

Wonders of Reality 15



Description

Tinkerbell and Vidia steal a diamond and hastily hide it in a bucket filled with amaranth seeds. Find out how Stokes' formula can help to retrieve the jewellery and where you've seen this equation but did not notice.

Wonders of Reality Episode 15 "George Stokes' Diamond"

A series of informative stories based on the animated film "Tinkerbell".

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Preceding events

Lightning struck the Home Tree. There is almost no pixie dust left, and fairies don't fly anymore. To survive, they started to master the new wonders—the wonders of reality.

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A bulky heap of withered leaves covered in writing plopped down on the table.

"Is that all?" Viola asked gloomily, knowing she was doomed to work right into the evening at the Queen's office.

"No, these are just urgent letters," the messenger fairy put her postbag over her shoulder, "the rest will arrive around noon."

"Got it," sighed the Queen's advisor.

"Have a good day working for the benefit of the Hollow!" The courier waved with her wings and left the hole in the sprawling maple tree where the ministers, officials and Queen Clarion herself were staying for the time being.

"I'll do my best," mumbled Viola, reading yet another letter with a request for help.

So, not enough water at the sunflower field? For as long as the tinker fairies continued building that underground water pipeline, someone would have to share. A thought came to her head, she pondered deeply whether it would work. *Maybe. Maybe not.*

Maybe the animal fairies could spare a little?

Viola was still thinking when two rolling balls crashed into the hole (or the Public Institution, as it was officially called). The transparent spheres as big as tennis balls flew just above the advisor, just missing her head, though she still ducked and yelped in fright. The shocked executive was about to ring the alarm and announce the invasion of ... trolls? Pirates? Birds of prey?

One glance at the corridor where the unwelcome objects had just rolled in showed that the matter was much worse.

"Tink, how many times do I have to tell you?" the bureaucrat spat furiously, her hair a mess and her heart still racing from receiving the nasty shock. She wasn't surprised in the slightest as she saw the

fidgety tinker fairy inside the soft plastic sphere.

“Oh, Viola! We’re just testing Stokes’ Law,” replied the artisan glibly, jumping out of her spherical transport.

“What?” the advisor spoke exasperatedly, staring with a look of complete disbelief.

“You know, Vidia’s sphere and mine have the same diameter, but since I’m a bit lighter and the air is some sort of viscous medium, my terminal velocity is slower, and because of the air resistance...”

“What the hawk are you talking about?” exploded Viola, ignoring the aforementioned wind fairy as she got out of her sphere; Tink grabbing her, holding her steady, she was scarcely able to stand after the dizzy ride.

“I’m saying that thanks to the George Gabriell Stokes’ formula, we can calculate the coefficient of dynamic viscosity,” Tink explained, keeping one eye on her fast-flyer companion. “Although, one usually uses balls with the same density, but different diameter. And since Vidia’s mass and mine are different...”

Viola growled. “Enough!” shouted the advisor angrily. “I don’t care what this ... this ‘Stode’s Law’ or ‘Vicious Medium’ or whatever you called it, is!”

“Um ..., it’s Stoke’s Law,” she corrected sheepishly as Vidia looked on, a small smile tugging at the edge of her lips at the raging fairy before her.

Viola glared at the tinker. “Get out of my sight right now!” she snapped. “If only I weren’t so overloaded with work over my head and ears...”

“I’m sorry. We didn’t mean to interrupt you,” Tink extended her hand in a conciliatory gesture. “Your maple tree is so tall—and it’s a perfect jumping board. I didn’t know that it would turn out this way.”

She paused to make sure Vidia was okay. She was; she was now leaning against the spherical ball that had stopped against the wall. “And keep in mind it’s not just for fun, it’s for science,” Tink added matter-of-factly.

Viola let out a disgusted noise. “Begone! If you interrupt me like that one more time, I’ll be lobbying for reopening the dungeons in Pixie Hollow!”

“Here we go!” Vidia groaned with a roll of her eyes. “The reformed, *enlightened* monarchy in *all its universal unfounded* glory!” She began rolling her sphere to the exit. “Oi, Tink, have you heard? We’re going to be the new prisoners of conscience.”

“You have no conscience!” shouted Viola, gathering scattered letters and documents that still lay strewn across the floor.

“Ha! Like *you’re* supposed to know that,” snorted the fast-flying fairy. “The name for political prisoners!”

Instead of replying, the bureaucrat stared daggers, swiping a folder at her. Vidia let out a mock yelp, pretending to be scared, as she moved to the exit, calling for Tink to follow her. Tinker fairy joined her with her own sphere, apologising once more for the disturbance. Viola ignored her and began muttering under her breath—no doubt some invectives, but Tink did not hear.

The friends left the hole, pushing their recreational or—if you wish—scientific balls in front of them. Soon they turned off the pathway leading to Tinker’s Nook. They paused in the grass, after making sure that no one was following them, they threw their plastic spheres aside.

