

BONUS DOCUMENT

PLUS **WAVE**
BY MAX LEVINE



PlusWave: Bonus Document

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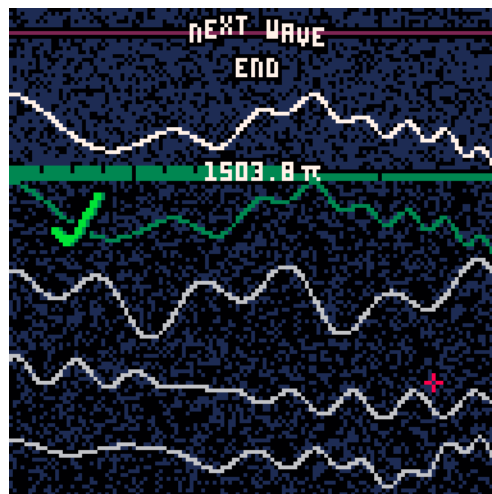
Table of Contents

Group Play	2
Crash Course	3
Dev Diary	5
Lost in the Waves (Unabridged)	11
Lost in the Waves (Abridged)	17
Wave Interference Worksheet	20
Notes	22

Group Play: Here are some ways to use this software in a group, perhaps in a classroom setting. It is advised for participants to turn off their device's volume, to avoid filling the room with cacophony. Luckily, sound doesn't work on phones anyway. This can be a fun way to learn wave interference by invoking a competitive spirit!

- ~ **NASA Control Room:** Only one participant, the chief executive, has an instance of *PlusWave* running, in practice mode. Everyone else should get into groups by table. Each group will need a small white board or paper to hold up. The chief executive will draw two question waves on the board, and it will be the job for each group to draw their best guess at what those two waves added together will look like. Each group will hold up their whiteboards, and the chief executive will rank each group's drawings by accuracy and reward points accordingly.
- ~ **Mythical Man-Minute:** Everyone should have an instance of *PlusWave* open, and should enter into practice mode at the same time (the score screen at the end will show the session time, so no head-starting!). Set a timer for 1 minute, and whoever can get the highest score by the end of the minute wins. (Don't worry about the tutorial text if you haven't passed the tutorial yet; score is still being recorded as normal in the background.)
- ~ **Sound Wave Interference:** Open an instance of *PlusWave* on a projector or a screen everyone can see, and go into normal mode. Be sure to turn the volume all the way up. Everyone should shout at once what they think the answer is - "It's the top one!" "No it's the second one!" Whichever option is the loudest, the controller should choose that answer. See how far the group can cooperate to get to a high score. Also, notice the effect of sound wave interference in the room creating a loud cacophony.
- ~ **"It's Complicated":** This is a game like the classic game of telephone in which everyone should draw their own personal wave - be creative, make spiky waves, squiggly waves, weird waves. Then a sheet of paper should be passed around the room and each person should try to add their wave to it and then erase the former wave (making a space for the next person to draw their wave added to it), until, at the end, a resultant wave is ended up with that is the summation of every person in the room's waves. It is sure to be a complicated, crazy-looking wave!

Crash Course: As the creator of *PlusWave*, I have play-tested the game a lot, and therefore know the best ways to play. I also programmed the game, and so can give insights into how the internals work that can also improve your strategy.



A pretty good run (totally legit)

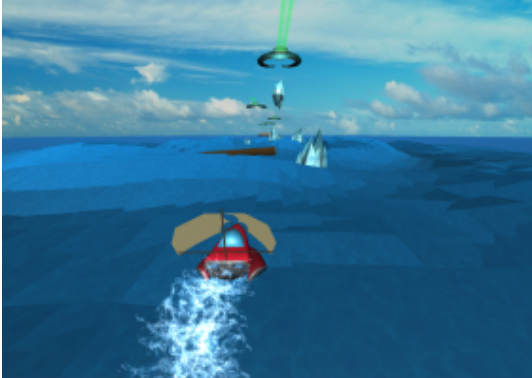
- ~ **Compare just one point along the wave:** It can be overwhelming looking at everything at once. Pick one vertical line down the screen to focus on. Which answer waves look like they are, at that point, in between where the two question waves are at that point?
- ~ **Pay attention to dips and spikes:** Does one question wave have a spike or a dip? The resultant, answer wave should have a corresponding part gouged out of it.
- ~ **Look for tiny differences:** Sometimes waves can be very similar, even to the point of seeming unfair. Usually, however, there is a tiny difference, even by a millimeter, that can give away which one is right and which one is wrong. One thing to look at could be, where does each wave go off-screen?
- ~ **Answer quickly:** You get more points for answering faster, and the waves will only be getting harder and more complicated, so its best to get as much as you can out of the easier waves.
- ~ **Know how waves are formed:** See pages 6-7 & 29-31.
- ~ **Know how trick answers are formed:** There are 4 types of wrong answers, and here they are in order from most common to rare (rarer becomes more common depending on difficulty): a completely new random-wave, a new random-wave added to one of the question waves, a new random-wave added to the real answer, and just a reuse of one of the question waves. See page 31.
- ~ **Try to get combos:** Get 4 in a row right, and you can earn a lost life back, or extra score if your lives are already full. Get 8 in a row and so on and get double that reward. In doing so, if you had 3 out of 4 lives, for example, but

got a combo of 8, and thus earned 2 extra lives, your life bar can be “overloaded”: you can have more lives than the life bar displays! Combos are essential for staying alive.

~ **Play practice mode:** It’s there for a reason. You won’t have to worry about lives or timing, which is a biggy. You can have all the time you need on studying a question and understanding how the wave interference works.

Dev Diary: This is the development process behind *PlusWave*.

The Global Game Jam of 2017's theme was "waves." While brainstorming a possible game to make, my group touched on the idea of a multiple-choice game in which the player had to add waves through wave interference. The idea was quickly shot down, however, for being mathematical and boring. Instead, my group decided to create *Sailors Vs. Aliens*. In this idiotic



Sailors Vs. Aliens (made in Unity)

game, players would have to sail a ship through a sea to get to an island "to warn everyone" as an alien from above was dropping ice blocks and other garbage. The game mechanics really had little to do with the theme of waves: they were just a decoration, with the real obstacle being to not run into the falling garbage. After being congratulated by an amazing "yOu

wein!" message upon winning, the game graciously provides no means of exiting, so you can just listen to the catchy music stolen from some unknown source until you force shutdown your whole computer to get out of it. I sneakily referenced *Sailors Vs. Aliens* in the unabridged story - see bottom of page 14.

About a year and a half later, the idea of a simple multiple choice game with waves was still floating around in my head, probably due to my propensity toward randomized elements in games I make, as well as my tendency to choose simple projects that I know I can complete. I was working as a steward at a Ruth's Chris Steakhouse that summer and needed to start a new programming project to prove to myself I was above the horrible, menial work I was enduring. I was listening to a lot of game development podcasts, such as the excellent Gamkedo podcast and a ton of Jonathan Blow lectures, to pass the time washing dishes, and needed an actual side project to complete the picture that would be a bright light shining in that dark hole.

At first, I brainstormed making a platformer mini-Metroidvania similar to *Cave Story* in Pico-8 - a sort of Pico-8 *Cave Story* de-make. It would be set entirely in the clouds - my favorite part of *Cave Story*. Following from that, *Cloud Quest* would be about life on the gas giant Saturn, and the story would be about a hero having to save the day, otherwise

there would never have been life on Saturn. I drew out a map of the small, Pico-8 sized world, which can be seen in the Notes section, on page 24. The Metroidvania would consist of three powerups: a cloud jump to enable visiting a higher area, a lightning clap that would enable defeating enemies and breaking blocks to another area, and a key to the firestorm area where the final boss lived. There would be gradations of art through the world: a cloudy aether area, lower down a fungusy area, a village, and the firestorm area. This is not, of course, what I ended up making, and I'm not sure I'll ever make it. I've made two games with Pico-8 now (*PlusWave* and *Zombyard*) and don't want to make another one, although it's been a great experience. And this game wouldn't really fit anywhere other than Pico-8. I would like to make a larger scale Metroidvania in the future though.

The game I ended up making was *PlusWave*. The first thing I made was the "music" on the title screen, a melody stolen from *Doki Doki Literature Club*, from a track called *Dreams of Love and Literature* (see pages 33-34, specifically measures 5-6). My melody, however, was randomly generated with a random starting and ending note. The melody in *DDLC* goes down the scale, every other note. I used this pattern to make a randomly generated version, thinking that randomly generated plus a simple descending sound would set the perfect tone and fit perfectly with the game. I added some random buzz sounds and a drumbeat base, and that's the music. I had zero prior experience creating music before this, having just started learning the piano, and it shows.

The second thing to do was create a way to create, store, and display waves. Here are my very first thoughts on that subject, one of the very first thoughts put into the making of this game:

Wave interference game: how many randomly generated wave interferences can you solve in 30 sec? Drawwave(): draw line between each point. Randomwave(): choose cos or sine (or any other periodic function) and multiply them by 1 2 or 3 or 1/2, 1/3 or feed them 1 2 or 3x, 1/2,1/3x. chance to add or subtract another randomwave. Very Rarely add arc tan, or abs value, or square or square root it, or do all of this nested (e.g. sin(sin(x)))... Difficulty: higher chance for recursion to add another wave, it gets slowly more difficult in race mode (30 sec) and accuracy mode both (3 mistakes). If right sound goes up scale wrong dissonant and scale start over. To generate wrong

answers, add another randomwave to one of the question's products. Right and left shift the waves right or left with the right left keys

I was struggling with the idea of storing possibly infinitely nested (e.g. $\sin(\sin(\dots))$) and infinitely added/subtracted (e.g. $\sin(x) + 2\sin(x)\dots$) waves in Lua. The insight came about and I realized I could store everything I needed in a 2D array. As Steve McConnell says, "Program 'into' your language, not 'in' it." (That is, at least, my excuse for not bothering to learn how Lua's amazing table structure works for the entirety of the project.) You start with x and then perform sequentially a number of operations on it. Those same operations could be invoked for any value of x needed, thereby allowing one to draw the wave across the screen. The 2D array would store, for example, [1,2,3,5,4] and each of these ID numbers would be mapped to an operation, such as multiply by 2, divide by 3, sine it, or cosine it. At the end of each row of the 2D array, there would be an ID which would say to either multiply by, add to, or nest the operations on the succeeding row of the array, or to simply end there. A few pages of notes where I worked all this out on can be seen in the Notes section. Page 31 shows the sequence of operations and their IDs, as well as the % chance to randomly choose the next ID when forming a wave, this % varying with difficulty. These numbers were tinkered with a bit once implemented in the code to get the best results. With that core of the game done, all that was left to do was construct the interface around it to make interacting with it juicy and fun. (How I worked out this core of the game can be seen on pages 29-32.)

