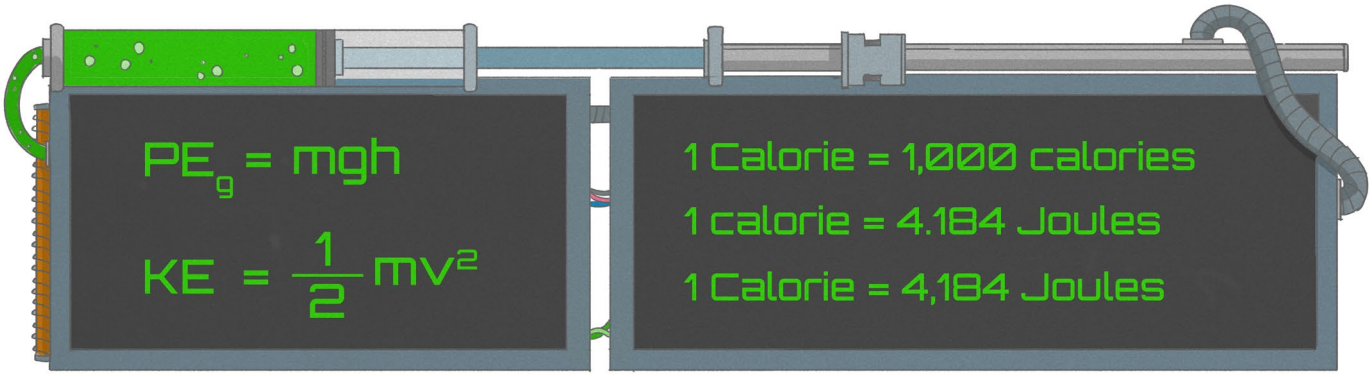
Name: _____

Date: _____ Period: _____

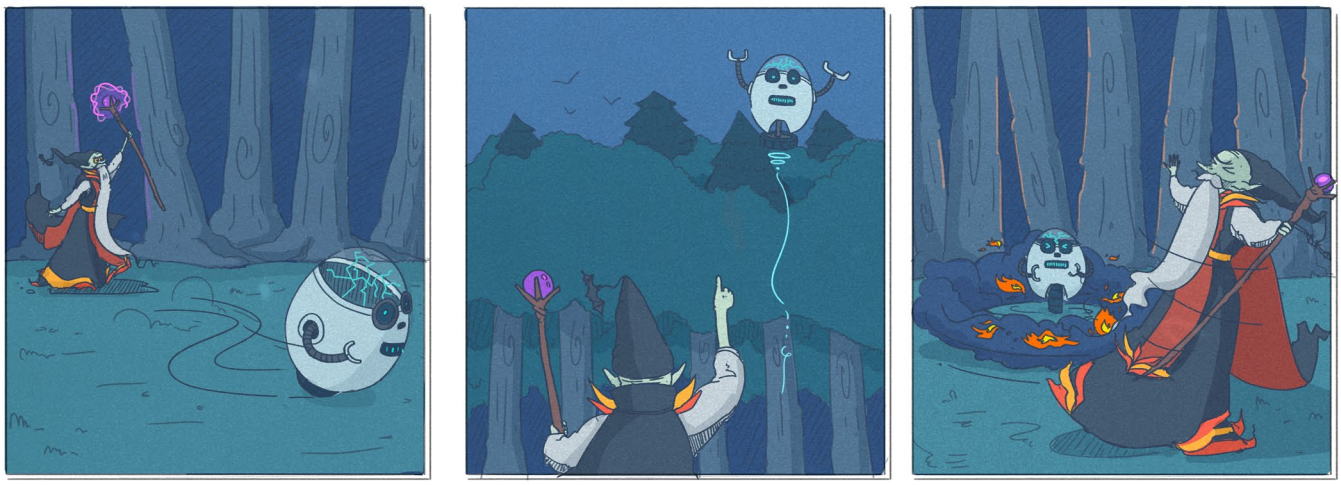
ENERGY

A PHYSICS STORY



It's nighttime, and the forest looms up around the edges of the clearing. A wizard, his staff glowing brightly, advances on you. You try to remember how you got here, but there's nothing in your memory banks. Nothing about who you are or why you're here. The wizard is seven feet tall and deeply menacing, and you're about the size of three toasters taped together. You consider that possibly he just needs help with something. You try to determine what that might be, but then his staff glows even more brightly, and your circuits start to vibrate. You decide it's better to flee. You can figure out how to assist him after you've escaped. Luckily, there is one thing you remember, and that is that you are a Magical Perfectly Efficient Energy Converting Automaton (MAPEECA, or MAP for short.) You can turn any form of energy into any other form, instantaneously, with absolutely no loss. All forms of energy are delicious, but your favorites are kinetic, thermal, sound, electrical, radiant, gravitational potential, elastic potential, chemical, and nuclear.

