space and time, which is expressed in the accelerated movement of other nearby bodies.
the great unification
Supersymmetry: string theory: interprets elementary particles as states of vibration in unimaginably small strings. This concept is automatically super symmetrical and can Many physicists see string theory as a key component within a theory of everything. also be applied to space and time (and thus to gravity)
order from disorder: in theory, a little butterfly could even tually cause a hurricane in New York or China. This concept is called the butterfly effect: small triggers creating large effects.
fractals in nature and technology: Medical physicists have been able to show that cardiac arrests are of chaotic nature, and carry out research to build better defibrillators.
models and fluid mechanics: The Kabba in the Al-Masjid al-Haram mosque in Mecca: Fluid mechanics improved the flow of pilgrims as many were being crushed in the massive crowds generated during the Hajj.
the environment, humans, and the brain:

Chapter #2: Technology
Agriculture, agricultural machinery and technology, animal husbandry,
Fisheries: HOW 00 WE KNOW IF A FISH IS STILL FRESH? A chef uses the following criteria to determine if a recently caught fish is still fresh: its eyes should be clear, the gills a shiny, dark red. the fish should not smell like "fish," and the flesh should w o '55 co n give a little but still feel elastic when pressed lightly.
genetically modified food, **food preservation,**
energy production, transport, and storage: High-tension cables are mounted on isolators made from glass, ceramic, or plastic. Their ribbed shape allows problematic moisture to escape easily.
energy consumption, **fossil fuels: coal, oil, and natural gas**
nuclear power: Pressurized water reactors are the most common type of power-producing reactor. They use superheated water as coolant and neutron moderator. The primary coolant loop is kept under high pressure to prevent the water from boiling. The Biblis plant in Hesse, Germany has two pressurized water reactors. The combined power output is 2,500 mega watts. When it opened in the mid-1970s, Biblis was the biggest nuclear power plant in the world and a milestone of power generation.
solar technology: When sunlight falls on a photovoltaic cell, the photons activate the electrons in the cell. These migrate through metal contacts between the two semiconductor layers, following the internal electric field. The circuit is closed once an appliance is attached to the solar cell
wind energy: Exposed mountainous areas (such as Germany's Harz the central Spanish highlands) typically experience much than protected Inland valleys
water power and geothermal energy, **fuel cells and biomass**

automobiles: motor and body: exploring alternative energy sources. These include biodiesel fuels (containing corn and soybean by-products), electric engines, and hybrid engines (utilizing both fuel and electricity).

automobiles: safety, **alternative propulsion systems**, **new developments**, **bicycles and motorbikes**

Railways: As the name suggests, maglev, or magnetic levitation trains, are propelled by magnets: alternating fields moving ahead of the vehicle accelerate or slow it as needed.

motor ships: Submarines dive and rise by filling large tanks with seawater. To dive, the tanks are opened. Air escapes from the top, while water flows in from the bottom. Once the overall density of the submarine is equal to the water around it. it has neutral buoyancy and will remain at that depth.

Sailboats: The air flowing over the windward side of the sail moves faster than the air flowing over the leeward side, creating more pres sure on the leeward side. This is the force that moves the craft. The angle of the sail relative to the wind's direction determines the drift; if the angle is wrong, the sails will flutter and there is no movement. Using a process called tacking, sailing vessels can move in a direction opposite the wind. Longer ships create longer waves, which disperse rapidly, allowing the boat to reach higher speeds. The shape of the hull determines the ship's top speed. Flat hulls can carry larger loads but make a ship slower.

airplanes: propulsion: Four forces act on an airplane during flight: weight, lift, thrust, and drag. The airflow is split when it hits the wings. The up per airflow has a longer path to follow than the lower one. This creates a difference in pressure so that the airplane is lifted upward.

The resulting lift is explained by Bernoulli's principle, which states that an increase in velocity occurs with a de crease in pressure. The magnitude of lift depends on the speed of airflow and the shape of the wing.

airplanes: speed: Strategies could involve coat ings or panels capable of changing color or luminosity, or the use of organic light emiting diodes to create "invisibility cloaks."

light aircraft: Some gliders have water tanks in the wings that provide extra weight, allowing the pilot to adjust the craft's center of mass. The water, however, must be jettisoned prior to landing in order to reduce the stress on the frame. Waterplanes do not require a landing strip. Many light aircraft are equipped for "out landings.'

