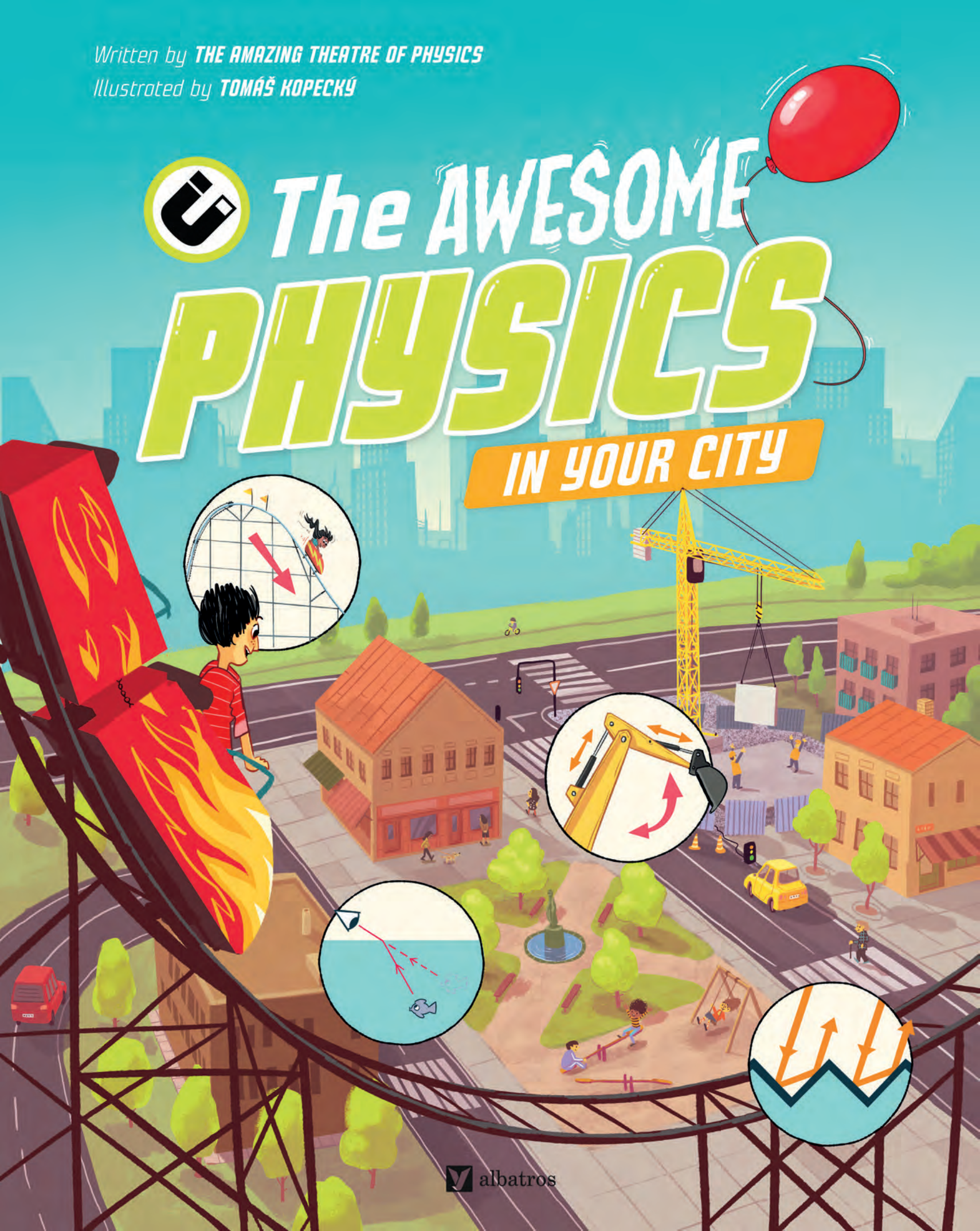
Written by **THE AMAZING THEATRE OF PHYSICS**
Illustrated by **TOMÁŠ KOPECKÝ**