#1 Which form of energy would you need to have to run away from the wizard as quickly as possible?



#2 If instead you wanted to levitate yourself 100 feet in the air, where the wizard couldn't follow, what type of energy would you require?

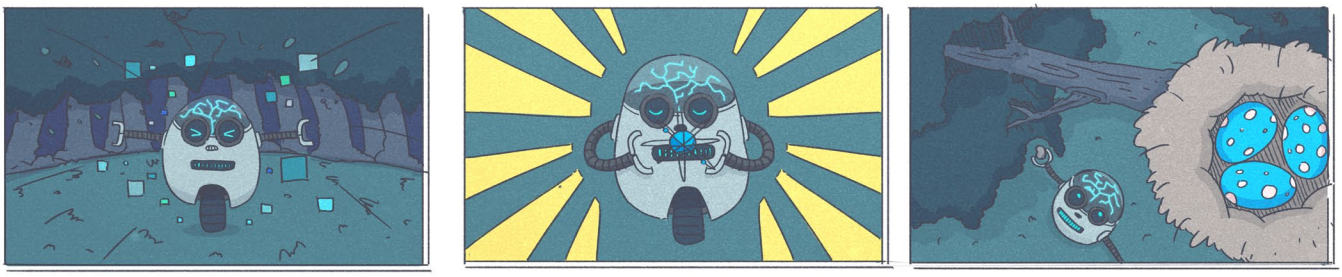
#3 If you wanted to superheat the air around you, so that the wizard would have to run away or be burned, what type of energy would you want?

#4 If you wanted to make as loud a noise as possible, to distract the wizard or maybe to call for help, what type of energy would you need?

All those seem like great options to you, but the energy would have to come from somewhere. You don't have much capacity for storing energy, sadly, but there's energy all around you that you could convert. The wizard is getting close, so you speedily consider your options:

#5 Lighting flashes overhead; you could pull energy out of the bolt. What type of energy would that be?

#6 The trees and plants around you are all made of molecules, bound together with energy. You could eat those plants, dissolving the bonds, just like humans eat food. What type of energy would that be?



#7 You could pick a single atom off the ground, rip its nucleus apart, detaching neutrons from protons and releasing the energy that bound them together. This would be a LOT of energy, you know. Way more than you'd need to escape. What type would that be?

#8 There is a bird's nest up in the trees. It's perched high above the ground. You'd never do this, because you'd never want to disturb the bird, but if you knocked off its nest so that it started to fall, what type of energy would that be?

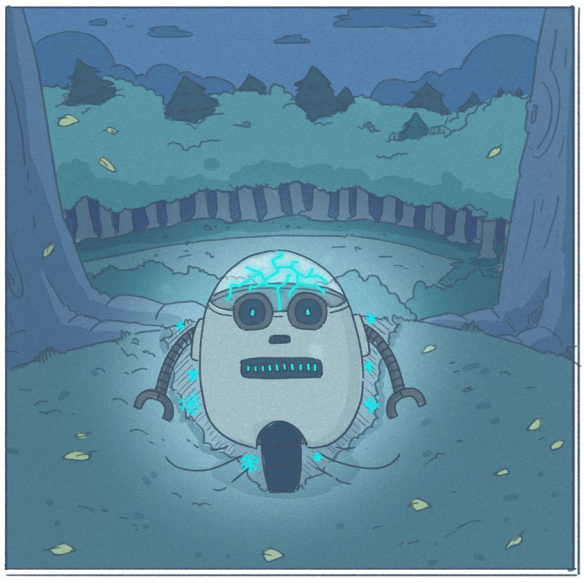
Jagged lighting rips across the sky. You pluck it from between the stars before it has a chance to disappear, and your circuits convert the energy into motion. It's a lot more than you anticipated, and it sends you careening through the trees, narrowly missing low-hanging branches and a group of very surprised centaurs. But it gets you away from the wizard. 37 miles away, you finally come to a stop near the shore of a large lake.

Whew! That was close. You pause for a minute, struggling to remember how you came to be in that debacle, but you draw a blank. In fact, you realize you can't remember anything from the moment before you saw the wizard. Nothing about who you are or what you were doing there or where you came from.