Helicopters: helicopter needs to exert lift and thrust to take off, The blades spin on the top of the helicopter, and air flowing over the blade has a higher speed than air flowing underneath, thereby creating a difference in pressure and causing lift. The tail rotor, spinning sideways, provides thrust to move the helicopter forward, but also. In some cases, two main rotors on top of the craft spin in opposite directions to balance the rotational forces and eliminate any need for a tail rotor. Due to their special abilities, like taking off and landing vertically and hovering for longer periods, heli copters are often used for rescue. Helicopters change direction on three axes through rolling (tilting sideways), yawing (turning left or right), and pitching (tilting forward and back). The steeper the angle, the greater the amount of lift. To control pitch, the pilot adjusts the angle of the main rotor blades at different points during the

rotation. To control roll, the pilot steepens the angle of the right or the left rotor blade at the proper point of the rotation.

Rockets

to outer space and back again: A higher speed extends the orbit into an ellipse.

building construction: The lattice truss structure of Colossos in Germany is one of the world's largest wooden roller coasters. Wood is more elastic than steel and thus allows a very intense riding experience.

Skyscrapers: Reaching for the sky (from left to right): Empire State Building. Taipei 101. Eiffel Tower. CN Tower, Shanghai World Financial Center. Burj Dubai, Guangzhou Television and Sightseeing Tower, and Freedom Tower.

environmentally sustainable construction: The UK's largest eco-village in Beddmgton, Lon don, allows for a lifestyle with no carbon emissions. The grass-covered roof of this "eco-villa" in Switzerland provides excellent insulation, while the pond serves as a natural habitat for local flora and fauna. A traditional element of Persian architecture still in use today is the windcatcher. This natural "air conditioning" system is both economical and sustainable.

energy-efficient construction:

roads and tunnels: Roads must be sturdy enough to sustain consistent traffic flow. They are made of a superstructure, or top cover, to protect them from climatic damage, and a substructure, which often consists of compacted soil. THE GOTTHARD BASE TUNNEL When it opens in 2015, the Swiss-Italian railway tunnel will he the longest in the world. Its 95-mile (153-km) course was measured out assisted by GPS and laser. The 30-foot (9-m)-wide tun neling shield "Sissy- spins as it drills through rock mass.

bridges and dams: Bridges, dikes, and dams are among the most demanding challenges of structural engineering. The central roadway of the Tower Bridge in London can be lifted almost vertically by electrical pumps. The Glen Canyon Dam on the Colorado River in Arizona: It provides eiergy and flood protection and is a source of drinking water.

the production process

industrial engineering: Computerized Numerical Control (CNC) machines are controlled by a computer program that directs the machine to perform specific tasks with minimal effort from the worker.

environmental protection and consumption:

recycling and disposal

the ubiquitous computer: One of the fastest computers in the world is the JUGENE (Julich Blue Gene) supercomputer in Germany.

computer components, input and output devices, data storage devices, operating systems, applications

intelligent machines: This is often done using a "teach-in" method: a human operator takes the robot through the steps of the process, which are then stored by the robot, **artificial intelligence, computer networks, the internet, the world wide web**

the networked world: An armband could call the ambulance after a fall or accident.

biometric techniques

rfid: identification through radio waves

1. RFID technology is expected to gradually replace barcodes on consumer products. The system offers useful applications for business, industry, and everyday life.
2. RFID, or radio frequency identification, is a technology used to identify objects, goods, and living things with the help of radio waves.
3. Depending on the technology used, the reception range for reading an RFID tag can range from anywhere between less than an inch to several feet
4. Their response signals may vary depending on their position or temperature RFID sensors can be used to monitor the temperature of frozen foods, for example, or to report wirelessly on a truck's tire pressure. RFID tags also make it harder to counterfeit products. They can be embedded in passports or other documents (p. 390), hindering fraud. RFID transponders in ID cards or keys can help control access to a building or vehicle. Similarly, they can monitor the time spent by a worker in a workplace. RFID tags in tiny glass cylinders, the size of a grain of rice, can be implanted under the skin of pets, livestock, or people.

fixed-line telephone networks

To digitize a voice signal, a converter samples the sound signal several thousand times per second. Each value is represented as a binary series of ones and zeros, easily processed by computers.

