Matter Compilation: Crash Course Kids

Physical Science
https://youtube.com/watch?v=wyRy8kowyM8
https://nerdfighteria.info/v/wyRy8kowyM8

=====Intro (00:00)=====

The world, the whole universe is made up of stuff and we call this stuff matter. But what does all of this mean? What is matter? What's the difference between the matter that makes up wood and the matter that makes up water? And why does it... matter? Eh? See what I did there? Let's see if we can answer these questions, and we'll start with the simplest ones: what is matter and what are particles?

=====Matter Matters (0:25)=====

You might have heard that everything is made of matter, and that's true. You, soccer balls, iPads, even your pet Fluffy, all made of matter. So... that's interesting, but what is matter exactly?

[text: Big Question]

The scientific answer is that matter is anything that has weight, and takes up space. You already know about weight, right? That's just how heavy something is. Like if you've ever been to the doctor's office. The first thing they do is have you stand on the scale so they can measure how much you weigh. As for taking up space, another way of thinking about it is that all matter has volume. It simply fills the area it's in. If you pour water into a glass, for example, the water's volume is the amount of space that it takes up in the glass. So, all matter has volume and weight, but it sure doesn't all look the same. Well, that's because matter comes in different forms, or 'states'.

Liquids are a state of matter that I'm sure you're familiar with. If you've every poured yourself a drink while trying to watch TV, you might have noticed that liquids take up space. Because, once the space inside your glass is full... GAHHHH! Right on the carpet. Sorry, mom. You also know that water has weight, if you carry a water bottle. As you drink from it, it gets lighter because you are removing water from it.

Solids are matter too, of course, probably the most obvious kind. Rocks are solid; so is ice, which is just solid water. Soccer balls are solid, iPads, your pet Fluffy, every single guy in One Direction. And just like rocks, all those things have weight and take up space. Now, you know what's weird? Sometimes matter can't be seen or felt, but it's there, like the air we breathe. Air is an example of gas, the third main state of matter. And I probably know what you're thinking. How do we know air - or any gas, really - is there if we can't see it? Well, we can prove it by doing an experiment. Science!

[text: Investigation]

Let's start by asking the question. Is air matter? Because if it is, it should take up space and have weight, right? To see if air takes up space, lookit. I can easily drop an empty balloon into this little box, but a full one won't fit. That's because the air that fills the space inside the balloon is bigger than the space inside the box. Now, does air have weight? Let's try something else. Take two empty balloons and tape them to the ends of a meter stick. Then we'll hang the meter stick on a string so that it's perfectly balanced. Now, let's see what happens if we blow up just one of the balloons and put it back on our meter stick. Check it out. The end with the full balloon sinks. It weighs more than the empty balloon because the air gives it extra weight.

[text: Conclusion]

The balloon full of air will always weigh more than the empty one. Because air is matter, and matter has weight, and takes up space, whether it's a liquid, a solid, or a gas. So listen. The next time someone tells you that something doesn't matter, you can tell them, to their face, that, technically, everything is matter. And tell them Sabrina said so.

=====Part(icles) of your world (3:30)=====

You ever hear someone say you look like a million bucks? Well you do, but you also look like a million particles. Let me explain. You and I are both made of matter. I don't mean we matter, like we're important, even though of course we are. I mean we actually are matter.

Matter, as you know, is anything that has weight and takes up space. And we did a whole video about it. But what is matter made of?

[text: Big Question]

It's made of particles. So you, as a big thing of matter are made of particles. The device you're watching this on is made of particles, your dog is made of particles. Ya get the idea.

Particles are so tiny though. You can't see them. Just picture them as super-small balls packed together to form an object. And how an object looks and behaves, which we call it's properties, has a lot to do with those tiny particles that it's made of. Let's take a look.

[text: Investigation]

You know that most matter comes in three states: solid, liquid, or gas. Particles in a solid are packed so tight that they don't move. And they keep you from moving through it, like a brick wall. Now, don't try running through a brick wall, just trust me on this.