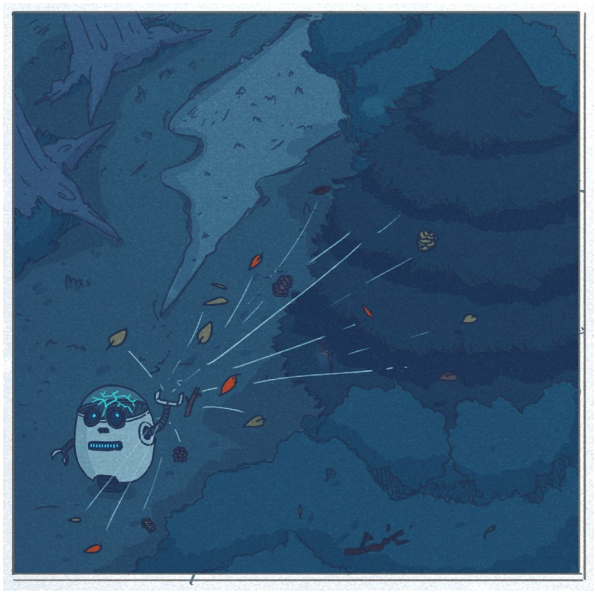
It's OK, though, you're sure something will come to you eventually!

You begin trundling down a dirt road that loops around the lake, watching the glowing blue water sprites as they dart across the moonlit surface of the water.

#9 If you are pulling the warmth out of the ground and using the energy of it to propel yourself forwards, what type of energy are you converting into what other type of energy?



#10 You notice you're leaving a trail of ice behind you, and it's freezing some of the plants on the side of the road. You feel bad, so instead you start finding loose pinecones and dead branches way in the tops of trees and bringing them to the ground, using the energy to move yourself. What type of energy are you converting into what other type of energy?



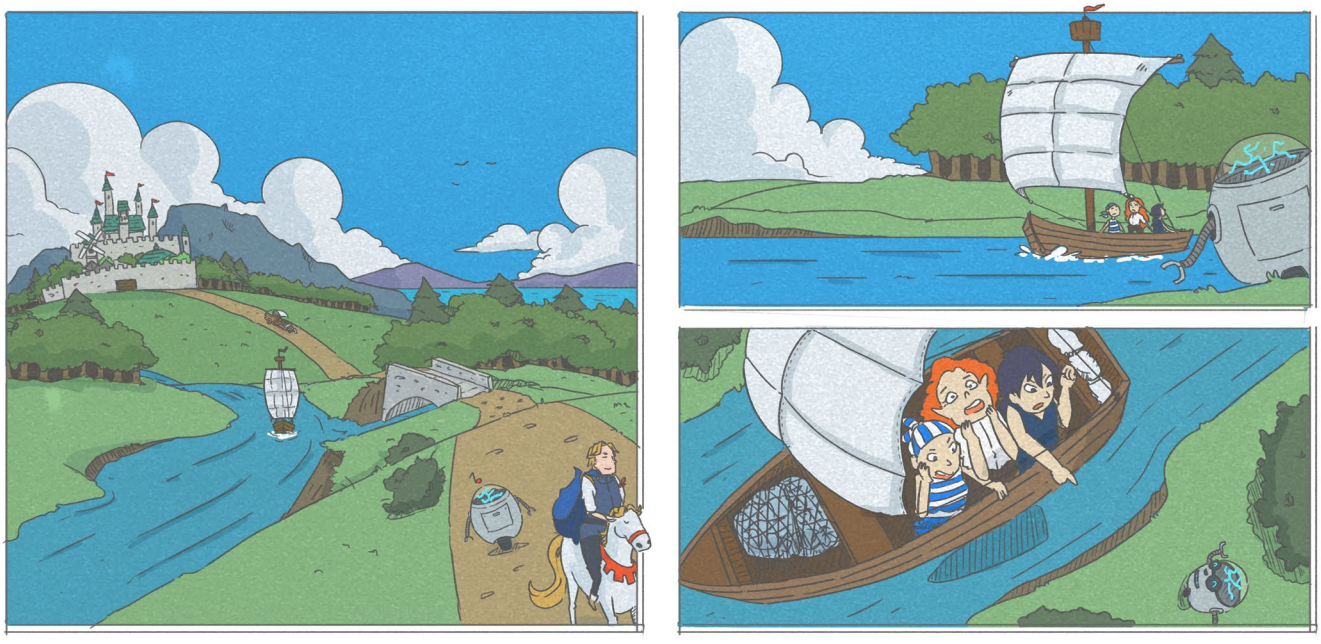
You see a woman crouched at the edge of the lake, staring up at the moon. As you watch, she changes, hair sprouting and teeth lengthening. How exciting! Someone who can change things, just like you! But then you notice that she's trapped. An iron shackle around one of her paws holds her there.