connecting to the internet

1. The ADSL (Asymmetric Digital Subscriber Line) system significantly increases the performance of the connection wire by using a wider range of frequencies for signal transmission than was usual in the past, and enhancing the ratio of data to noise.
2. An internet connection is shared publicly using I Many cafes offer open wireless Internet access to their customers. a wireless network access point (p. 386), which employs no encryption or password security, enabling Inter net access for anybody in the locality. Due to the lack of security, it is very unwise to access banking details or to access unencrypted Web sites using open wireless networks.

internet telephone systems

Internet telephone systems allow an exchange of data, like any other Inter net connection. This allows for unau thorized access to communications; for example, a call may be monitored or diverted. Although encryption is pos sible, it can reduce sound quality.

mobile telephone networks

ELECTROSMOG This term refers to the environmental effects caused by electromagnetic fields.
The fields can affect liv ing things as well as electronic devices. Crowded transmission masts can often be seen in urban areas.

audio technology

1. Sound waves are traveling vibrations in gases, liquids, or solids. Humans can generally perceive a range of some 16 to 20,000 hertz (cycles per second), although this varies according to age, hearing ability, and the volume of the sound.
2. Larger mem branes are better suited for emitting lower notes, while smaller membranes reproduce higher tones more effectively. Thus signals are routed to various sizes of speaker within a speaker box, depending on their frequency ranges.

digital cameras

The aperture setting also affects the sharpness of the picture. A small opening means increased sharpness, and a greater depth of field. A larger aperture setting reduces the depth of field.

video technology: plasma screens

radio technology: PROPAGATION OF RADIO WAVES In space, waves spread out in straight lines. On Earth, their movement depends on the wavelength. Longer waves act as "ground waves," spreading with the help of the Earth's electrically conductive surface. Shorter waves expand in all directions; however, they are directed back to the Earth's surface by the ionized upper atmosphere. Through a zig zagging process of reflection, they travel around the entire planet.

internet radio and tv: UMTS or 3G capable phones and laptops allow Internet access at speeds capable of streaming media.

film technology

printing technologies: Glossy color magazines with large readerships are usually published using gravure printing.

newspapers and magazines

Chapter #5: Mathematics

The First Mathematics: The first approaches to mathematics as we know it today date back about 5,000 years (before 3000 B.C.), from Mesopota mia. They generated the Sumerian, Babylonian, and Assyrian cultures.

numeric systems

the subject of mathematics

1. The number series begins with zero and one and each of the following numbers is the sum of the two previous Fibonacci numbers. Amazingly this number series reemerges in many other areas, for example the so-called golden section, Pascal's triangle, and the spiral-shaped alignment of leaves or seeds in many plants.
2. Applied mathematics, as the name implies, focuses on the ability to apply mathematical knowledge to solve real problems. The major branches of mathematics include number theory, topology (an extension of geometry), numerical analysis, and discrete mathematics
3. In virtual table tennis, numerics and mathematics play an important role in data processing and calculations.

practical application

Geometry: The Vilruvian Man. by Leonardo da Vinci, is a world-renowned painting that connects aesthetics and geometry.

arithmetic and numbers

coordinate geometry

1. In coordinate geometry every point is allotted a fixed place in the coordinate system around a selected set of axes.
2. Coordinate geometry is put into practical use in GPS navigation systems in cars and other vehicles.

Vectors: The Mandelbrot set plays an important role in chaos theory. This geometric figure is produced using a defined series of complex numbers.

differential calculus

integral calculus: To take full advantage of their focusing properties, a special concept from calculus must be used— the Bessoid integral—which takes the wave nature of light into account. Microspheres are so tiny that they must be analyzed using a microscope.

Statistics

probability theory: such as economic developments, quantum mechanics, changes in animal populations (STOCHASTIC THEORY)

pure mathematics: The Fields Medal is the highest possible award for a mathematician (apart from the Abel Prize first awarded in 2003), as the Nobel Prize does not include a cate gory specifically for mathematics.

applied mathematics

1. Today's cryptology has many applications, for example, data encryption, user identification for computer systems and digital banking. These applications are based on mathematical theories such as algebra, numeric theory, and probability theory.
2. The encryption machine Enigma was used by the German military during World War II for encrypting military information.

Proofs: euclid's Theorem

mathematics in the 21st century

1. THE GOOGLE ALGORITHM
2. Four different colors are enough to differentiate regions of a map from one another.