The AWESOME PHYSICS IN YOUR CITY

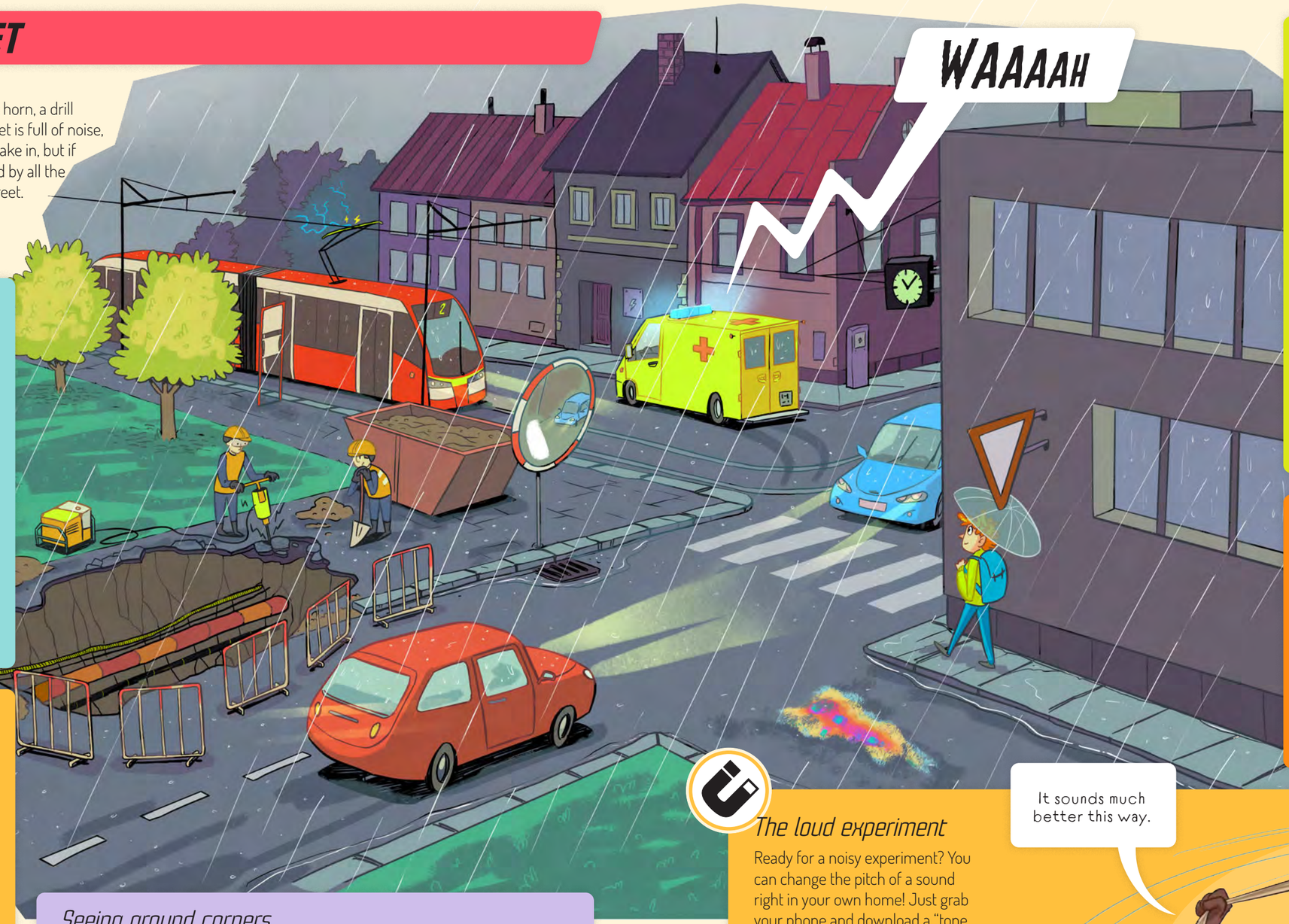


albatros

DISCOVER PHYSICS...