“Tink, you’re a genius!” grinned Vidia happily, rubbing her hands. “Who else can pull so much wool over their eyes?”

"I didn't even start telling the proper definition of the law," the tinker spread her hands and then asked in a low voice, "Did you get it?"

The wind fairy replied by taking out a diamond set in gold from her pocket.

"Ha! Now, would you make a new window for me?" asked Vidia with a wide happy smile. "Cold draught at night isn't exactly comfy."

"Glad to help," Tink smiled, squinting her eyes from the sparkle of the gem. "With such a cutter, I can prepare a hundred glasses. Finally, I'll be able to sharpen my tools properly."

"Yup! I told you, we should have borrowed this little diamond. And you were like 'Permission! Permission!'" The fast flyer weighed the loot in her hand.

"But Viola said that she would consider my request in a couple of days."

"As soon as she does that, I'll enjoy my new window. Off we go for a snack and then to your workshop, eh?"

"Sure thing! Let's celebrate a little victory over the bloated bureaucracy."

And their little party would have been a success, but alas, the chef-fairies had neither cakes nor pies. Not even a tiny biscuit was available for the two fairies.

"Hey, Gelata, where's the baking gone?" snapped Vidia, examining the table of dishes with an unimpressed look, almost as if *she* were a queen and was looking at peasant's food.

"No flour left," shrugged the hostess as she began work on more food. "We'll mill some more today, but of course it will take time," she added, ignoring Vidia's tutted response. "So, is there an occasion that requires us to bake something special?"

"Yeah, today we..." exclaimed Tink, but fell silent quickly, nearly spilling the beans about the diamond. "We tested how Stokes' Law works."

"Never heard of it," muttered Gelata, decorating the slices of a cherry.

"But in your kitchen, you see it in action all the time," the tinker flattered her wings in excitement.

"Really?" the chef-fairy livened up, giving her a look of interest. "Tell me more then. As you know, my cooking is the best in the Hollow, so I'm supposed to know the theory."

"Alright. Let one small and one big drip of honey fall in a glass of water." Tink said. "Which one do you think will sink faster?" she asked.

"The big one," replied Gelata after quick consideration.

"That's right! The size of a particle influences its velocity in a liquid. Now, let's say that we drop two balls of equal size in water. One is made of lead, and the other one is plastic. Which one hits bottom first?"

"The same size, you say?" Gelata paused, then spoke again. "Well, obviously, the heavy one sinks first."

"Exactly!" Tink said happily. "The density of the body also influences its velocity if it moves through a liquid or a gas. And now here comes the last little question. This time the balls are the same, but one glass contains water, but the other one is filled with honey."

"That's easy! Honey is denser, and it would greatly slow down the ball."

"Yes, but don't confuse density with viscosity. Those are different things. Mercury, for instance, is dense but not viscous. So, the last component that affects the velocity is the liquid's viscosity." Tink explained.

"Let me guess, Stokes derived a formula that lets us calculate how strongly the body is slowed down

when it moves through a liquid or a gas?” Gelata suggested.

“Almost right. The formula helps us calculate the terminal velocity of particles that move through a liquid. It works, however, only when we have a laminar flow.”

Gelata stared at her blankly. “A *what* flow?”

“I mean calm.” Tink put it more simply. “Without vortices.”

Vidia thrust in a word:

“The air was pretty turbulent today. Did we jump and roll for nothing?” She asked.

“Not for nothing,” Tink winked at her and caught her friend’s sly glance in reply. Still, Gelata was a little confused, so the tinker took a serviette and wrote down the formula:

$$v_{\text{settling}} = \frac{gd^2(\rho_{\text{particle}} - \rho_{\text{medium}})}{18\mu},$$

where g = free fall acceleration, d = diameter of the particle,
 ρ = density, μ = fluid viscosity.

“Wow! I’ve never seen such a monster in my kitchen,” chuckled the cooking fairy. “That’s just it—you see it but don’t notice,” explained Tinkerbelle happily. “By the way, this formula helped tinker fairies design a very efficient separator for cream and milk for you. In some sense, we treat ourselves to cakes with buttercream, all thanks to Stokes. I’ll tell you more. If you let the milk stand for a long ...”

Vidia, however, didn’t let her friend finish. She warned her with a worried expression that there was danger right behind her.

Before the tinker turned around, the wind fairy stepped aside, quickly hiding the diamond behind her back.

“I knew that you two were lazing around here!” growled Viola, the gloomy advisor, pushing her way towards the tables with snacks.

“*We’re busted!*” the wind fairy thought, swallowing hard at the prospect of being found out by the bureaucrat.

“Not only did you turn my workspace upside down, now you’re here trying to scrounge for food and disrupting the work of the baking fairies.”