But in a liquid, there's more space between particles. That extra room between them allows them to slide around. That's why you can stick an object into or through a liquid. Like dropping a straw in a glass of soda or wading through a pool of water.

And there's so much space between the constantly moving particles in a gas, that you can move around in them easily. In fact, when you walk from one side of the room to the other, you've walked through a bunch of gases that make up air.

But if something is a solid, will it always stay a solid? Is a liquid always a liquid? Do gases ever become non-gases? To find out if matter can change states, let's find examples of when objects' properties change. Then we can figure out what's happening to their particles. Here's one, a candle. It's solid right, made of wax? But when you light the candle, the packed particles loosen up and the wax begins to melt, liquid wax. So a solid can become a liquid.

Now, here's another. Let's say you've got a pot of water on the stove. If you heat a liquid up, its particles will move around so fast that they can't hold on to each other. When that happens, all of the particles fly apart and become a gas, like the steam you see when you boil water. So a liquid can become a gas.

Okay, one more. How about a forest on a really cold night or even on your front lawn. When it's cold enough, water vapor, a gas in the air, turns into tiny crystals of frost, which you see on trees or grass. The free-floating particles in the gas join together and form a solid around the plants. So a gas can become a solid.

But my favorite example of a state of change? The Wizard of Oz, definitely. Remember when the Wicked Witch of the West melts at the end? She totally goes from a solid to a liquid. Okay, but seriously, what does all of this mean?

[text: conclusion]

An object made of matter can change its properties when it changes states. And remember, it doesn't make a difference which state of matter an object is in: solid, liquid, or gas. It's still always matter.

To sum up: matter is everywhere. Matter is made of particles. Therefore, particles are everywhere. So, like I always say, "Never trust a particle, they make up everything."

So now that we have an idea of what matter is, we have to ask more questions. Like how to figure out what kind of matter something is made out of, and how we can figure out what an object is just by having measurements and making simple observations. Well, let's take a closer look.

=====Hunting for properties (7:16)=====

Hey guys! Remember what it was like in preschool? If you don't remember, here's a reminder. It was way easier! Playing with colored blocks, learning with shapes. Those were the days... good times.

But here's a fun fact: when you were learning how to put all those yellows blocks in a line, or stuffing square shaped blocks through a square hole, you were also learning something very fundamental, and that is how to judge an object's properties. But what do we mean when we talk about the properties of stuff?

[text: Big Question]

Well, let's start with this, The stuff that makes up everything is called matter. Doesn't make any difference if it's a tiny grain of sand or all of the air that surrounds the Earth, everything is made of matter. And a property of matter is just any characteristic that we can list about it, like how it looks, feels, or acts. For example, my characteristics include having black hair, wearing glasses, having some wicked awesome nerd cred and well... you get the idea.

Properties of matter are also things that we can observe. This means that they have differences that are big enough to notice. For instance I'm currently observing that my desk is messier than it was 5 seconds ago. And to round it out, properties of matter are also able to be measured, that is, we can compare objects to each other. But instead of just looking at them and getting a general idea of how they compare, we measure them by using tools that give us values or numbers.

Now let's put all of these ideas to work by demonstrating how we can find a few basic properties of a simple object. Let me grab my measuring tape.

Okay, okay look, I know I was just talking about how fun it was to play with blocks, but let me be clear, I am not playing with these blocks. This is science, people!

Now let's start with a couple of questions.

1) What properties does this block have?
Well, there are some properties that we can observe, but we can't really measure or describe them with numbers, like this block's color or what it's made of, or even the fact that it holds its shape which makes it a solid.