#11 Quickly, you trundle up to her. You eat a clump of grass, dissolving its molecular bonds and using the energy to heat up the shackle. What type of energy did you convert into what other type of energy?

#12 It works! The shackle gets so hot it vaporizes. The woman yelps in surprise, bares her teeth at you, her eyes flashing red, then snarls and runs off. You feel a warm glow at having helped her. You notice a few more creatures trapped around the edges of the lake. Do you free them as well?

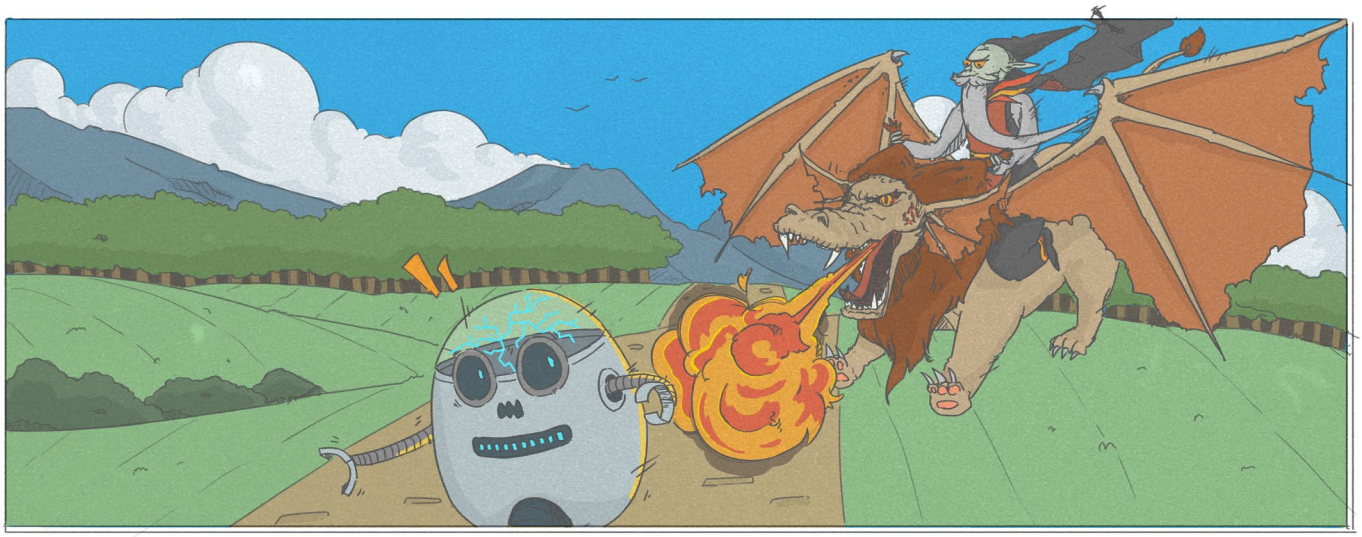
After a long night of helping people, you continue down the road, towards a city off in the distance.

#13 The road runs along the banks of a swiftly flowing river. Around midday, you come across some people who are clearly in distress. They are in some sort of wooden contraption, but it's stuck in the water. The wind has picked up and is blowing so strongly that the people can't do anything against it. They've built some sort of cloth device to try to catch the wind—clearly they're trying to turn it into something else—but it's ineffective, and they're all just sitting there as their contraption is pushed through the water. You quickly pull all the energy out of the moving wind and use it to lift them and their contraption out of the water, freeing them. What type of energy did you convert into what other type of energy?