“I’m sorry, would you like to order something? A cup of tea, perhaps?” squeaked Gelata, hoping to calm down the raging official, though the baking fairy was quickly silenced with a look.

“Go do something productive!” growled the executive. “Have you forgotten about the lack of pixie dust? The Hollow is facing famine!”

Whilst Viola was distracted, Vidia looked around quickly and, like a skilled conjurer, shoved the diamond in a basket with the grain. She motioned for Tink to leave with her and they began to scoot towards the exit

“Where do you think you’re going?” scowled the advisor, noticing the two’s attempt at leaving.

“To the workshop,” replied the artisan without batting an eyelid, though a noticeable jolt of concern ran through her.

“Oh no, you are not going to any workshop!” the civil servant snapped.

“How come? What are we being accused of?” Tink asked.

“Don’t you know?” the advisor frowned even more.

“Actually... no,” the tinker smiled nervously, knowing that things were not looking good.

“The valet-fairies wanted to clean up after you, but I insist that you take away your plastic spheres yourselves!”

“Oh, you mean this?” the artisan heaved a sigh of relief, pointing to said spheres nearby.

“Yes, this! Only humans litter like that!” said Viola, looking at them with disgust. “In former times, the discipline in Pixie Hollow was better!” she added in a dissatisfied tone.

“Will do! Absolutely!” assured Vidia, casting a glance at the basket or rather at the spot where it was a moment ago. “But first, we have to help Gelata!”

The wind fairy grabbed Tink’s hand and rushed to the kitchen, though the hostess was nowhere to be seen. On the way, Vidia whispered in her friend’s ear about everything that had just happened. Tink asked a logical question, why did she hide the loot in the basket? She shrugged. “It is either that, or we get found out and we lose it,” she told her.

The friends slipped out into the garden through a back door.

“That’s the last one!” shouted Gelata to the coachman-fairies, pouring the contents of her basket into a bigger one mounted on the carriage. The mouse carriages left.

“Where are you carting this millet?” asked Tink hastily, desperately trying to look casual.

“Millet, you say? This cereal is called amaranth. We’ve been using it for centuries for baking. And to the mill, of course.” Gelata replied.

“To the pirate mill?” Tink was appalled, imagining how the jewel would be ground.

“Yep, so? Why’re you so scared? There haven’t been any pirates there for a century.”

“Where do the pirates come in? The millstones aren’t calibrated there!” the inventress was making stuff up on the fly.

“Oh, please! Last year we milled just fine,” Gelata dismissed her.

“Do you even know how dangerous it is?! If one millstone hits another, it might create a spark!”

“One spark won’t burn all the flour,” Gelata stated, smiling competently.

The Tinker’s face reddened in annoyance at the carelessness of the baker fairy. “You have no idea how volatile the fine-dispersed dust from grain actually is!”

“Oh!” Gelata stopped, a surge of realisation sweeping through her. *That* was something she didn’t think about. “Yeah, I read about such accidents. What should we do?”

“Vidia and I will dash to the mill and fix everything today.”

“Perhaps we should call Fairy Mary and the other tinkers?” suggested Gelata.

“No-no! Please don’t!” Tink exclaimed apprehensively. “I mean, she’s awfully busy today. And who knows what she’ll say if she sees what we’re up to.”

“Alright, then. Just hurry up, please. You’ve seen it—Viola is angry today. Because of your caper, right?”

“Well, yes,” the tinker scratched her head. “And the best thing we can do is to help.”

Gelata agreed and ran forward to give instructions to the coachman-fairies. Whilst the baker fairy was occupied, Tinkerbell quickly whispered into Vidia's ear: "Make sure that all that amaranth lands in one bucket."

"And how're we supposed to get the diamond out of it?" the fast flyer asked, keeping one eye on Gelata

"I have a couple of ideas. Just don't let anyone start milling." Tinkerbell paused to glance at the baker fairy—more for her own reassurance than anything else. "Gelata doesn't have to know that the mill is fully operational. I just need my tools and supplies."

"Fine. Just shake a wing!"

"Will do!"

No sooner said than done—Vidia rushed to the windmill waiting for Tink. Soon, the pail was filled with golden grains. Gelata and her helpers got back to the Hollow, and the fast flyer had nothing left to do but wait. To save some time, she decided to sort out at least a small part of the grain, thinking she might get lucky and find the gem right on the surface. Grabbing one handful after another (amaranth seeds for fairies are about as big as a hazelnut for a human), Vidia quickly realised that she alone would need a lot more time to sift through the whole bucket. There was enough grain for all the fairies from Pixie Hollow.

Finally, she heard clanking, carts creaking and strained mice squeaking. Vidia glanced out of the window and cringed. She didn't care much about animals, but still, she felt sorry for three voles in a harness that were pulling a whole train made of supplies and tools: cardboards, duct tape, cables, hoses and tool bundles. An electrical generator on wheels towered above all this gear.