But there was one other technical problem to solve. The frame rate was drastically too low to allow for a smooth, animated game, because every frame had to recalculate every point on each wave. 512 points were calculated for each wave (probably excessive for a screen with only 128 pixel width, but it made the waves smooth-looking), and with 6 waves on screen, that's 3072 points to calculate, and most waves consisted of multiple sine and cosine operations, which are quite computationally expensive. To solve the problem, I had each wave remember or "bake" every time a new x was called. If the same x was called for that wave afterward, the value mapped to that x would be looked up, instead of being recalculated again. Looking up a number in a table is a lot faster than doing any trigonometric operations. This way, sine

and cosine would only have to be called on the first frame that the wave is in, and none after that.

When school started, the version I showed to my friend Chloe did not yet have the ability to advance to a second question after running the game, but within two weeks, that was quickly remedied. At my last day at Ruth's Chris, I had a fully playable demo on my phone to show to my boss.

By this point, I had also written the first draft of the game's story, which became much better in subsequent drafts. (You can see an early draft with editing marks in the Notes section, pages 35-41) I could have chosen a heart rate monitor in a hospital, or perhaps an ultrasonic wave monitor in a nuclear submarine. But the core premise I ended up with was that brainwaves had become entangled, and the player had to untangle them. I was reading *Masters of Doom* and was inspired to make the game set on a "distant moon."

I wanted the story to have a didactic undertone encouraging science, because this is an educational game, but still have a sinister, serious aspect that could engage older players. The ending story I think captured all of this and also touched on themes I have dealt with in my own life. The story combined with the game feel and mechanics that support it make my creation double as both educational software and art piece. I had to edit the story down to less than half its original size to fit it into the game, but you can read the complete, unabridged version on page 11.

One inconsistency one might notice is that the Apple III+ shown in the game is an old computer - why is it in a futuristic setting about space travel? The answer is that it is hard to depict newer computers in pixel art, and old computers are much more expressive. That is why I chose an old computer as a reference image.

Another inconsistency one might notice is the reference to "alpha waves" that Ernest Rutherford used to deduce the structure of the atom. Alpha waves were once thought to be waves but have since been determined to be particles. Alpha waves are, however, also a type of brainwave picked up by electroencephalogram. The error, then, hints at the story's direction for the few who may notice the detail.



Apple III+

During the course of the project, there were other times that I had difficulty, where my disorganized and confusing code twisted my brain into hellish knots that followed me throughout my day trying to get things to work and, due to my lack of version control, not mess up the entire program with faulty code editions. For example, I went down a rabbit hole with getting – and this is embarrassing because of how simple it should have been – the tutorial text to work. The root of the problem was that

only after the score particles had touched the score bar did they increase the score, so the program didn't know what the actual score was until this happened. Because of this, I build a bizarre system around it where combos would increase the score required to beat the tutorial, losing points would decrease such increments, and whether the player beat the tutorial was based not on the score having passed a certain threshold, but whether a Boolean `shown_win` was true – which recorded whether the player had been shown the congratulations message, which would strangely only appear a few seconds after beating the last required wave due to the slow score particles, or, if the player advanced to the next wave before that happened, the message would be delayed until after *that* wave. All of this could have been avoided by creating a hidden score counter that kept track of the “absolute score” – what the score is including all score particles in existence. It took literally thirty seconds to implement this and solved everything, and made the game look so much more intelligent seeming in regards to knowing what is going on.

Only near the end of the project did I reach another technical problem that also had a simple solution that solved itself. I was running out of space due to Pico-8's size restrictions – at ~97% capacity when I still needed to add in the story text which was another ~11%. To solve this, I turned to Picotool, a program that can modify Pico-8 carts with various commands, one of which, `luamin`, would shorten the code by renaming all variables and such with as small as possible names, and shorten everything by other means – a sort of precompiler. This reduced the cart down to ~65%! However, the cart wouldn't run. It turned out that Picotool for whatever reason didn't work with `goto` statements, of which I had 3.



The game's spritesheet

After manually renaming the `gotos` whilst stumbling through the obfuscated code, the program worked. The downside was that the code was now completely unreadable. Then, in the Pico-8 Discord someone mentioned that you could save a lot of space by just deleting all the tabs in the program. It turned out that this was all that was necessary to make the room that I needed, and only made the code somewhat unreadable.

Another way I saved space was storing one lookup table in the unused sprite flag subsystem, and another lookup table embedded in the lower left corner of the spritesheet. `bab_B` - who was very helpful throughout the project - helped with both of these.

Balancing working on this game when I should be studying for school became an issue. Although washing dishes used up the same amount of time as school, it was physical work while this was mental work. Should I be mentally exerting myself for this game when my mind should be focused elsewhere? I feel I have done a good job balancing it, but at the same time, this is schoolwork -

I am a computer science major with interests in artificial intelligence, video games, educational software, scientific applications, and crowd sourcing. As a senior project in this field I would like to make another educational game, which also feature sine and cosine prominently. I have thought that it would be cool to embed *PlusWave* inside that game, perhaps hidden in an old arcade cabinet or something. I cannot say much about this game idea at the time, though, as it is still a secret, and could make some money on tablets. *PlusWave* has been a good precursor to that project. And even further into the future, I have an idea for *another* educational game, also touching on similar topics. In conclusion, the journey that has been *PlusWave* was fun and totally worth the time.

Lost in the Waves (Unabridged): This is the full story behind *PlusWave*. Pico-8 has size restrictions, and even if it didn't, a huge wall of text wouldn't be good to have in a game. Nevertheless, I am proud of how the full story combines with the game mechanics to work toward the same themes.

My colleagues and I are on a distant moon studying an anomalous source of electromagnetic waves. We are going slightly insane, for many months decoding these waves blipping across our monitors. Waves pervade everything. We have to study them. Using waves, we can look into the ethereal plane and uncover the secrets of the universe. Waves reveal what is on the inside, be it x-rays revealing the insides of luggage or the human body, or waves peering into the black box of quantum mechanics; by bombarding a sheet of metal with alpha waves, E. Rutherford first deduced the structure of the atom. Through the Doppler effect, we can determine the motion of distant suns by looking at the wavelengths of light that reach us. The ancients believed that waves, or, in Sanskrit, *spanda*, pervade everything and emanate from the supreme god or consciousness. Furthermore, as human beings, interpreting the sound waves that hit our eardrums and the light waves that hit our corneas forms most of our knowledge of the world.

And here on this moon, the communicative power of these waves is eerily pronounced. Only another intelligent life form could be the root of these complex waves. Yesterday, we learned from the waves that a certain tenth order polynomial of the fifth dimension is equivalent to its fourth dimensional counterpart. I learned that I am able to hold such a concept in my head in its whole for about 3 seconds, or not at all, but I did write it down. We are going slightly insane, for many months staring at the waves creeping across our monitors. Then, in an expedition to the source of these waves, deep into a crayon colored canyon, my colleagues vanished, leaving me here alone.

The moon's surface was built of layers of terraces, the contour lines circling outward from a central point—like a ripple in water frozen in time. This central point was our object of study and source of the waves. Each layer of elevation was brightly and uniquely colored, getting darker and redder near the center. The elevation began to drop rapidly, with at its center a chasm. It was there that the waves were emanating from and where we sent the expedition

team. I was the only one to stay behind in the lab, to watch the waves.

An unsettling gravitational pull grew as one descended the terraces—the “giant’s staircase.”

“Aaahh!” was a buzz of static that my colleague, Genevieve, reported into the microphone. She continued: “I feel like a magnet. I’m putting pressure on my heels just to keep myself from falling forward; I wish we could go back, but we’ve passed the event horizon of going back.”

“A spider snake just floated past me!” yelled Clyford. They were walking along a deep magenta terrace, close to the drop-off.

“That’s a centipede,” answered Genevieve deliriously. “I’ve never seen a swimming one before but we used to have swarms of them in my childhood home; that one looks like something from the Triassic.”

“And if anything touches you down here, it won’t really touch you of course because of the layer of gas between you and it, but then you would become aware only of that infinite darkness that divides you from everything, and what would your soul do in such darkness?”

“A centipede—same difference,” answered Clyford. “I’ve been on this moon for so long, I feel fuzzy, like this is a dream. Oh—this is a dream! Now there’s all this fuzz down here, just because I thought of it. I feel like I’m wading through— It’s getting so thick, I can’t move.” Here the audio feed and my colleagues were fully consumed by the static. Their body signatures were frozen as if in a block of ice.

Back in the lab, the monitors were ablaze with a seizure-inducing amount of waves running across them. All those years of staring at them I knew there was organized information. Looking into the flashing screens, I could continue to hear my colleagues’ ramblings. “Wait this isn’t the end though,” Clyford said. “Now my mind is flying up away from all of it, leaving my body behind.” I realized I was reading brainwaves. Among them was a more dominant, alien brainwave.

“Alone, with nothing, for so long,” the brainwave read. I recognized this as the same voice that had been droning mathematical esoterica that I had spent the last months recording. “Sleeping yes,” the brainwaves continued, “there is still time. Finally a new stimulus; oh it is so interesting! I feel so alive!” I could still pick out the mannerisms of my colleagues and read their thoughts in the background:

“It is coming!” warned Genevieve. “Hurry! It is coming!” shouted Clyford. Time was running out. The facility was shaking, the seismic sensors were off the charts, the mountains were crumbling in the distance—the whole moon was collapsing in on itself! But I couldn’t escape on the rocket back to Earth yet. My colleagues hadn’t been lost without reason. It was my duty to study, untangle, and decode these brainwaves to find out what this sinister entity was, what exactly was coming.