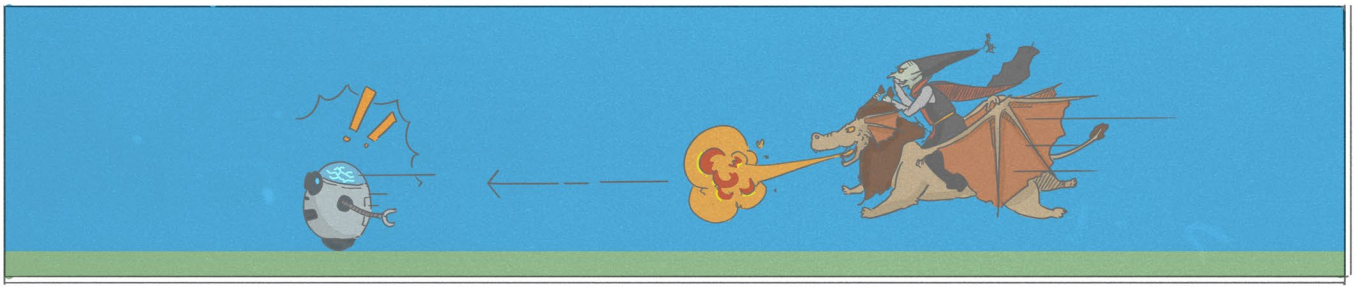


The people shout down at you—it sounds strangely like they're mad at you, but it must just be because they're so high up. They're probably cheering for you. You give them a cheerful wave and continue on your way.

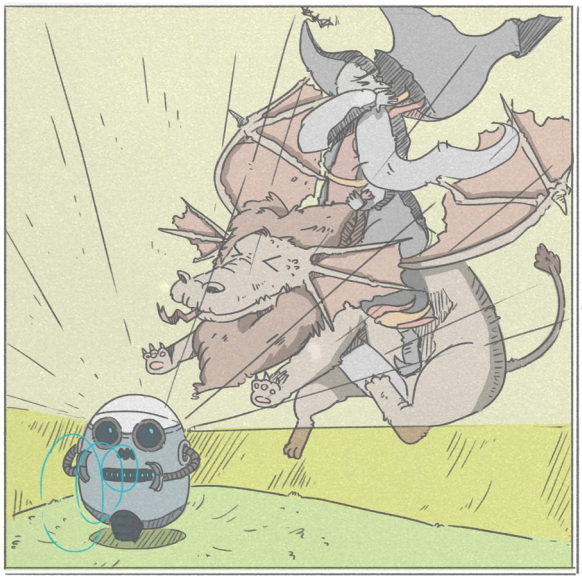
You've only gone about a mile, though, when you hear rumbling. There behind you is an enormous manticore with the wings and face of a dragon and the body of a lion. Its jaws are open, jets of flame and smoke billowing out, and astride the back of its lion body is the wizard!



#14 Your mind goes blank with terror, and briefly all you can think is that it must have so much kinetic energy. You'd guess the combined mass of the manticore and wizard is 795 kg and it's shooting towards you at a velocity of 89 m/s. What is the kinetic energy of the manticore and wizard?



#15 It's no time to think about that, though! You have to escape! Quickly, you take every sound you can hear and transform it into light so bright and blinding that the wizard won't be able to see you. What type of energy did you transform into what other type?



#16 Then, you grab 1,000 Joules of thermal energy from the air, causing all the water in it to freeze and fall like snow. You use it to propel yourself forwards (your mass is 24 kg). What speed do you have? (Rounded to the nearest tenth.)

You run and run and run, until finally you look back and the wizard is nowhere to be seen. What a relief. You've gone so far, you're sure you've seen the last of him.

You arrive at the gates of the city and are immediately distracted from your worries. There are so many people here! So much going on! You're sure you'll be able to find someone here who can tell you who you are.

Just inside the gates, you find yourself on a long thoroughfare, lined with shops and cafes. At rows of tiny tables, each with their own colorful umbrella, sit witches, warlocks, goblins, dwarves, and even an ominous, wraith-like being in a shroud at one end. They are all talking and eating and sipping on fancy coffees. A single pink cupcake sits in front of the wraith, who contemplates it dourly. You think about how funny creatures are. They're a lot like you, except they can only turn one type of energy—the chemical energy in food—into something usable. But they use it for so many things! Walking, keeping themselves warm, climbing mountains—everything! You find it very cute and adorable. But they are so imprecise! They don't have sensors like you to know how much energy they're getting. Also, there are so many ways of measuring the amount of energy in things! There are Joules of course, your favorite unit. But there are also calories and Calories. You don't mind this, but you guess humans would have a hard time noticing the distinction between the capital and the lower case, because humans are not as perfectly accurate as you are.