"You've taken everything except the kitchen sink!" shouted the wind fairy, jumping out of the windmill's window. "Hopefully, this junk will be useful."

"It will be if you'll help me," replied Tink. "Unpack the supplies, and I'll feed the rodents. They deserve a little treat."

Unwillingly, Vidia got to work.

"Keep in mind," groaned the fast flyer, dragging a sheet of cardboard, "By hand, we won't sort this amaranth out in a week."

"By hand? Don't be silly," Tink opened a grass bag with wheat corns (the voles loved them, which was evidenced when she tossed a few to them and they literally dove on top of them began munching away). "A machine will help us!"

Vidia snorted. *What is she thinking?* "Sure! A smart machine that can tell diamonds from grains just by looking," she said sarcastically.

"If I had some equipment from the Mainland, I would make it," Tink commented. "A trained artificial neural network can easily distinguish a diamond even if it sees it for a moment. But why should we complicate things? Let's just design a separator!"

"For today, I've heard this word twice," chuckled Vidia.

"That's simple. Our diamond's about as big as an amaranth seed. It's just denser and, therefore, heavier."

"So what?"

"If we could shake this big bucket, the gem would literally sink like a rock. A diamond is about three times denser than a grain, and gold even more — fifteen times as a matter of fact. So, what force is

preventing it from 'sinking'? It's friction! Have you forgotten Stokes' Law I mentioned earlier? Viscosity is basically the friction of a liquid. Same principle."

"Sure, amaranth seeds are a liquid now," Vidia said, tossing another tool into the windmill. "And how're we going to shake it? We might as well shake an elephant!"

"Let's assume this bucket is, by two orders of magnitude, lighter than an elephant," Tink objected calmly. "It's about twelve kilograms. We'll build a vibrating table, and I'll need your help to make it. We'll put the bucket on a board that will rest on four springs. In the middle, below the board, we'll fasten an electric motor with a curved axle. It would be our make-shift eccentric. Oh, and we should seal the bucket first. It will shake violently, and the seeds would fly all over the mill if we don't. And as soon as the diamond sinks, we'll turn over this pail, open its bottom and find our gem!"

The fast flyer just sighed in reply. She would gladly offer something else, but her idea wouldn't be better, would it? After all, Vidia felt winds and knew a thing or two about aerodynamics, but not much about mechanics. Though, at the back of her mind, the fast flyer admitted that sometimes she was too lazy to think. Why even bother? Her friend invents everything they need anyway!

"Help me, please, to saw up this board," asked Tink, marking the bar with her pencil. The friends just touched the two-man saw and were about to begin when a voice suddenly spoke up at the exit:

"Well, where's the flour?" Viola was standing near the exit looking annoyed. Vidia inwardly groaned. How could she sneak up so quietly?

The tinker flinched and replied: "We're ... fixing the millstones," she spoke quickly. "Making the spare parts. Ask Gelata if you wish."

"Yeah-yeah, she told me about the sudden mill failure. Why would that happen?" she frowned. "Fine, I'll send you five tinkers," the civil servant raised her pen above a leaf covered in writing.

"We'll make it on our own..." started Vidia.

"That won't speed things up!" the artisan called her over.

"Why not?" wondered Viola. "In general, the more workers, the faster the task is done."

"In general—exactly," Tink did not give up. "But if the task is one-threaded, you may invite a hundred fairies, but only one would work—the rest must wait. In about ten minutes, I'll explain to you why the grooves on millstones have to be dressed one by one, what spare parts are needed, and what it would take to implement multitasking..."

"Enough!" Viola cut her short. Looks like the tinker's chatter worked. "We have to start milling today. Otherwise, the fairies in Winter Woods would start starving! When will we get the flour?"

"One hour for setup, one hour for calibrating... well, about four hours."

"Too slow! I'll make Gelata prepare her old windmill."

"Come on, it's tiny!"

"I also know a thing about multitasking," Viola made a mark on her leaf. "Otherwise, the Queen wouldn't let me control the Hollow in times of crisis. We'll carry the grain back to Gelata and mill it there. Still better than just waiting, am I right?" the Queen's advisor cast a stern glance at the tinker. There was nothing to be said.

"Hurry up and get the big mill running!" She ordered, then mounted a little jerboa tied at the entrance. Viola galloped away. The rideable voles that helped tinker fairies could only dream about such a speed.

Vidia shook her head and asked cautiously:

“Can we really sift our diamond through, before she comes back?”

“I don’t think so. A vibrating table isn’t an option anymore. We don’t know how fast the gem would sink. We risk missing it and loading together with grain for Gelata’s mill. That would be a surprise for her!”

“Let’s make a different design then!” The fast fairy grabbed a saw.

“Do you know how much time we spent working on that centrifugal separator for milk?” Tink sullenly looked at her enthusiastic friend. “Three days! Not including the time needed for testing and troubleshooting.”