1. IN THE STREET

An ambulance wailing, a car honking its horn, a drill buzzing... Everywhere you look, the street is full of noise, movement, and sensations. It's a lot to take in, but if you look around, you might be surprised by all the interesting things you can find in the street.



ELECTRICITY

Lightning on cables

Hey, have you ever seen any trams in your city? If so, you might have noticed something cool on dark nights: a quick flash of light and a soft rumble near the wires above. This happens when the poles on the tram drift a bit away from the cables. It's like what happens during a storm. There's so much electricity in those cables that it can jump through the air onto the nearby poles, making a neat show!

ELECTRICITY

Underground

Beneath the surface of the pavement or a road lies a hidden world waiting to be unearthed. A city is a labyrinth of sewers, pipes, and cables intricately woven together, allowing us to turn on taps, illuminate our homes, and cook dinner on a cozy gas stove. But imagine if all these essential lifelines were exposed. It wouldn't be very practical, would it? That's why everything is cleverly hidden underground, keeping our cityscapes uncluttered and safe for all.

Seeing around corners

Sometimes when we're driving through crossroads or bends in the road, our view is blocked by buildings or tall fences, making it tricky to see very far ahead. That's where rounded mirrors come in! Have you ever noticed how they stick out? They're shaped like inverted spoons, so we can see much more than with flat mirrors. Light bounces off the mirror from around the corner and reflects towards us.

LIGHT

SOUND

Blaring sirens

Ever noticed how when a vehicle comes towards you, its sound changes? You might hear it most clearly when an ambulance rushes by, siren blaring. As it zooms closer, the pitch gets higher. But as it moves away, the pitch drops lower. This is just how sound works when things move closer or farther apart. It's called the Doppler effect. And guess what? It's not just sound that does this; light does too. Astronomers detect this exact kind of shift in light. It helps them know if stars are moving closer or farther away – which, believe it or not, is how we know how old the universe is. Amazing, right?

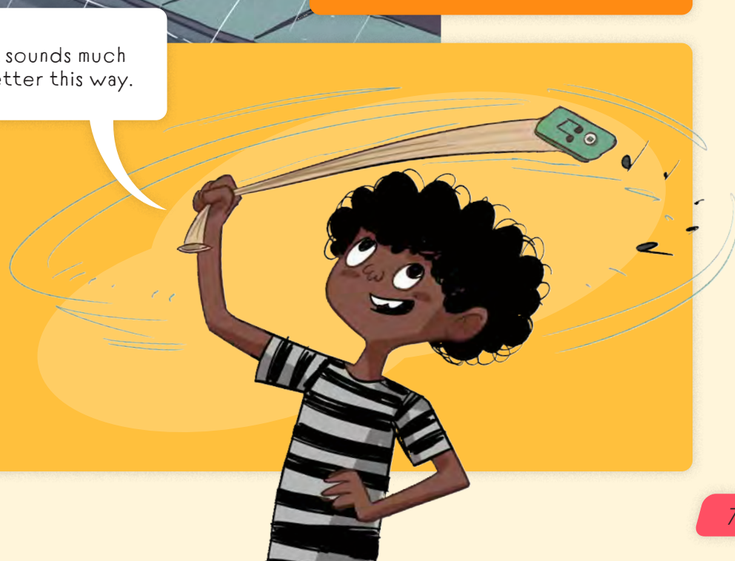
LIGHT

A rainbow on the road

Sometimes, after it's been raining, you might spot a rainbow on the road. Unfortunately, this kind of rainbow forms on spilled oil spreading over a puddle. Light interacts with it, creating different colors based on the oil's thickness. It's like the rainbow streaks you see when blowing bubbles.

