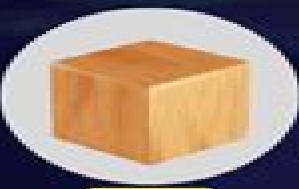


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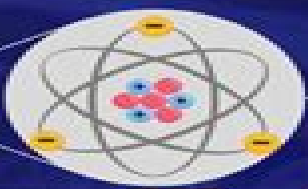
Matter

(All things are composed of atoms)



Molecule

(Matter is composed of molecules, which are groups of two or more atoms bonded together)



Atom

(Electrons orbit the positively charged nucleus of an atom)



Nucleus

Fundamental particles are classified into "Bosons" and "Fermions" based on their spin.

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BOSONS



Particles with **whole number spins** (0, 1, 2, etc.). They are energy and **force carriers** throughout the universe. They include **photons** (light), **gluons** (particles that act as force carriers in the nucleus), the **Higgs boson**, and the **W and Z bosons**.



Photons

Photons are massless, **charge-less** particles of light that travel at the speed of light.



Gluons

Gluons are **charge-less** particles that mediate the **strong nuclear force**, holding quarks together in protons and neutrons. They have color charges (red, green, blue) and are studied in high-energy environments like the **Relativistic Heavy Ion Collider (RHIC)**.



Higgs Boson

The Higgs boson, linked to the Higgs field, **gives mass to particles like electrons and quarks**. Mass determines a particle's resistance to force. **Photons**, which carry the electromagnetic force, **have no mass**.



W and Z Bosons

W and Z bosons are elementary particles with **spin 0 or 1**, discovered in 1983. They mediate the weak force, which is weaker than the strong force. There are two W bosons (W+ and its antiparticle W-), while Z bosons are their own antiparticles.

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Three Components of Matter (Fermions)



Force Carriers (Bosons)

Quarks

up u	charm c	top t
down d	strange s	bottom b

Leptons

electron e	muon μ	tau τ
electron neutrino ν _e	muon neutrino ν _μ	tau neutrino ν _τ

Gauge Bosons

photon γ	gluon g	Z Boson Z	W Boson W
-------------	------------	--------------	--------------

Scalar Bosons

Higgs Boson H

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FERMIONS



Particles with **half-number spins** (1/2, 3/2, etc.). They include protons, neutrons, electrons, neutrinos, and quarks.



- **Leptons** are fundamental particles that do not feel the strong nuclear force.
- **Electrons**, commonly found in atoms, are the most well-known leptons.
- There are six types of leptons:

μ Muon	e ⁻ Electron	τ Tau	ν _e Electron Neutrino	ν _μ Muon Neutrino	ν _τ Tau Neutrino
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Neutrinos

- **Neutrinos** are tiny, neutral particles with nearly undetectable mass.
- They are the **most abundant massive particles in the universe**.
- Produced during nuclear reactions in stars, reactors, and particle accelerators.
- **Bananas emit neutrinos due to their natural radioactivity.**



Quarks



- **Quarks** are the building blocks of protons and neutrons. They combine to form protons and neutrons.
- **Protons and neutrons** are **not** fundamental particles because they are composed of smaller particles called **quarks**.
- There are six types (flavors) of quarks:

u Up	d Down	c Charm	s Strange	t Top	b Bottom
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All About Particles

RJ Alexander



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1. Understanding the eBook All About Particles
 - The Rise of Digital Reading All About Particles
 - Advantages of eBooks Over Traditional Books
2. Identifying All About Particles
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an All About Particles
 - User-Friendly Interface
4. Exploring eBook Recommendations from All About Particles
 - Personalized Recommendations

- All About Particles User Reviews and Ratings
- All About Particles and Bestseller Lists
- 5. Accessing All About Particles Free and Paid eBooks
 - All About Particles Public Domain eBooks
 - All About Particles eBook Subscription Services
 - All About Particles Budget-Friendly Options
- 6. Navigating All About Particles eBook Formats
 - ePub, PDF, MOBI, and More
 - All About Particles Compatibility with Devices
 - All About Particles Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of All About Particles
 - Highlighting and Note-Taking All About Particles
 - Interactive Elements All About Particles
- 8. Staying Engaged with All About Particles
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers All About Particles
- 9. Balancing eBooks and Physical Books All About Particles
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection All About Particles
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine All About Particles
 - Setting Reading Goals All About Particles
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of All About Particles
 - Fact-Checking eBook Content of All About Particles

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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