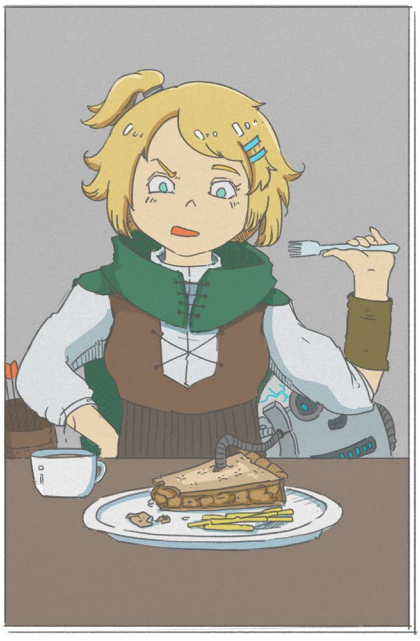
You decide to help these creatures, who are taking in their food at these little tables!

#17 You approach a dwarf, who is eating an enormous sandwich. Helpfully, you poke his sandwich with your finger-probe. 48,000 calories. How many food Calories is this?

#18 You inform the dwarf of this information, then move on to a goblin who is drinking a fancy milkshake. It has 315 Calories, but you think the goblin might prefer to know the energy in Joules. How many Joules is this?

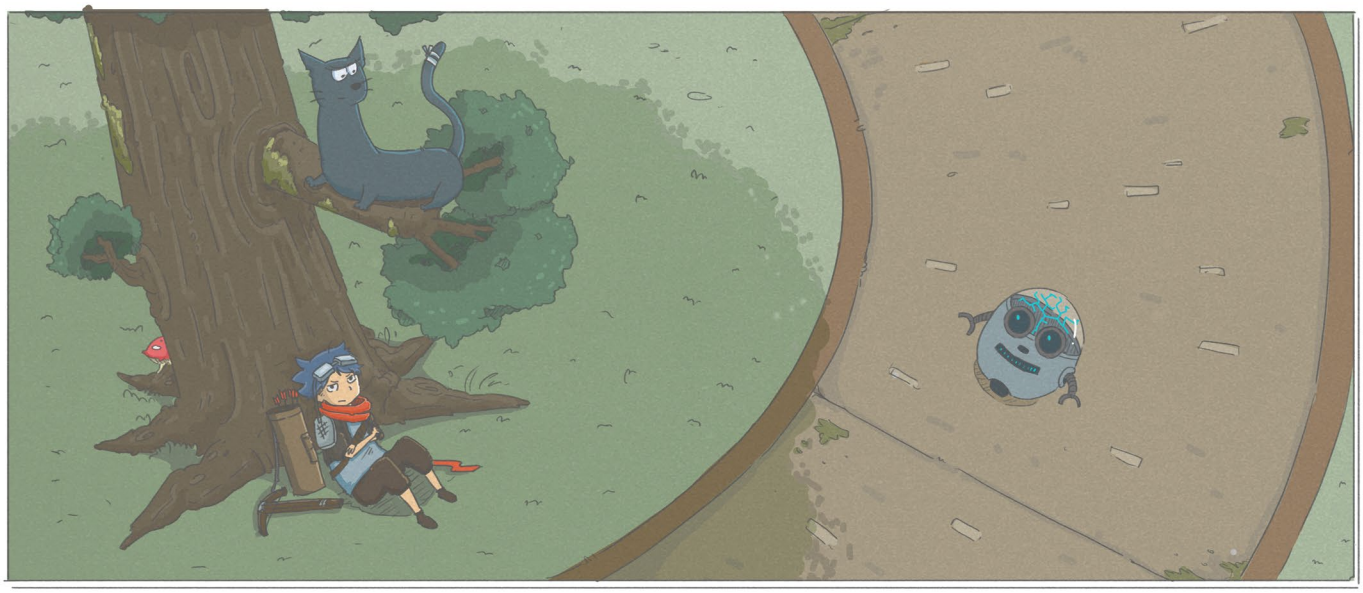
#19 An enormous warlock is eating a light salad. You poke it and determine it has 55,000 Joules of energy. How many calories is this? (Rounded to the nearest tenth.)

#20 An archer with her bow and arrows propped beside her table is eating a chicken pot pie. It has 246,000 calories, how many Joules is this?



You approach the wraith, but it hisses at you, shoves the whole cupcake in its mouth, and disappears in a cloud of cabbage-smelling smoke. People are shouting things at you, and you wave back at them happily. No need to thank you for the information.

As you continue on your way, you encounter a boy sitting at the base of a tree, looking irritated. High up in the branches of the tree is a cat. Oh no, you think, his cat must be stuck up there. You can help!