Translating the waves was usually work enough to occupy all five of us, but now it was just me, so I had to scramble from monitor to shaking monitor, decoding as fast as I was able. Luckily, my years of training prepared me well. This was my moment. I noted the amplitudes, the periods, the frequencies, the wavelengths, the maximums and minimums, the peaks and troughs, slopes, every spike, smash, far average, full-down, full-up, corner turn, rendering it all into clear English:

“Entropy, the heat death of the universe, is coming,” said the alien brainwaves. “Faster than life can reproduce and propagate, entropy is coming. It is disorder, collapse, decomposition. Life and its complexity is its opposite and enemy, and is the only force in the universe that might counter it. Science is the tool of life that can save us from this ultimate end, as well as sooner ends such as by asteroids or mortality. Any disaster, either by fire or ice, that kills life, is a victory by entropy.

“I am a mere fragment of a being that was shattered by the chaotic force of entropy. I scattered myself across the universe, imbuing each of these fragments with the mission to fight back against entropy. I have been here on this moon, bleeding my thoughts into space, waiting. I was made weak and disordered by entropy, unable to do more than drift through space, almost as dead as an asteroid. I needed to be revived by complexity—another life form, its cultures and knowledge. So I broadcasted my most interesting, crystallized pieces of knowledge.

“And finally, a few morsels have fallen into my maw. I have assimilated your colleagues by triggering deep emotions, creating images of ‘spiders’ and ‘snakes’ until I could find enough nodes with which to interface with. From them I glimpsed your cities, art, math, and it will all be more than sufficient. I’m absorbing this moon now, turning its mass into a propellant. Join me and with your mind help me deduce the

location of Earth, so I may come and absorb it. Then, we will focus our efforts on ever-increasing knowledge of science. Ally humanity with me against entropy!”

The hair on my arms was raised. I didn't know if it was the creepiness of the alien voice or the rising amplitude of static electricity. I looked out the window of the bunker to find the landscape distorted with something like heat waves. Vibrations penetrated to my bones - an akathisic sensation made from waves, which I momentarily tried to decipher the meaning of. This alien I had discovered - the galactified majesty of it! Hiding a conspiracy in the laws of physics and time!

But the sound of rending metal filled the air and I looked down a corridor to see it bend downward into the earth. I was out of time. Rather than waiting to be “eaten” by this thing, I leapt into the escape pod, buckled myself in, and pressed the button.

The spaceship aimed itself in the direction of Earth and went into light speed. My body survived the acceleration due to the invention I had created back on Earth years ago—the one that enabled light speed travel by allowing the shock waves to pass fully through a medium, be it spaceship metal or human flesh. I looked out the window, however, to find myself already at my destination, looking out on a California blue sky and a sun comfortably on the opposite side of the atmosphere. Had I blacked out? The journey should have taken several weeks. I tried to release the straps holding my wrists and ankles, but they were fastened in place. I strained my neck to see different computer monitors around me, each displaying various readings. To my horror, I translated, “Hah, hah. Now we have a sixth of you. We will triangulate your planet even sooner. We are coming, to fight entropy.” There was nothing I could do, so I resigned myself to becoming a part of this morally ambivalent being, and stared uselessly out the window at the beautiful day outside. I thought about waves, but not the usual kind.

“Why am I such an idiot?” I thought. “What am I doing here, when I could have been at the beach? I could have been a surfer on a beach, or riding a speed boat through the surf, and instead I'm here decoding hell out of these sinusoids.” Of course they would put this imagery outside, to make me feel this way. They were teasing out nodes with which to connect to. I could feel it now, the cold massage on my hair, the

feeling of putty sticking to my scalp—they were going straight to the point.

“Mr. Abernathy?” said a voice. Yep, they had my name already, though I hadn’t told them yet. “Try to keep your neck completely still.” I obeyed. The only thing worse than an alien brain surgery is a botched alien brain surgery. I looked at the displays:

“We will be at Earth in 23 days,” they reported. “We will infiltrate into the population using the social patterns gleaned from the assimilated humans. The planet will soon be ours. With the higher complexity gained, we will be in a position once again to defeat entropy. At the moment, we are assimilating we are assimilating we are assimilating—” I broke my gaze free of my own brainwaves on display – a paradoxical hallway of mirrors – which the monitor had trouble drawing coherent lines out of, instead drawing a randomly placed field of dots.

I could see two human forms nearby. One was wearing doctors’ scrubs, and the other, a suit. The man in the suit saw me looking and waved. They were talking quietly, so I could barely hear them:

“The way he’s staring at his own brainwaves like that,” whispered the man in the suit, “like he knows more about them than the technician—”

“Apophenia,” answered the doctor, “is a common symptom of those with his condition. He believes he is finding patterns and information where there are none.”

“And yet,” said the man in the suit, “he used to be the best mind we had on the subject.”

“On deciphering waveforms?” finished the doctor. “Even so, right now he would only be deciphering his own brainwaves, which is absurd.”

“The nation is on high alert due to the Earth being bombarded by an unsubstantiated amount of alpha waves. Are you sure that that instrument”—the man in the suit pointed to the device connected to my head and what I now realized was a simple EEG machine—“is picking up his brainwaves, or the ones coming from outer space? And what if what he thinks he is reading is true?”

“He may have been a genius,” said the doctor, “but his state has degenerated. Psychic aliens, the impending apocalypse...the man is no more than a bumbling idiot.”

“It’s all true!” I burst out of the restraints, trying to warn the man in the suit. “Entropy is coming! I’ve read all of it in the waves!”

Lost in the Waves (Abridged): This is the version of the story that appears in game. Due to the heavy size restrictions in Pico-8, I had to edit down probably more than I would have preferred.

Intro:

My colleagues and I are on a distant moon studying an anomalous source of electromagnetic waves. We are going slightly insane, for many months decoding these waves blipping across our monitors. Waves pervade everything. We have to study them. Using waves, we can look into the ethereal plane and uncover the secrets of the universe. Waves reveal what is on the inside, be it x-rays revealing the insides of luggage or the human body, or waves peering into the black box of quantum mechanics; by bombarding a sheet of metal with alpha waves, E. Rutherford first deduced the structure of the atom. Through the Doppler effect, we can determine the motion of distant suns by looking at the wavelengths of light that reach us. The ancients believed that waves, or, in Sanskrit, *spanda*, pervade everything and emanate from the supreme god or consciousness. Furthermore, as human beings, the sound waves that hit our eardrums and the light waves that hit our corneas form most of our knowledge of the world.

And here on this moon, the communicative power of these waves is eerily pronounced. We planned an expedition to the source of these waves, into a radial depression in the earth. I was the only one to stay behind in the lab, to watch the waves. Near the bottom, a magnetic force pulled my colleagues into the abyss.

Back in the lab, the monitors were ablaze with a seizure-inducing amount of waves running across them. I could read my still alive colleagues' brainwaves. Among them was an alien brainwave.

"Finally," the brainwave read. "Among all these rocks, another intelligence."

"It is coming!" warned my colleague Genevieve. "Hurry! It is coming!" shouted Clyford. The facility was shaking, the seismic sensors were off the charts—the whole moon was collapsing in on itself! But it was my duty to untangle these brainwaves, find out what this sinister entity was, what exactly was coming...

Won:

Translating the waves was usually work enough for five of us; I had to scramble from monitor to shaking monitor.

Luckily, my years of training prepared me well. I noted the amplitudes, the periods, the frequencies, the wavelengths, the slopes, the maximums and minimums, the peaks and troughs, rendering it all into clear English:

“Entropy, the heat death of the universe, is coming,” said the alien brainwaves. “Faster than life can reproduce and propagate, entropy is coming. It is disorder, decomposition. Life and its complexity is its opposite and enemy, and is the only force in the universe that might counter it. Science is the tool of life that can save us from this ultimate end, as well as sooner ends such as by asteroids or mortality. Any disaster that kills life is a victory by entropy.

“I have assimilated your colleagues, glimpsing from them your cities, art, math, and it will all be more than sufficient. Join me and we will focus our efforts on science. Ally humanity with me against entropy!”

I was out of time. I leapt into the escape pod and pressed the button. The spaceship aimed itself in the direction of Earth and went into light speed. I blacked out to reawaken at my destination.

Upon waking, I tried to release the straps holding my wrists and ankles, but they were fastened in place. I strained to see the monitors:

“We will be at Earth in 23 days,” they reported. The broadcasted waves must have been arriving ahead of their progenitor, the alien. “The planet will soon be ours.”

Two human forms were nearby. One was wearing doctors’ scrubs, and the other, a suit. How they got into my spaceship, I don’t know.

The man in the suit waved at me. “The way he’s staring at his own brainwaves like that—” he whispered.

“Apophenia,” answered the doctor, “is a common symptom of those with his condition: finding patterns and information where there are none.”

“Earth is being bombarded by an unsubstantiated amount of alpha waves. Are you sure that that instrument”—the man in the suit pointed to what looked like an EEG machine—“is picking up his brainwaves, or the ones coming from outer space? And what if what he thinks he is reading is true?”

“He may have been a genius once,” said the doctor, “but his state has degenerated. Psychic aliens, the impending apocalypse...the man is no more than a bumbling idiot.”