“Don’t overcomplicate things. All we need is to sift out a part of the grain in which there is definitely no gem.”

“I know that!” snarled the tinker. “A centrifugal separator will take forever to make. It would be easier if the seeds were floating in a liquid. We’d stir up the suspension and let it flow down the gutter, and... So, what’s good about it?” The artisan was thinking aloud. “Sure, the diamond would sink first, and the seeds from the surface are good to go.”

“Look, I’m not a tinker, let alone a food-fairy—or what Gelata calls herself—but is it okay to mill the wet grain?” asked Vidia almost without irony.

“Not really. It would smear and might choke the millstones. Then we’ll need to repair the mill for real.”

“Seeds in a liquid. Ha! How about lifting them in the air...” Vidia suddenly froze and, after a moment, opened her eyes widely. “Hey, I think I’ve got it! Maybe it will set the ball rolling. Imagine the seeds are falling one after another, and the wind blows from the side. It’s easy to push an amaranth seed, but a heavy diamond set in gold is another story. Wind fairies knew that even before Stokes.”

“Vidia! That’s a great idea!” the artisan beamed with joy. “You’ve just invented a simple but effective pneumatic separator.”

“Did I?” the fast flyer didn’t believe it.

“Of course you did! Today I told you about the velocities of objects in liquids and gases, but I didn’t figure out how to use a stream of air.”

“So, what do you suggest?”

“That’s what we’ll do! Let amaranth flow through a funnel. Below, we’ll place a ventilator that will gently blow the seeds to the side. The flow will be fan-shaped, and the lightest seeds will fly farthest. Down below, we’ll install a shutter that will cut the fan of seeds. If we rotate the door in one direction, we’ll sift out more light seeds. And vice versa.”

“Sure, but amaranth will fly all over the place.”

“Not a big deal. Let’s cut a casing out of the cardboard box. Help me a bit, please!”

In less than half an hour, a simple separator was ready. Under a tall cardboard box with two openings (that’s the whole casing), two empty buckets were placed. The first one was standing right on top of the milling stones, and the other one nearby. To prevent the runner stone from rotating accidentally, the friends took one cogwheel from the gearbox and replaced it with a belted sheave. Now, the central axle of the windmill was turning the electric generator instead of the milling stone. A thin cable connected it to the ventilator that was cut at the side of the box.

“Tink, wouldn’t it be easier to tie the ventilator to the axle directly? You told me that this way we just lose energy. What’s the point of turning the generator that feeds the electric motor?”

“You’re right,” the inventor shook her head in respect. “But trust me, we would have spent more time messing around with all those gears and belts. Small energy loss isn’t a big deal. Besides, it’s easier to control the spinning speed using electricity.”

“Whatever you say. Let me go upstairs then. Time to get this thing working!” Vidia rubbed her hands.

“Turn on!” exclaimed Tink after checking for the last time whether the box was properly fastened.

Vidia obediently pulled the lever under the windmill’s roof, and gigantic (for fairies) blades slowly started rotating. The iron flywheel was lazily gaining speed. Finally, the vertical axle started spinning with sufficient speed to get the generator going and then the ventilator.

“The first test is a go!” yelled Vidia throwing one spoon of grain after another on the funnel. The wind fairy wasn’t fond of this work, but the separator had to be tested.

“Add a couple of stones!” shouted Tink, rotating the wheel that was adjusting the angle of the shutter. “We made it!”

“It really worked?”

“It did! The stones went in the other bucket.”

“Let’s cast caution to the winds then?”

“Do it!”

Vidia put her teaspoon aside (the size of a shovel for a fairy) and started tilting the pail over the funnel. Of course, not with her bare hands, but by using a system of pulleys, like a crane. Tinker fairies installed it recently, right after the accident, after which there was no more pixie dust. And now, an amber waterfall of grain began to flow. At first, the wind fairy was worried whether the seeds would jam the funnel or not. As it turned out, the flow went smoothly like sand in an hourglass. The fast flyer jumped down to the ground floor, and asked after seeing that the seeds are flowing in both buckets:

“Wait, did you assemble everything correctly? I thought that bucket was just for our diamond,” she pointed at the pail that was standing on top of the runner millstone.

“I decided to play it safe,” replied Tink. “The more light seeds we sort out, the more likely it is to take the gem with them. That’s why the separator sifts out just about two thirds. On the bright side, this grain is safe to be sent for Gelata.”

“Aha! We want to minimise the chance of a false negative, right?” pronounced Vidia fluently.

“Nice one! You remembered this term?” the tinker’s face lit up.

“We’re birds of a feather!”

Creaking from wheels was heard outside. The friends thrust out their heads and saw Gelata’s cart.

“Why’s it taking so long?” she asked annoyingly.

“We’re on it,” Tink spread her hands.