The loud experiment

Ready for a noisy experiment? You can change the pitch of a sound right in your own home! Just grab your phone and download a "tone generator" app. Then, grab a pair of your mother's tights and place your phone at one end. Now, spin it above your head and listen closely. As the tights spin, the pitch of the sound will go up and down, just like a siren!



2. ON A BUILDING SITE

The bustle of construction work never stops in cities – something's always being built. It's a marvelous sight, especially when it involves big yellow diggers, bulldozers, and other machines.

SOUND

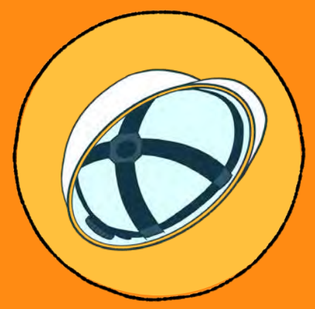
Racket, din, and noise

As soon as you step onto a building site, the noise hits you hard. All those machines, diggers, bulldozers, and pneumatic drills make a real racket. Listening to loud noises for too long can hurt our ears. That's why it's so important for construction workers to wear earmuffs.

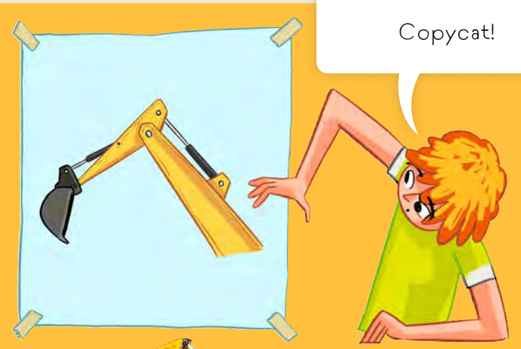
PRESSURE

No helmet, no entry

Every worker on a building site has to wear a helmet to protect their head. But how does it do that? Inside the hollow plastic shell, you'll find a couple of plastic straps. When you bump your head, these straps spread the impact to a large area so it gives your head just a gentle squeeze. For the helmet to work, it must fit closely around your head. That's why you shouldn't wear a helmet that doesn't fit you properly and you should always fasten it tightly.



FORCES



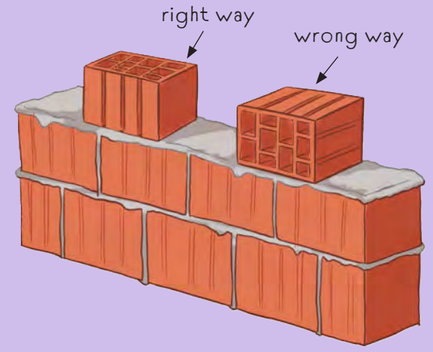
An excavator's arm

Digging a hole takes a lot of work. But instead of slaving away doing it by hand, it's much better to leave it to a machine called a digger. If you watch a digger digging, you might notice how similar its arm is to a human arm. A digger also has a shoulder, an elbow, and a wrist. The difference is the digger has a bucket at the end instead of a hand. Each of the excavator's joints has a piston that can extend or contract to bend or straighten the joint. An excavator gets by with just one piston for each joint, while our arms need two different muscles for each joint. One muscle bends the arm, the other straightens it. We can only shorten our muscles; we can't lengthen them.

PRESSURE

How much can a wall bear?

The bricks we use to build houses are often riddled with holes. Inside them are hollow tubes filled with air, which help to trap heat inside the house. Most importantly, a brick must be sturdy, as the bottom row of masonry bears the weight of everything above it. So, even a brick with cavities in it can support a hefty load from top to bottom. But if you were to lay it on its side, the brick wouldn't support your weight without breaking. However, that doesn't matter, as the bricks in a wall only experience pressure from the top down, never from the sides. So, as long as you put them in the wall the right way, it's totally safe!