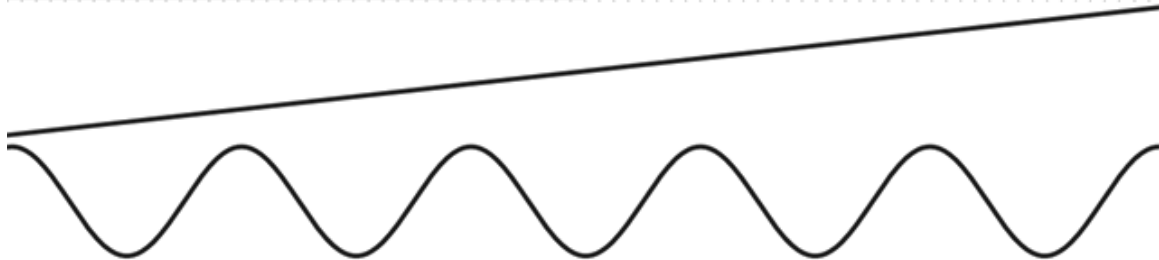
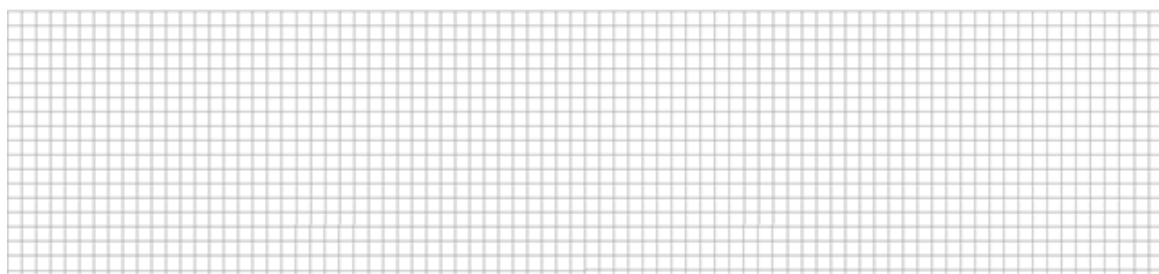
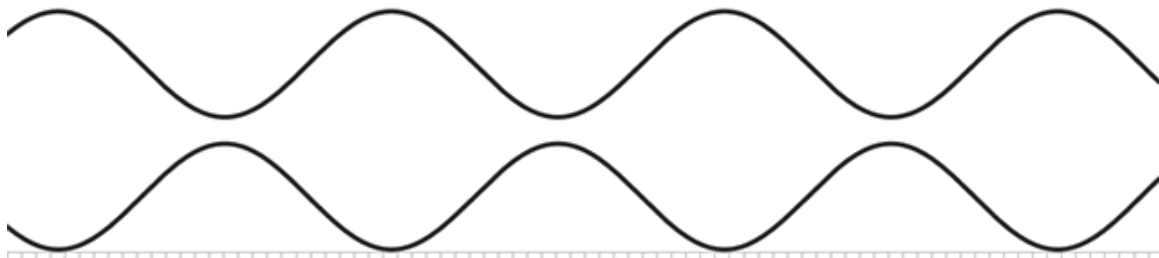
“It’s all true!” I burst from the restraints. “Entropy is coming! I’ve read all of it in the waves!”

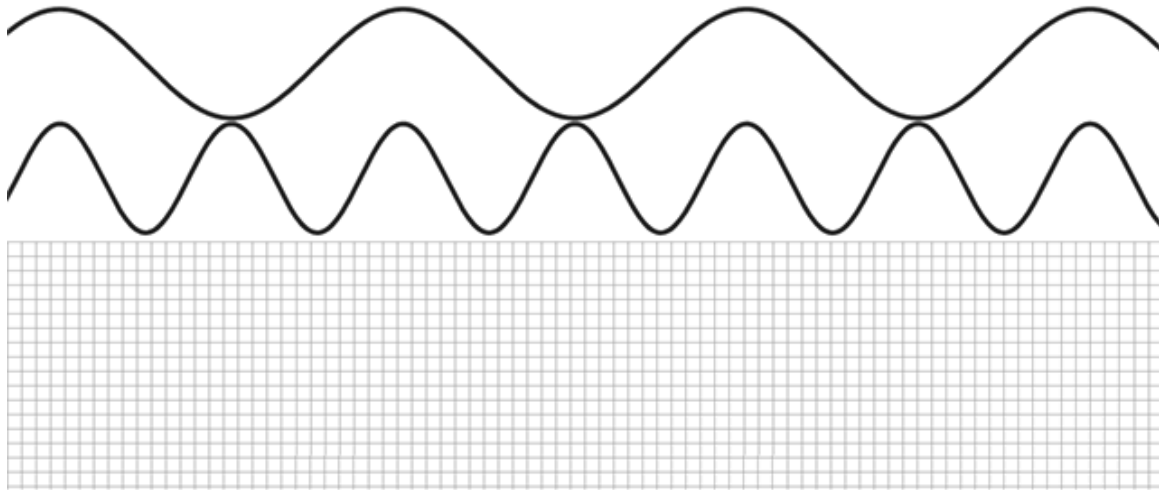
Lost:

Translating the waves was usually work enough for five of us - it was all too much. I made it through x% of it. [if x>=75: I was so close!

But][else: Then] the sound of rending metal filled the air as the bunker turned sideways. I found myself tumbling into the depths of the planet. If only I had been faster, more accurate in my translation, I could have learned the truth behind all this. As I fell, my last bodily sensation was the akathisia of the waves echoing through my bones.

Wave Interference Worksheet: Draw the resultant wave of adding each of these sets of waves.





Notes: The following pages are the scrapbook of notes that I took in order to develop the game. Among them you will find how I worked out random wave generation, managed ideas, edited an early draft of the story, and obsessively scrawled ideas on sticky notes while half asleep.

when question phase time = 20
 and showing "you're ready..." also
 show arrows pointing at "End"
 use these arrows instead of btn icons
 in the tutorial text

Put Selector text where it belongs
 Fore and background (for hint arrow
 pointing at end)
 using sprite scale make logo screen
 twice as big (will have to update
 end of global vars in init
 shorten transition function redo all text
 use max(min()) to shorten these

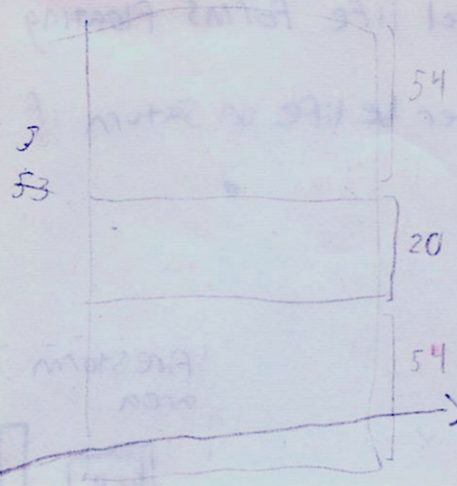
try score particle vectors again. Calculate
 the angle + width again
 Tutorial arrows point at next thing
 on menu

end text
 practice Make helper
 better switch between the two
 saved high score
 while text b-ckg.
 (100% translated) show
 paper auto select menu
 more sound
 - turning out of time
 - transition
 - end game win or not
 Alien! "I behop"
 the intelligent life
 black text, white back

Save score in menu help after forming
 end string

Show old high score "High score!"
 If not shown - win
 text + "yagoin"
 Can get/show
 Start doc: ~~change~~
 look for ~~game~~
 differences ~~of text~~
 as smaller
 waves
 Is ~~quicker~~ place to be
 19 for when ~~adjust~~
~~practice high score!~~

X doc: don't worry about
 tutorial blocking score
 X details where do the each
 wave go offscreen? even a millimeter can give (+ waves).



(end of story - win)
 created by
 Max Levine
 Additional Coding
 * bab - B
 smallfx
 Thanks for playing!
 X shake / compare mentalize
 score particles
 X template (re. and) to c. + 0
 generalized function

I feel like I'm
 enough
 ready for the
 real
 thing
 I could feel the
 pulse of the waves in my
 feet
 x - game work better

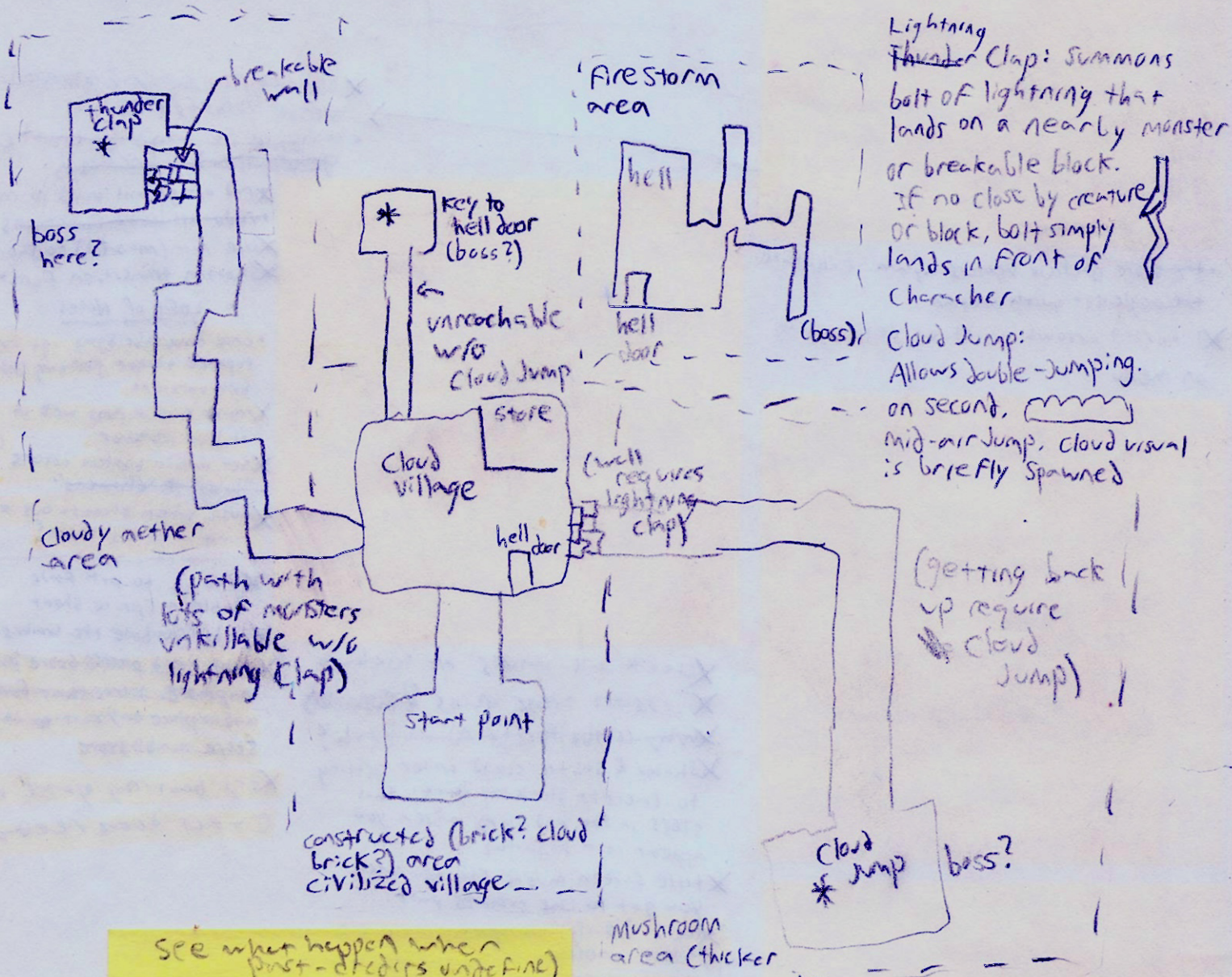
X check all waves of lookup
 X session time mins & seconds
 X why combo for gain in both?
 X shake & static sound after getting
 to facility shaking part: this
 stops in the end story after you
 appear in a hospital
 X title screen music starts once
 you get to the credits part.
 X doc: "only at very end of the
 project another technical challenge
 (using picotool and having to fix
 gates)" - ended up not having to as someone
 on discord said remove tabs
 X jingle when won
 X end screen tells what % was translated
 X black score pixels
 X make them not touch score/tutorial
 messages
 X better happens when score = highscore
 (practice and normal)