So a better question to ask might be: what can we observe and measure about this block?
Let's start with the big one here: length.
Length is just the distance of something from end to end, and this block's length is 8 and a half centimeters.
Width meanwhile is the distance of something from side to side, and its width is 8 and a half centimeters.
Height! That's an easy one. It's the distance of an object from its bottom to its top, not to mention a major factor in being able to play basketball successfully, and the height of this block is 9 centimeters.

So, length, width and height are some of the commonly used properties, but there are a lot of others too. For instance, our block is also an object that is shaped like a box that takes up space, that is, it fills up the space it's in. We call that space the block's volume. We can measure the volume of this block using math based on the measurements I just made. But we could also to get a more general idea of its volume by making other observations like the medium block easily fits into the bigger block, so we know that the medium block has less volume than the bigger block. But there's no way that the medium block is fitting into the little block so we know that the medium block has more volume this small block.

Finally, weight is another measurable property of matter. Weight just tells us how heavy an object is. When you go to a doctor's office and they ask you to stand on a scale, they are using that scale to measure your weight. Got it? Good!

[text: Conclusion]

So all matter has properties, and properties are observable, measurable characteristics that we can use to tell them apart. And we got to know the most common and useful properties that we can put a value or number on, like length, width, height, volume and weight.

So, hey, blocks- not just for little kids, also super handy for doing science.

=====Measurement Mystery (10:48)=====

Have you ever gotten up in the middle of the night to use the bathroom and stumbled out of bed and then, SMASH! And then after that, "OW?!" Well, that has happened to me. In fact, just last night. Got up, went to get some water, and kicked something really hard. And now, my toe hurts. So bear with me.

But if you're at all like me, having this happen to you likely brought a few things to your mind. Like one, turning on the lights would probably have been a good idea. Two, "What did I trip over?" And three, "Who left it there!?" The second of these questions is pretty important because it's a question that's the essence of so much science. And that is, "What is this thing?"

[text: Big Question]

No matter what that "thing" is, I can tell you that it's made up of matter and all matter has properties. Specific characteristics that separate it from other kinds of matter. If you remember from the last episode, properties are things we can observe and measure.

Things like an object's length, width, height, and volume. But how can we use these kinds of properties to identify an object? I am so glad you asked. Because we're going to do a little investigation together.

[text: Investigation]

So today we're going to solve the mystery of, "What did Sabrina trip over in the middle of the night?" And we'll do this by examining the properties of said mystery object, which I happen to have right here hidden under the cloth.

But before we start our investigation, did you know that there are different kinds of units that can be used to measure things? You can measure in feet or pounds, or gallons. If you wanted, I guess you could also measure in jelly beans, but that would take a long time. So we'll just go ahead and use the international standard units, also known as the metric system. You might know these units as meters, grams, and liters. And the markings on my measuring tape here divide a meter into 100 smaller pieces of equal size. Each of these is a centimeter: one hundredth of a meter.

Okay, now back to this mystery object. Feeling around, it's got nice straight sides and two sides are larger than the other two. That means we're dealing with a rectangle here. Now let's give those sides a measure. Looks like it's about 23 centimeters wide, about 30 centimeters tall, and about five centimeters high. So we have some measurements. That's a good start, but it's not enough to tell us what this thing is.

So let's measure another property, its mass. To do this, we need a different tool, a scale. And we'll use a different unit too. In the metric system the unit of mass is called a gram. A paper clip has a mass of about a gram. Whatever this is is kind of heavy. It's almost 3,000 grams.

So here we have an object that is pretty heavy, hard, smooth, and rectangular. Let's see, what other objects do I know of that fit that description? Tennis racket? Nope. It's not my socks or my stuffed panda, and we've already ruled out my tablet. Oh! I know! It's my science book! I was doing a little reading last night and put it on the floor before I turned the lights out.

[Text: Conclusion]

So we've been able to identify a mystery object by observing and measuring its properties. We used units in the metric system to put values on properties such as grams for mass, and centimeters for length, width, and height. And those numbers gave us enough clues to solve the mystery of what I kicked in the dark. So remember, when it comes to measuring, think metric. And when it comes to identifying objects, take a tip from me. Avoid identifying them with your toe.

