

## QUANTUM FUNDAMENTALS

### ATOMS

'Atoms' are the tiny particles that make up all solids, liquids and gasses. They're like a kind of really small Lego block. They're so tiny that you can't see them, not even with a normal microscope!

Different things are made from different types of atoms. Some things are made from just one type of atom, like gold, but others are made from mixtures of different atoms. Water is made from hydrogen and oxygen atoms. People are made from lots of different kinds of atoms, but the main ones are carbon, hydrogen and oxygen.

The word 'atom' comes from the Greek word 'atoma' meaning 'indivisible'. When we first discovered them we thought they were the smallest things possible.



This means everything!

Since then we've learned that even atoms are made up of smaller particles. In fact, we can 'split' atoms – that's how nuclear power stations work.

We've arranged all of the different types of atoms we know about into the 'periodic table of elements', based on the number of protons each atom contains.

Protons are one of the things that make up an atom.

For example, a hydrogen atom has one proton, oxygen has eight and gold has 79.

A section of the Periodic Table

A section of the periodic table showing elements from Boron (B) to Oganesson (Og). The elements are arranged in rows and columns, with their symbols, names, and atomic numbers. The elements shown are: B, C, N, O, F, Ne, Al, Si, P, S, Cl, Ar, Ga, Ge, As, Se, Br, Kr, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn, Mt, Ds, Rg, Cn, Nh, Fl, Mc, Lv, Ts, Og.

### ENERGY

Energy makes things happen! Energy can make things that are standing still move, make cold things hot or light up the darkness. We use energy every day – it makes our cars move, cooks our food and makes our phones work.

There are different types of energy and it can change from one form to another. For example, a car changes the chemical energy in petrol to kinetic energy as it moves. And our kitchen stove converts electrical energy to heat.

Your own body even does this by converting the chemical energy in your food to kinetic energy when you move around.

Energy is what allows us to do 'work'. Work is using energy to do anything useful, like lifting a weight, or even just thinking.

Kinetic energy is the energy of movement.



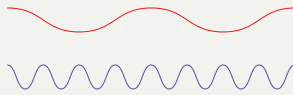
# LIGHT

We see things when light bounces off them and enters our eyes.

The colour of light depends on its **wavelength**. Red has a long wavelength, while violet has a shorter one.

That's why they're at opposite ends of a rainbow.

Wavelength is the distance between peaks or dips of a wave



We can see lots of different colours – all the colours of the rainbow. But

there are some colours that we can't see, like **infrared**,

which is what makes you hot in sunlight and **ultraviolet**,

which we protect ourselves against with sunscreen.



# NOISE

When you think of something being noisy, you may think of sounds that stop you hearing what you want to hear, like someone talking when you're trying to watch a movie.

In science, 'noise' isn't just sound, it can be anything that makes it difficult to find what you're looking for, like smoke from a fire making it hard to see the stars.

In quantum physics, we need to measure things that are **really** small. This can be hard because the noise is often bigger than the thing we're trying to measure.

Noise is grouped into different types. (We give them colourful names, but they're not actually coloured).

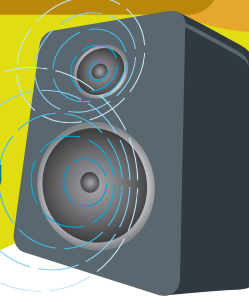
**White noise** appears across a broad range of **frequencies**.

**Brown noise** comes from machines or electronics and usually occurs at particular frequencies. **50 Hz** noise coming from electrical equipment is a very common problem in science labs!

**Pink noise** comes from nature. For example, people on submarines sometimes have their sonar systems interrupted by lots of shrimp snapping their claws at the same time!

Sound moves as waves. The width of the wave is related to its frequency.

Frequency is measured in Hertz (Hz).



# QUANTISED AND QUANTUM

The word 'quantised' means that you can only ever have certain numbers of something.

Eggs are a good example of this.

A chicken may lay an egg or maybe even two in a day, but never half an egg or three-fifths of an egg. So we say that eggs are '**quantised**' in whole numbers.



Something like water is very different. You can have a lot or a little water, but you can never have 'one' water – water is **continuous**, not quantised.

A quantum is a single amount of something that is quantised, so one egg is a single quantum of egg.

Quantum physics deals with the world on a very small scale, where lots of things are quantised, including things like energy that are normally continuous.



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