X rid of global vars in init
 X redo all text functions
 X use min(max()) to shorten
 X shorten transition function
 Left of Notes
 X once done abridging, go over and
 replace terser phrasing best for
 both versions
 X make sure it runs well in
 itchio browser
 X set mobile button colors
 "lives" -> "chances"
 X music when almost out of
 time - betas likes?
 X Bab - b to put fade
 table in sprite sheet
 X "add/combine the waves"
 X don't need process score particles
 anymore, delete that function
 and replace any call to it with
 score = abs score
 X try bounding game w/
 exact score needed

already - played win -
 jingle
 (1 sex) for prac and
 result

Cloud Quest - crystal life forms floating in the clouds of Saturn or Jupiter.

Paradox: there will never be life on Saturn if don't save day!



Lightning
Thunder Clap: Summons bolt of lightning that lands on a nearby monster or breakable block. If no close by creature or block, bolt simply lands in front of character.

Cloud Jump: Allows double-jumping. on second, mid-air jump, cloud visual is briefly spawned.

see what happen when post-dreaders undefine
move win sound
further down in the tracker
so it plays faster
can mouse change
Selector when transitioning no
are combo winnings un-form?

Mushroom area (thicker as closer to planet surface)

how far does score - to win
preace move up for each comb
Make absolute
make score
arrows and tutorial function
text based for showing
off this) yitona
MISS
transition wash sound effect
of transition amount = 10
beep sound when almost out of time

Change it after back
to no atm space
to practice mode

don't show dec avg if
1.0 1.0 = 1

✗
!

Outline needs

use pret
to see if
x doesn't already
have part of
wave point
x = black points
& selector line

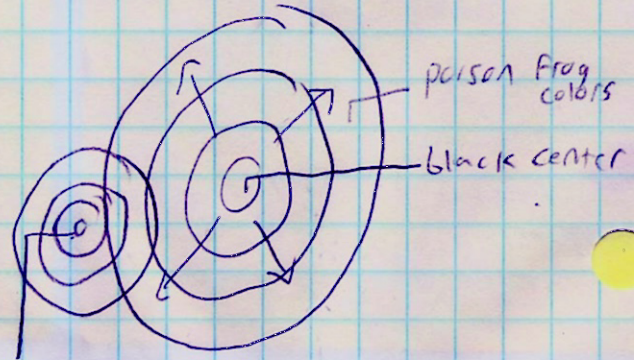
More wave for
one level and
symmetrical

Gamestates

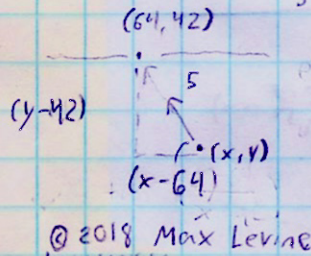
- 0 main menu
- 1 in-game (is-practice bool)
- 2 logo screen
- 1 intro text
- 3 info screen
- 2 final/score screen

store
high-score (who & dec)
high score practice²
looked-at-info³
shown-win⁴

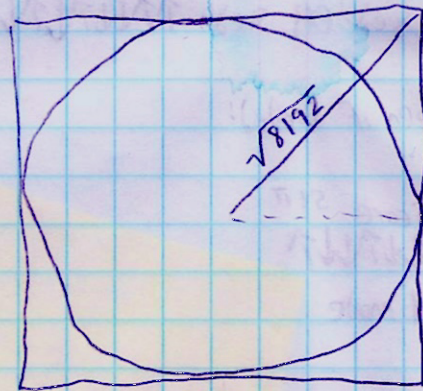
transition animation



Slightly smaller one orbiting
(+ speed T)?



© 2018 Max Levine



$$r = \sqrt{8192}$$

$$r = \frac{1}{8} + 2$$

$$\frac{1}{8} + 2 = \sqrt{8192}$$

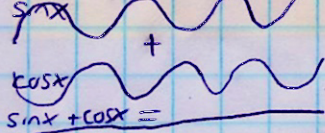
$$+ 2 = 8\sqrt{8192}$$

$$+ = \sqrt{8+8192}$$

$$\approx 26.90868$$

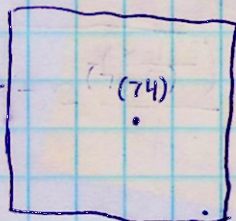
$$\sin x + \cos(x + \frac{\pi}{2}) = 0$$

when 2 waves collide, they form a resultant wave that is a summation of each of the starting wave's amplitudes. Some waves cancel (or interfere destructively)



Some waves are constructive
sin x + sin x = 2 sin x
a more complex example!

13
(-13)



(161)

$$\frac{150}{1} = \frac{30 \cdot 7}{x}$$

$$x = \frac{30 \cdot 7}{150}$$

question \times time = 210
 $F(x) = 150$
 $F(210)$
 $150 = (210) \times$
 210

$$F(x) = \frac{150}{210} x$$

$$F(x) = 150 - \frac{150}{210} x$$

- random seed for group play?
- 1 point per full second left, times pi?

delete
 menu - waves()
 from
 init

Maybe the message only displays once, when you first reach the threshold

You solved enough to translate 100%!

Next wave

replace w/ end "keep going" when = threshold

when the congrats message first displays, "next wave" -> "keep going"

If you select "end" but NOT at threshold: Are you sure (progress will be saved)?

yes
 no

You actually get functional pi points for portion of wave time left

To avoid overflow use 2 variables: full pi's and dots until the next pi

How many dots in (1/pi):

Each dot worth $\frac{\pi}{\text{number of dots}}$

no decimals for score display use rx then append π symbol to score

100 dots in 0.0

Seeds

OPTIONS

Seed: no seed OR Seed: $\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow\uparrow$ (as much till edge of screen)

End screen if seeded:

Final score 51π
 Seed: $\uparrow\downarrow\uparrow\downarrow\uparrow$

Normal mode

You cannot make progress with a seeded run

600 x 700 (six, y, cl, cz)

499 x 527

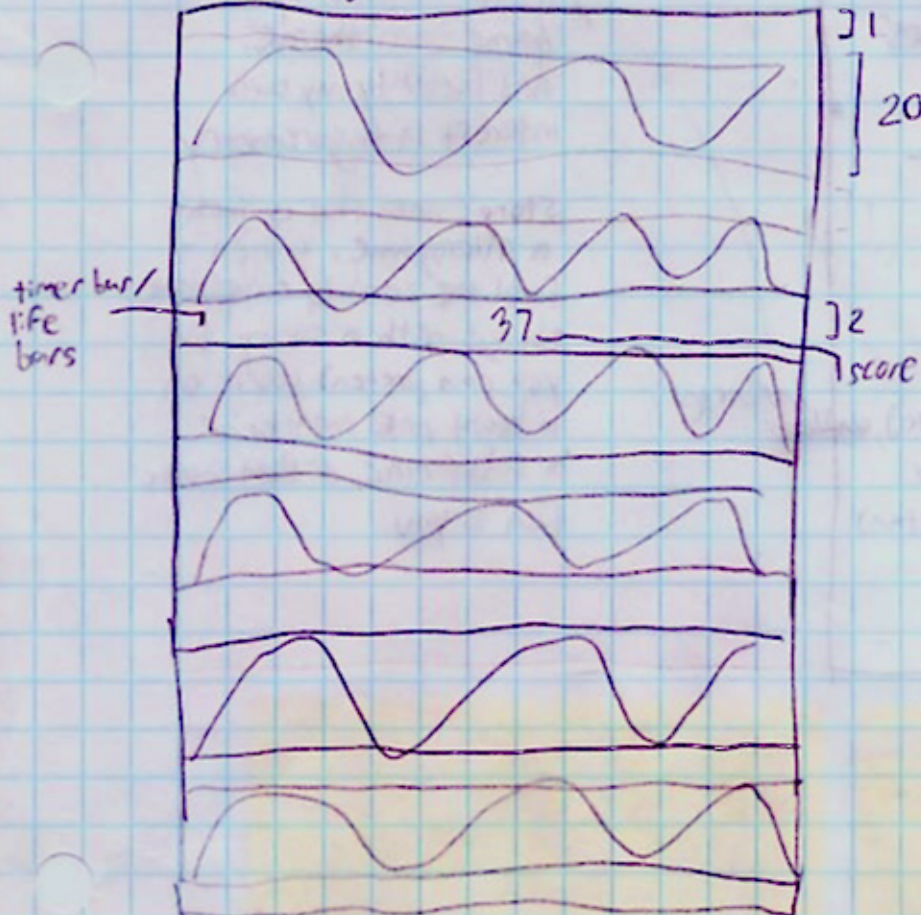
perform calculations for transition in another function in update and keep the other part in draw

High score

Combo = in a row
 Check multiple draws can

- Make seed char / 1. fetch change colors
- Make "particles"
- X make right answer/wrong answer green/red, question green
- X increase difficulty per right answer
- Dont draw-question() when loading new wave

128 x 128



Startup:

PA, CA, DA, CA, AA, CA, DE

Z =

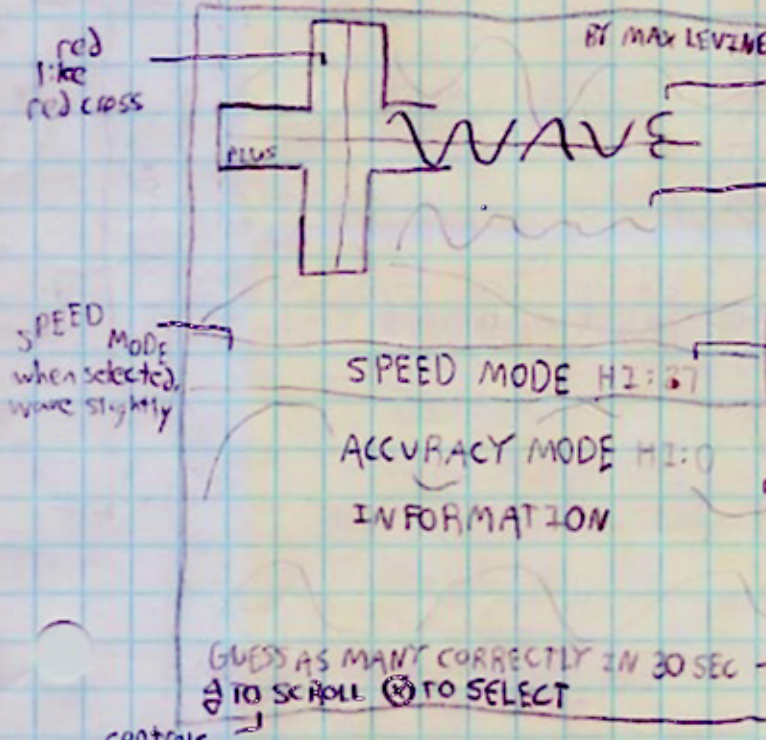
$$128 = 2 \cdot 50 \cdot 0.005$$

$$\frac{128}{50 \cdot 0.005}$$

2.6

$$X \cdot 50 = 128$$

Wave, Amplitude Addition, Wave Marine, Plus Wave wave interference, wave wars, interference addition.



title thing floats very slowly up and down on a sine wave

displays a randomly generated wave once per second like a heart rate monitor
1st wave is a random wave, 2nd is a random wave + that one

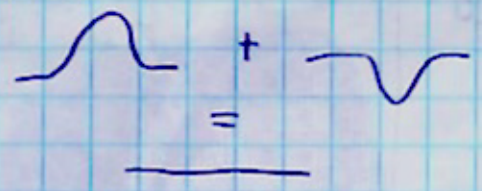
high scores for each mode

a few pre-chosen important waves like $\sin(x)$ scroll in the background background color outlines around text, title, etc. keep waves from overlapping/intersecting

blurb about currently selected mode "how many can you guess before 3 wrong?" "what is adding waves?"

More complicated, real example: $M + \dots$

wave interference is simple.
In destructive interference waves cancel



...
this game has randomly generated, endless content, so feel free to play as long as it takes to understand the concept!

⬆️ to scroll ⓧ to return

→ game inspired by global game jam theme, and fueled by my own interest in trigonometry

story: since this is such a microgame, I didn't feel the need to complicate things with a story, but you can pretend you're on a heart rate monitor or a submarine, & that sounds fun to you

infinite

also if it's identical (in create - question) to real answer (yet no) of answer were in it is too find out make a new one! (analytic geometry, 20 1 or 2) then increase question trickiness

- replace mouse w/ red reticule if $50 - (102) = 0$
- hide mouse if it's at edge of screen (to get rid of 0,0 but symmetrically)
- make each wave (a game one pixel) wider (so they are odd)
- splash screen: two waves collide make staticky noise and create logo (and black & white static) Max Levine Presents

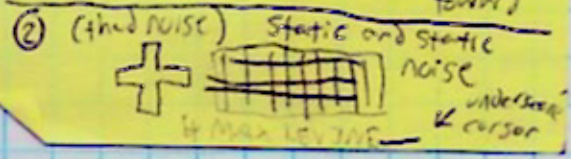
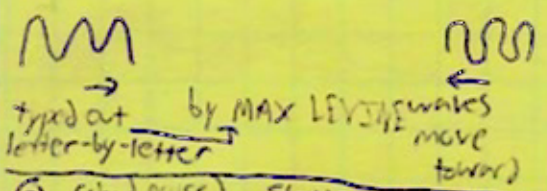
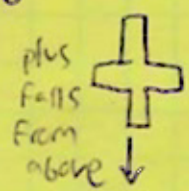
$$\frac{128}{50} = \frac{x}{40}$$

$$x = 1.024 \cdot 40 = 40.96$$

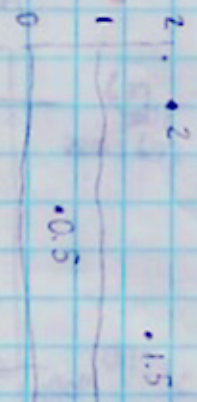
make title fit golden ratio
outline pulse line?
 $50 \cdot 2.56 = 128$
 $40 \cdot 2.56 + x = 128$

128 - 40 * 2.56
bake the wave points (could use like words)
Bake - menu waves doesn't work because it doesn't have the...

① (pure black background)



the story is structural and a cell to action but doesn't mess around and its dark accents will grip students lol
bake wave if it's wtf? anything strange set number or if wave + menu start
call it loop
a) them ever, which way
Bake background menu waves w/ loop point



Start with X

[another phase 4 first]

Phase 1

- 1 multiply by 1
- 2 multiply by -1

Phase 2

- 3 none
- *4 square
- *5 ~~square root~~
- *6 abs value
- *7 cube
- * fourth

Phase 3

- 7 multiply by 1
- 8 ... 2
- 9 ... 3
- 10 ... $\frac{1}{2}$
- 11 ... $\frac{1}{3}$

Phase 4

- 12 add -1
- 13 add -2
- 14 add -3
- 15 add 1
- 16 add 2
- 17 add 3
- 18 add 0

Phase 5

- 19 sine it
- 20 cosine it
- 21 ~~rearrange it~~

- 22 multiply by 1
- 23 ... by $\frac{1}{2}$
- 24 ... by $\frac{1}{3}$

Phase 6

- * add 0.1
 - * add 0.2
 - * add -0.2
 - add 0
- extend code so that shrinking too-big waves is possible

Phase 7

- 25 * abs value
- 26 ~~sq root~~
- 27 none
- 28 * square
- 29 * cube
- * fourth

* = less likely based on difficulty

make these #s flexible to stand for arbitrary amounts to add/multiply

highest point = 1
 actual point
 highest point | multiplier = 1
 multiplier = $\frac{1}{\text{highest point}}$

1 2 3 4 5 6 7 8
 - 1 2 3 4 5 6 7 8

- 1 done.
- Phase * 2 repeat process modifying result
- Final * 3 repeat process adding to result
- * 4 repeat process multiplying by result

5 ~~repeat process adding~~
~~result~~

val-at-x (table, x, starting #)

[do stuff to x] ← start going through table
store in y ← at starting # dimension (default: 1)

Depending on end marker → 0: end.
1: repeat modifying result
2: repeat adding to result etc.

Just return y

return val-at-x (table, y, starting # + 1)

or

return val-at-x (table, x, starting # + 1)

+ y
if starting # = 1, divide the return by "scale" (or make draw wave responsible for this?)

question 1 = []

question 1 ["scale"] = 1

question 1 ["depth"]

question 1 ["right"] = false

Scale up too!!

(highest point) * multiplier = 1

scale wave: find appropriate multiplier
fix wave(x): for wave to fit

if any wave exceeds 1 at any point
increase its multiplier until not

draw wave(x, y):

draw the wave at the location

draw-added-wave(x, y, wave1, wave2)

~~draw 2 waves added together~~

add-wave(wave1, wave2)

Fake answer types:

- * 1. add random wave to one of the question waves
- 2. completely new, random wave

Setup:

1. create question 1 wave
2. ~~question 1 wave~~ ^{scale}
3. create question 2 wave
4. ~~question 2 wave~~ ^{scale}

otherwise, = random wave

repeat for answers 2-4

6. choose answer 1-4 randomly, replace w/ q1 + q2 & "right" = true use add-wave()

5. (5 + difficulty % answer) = one of the questions + random wave

2/5/06 wmp

difficulty 0-25%

80% -diff $\begin{cases} 0 & \text{multiply by 1} \\ 1 & \text{multiply by -1} \end{cases}$

121% $\begin{cases} 0 & \text{none} \\ 1 & \text{abs value} \end{cases}$

122% -diff $\begin{cases} 0 & \text{none} \\ 1 & \text{abs value} \end{cases}$

118% $\begin{cases} 0 & \text{none} \\ 1 & \text{square} \\ 2 & \text{cube} \\ & \dots \end{cases}$

111% $\begin{cases} 0 & \text{none} \\ 1 & \text{square} \\ 2 & \text{cube} \\ & \dots \end{cases}$

75% $\begin{cases} 0 & \text{done} \\ 1 & \text{repeat process adding to result} \\ 2 & \text{repeat process multiplying by result} \\ 3 & \text{repeat process modifying result} \end{cases}$

50% $\begin{cases} 0 & \text{add 0} \\ 1 & \text{add -1} \\ 2 & \text{add -1} \\ 3 & \text{add 2} \\ & \dots \end{cases}$

Statically drum beat at same tempo as DJC music

- use cords in first part of dreams of the and lit

and a set jingle to play inbetween the random generated parts

47% $\begin{cases} 0 & \text{multiply by 1} \\ 1 & \text{multiply by 2} \\ & \dots \end{cases}$

- maybe cut down possible length of the gen'd ~~part~~ pieces

57% $\begin{cases} 0 & \text{divide by 1} \\ 1 & \text{divide by 2} \\ & \dots \end{cases}$

possible answers

74% $\begin{cases} 0 & \text{sine it} \\ 1 & \text{cosine it} \end{cases}$

82% $\begin{cases} 0 & \text{completely new random wave} \\ 1 & \text{add random wave to one of the question waves} \\ 2 & \text{add random wave to the real answer} \\ 3 & \text{just reuse one of the question waves} \end{cases}$

69% $\begin{cases} 0 & \text{add 0} \\ 1 & \text{add 0.1} \\ 2 & \text{add -0.1} \\ & \dots \end{cases}$