Ok, so now that we know a bit more about matter and properties of matter, let's look at how matter can change. Let's look at how coal can change into diamonds. One note though, it takes a lot, like A LOT to change coal into diamonds.

=====Material Magic (14:40)=====

You can't make something from nothing. I mean if you could, you'd see me surrounded by an unlimited supply of Harry Potter books and Jolly Ranchers right now. But what you can do is take some stuff and change it to create what's basically brand new stuff. Well, I can't, but material scientists can.

Last time we talked about how scientists can improve existing materials by altering their properties, like turning glass into super extra hard gorilla glass, but they can also make new materials. So today we'll find out how and why scientists can make materials with whatever properties they want.

[text: Big Question]

But first, let's do some review. We all remember what a material is, right? A material is an object made of matter. All materials have properties, a property is a distinguishing quality of a material like its color, shape, size, or weight. And material scientists study the properties and uses of different materials and invent completely new ones.

Think of a material that we use all the time like rubber or plastic. Chances are at some point in history it might not have existed until a material scientist invented it. And more often than not, materials are made to solve a specific problem. Let's take a look at a real-life material that's been made by scientists to have the properties that they wanted in order to solve a problem.

[text: Investigation]

This is a diamond. Sparkly. These are also diamonds. In fact in a lot of ways these diamonds seem to be pretty similar. They're both materials, or objects made of matter, but one of these materials was made naturally, deep inside of the Earth. The other was made in a lab. That's right, we can grow diamonds in a lab. Well, maybe not "you and me" we, but material scientists can and do make them.

Natural diamonds are formed deep in the Earth, far below the surface. This part of the Earth is super hot, there's also a ton of pressure there with the weight of all of that rock above pressing down. This combination of high temperature and high pressure pushes atoms of the element carbon together to form diamond crystals. Their hardness and sparkliness are two of the main properties of diamonds that make them different from other forms of carbon like graphite or coal.

So when people want diamonds, do they just drill down into our planet and start picking up their favorites? Um, no. Diamonds are cool and all, but that would be a lot of work. The diamonds that we see on jewelry and such are the ones that have been brought closer to the Earth's surface by violent eruptions a long time ago. This means there's a limited supply of diamonds in the world. This is a problem because diamonds are not only pretty, they're also really useful. Namely, diamonds are some of the hardest substances on the planet, so they're super handy for cutting through or polishing surfaces that would break almost anything else. Tiny diamonds are actually used in some kinds of saws and drills that can cut through rock and even concrete.

But since natural diamonds are really rare, they're also really expensive. So a bunch of clever scientists figured out a way to make their own diamonds without having to spend weeks drilling into the Earth. One process for making diamonds in a lab is called high pressure, high temperature or HPHT for short. This process basically tries to replicate what's happening deep within the Earth using just a key natural material called graphite.

Scientists place graphite, a soft, grey form of carbon and the stuff that you can find in your number two pencil, under intense pressure and heat. Heavy blocks in the HPHT machine press down on the graphite creating pressure while a zap of electricity creates the high temperature. The pressure and temperature start to change the properties of the carbon, and BOOM in just a few days a hard, sparkly diamond is created. Of course jewelers would need to cut it to get that classic diamond look, but even in its pure form you can

see that it's clearer and much harder than the original graphite. That's how one material, lab-grown diamonds, went from a form of material with completely different properties to a form with the properties we wanted.

[text: Conclusion]

Humans can make materials using basic natural elements like graphite when they really need to solve a specific problem. There are also tons of other examples out there of materials that people have created, like rubber or plastic or nylon. None of those things existed until some intrepid scientist started thinking and fiddling. Who knows what brand new material we'll cook up next. I know lab-grown diamonds are hard to outshine, but I think we're up to the challenge.