“Get on with it! Viola’s wearing me out. She made me get my old mill going. At least she doesn’t insist on milling all by hand! Why such a rush? I was told there are still supplies in Winter Woods left.”

“You’re telling me,” Vidia played along. “Would be nice to send her to the Winter Woods herself. Frost is healthy for a hothead.”

“Let’s go, I’ll help you to load some grain,” suggested Tink.

“Blimey! What’s this device?” amazed Gelata.

“It’s a pneumatic separator. It sifts out... well, who knows, some litter, like little stones that might get in there...” the tinker stopped at the proper spot.

“That’s a brilliant idea. Well done!” complimented the chef-fairy. “Thanks, guys! If only you knew how hard it is to sift the flour with impurities. It’s so nice that you care!”

“That’s nothing,” Vidia made a careless gesture, and the artisan blushed—she felt uncomfortable.

As soon as the grain was loaded, Gelata went back to the Hollow. And the friends kept watching for a tiny sparkle that might appear in the waterfall of amaranth.

“Tink, you know, maybe we don’t need to worry?” Vidia rubbed her eyes.

“What do you mean?”

“Well, even if the diamond lands in the millstones—so what? It’s the hardest thing in the world!”

“Right, it’s hard. But also brittle. Hit it hard enough, and it will split parallel to the faces of a regular octahedron.”

“Split? Just-like-so?” the wind fairy didn’t believe her.

“Oh, yeah,” nodded the tinker. “Besides, diamonds burn in pure oxygen. A diamond is basically carbon. So, it’s not that indestructible. It will be a disaster if the shards land in the flour.”

“Come on! Don’t tell me that you believe that someone was really poisoned with a pounded diamond,” chuckled the fast fairy. “Those are just fables of medieval dreamers.”

“Believe or not believe—that’s in a temple of the Holy Dove witnesses. In science and technology, the experiment is the ultimate judge. Personally, I don’t want to bite any diamond shards.”

“Experiment, you say?” Vidia gave a bark of laughter. “What do you think, what’s more dangerous—to chew a diamond shard or a shattered glass?”

“Well, it depends on the exact shape of the shards...” began the artisan and stopped after realising what she was thinking about. “Away with you! Better keep your eyes peeled. The bucket upstairs will soon become empty.”

“We keep waiting for forty minutes. And still, no luck!” grumbled the wind fairy.

“That’s alright. Every time we sift two thirds away. It gets faster.”

“Sure. Unless... Wait! I think we’ve got company!”

The fast fairy looked out of the window. The sun was descending, but it was still enough light to discern the surroundings. No one was going along the path leading back to the Hollow. Was Vidia just imagining things?

“False alarm!” she breathed a sigh of relief.

“Sure?”

“Hopefully,” she shrugged.

“Oh, the pail upstairs is empty! Let’s lower it and start over again.”

“Put the flags out. It’s about time! Don’t even think that Viola will have forgotten about us for long.”

The friends swapped the empty and the filled bucket, making the amber waterfall flowing again. This time, Tink adjusted the shutter to sort out only the heaviest seeds hoping to find the gem. There was less and less unsifted amaranth left, but no luck with the diamond either. The fairies decided to play chess to fill in time (Tink knew that a small chess set she took along would come in handy). And then, after the second sifting was about to end, the adventuresses heard clearly a short ding against the rustle of amaranth.

“It worked!” Tink darted to the separator scattering the chess pieces. “See? Some creative thinking and we made it!”

Vidia jumped in the bucket first. Amaranth seeds were still falling. As Tink looked inside, she shuddered from a burst of sardonic laughter that came from there.

“What? What happened? That wasn’t the diamond?”

“It depends!” The wind fairy jumped out and showed the golden setting. The gem itself was missing.

“Jingles!” Tink punched the filling bucket with her tiny fist.

The door creaked.

“I knew that you’d be slacking here!” bellowed Viola right from the very threshold, balefully looking at scattered chess pieces.

“We’re waiting till the amaranth is sifted. Only then it can be milled,” stated the tinker.

“How many times do you sift it? Begin the milling, or I’ll call for fairy Mary and the other tinkers.”

“One more time and we’re good to go,” assured the artisan.

“You make such an effort, it’s as if you were going to bake a cake for the Queen’s anniversary!”

“Aha! Does that mean that ordinary fairies aren’t worth it, to enjoy some decent baking?” Vidia frowned, hiding the gold setting behind her back.

“That’s not what I meant,” the civil servant stepped back.

“You may call every fairy from the Hollow, but they won’t make the seeds fall faster. Why can’t you just wait an hour?” asked Tink.

“I can,” strained the official through her clenched teeth. “In contrast to someone else, I was working hard all day!” she shook with the leaves covered with filled spreadsheets. “I also want the report about the milling so it lands on the Queen’s desk today. Today. As planned. I’m in charge, and I always keep my word.”

“We know, and we’ll try to help,” the tinker nodded heartily.