99% $\begin{cases} 0 & \text{multiply by 1} \\ 1 & \text{multiply by 2} \\ & \dots \end{cases}$

$$\text{difficulty} = \frac{-0.2}{\left(\frac{\text{score}}{512} + \sqrt{\frac{0.2}{30}} \right)^2 + 15}$$

points earned per wave

change to change min, max

decrease to flatten

78% $\begin{cases} 0 & \text{divide by 1} \\ 1 & \text{divide by 2} \\ & \dots \end{cases}$

Score displayed as multiples of pi?

gamestate	substate
0 menu	0 regular
1 in-game	1 after-question
2 information	0 page 1
-1 story	1 page 2 ...
3 Afterstory	0 page 1
	1 page 2



$$0 = -\frac{x}{0}$$

$$0 = -\frac{400}{(0+x)^2} + 15$$

$$-15 = -\frac{400}{x^2}$$

$$15x^2 = 400$$

$$x^2 = \frac{400}{15}$$

$$x = \sqrt{\frac{400}{15}}$$

store real values in the wave info not just IDs

in game: hot damages from menu

make each wave structure

have a second = {3 and a third} and a boolean saying if to add each

Set 0.9 modifier to value that normalizes it

don't generate of the answer waves

in the colorful like a person frog

Spider snake he is really waste 100
Combine with wave story first site

$\sin(\sin x)$

reduce chance of reuse question wave by reshuffling it artificially

make scale multiplier same across all on-screen waves

Story "uncovering the secrets of the universe... these waves"

harder meta music & everything
possibility for answer waves: 1st random wave physical answer

$$\left(\frac{1}{3} \cos(2(x-1)^2 - 2)\right)^2 + \sin\left(\frac{1}{2}(x+1) + 1\right)$$

"Dreams of Love and Literature"

Doki Doki Literature Club!

Composed by Dan Salvato

Arranged by Nacho2420

♩ = 100

Piano

mf

5

random start

end the same note as start

endless

one note below last note of prev. measure

9

13

percussion cues:

"Dreams of Love and Literature"

16

0 → start ← if have_won() and not high_score >= score_to_win

1 → practice ← if looked_at_info and not have_won

2 → info ← if not looked_at_info and not have_won

practice for the left hand use question phase time = 20 and ...

3 → next wave ← not shown_won and not score >= score_to_win practice

4 → end ← not (↑) (sure?)
shown_won or score >= score_to_win practice

normal

5 → next wave ← not high_score >= score_to_win and ...

6 → end ← if score < score_to_win

if score >= score_to_win

↓/↑ ↓/↑ does separate call arrows() in w/ "choose the right ..."

24

28

D.S.

play track sound
only when gamemode = 1
or 1 or
q-phase-time = 20
(should be and note)
of or here?

What if what he
thinks he is reading
is true?
They're coming!
Screened / unscr
(at the end)

ve Story

have to study them, slowly uncovering the
as communicate. Through them we can
universe. Waves reveal what is on the
of luggage or the human body, or waves
mechanics. The rigidity of any medium
can be measured by the speed at which waves pass through it. E. Rutherford
used alpha waves to probe the atom, drawing conclusions from the manner in
which they penetrated a sheet of metal. By bombarding it with waves, he first
deduced the structure of the atom: the size of its nucleus and its orbiting
electrons. Furthermore, as human beings, interpreting the sound waves that hit
our eardrums and the light waves that hit our corneas forms most of our
knowledge of the world.

And here on this moon, the communicative power of these waves is eerily
pronounced. We are here studying an anomalous source of highly expressive
and complex electromagnetic waves. Yesterday, we learned from them that a
certain tenth order polynomial of the fifth dimension is equivalent to its fourth
dimensional counterpart. I learned that I am able to hold such a concept in my
head in its whole for about 3 seconds, or not at all, but I did write it down.
Staring at these waves all day, we are going slightly insane decoding the waves
across our monitors for many months. But in an expedition to the source of
these waves, deep into a crayon canyon, my colleagues vanished.

I love
the
concept
of
waves!
"Spanda"
Sanskrit

I need basic
concrete
descriptors
to tell
me what
is this
about?

this
is very
heady.
Can you
be
more
concrete
and spell
out
what this is

basic terms in
describe in
concrete terms?

I need
a better
basic
intro added
to this.
You're assuming
the reader
already
knows
a lot.
Where are
you? What
is this
story about?
It didn't
seem like a
story at first.
It seemed more
like an essay.
So it is a little
confusing / jarring
beginning.
Just
give some simple basics
first.

Start
my colleagues and I are on a distant moon
Staring at the waves we are going insane decoding.
unscr

body there to be absorbed by the roots." I realized that I was reading his brainwaves.

"Alone, with nothing, for so long," a different, more alien brainwave read. "Sleeping yes, there is still time. Finally a new stimulus, something novel, oh it is so interesting! I feel so alive!" I could pick out my familiar colleagues' mannerisms and read their brainwaves—

"It is coming!" warned one of my colleagues. "Hurry! It is coming!" Their brainwaves must have gotten all tangled up and I had to untangle them. Time was running out. The facility was shaking, the seismic sensors were off the charts, the mountains were crumbling in the distance—the whole moon was collapsing in on itself! But I couldn't escape on the rocket back to Earth yet. My colleagues hadn't been lost without reason. It was my duty to study, untangle, and decode these brainwaves to find out what this sinister entity was, what exactly was coming.

Translating the waves was usually work enough to occupy all five of us, but now it was just me, so I had to scramble from monitor to shaking monitor, decoding as fast as I was able. Luckily, my years of training prepared me well. This was my moment. I noted the amplitudes, the periods, the frequencies, the wavelengths, every spike, smash, far average, full-down, full-up, corner turn, rendering it into clear English:

"Entropy, the heat death of the universe, is coming," said the strange voice. "Faster than life can reproduce and propagate, entropy is coming. It is disorder, collapse, decomposition. Life and its complexity is its opposite and its

?
when did they
"get lost"?

• Maxes, mins, peaks, troughs, slopes

In an aerial view of the moon, it is built of layers of terraces, the contour lines circling outward from a central point like a ripple in water frozen in time. This central point is our object of study and source of interesting waves. Each layer of elevation is brightly colored, recalling a poison frog, getting darker and redder near the center. The elevation begins to drop rapidly, and the center is a ravine of great depth. An unsettling magnetic pull grows as one nears the epicenter, as my colleagues soon discovered in the form of hair-raising static electricity.

As soon as
an aerial view

"I have a bad feeling about this," my colleague reported into the microphone. "I wouldn't be doing this if it weren't my job. I mean I'm not doing—this of my free will. I'm like a magnet being pulled here and there's no way out."

"A spider snake just floated past me!" yelled another, "like in 'Alien'!"

"That's a centipede."

"I've been on this moon for so long," continued the talkative one. "I feel fuzzy, like this is a dream. Oh—this is a dream! Now there's all this fuzz down here, just because I thought of it. It's getting so thick though, I can't move." Here the audio feed and my colleagues were fully consumed by the static.

I had stayed behind in the lab to watch the waves, and the monitors were suddenly ablaze with an almost seizure inducing amount of waves running across them. All those years of staring at them I knew there was information and not chaos, and the message was clear. Looking into the flashing screens, I could continue to hear my disturbed colleagues ramblings. "Wait this isn't the end though," he said. "Now my mind is flying up away from all of it, leaving my

Not realistic.
a mature
adult with a
good job
wouldn't
say they
aren't performing
of their job
free will.
They'd take
responsibility
and ownership
for their
choice/job.

I need
back
sound/
placement
and
context.
Reading
this cold,
without
context
is
confusing/
random.

heat waves. The sound of rending metal filled the air and I looked down a long corridor to see it bend downward into the earth. I was out of time. Waiting to be absorbed by this thing didn't seem appealing. This thing didn't seem capable of traveling at light speed with its "propeller," but if it could I would surf the thing back to Earth and still get there before it. I leapt into the escape pod, buckled myself in, and bit the button.

The spaceship aimed itself in the direction of Earth and went into light speed. My body survived the acceleration due to the invention I had created back on Earth years ago—the one that enabled light speed travel by allowing the shock waves to pass fully through a medium, be it spaceship metal or human flesh. I looked out the window, however, to find myself already at my destination, looking out on a bright blue sky and a sun comfortably on the opposite side of the atmosphere. Had I blacked out? The journey should have taken several weeks. I tried to release the straps holding my wrists and ankles, but they were fastened in place. I strained my neck to see different computer monitors around me, each displaying various readings. To my horror, I translated, "Hah, hah. Now we have a sixth of you. We will triangulate your planet even sooner now. We are coming, to fight entropy." After a moment, I resigned myself to becoming a part of this morally ambivalent being, and stared uselessly out the window at the beautiful day outside. I thought about waves, but not the usual kind.

"Why am I such an idiot?" I thought. "What am I doing here, when I could have been at the beach? I could have been a surfer on a beach, or riding a

enemy, and is the only force in the universe that might counter it. Science is the tool of life that can save us from this ultimate end, as well as sooner ends such as asteroids or other disasters not to mention mortality. Any disaster, either by fire or ice, that kills life, is a victory by entropy.

"I am a mere fragment of a life form that was shattered by the chaotic force of entropy. I scattered myself across the universe, imbuing each of these mind fragments with the mission to fight back against entropy. I have been here on this moon, bleeding my thoughts into space, waiting. I was made weak and disordered by entropy, unable to do more than drift through space, almost as dead as a rock. I needed to be revived by complexity—another life form, its cultures and knowledge. So I broadcasted my most interesting, crystallized pieces of knowledge—things I had retained—to attract one.

Who is talking?
the "enemy"?

"And finally, a few promising morsels have fallen into my maw, and have made me hungry. I have assimilated your colleagues by triggering deep emotions, creating images of 'spiders' and 'snakes' until I could find enough nodes with which to interface with. From them I glimpsed your cities, art, math, and it will all be more than sufficient. I'm absorbing this moon now, turning its mass into a propeller. Join me and with your mind help me deduce the location of Earth, so I may come and absorb it. Then, we will focus our efforts on ever-increasing knowledge of science. Ally humanity with me against entropy!"