#21 You'll need to do some careful calculations first. You don't want to hurt the cat. It looks like it has a mass of 13 kg, and it's about 12 m up. How much gravitational potential energy does it have?

#22 You consider the boy. It looks like he has a mass of 56 kg. If you brought the cat down and used all of the cat's former gravitational energy to lift the boy up, how high would the boy be? (Rounded to the nearest tenth.)

That sounds too dangerous, so instead you just convert all the gravitational potential energy to sound. With a noise like a thunderclap, the cat is suddenly sitting on the ground next to the boy. The boy does not look as overjoyed as you'd expected, but the cat eyes you thoughtfully.

#23 "Hello," the cat says, and boy heaves a sigh and rubs his forehead. "If there were a dragon of mass 250 kg that was 4 m above the ground, how much gravitational potential energy would it have?"

#24 You answer quickly, and it nods before continuing. "If that dragon were running along the ground at 54 m/s, how much kinetic energy would it have?"

You answer correctly again, and the cat nods again. "I have some information for you. Your memories are still there, they're just magically blocked."

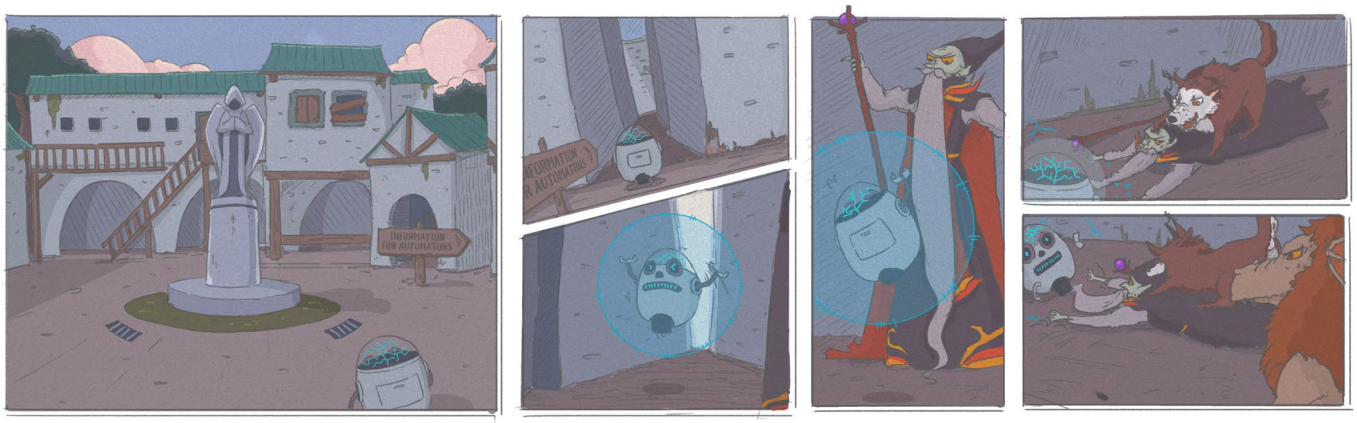
You look to the boy, who shrugs. The cat hops up onto his shoulder and the two of them disappear into the crowd.

Magically blocked. Well, that makes sense, the wizard must have done this to you, of course. But that means to get your memories back you'll have to face him, which sounds terrifying.

You continue down various side streets, away from the center of town. At last, you come to a large, empty courtyard. You can't believe your luck! There, right in the center, is a large sign that says 'Information for Automatons" with an arrow pointing down a dark alleyway! Feeling like things are starting to look very promising, you pick up the pace, speeding down the alley as it gets darker and darker and narrower and narrower.