Diamonds and coal are one thing, I think we can all understand them. They exist in a solid state and if you hit either of them hard enough, they'll break. But what if there was something weird? Something that didn't behave like normal, or Newtonian, substances? Shall we talk about oobleck?

=====Non-Newtonian Fluids (19:12)=====

You know what we haven't talked about in a while? Things that matter. Like mass and materials and particles. I guess what I mean is things that have to do with matter. We've already talked a lot about the different states of matter. You know, some matter comes in the form of a solid, others in a liquid, and still others in a gas. But are you ready for a question that will bend your brain a little? What if there's matter that fits into more than one of these categories? Is there such a thing? If there is, what's it like? And can I make some? Maybe... in my kitchen.

Before I answer any of these questions, let's take a closer look at different states of matter. You remember what a solid is. It's matter that has a definite size and shape, like this desk that I'm sitting at or the clothes that I'm wearing, and well, all of me. I'm a person with a definite size and shape.

Liquid is matter that has a definite size, but no definite shape. The water in this glass is a liquid. It has a definite size, but no definite shape. Like you could say that my desk is "desk-shaped", but there's no such thing as "water-shaped".

And a gas is matter that has no definite size or shape. The air around me and you is a gas. It's not shaped like anything and its size changes depending on how big the container is that it's in.

Now all solids, liquids, and gases are materials or objects made of matter. And all materials have properties, or traits, that help identify them like their color or shape or size or temperature or weight. And now that you're properly refreshed on the states of matter, I'm going to cheat and answer our big question a little early. Or at least part of it.

Yes, some materials aren't so easily lumped into just one state of matter. These unusual materials can actually act like multiple states of matter. Neat, right? Wanna meet just such a material? Then let me introduce you to Non-Newtonian Fluids. The non-what-now?

Non-Newtonian fluids are substances that don't behave like we'd expect them to. These fluids might look like one thing, but they behave like another. So, what makes a substance Non-Newtonian? Let's find out by making a Non-Newtonian mixture of our own. Say hello to oobleck.

[text: Investigation]

Believe it or not, I didn't make this word up. It comes from a book written by Dr. Seuss. You know the guy who wrote The Cat in the Hat? In another book he wrote called Bartholomew and the Oobleck there's a king who gets bored with normal, everyday weather, so instead he makes sticky stuff fall from the sky. That's where oobleck, the stuff that we're going to play with today, gets its name. But the stuff we're talking about is real. Our oobleck is a Non-Newtonian substance with a pretty simple recipe. No magical kings required.

All you need is about one and a half cups of cornstarch, about one cup of water, a big bowl, and a spoon. Pour the cornstarch into your bowl and slowly add some water. Keep stirring until the mixture feels kind of like honey. In the end, it should look like this. Now grab some of this goo in your hand. When you squeeze it, it will form a solid ball in your palm. But, when you unclench your fists and release the pressure, it will slide between your fingers, like a liquid.

All fluids have a property known as viscosity, which is basically the rate at which a fluid flows. And Newtonian fluids or "normal fluids" flow at a consistent rate. But Non-Newtownian fluids or "non-normal" fluids flow at a different rate depending on how much force or pressure is applied to them. So your oobleck flows at a much slower rate when pressure is applied to it, acting like a solid. But, when the pressure is removed, it flows faster and behaves like a liquid. Good for you oobleck! Being normal is overrated, right?

[text: conclusion]

So if an object's viscosity, or flow rate, is not constant, or changes depending on the pressure applied to it, it's a Non-Newtonian fluid. Which means, yes, some materials can fit into more than just one state of matter. These materials are called Non-Newtonian fluids. And they don't play by your regular rules of matter. They'll be a solid sometimes and then a liquid at others.

Matter is weird, but it's pretty much everything all around us: air, water, me, you, it's all matter. If you enjoyed this, check out the rest of our channel and subscribe!

[CrashCourse Kids Outro plays]