EQUILIBRIUM

Piles of sand

On a building site, there are usually piles of different materials. You'll find sand, gravel, and sometimes even rocks. But each pile has a different angle of steepness. When you pour sand out of a bag, it always forms the same cone shape. Each type of material forms a pile with a different steepness. Sand and gravel, as well as sugar, salt, and flour, always form their typical cone shape when you pour them out.

WORK

Slow but strong

Every type of work follows the same rule – either we have to put in a lot of effort or we can be fast. If you're carrying a light backpack, you can run easily. But if you have to lug around a ton of heavy shopping bags, you'll have to take it slow. Machines are similar to people in this way. If they need to handle heavy work, they have to do it super slowly. That's why diggers, bulldozers, cranes, and steamrollers move at a snail's pace.

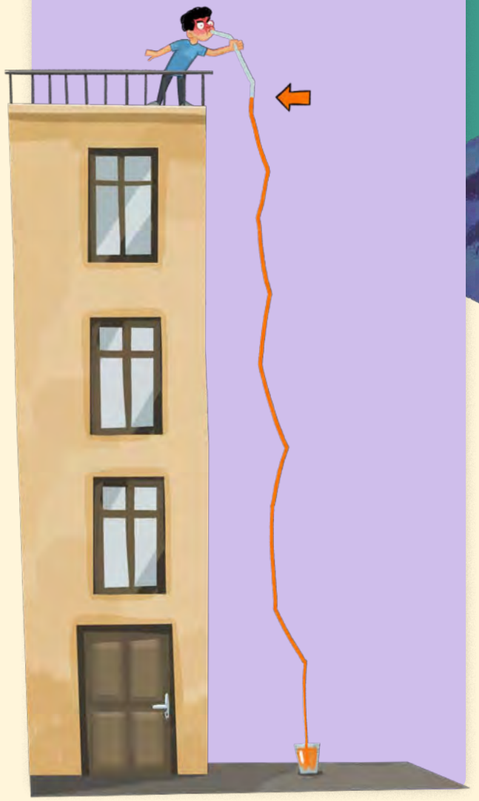
4. IN A RESTAURANT

In a restaurant, there are always lots of delicious foods and drinks to enjoy. During family meals or coffee breaks, there's always something new to try. Next time you go out to eat, here are some fun physics facts you can share with everyone.

PRESSURE

Drinking through a straw

Sipping through a straw is always a delight! It's fun to watch your drink climb higher and higher up the straw. But did you ever wonder how high it can go? Well, here on Earth, there's a limit: about 30 feet. Even if you give it all your might, you can't make it go any higher. Why? It is actually Earth's atmosphere that is pressing the drink up the straw. If there were more of the air above us, you'd be able to drink from a straw even more than 30 feet tall.



PRESSURE

Loods of bubbles

Bubbles in fizzy drinks aren't just for show – they add flavor! But they're not regular air; they're what's called carbon dioxide gas, packed in under high pressure. This gas slips in between water molecules. Surprisingly, there can be as much CO_2 as there is drink! Ever notice bubbles clinging to the sides of your glass? It's easier for them to escape there. Try adding a pinch of salt – the bubbles will rush out because they have more surfaces to cling to.

BUOYANCY

Who's up for some coffee?

There's an art to making a good cup of coffee, even if you're too young to realize it yet. But you can still notice how coffee naturally forms layers. When you add milk to your mom's coffee, it sits at the bottom before blending in. With skill, you can turn it into a latte macchiato. Pour warm milk first, then carefully add the coffee, and finish with frothy milk on top. Do you know why the layers in coffee are arranged this way?

BUOYANCY

Pour yourself a cuppa

Whenever you pour a hot cup of tea, the hot water swiftly changes color as it's poured over the tea bag. But if you accidentally use cold water, you'll notice it's slower and often only the bottom changes color. In hot water, particles move faster, carrying tea with them, while in cold water, everything moves slower, allowing tea to settle. That's why stirring sugar in cold water takes longer, while it dissolves more easily in warm water.