“I’ll come back in an hour,” she slammed the door.

“Give Gelata my regards!” The artisan’s cheer followed Viola, who darted away.

Vidia shook her fist at the closed door, then limply hung her wings and asked:

“What now?”

In reply, Tink rotated the wheel, making more seeds land in the bucket standing on the milling stone.

“How’s that gonna help?” the fast flyer twiddled with the gold setting.

“We’ll have to go more carefully. It will be more difficult to catch the diamond. With this setting, it was denser by order of magnitude, now it’s only three times denser.”

“Then, we’ll have to start all over again?”

“I’m afraid so. Hopefully, this gold thing came off after we sent a part of the grain to Gelata. Let’s get busy! The clock is ticking. Let’s just turn on the light. It’s getting late, and we don’t want to risk missing the diamond.”

Formerly, the windmill had been lit by orange lamps filled with sparkling pixie dust. Now they were replaced by bunches of tiny light-emitting diodes. The rustle of the amber waterfall was heard once again. In this light, however, it seemed to be grey. It was hard to argue with maths—the less amaranth left, the higher the chance to find the gem. This logic, however, wasn’t comforting for the friends. What if the diamond got to Gelata’s mill? No, that’s very unlikely. Tink looked at the bucket with sorted amaranth, where the diamond was not supposed to be, at least, according to the Stokes’ law. It is not that it would be fully applicable in this case. Technically, the air is a medium with a very low viscosity.

“Let me check the funnel. Maybe I’ll get lucky,” Vidia distracted the tinker from her thoughts. She took a shovel and wearily went upstairs, pretending to not be tired.

“Alright. I’ll keep watching here,” replied the artisan without much joy.

“You know, if we don’t find this diamond, never mind—a window made of plastic would do just fine for me,” grinned Vidia. Tink forced a smile and warned her friend:

“Careful, don’t fall in the funnel.”

“Come on, I’m not Fairy Mary, after all, but still I won’t fit through.”

She left.

Soon after, an idea occurred to Tink. A bright idea, she thought. It has been several rounds, but the diamond was still missing. Maybe it just stuck in the separator? If a hastily glued cardboard box with a shutter and a fan could be called that. Tink decided to act. She found her torch among the scattered tools and, with a light heart, climbed in the hole from which, every now and then, seeds were falling out.

Amaranth was too rustling, too loud—no wonder Tink didn’t hear from the inside that the door had creaked again. Exhausted Viola clenched her fists after looking around. Reckless rogues! They left everything and went to bed!

“Worse than humans!” she cursed aloud, but no one heard her—Vidia was stirring and watching the grain upstairs, and Tink was carefully examining the casing of the separator from the inside. Indeed, some seeds had gathered in corners of the box.

Viola decided not to waste time. Of course, she helped to govern the Hollow in general, but she wasn’t shy of taking a hands-on approach either. With the crane, it wasn’t hard at all to move the half-empty bucket away from the millstone. And the bureaucrat didn’t need the tinker talent to understand how to get the millstone going again. All she had to do was to bring back the cogwheel lying near the gearbox.

Or transmission? Viola didn't know the correct term for this part, but it took only one push to put the cog back on the spinning axle. Even Tinkerbelle would be horrified if she saw such a safety violation.

"Vidia? What's going on?" shouted the artisan as she felt the millstones creaking. But the fast flyer did not hear her, she just felt the mill shaking. At that moment, Viola rotated the separator's shutter and the grain that was previously rained down upon the tinker. She had to close her eyes—the seeds were hitting her face. Without losing any time, she climbed out. She could not believe that her friend would make such a joke.

Tink jumped outside, assuming that the bucket was still standing on the millstone. Nothing of the sort—the tinker fell about half a metre down and hit against the rotating runner stone. Viola did not notice anything—she was sharply concentrated on tilting the bucket with cleaned amaranth. An avalanche of grain rained on the artisan.

"Stop!" cried Tink, hoping to outvoice the rumble from the mechanisms and the grain falling. She tried to stand up, but the waterfall of amaranth kept knocking her down and burying her. Is it possible to drown in grain? The inventor had no wish to find it out.

Meanwhile, Vidia jumped down to the ground floor.

"Hey, who allowed you to run the show!" she growled at Viola, trying to grasp what was happening.

"You promised me you'd start milling an hour ago!" she pushed the lever harder, and a new avalanche crashed down, filling the space between the milling stones completely. "Here, now I can, with a clear conscience, give our Queen a report. Gelata's helpers are arriving soon to take the flour."

"I don't get it. How on earth Tink allowed you to..." the fast flyer recollected suddenly. "Where is she anyway?"

"No idea," shrugged Viola. "I thought that you both just left."

Went to get fresh air? Additional tools? To feed the voles? Vidia caught herself thinking that she could have just left without telling anyone, but there was no way Tink could have. The fast flyer looked around quickly, and then it struck her!