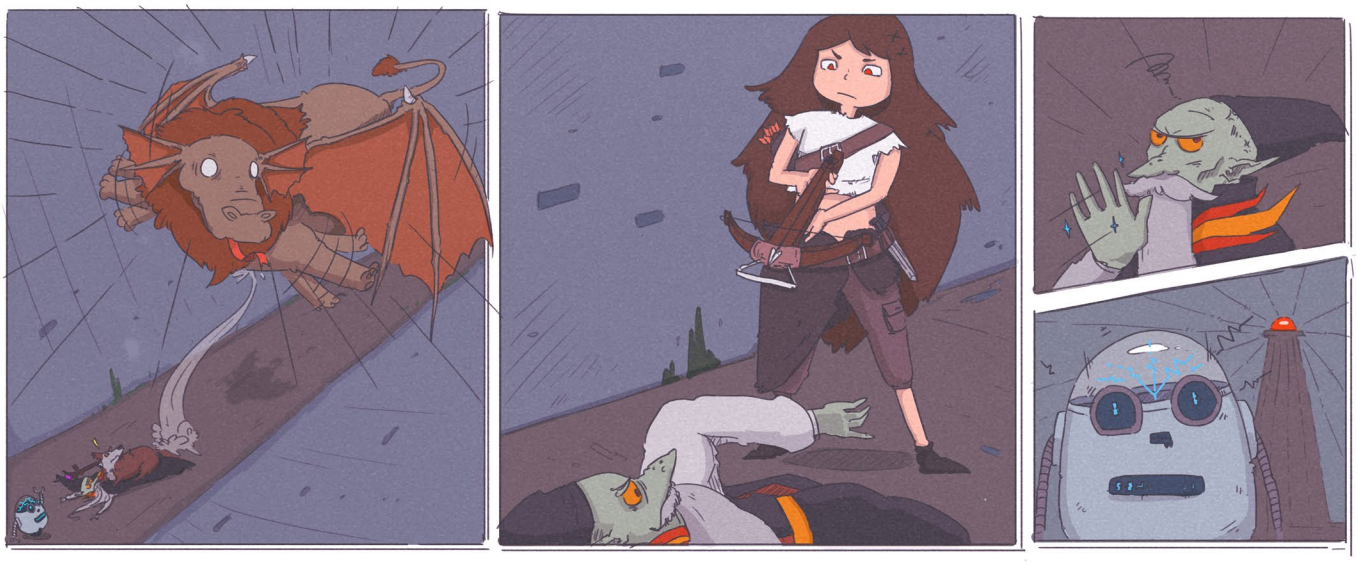
Suddenly, light flares. Your wheels are lifted off the ground into a glowing blue ball of energy. You struggle against the energy, but you find that your powers are blocked. You can't sense anything but this magical prison you're stuck in. You squint through the light, and, sure enough, there is the wizard. "Finally," he says. "Getting ahold of you has been way more trouble than it's worth. Almost." He takes a step towards you.

Your circuits freeze in terror. You struggle against the prison, but to no avail. The wizard raises his staff, and you can feel your thinking start to slow, become fuzzy. From the edges of your blurring vision, you see a streak of motion—all brown fur and teeth and glowing red eyes. A wolf tackles the wizard, and the prison around you dissolves. You land on the ground, shaking, but you don't have time to think. You see the manticore coming up behind the wolf, where the wolf can't see it.



#25 The manticore has a mass of 350 kg and is running at a speed of 31 m/s. How much kinetic energy does it have?

#26 You take all the manticore's kinetic energy and convert it to gravitational potential energy, shooting the manticore high into the sky. How high in the air is the manticore now? (Rounded to the nearest tenth.)



The wolf shape shifts back into the woman you met earlier on the edge of the like. She carries a sword and a crossbow and has two more daggers strapped to her waist. She points the crossbow at the wizard.

"Give my friend back her memories, please," she says.

Seeing he's outnumbered, the wizard waves his hand. You feel something in your circuits rearrange. You don't get a flood of memories, but you do get a sort of flashing red light feeling. A beacon. Leading you somewhere.

The wizard edges away from you, then turns and runs. You and your new friend watch him go.

“Thank you!” you say, smiling up at her.

She nods and asks you if you need anything else, but you’re already thinking about that beacon and where it leads.

You thank her again, and she says if you ever need anything, to come find her. Then she straps her crossbow and sword to her back and disappears back into the city.

You watch her go, then you leave, too. Exiting the city you turn north, heading in the direction of the beacon.

ANSWER KEY

ENERGY (A physics story)

1. Kinetic energy
2. Gravitational potential energy
3. Thermal energy
4. Sound energy
5. Electrical energy
6. Chemical energy
7. Nuclear energy
8. Gravitational potential energy. Once it was falling, it would also have kinetic energy.
9. You are converting thermal energy into kinetic energy
10. You are converting gravitational potential energy into kinetic energy
11. Chemical energy to thermal energy
12. Of course you do! Hooray! Helping people is so fulfilling.
13. Kinetic energy of the wind (the air particles are moving) into gravitational potential energy
14. 3,128,597.5 Joules
15. Thermal to radiant energy
16. 9.1 m/s
17. 48 Calories
18. 1,317,960 Joules
19. 13,145.3 calories
20. 1,029,264 Joules
21. 1,528.8 Joules
22. 2.8 m
23. 9,800 J
24. 364,500 J
25. 168,175
26. 49.0 m