The (un)spilt experiment

Let's play magician! Fill a glass to the brim with water. Cut out a piece of card or stiff plastic film to cover the glass. Carefully turn the glass upside-down while holding the card in place. Slowly release your grip on the card – it'll stay put as if by magic! But be cautious; try this over a sink because accidents can happen. There's a very thin layer of water between the edge of the glass and the card that won't let any air in, so the water has no way to get out.

5. AT THE PLAYGROUND

Playgrounds are full of fun activities like swinging, spinning, sliding, and climbing. After a whole day of playing and running around, you're exhausted, right? Well you can give your brain a workout too. Thinking about the best way to approach the playground can make it even more fun and interesting.

SPEED

Feeling dizzy

Riding on a merry-go-round can feel like a whirlwind! Although there's no invisible monster trying to pull us off, we need to really hold on tight to stay on. The farther away you sit from the middle, the tighter you need to grip. You see, when you're farther out, you turn in a larger circle. You move faster than in the center part. So you have to hold on tighter. So, hold on tight and enjoy the dizzying spins of the merry-go-round!

FORCES

Climbing up into the clouds

Scaling a climbing wall is quite the adventure! It requires not only strong arms and legs but also careful thinking. Grip is key to prevent slipping, so having sturdy shoes with rubber toes for your feet is essential. However, keeping a good hold with your hands can be trickier, especially when they get sweaty. That's where climbers use chalk, a white powder that greatly increases friction, helping your hands grip the wall better.

EQUILIBRIUM

Sticking to the wall

Climbers are careful to keep their body as close to the wall as possible. When you're climbing try to do the same. The farther you are from the wall, the more strain on your arms and the quicker they tire. Remember the three-point method for safety: always keep three of your limbs securely positioned on holds while moving the fourth. Wait until it's secure before freeing up another hand or foot. Holding on in only two places makes it easier to lose balance.

ENERGY TRANSFORMATIONS

Slow going up, quick coming down

Climbing up all the steps to the top of a slide can be quite the workout. But the higher the slide, the better the ride down. Every bit of energy you put into climbing up is returned to you by the slide, even if some of it is lost to friction. The same principle applies to riding a bike. It's tough work pedaling up a big hill, but the thrill of coasting back down makes it worthwhile. However, it's a different story when you exert a lot of energy lifting something heavy, only for it to slip and come crashing down on your foot.

FORCES

How to dress for a slide

Wearing the right clothing (like pants) makes sliding down the chute a breeze. But if you're wearing shorts and sliding mainly on your bare legs, you won't glide as smoothly. Not only will you go slower, but you might even get painful friction burns as your skin sticks to the metal. That's also why water pours down a water slide – to reduce friction and make the ride more fun.

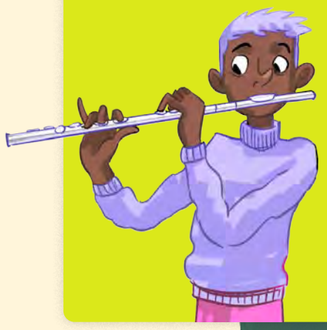
6. AT A CONCERT

All sound is the result of vibrations, which can range from very faint to so strong they make things move on a table. But where does sound come from? And how do we hear it?

FLOW

Flute

Wind instruments, such as flutes, clarinets, saxophones, trumpets, and trombones, work by controlling the air you blow into them. The easy ones, like pipes and recorders, need air blown through a small hole against a sharp edge. You blow – and music comes out. Flutes are a little harder, though. To play a flute, you have to shape the air with your lips just right. You can even try it yourself – blowing down into a glass bottle is almost like playing a flute.