"Stop pouring grain!" she shouted to Viola and rushed headlong to the gearbox. "She fell in the millstones!"

The official did not really believe that but decided not to argue as she remembered how fidgety the young tinker was. Pulleys creaked, and the rain of amaranth stopped. Risking pinching her hands, Vidia tried to rip out the ill-fated cogwheel, but it didn't give in. What would be faster—to jam the mechanics or uncouple it with the lever upstairs? The wind fairy ran upstairs. As luck would have it—almost no reflected light reached the attic. Vidia found the lever by touch and pulled it with all her might. The millstones stopped at once, and the wind blades were rotating on idle. One should usually park the blades with a special brake in such cases, but the wind fairy couldn't care less about it now. She jumped down and grabbed a teaspoon.

"What are you waiting for? Help me dig!" she shouted to Viola.

The Queen advisor was taken aback but eventually agreed to help. She grabbed another shovel made of a wooden spoon and jumped on top of the runner stone, the inner space of which was filled with

amaranth. The fairies were throwing the grain away, trying to free the tinker.

“And what if she isn’t there?” enquired the public servant.

“If she is, I’ll hate myself for stopping! And you as well!” Vidia cut her short, throwing amaranth furiously. After scooping another time, her spoon hit something solid. The wind fairy petrified with horror as she saw the shining torch. It became totally clear what had just happened.

“Dig carefully!” warned the fast flyer. She did not want to harm her friend and tried to work as carefully as possible. The fast flyer was cursing the morning of that day, she was cursing her window and her own decision to persuade Tink to steal the diamond in the first place.

And suddenly a hand emerged on the surface. Vidia and Viola rushed to rescue and free their friend.

“Thank goodness you’re alive! You scared the daylights out of me!” the wind fairy hugged the tinker, ignoring the fact that it might hurt her. Tink caught her breath and found the strength to hug her friend in return. After a while, the Queen’s advisor cleared her throat and asked calmly:

“I’m glad that all ended well, but what exactly is this?” she pointed at the diamond the artisan was clenching in her fist. The adventurers froze on the spot, still hugging each other. After realising that she had nothing to say to this, Vidia let her friend go and noted with a usual touch of sass:

“You know, you can keep the diamond. I guess a plastic window would do for me.”

Viola put her hands on her hips and shook her head in disappointment.

* * *

News about Gelata’s new pastry spread like lightning all over the enchanted island. We may only guess how the talented chef-fairy managed to bake such delicious cherry pies, rice crumpets, cheese casseroles and sugary buns from amaranth flour.

“Another piece?” offered Gelata. She was so glad that fairies were delighted with her work.

“I’ll take one with me,” smiled Viola. “So, how are ‘the prisoners without conscience’? Are they useful for a little bit?”

“They are! They locked themselves in a utility room in my windmill and wash dishes.”

“Do they shirk?” the advisor raised her brow.

“They don’t. Surprisingly. I load them a pile of dirty plates and cups. Everything shines in half an hour. it’s a bit strange though—they give me back all the plates and cups at once. But it doesn’t matter.”

“Very well. Keep watching. And do let them know that the Queen has signed the permission. As soon as they serve a week in your mill, they may get a diamond for their work. I’ve got to go. The service can’t wait.”

“Come again!” shouted Gelata after her.

Meanwhile, gentle water murmuring and quiet buzzing were heard behind the closed door.

“Check!” whispered Vidia, moving a cup on a checkered floor. She pointed at the rustic white box and asked: “Hey, did you apply those Stokes’ formulas while designing this thing?”

“Not exactly. But you’re right—using Stokes’ equations, it’s possible to calculate how each droplet of water flies inside. Too bad that we’ll have to dismantle the invention,” the tinker heaved a sigh, moving a glass with a fork in it one square to the right.

“Sure. Or else Viola will come up with something else. Our current punishment isn’t too bad, you know!” the fast flyer smiled cunningly, thinking about her next move.

The troublemaking fairies kept playing while the blades of a toy-sized windmill (for a human) were rotating the axle, which in turn ran a small, but handy self-made dishwasher.

Thanks to English mathematician and physicist George Gabriell Stokes, we can do more than just finding diamonds in buckets of grain. Navier-Stokes equations (Navier is his French colleague) help engineers improve aeroplanes and cars’ aerodynamics and make efficient separators (including those for milk). And the climatologists rely on them when modelling the Earth atmosphere.

Among others, there is one special application that you have all seen. In modern animated films (including those about our fairies), the effects of fire, smoke, water and even pixie dust are created using the same equations that Stokes derived in the middle of the 19th century. He probably never supposed that one day his work would become a wonder of reality.

I’d like to thank Cossacks for editing. He helped me with spelling, grammar, style and phrasing. Check out his works:

<https://www.fanfiction.net/u/1824306/>