Head of a flute

SOUND

Drums

Every musical instrument makes the air around it move in some way. For example, when you hit a drum, the drum skin ripples like a wave. You can make a drum sound different by tightening or loosening the skin.

SOUND

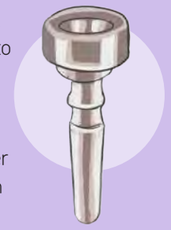
Guitar

A guitar has strings that you can pluck with your fingers or play with a pick. When you play, the strings vibrate so quickly they look like a blur. Thicker strings make lower notes, while thinner strings make higher notes. You can also make a higher note by stretching the string more or by pressing it down on the fretboard to make the string shorter, as shorter strings make higher notes.

FLOW

Trumpet

Trumpeters (like all brass players) face their own challenge. Simply blowing into a trumpet won't produce any sound. A trumpeter has to control their breath using their lips. It's similar to when you try to imitate a horse whinnying, with your lips flopping around as you exhale – but much faster and with firmer lips. A skilled trumpeter can create enough notes for an entire song just by using their lips!



Trumpet mouthpiece

SOUND

Piano

A piano makes sounds similar to a guitar – by using strings. Each key on a piano is connected to a small hammer. When you press a key, the hammer hits a string, making a sound. Every key has its own string. Thin strings are quieter than thick ones, so there are often two or three thin strings for each note. A piano is basically just a cabinet filled with strings. To keep all the strings tight, it needs a cast-iron frame. That's why pianos are so heavy.

SOUND

Violin

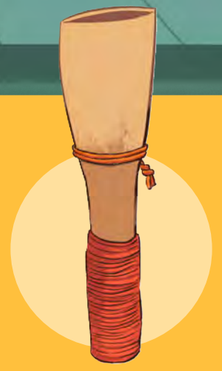
A violin has strings, but you don't usually play them with your fingers. Instead, violinists use a bow. If you were to slow down the bow a lot, you'd see how it catches on a string and pulls at it. Then, it breaks free, and the string springs back, only for the bow to catch it again. When this happens over and over, you'll hear the lovely sound that string instruments make.

FLOW

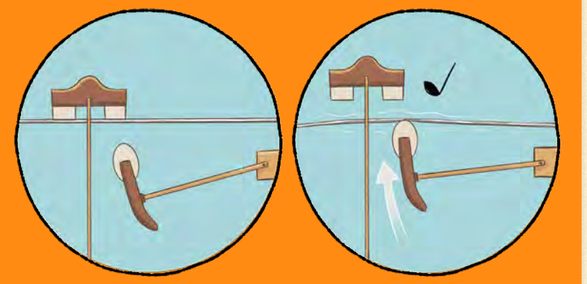
Saxophone

A saxophone has a sturdy mouthpiece with a thin piece of wood called a reed stuck to it. You hold this between your teeth and blow into the space between the reed and the mouthpiece. The saxophone has many keys for making high and low notes, but you can also change the pitch by adjusting how hard you blow and how you hold the reed. Oboe and bassoon players use two reeds instead of one. They blow between them like you do if you've ever "played" a blade of grass.

Reed of a saxophone



Double reed of an oboe



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THE AMAZING THEATRE OF PHYSICS
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TOMÁŠ KOPECKÝ

Have you ever wondered how the world around us works? Well, that's what physics is all about. Sometimes you'll spot it in a curved mirror at an intersection in the road. Other times it'll surprise you at the playground or on an amusement park ride. Physics even helps doctors see inside our bodies. But how does it really work? Join us as we dive head first into the fascinating world of physics, showing you how it's everywhere – and we mean *everywhere*! So keep an eye out as we explore the city. From construction sites to swimming pools, ordinary shops to concert halls, you'll discover where changes, electricity, radiation, and all sorts of forces are hiding in plain sight – and often invisibly. Plus, there are fun experiments to try at home or take on your journey around the city.

LOOK, SCIENCE IS ALL AROUND US!

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