The hair on my arms was sticking on its ends. I didn't know if it was the creepiness of the alien voice or the rising amplitude of static electricity. I looked out the window of the bunker to find the landscape distorted with something like

speed boat through the surf, and instead I'm here decoding hell out of these sinusoids." Of course they would put this imagery outside, to make me feel this way. They were teasing out nodes with which to connect to. I could feel it now, the cold massage on my hair, the feeling of putty sticking to my scalp—they were going straight to the point.

"Mr. Abernathy?" said a voice. Yep, they had my name already, though I hadn't told them yet. "This will only take about half an hour. Try to keep your neck completely still." I followed the instructions. The only thing worse than an alien brain surgery is a botched alien brain surgery. I looked at the display that was still in my vision:

"We will be at Earth in 45 days," it quite clearly reported. "We will infiltrate into the population by using the social patterns gleaned from our six instigators, starting in their various hometowns in the region called America. By 75 days, the planet will be ours. With the higher complexity gained, we will be in a position once again to defeat entropy. At the moment, we are assimilating we are assimilating we are assimilating—" I broke my gaze free of the infinitely nested loop, which looked like a scramble of waves that the monitor had trouble forming coherent lines out of, making a randomly placed field of dots.

I could see and hear two human forms nearby. One was wearing doctors' scrubs, and the other, a suit. They were talking quietly and mumbling, so I could barely hear them.

"The way he's staring at his own brainwaves like that," whispered the man in the suit, "like he knows more about them than the technician—"

"Apophenia," answered the doctor, "is a common symptom of those with his condition. He believes he is finding information where there is only completely random data."

"And yet," said the man in the suit, "he used to be the greatest mind we had on the subject."

"On deciphering electromagnetic waves?" finished the doctor. "Even if so, right now he would only be deciphering his own brainwaves, which is absurd."

"The reason I am here, doctor, if you have forgotten, is that the nation is on high alert due to the Earth being bombarded by an unsubstantiated amount of electromagnetic waves. Are you sure that that instrument"—he pointed to the device connected to my head and what I had now realized was a simple EEG machine—"is picking up his brainwaves, or the waves currently coming from outer space?"

"The room should be insulated from that," replied the doctor, "but maybe not. You do, of course, have the clearance to speak to my patient directly. In all confidentiality, however, in my opinion, the man is now no more than a bumbling idiot."

The man bent down to my eye level and said, "Tell us everything." I was confused at first about the plurality of the statement, as he had left the doctor behind, but the words crossed out in mid-air; the man had said two things at once. "Tell me everything," he had said.

interesting
but
not
sure
what's
happening.

(good quick pacing!)

Wednesday, August 1, 2018

5:45 PM

Wave interference game: how many randomly generated wave interferences can you solve in 30 sec? Drawwave(): draw line between each point. Randomwave(): choose cos or sine (or any other periodic function) and multiply them by 1/2 or 3 or 1/2, 1/3 or feed them 1/2 or 3x, 1/2, 1/3x. chance to add or subtract another randomwave. Very Rarely add arc tan, or abs value, or square or square root it, or do all of this nested (e.g. sin(sin(x)))... Difficulty: higher chance for recursion to add another wave, it gets slowly more difficult in race mode (30 sec) and accuracy mode both (3 mistakes). If right sound goes up scale wrong dissonant and scale start over. To generate wrong answers, add another randomwave to one of the question's products. Right and left shift the waves right or left with the right left keys

Once done abridging, go over unabridged and replace any terser phrasing that will be best for both versions

~~For every dot in ending ellipse, check position in original string to see if line break is needed~~

New score() function called at the end of the end text screen. Handles either practice score or real score. Finds if new score is higher than old high score, if so replaces in-game version and dset/dget version

An is_score_greater_than_high(whol, frac) helper to the previous method, as well as displaying final text: tells if it should say "new high score" or not

Score particles: random initial velocity for a second, then using vector components calculate (only once for each particle) the direction that it will add its velocity to from then on, toward the score. Maybe make it so the particles further left launch first and across the wave the rightmost particle launches last; will have to make the "special" practice mode particle the middle one .

~~Add dreams of love and literature sheet music page to pile~~

Highest score in practice mode per session is remembered and used as final score

~~Remove controls from main menu~~

~~Center main menu vertically~~

~~Ctrl f 0.02 see if there is a better way that may not fail~~

Tutorial instructions for first wave in practice mode; and another message "your ready for the real game" when you get high enough practice score; and menu selector is over "practice" first time game loads up w/ no high score saved; all of this when no high score/ practice high score lower than required for "ready for real game" message

Make drumbeat sound more like heart beat

~~Set blip to 2.4 when returns to intro text from menu~~

~~Remember to process score_particles() at the end of a game~~

~~Remember to call the functions, and in practice and real~~

~~Make sure it runs well in the itch io launcher~~

~~When you lose your last life, screen keep shaking until you get a new game~~

~~and doesn't stop~~

~~Use vectors to add score particles from toward score part~~

Play sinister sound at end of game if you lose. happy sound if you've gotten high enough score. only in request mode

Outline waves w/ black outline; use pget to not draw over own wave (see sticky note)

Mouse is not visible on screens where it's ^{position} useless (logo screen)

Add or z button so z works the same as x

Check for every btnp that there isn't is_inbetween()

Wavy text parameter to make less amplitude an option; use this option for the combo text

Add "(100% translated)" next to end button in game mode when translation is 100%

Set mobile button colors to the purple "selector" color

Practice mode score is just one integer that increment/decrement by 1 (no longer need subtract_score function)

Promotional logo/icon: plus wave logo stretched out to look like a surface/plane from slight above angle in photoshop looked at from above, with interference as if it were a monitor

Make score notches more efficient: use time or lives left instead of pget. Don't even bother checking for the middle notches. Also, are the notches properly below the score particles?

Make difficulty only decrease by increment amount (3) in practice mode

Set higher minimum score per wave so there isn't such a huge difference in points $x - 7x!$ That can be earned per wave if you answer really quickly. Maybe a logarithmic system so that if you answer really fast you can get a more amount of points but diminishing returns

When the game ends be sure to process any remaining score particles before doing any score calculations

Make ui ("next wave/end") ~~and waves~~ not screenshake

See if stuff after next wave should go under create_question()

Transition "fade": hot colored "ripple" topographic map waves randomly appear and blot out the screen

How are a completely new random wave added to one of the question waves?

End screen also shows time of the play session (for group play purposes), so, score, high score, percent translated (taken from high score), and time taken

Undecoded part of message is scramble of /-W or maybe drawn waves

Screen fade: circles of different colors burst outward then disappear from the center out to show the new screen

Main menu starts with selector=1 (not selecting the title)

Copy start menu to init

Screen shake if wrong right when particles would appear

Right wrong waves turn green red at this point, 2 ticks after option to continue appears and purple selector moves up there

bob.B and smallfx

Additional coding by bob.B and smallfx

For story/text parts: just a metronome tick and a wave in the background that bounces/spikes with the rhythm (maybe use something like the wave_merge function to animate this).

The text starts shaking (and/or the computer monitor sprite) once you get to the point in the story where the moon facility is shaking; stops shaking when you get to point in end of story when you realize he's in a hospital

First test to see if seed works through multiple questions and on multiple platforms

Options menu: adjust volumes; add seed (disables high scoring and story progress) by selecting add seed with u, then input a series of arrow presses, press y again to give seed

selecting and seed with x, then input a series of arrow presses, press x again to save seed, visualized as a string of arrow presses. Will have to call `smd(seed+question_number)` before each `create_question()` if seeded

Story/tutorial text scrolls instead of in pages. Scrolls automatically at first and will auto proceed at end, but if up or down arrows becomes manual for user and have to press x to continue.

Spiky monitor at top of text scrolls with text.

In-game the story is in 2nd person

`Pi=1?` Check grapher. **There are 100 dots in (0,pi)**

Draws a pi symbol in the centered wavy text right after the score number

`Scoredisplay`—unused

~~Does question answer possibly go on all possible answer places?~~

Answer waves merge, then check and if wrong x appear at the same time, and if wrong red screen shake happens at same time then too. Menu prompt appears over right answer after a short time

Plus mouse cursor turns into equals sign when hovering above clickable

`Scoredisplay(num)` multiply by pi, to two decimals

`Isanswertight()` Boolean. Checks if `arg =set` answer num, can make more sophisticated to check similar/duplicate waves later, where it can check if every point along the real answer is within a certain threshold of the same point on the selected answer

Use `dset` and `dget` to save data (works on web too! Save data stored in cookie)

On text screens, illustration of a wave monitor with spiky waves

Dynamic transitions between intro, menu, in-game, etc.: screen fade to black and fade from black

Screen shake (use camera) (and dynamic red flash) when question wrong?

'Plus' text in front of red line

Percentage of translation preserved to highest ever

Make `calc_wave()` more efficient by storing a baked table in each wave structure

Mouse controls, only change selector value moused over when the mouse moves

Set background color in html/css for the game

Playable on phone

Score particles only appear for part of wave covered by how much time left

Don't clear whole screen in-game to save performance maybe

Red line that strikes through title moves and is selector, same in game and acts like $y=0$.

Clicking on title shows intro text. Split outline text function into two so red line can go over shadow but under text

Still need to make wavy text function

Background static stays still for unselected waves, moves for selected wave

Add copyright 2018 max Levine to title screen

Double size of plus wave title logo

Make the program check the whole wave answer allowing for a fairly large margin of error to account for very similar waves, but first check to see if the wave is the official answer to avoid the computational cost

Adjust lookup table stuff to account for 15 difficulty, increase abs value chance maybe

Check adjacent pixels to get the outline effect for background waves with foreground elements

Make the multiplier actually apply to the value of the wave and not just to how it's drawn—directly edit its multiplier modifier when the wave is first generated with a modified scale-wave function

Change font for plus to pico8 font

Completely `rnd(100)` all less important to difficulty wave mods like multiplication, division, adding, etc.

adding to

Combine mult and divide into one *md(4)-2

Set background waves to color 5

Play the betus blues music when you only have 1.5 seconds left

On the final score screen, a message is partially decoded depending on the score. "[you managed to decode x% of the message]"

Make scale multiplier same across all on-screen waves

After each question, a dialogue box asking "next wave?" or "return to menu?" How else would you return to the menu in practice mode?

Make everything /dt for performance

Alternate between loud buzz and soft buzz in the music

As difficulty increases chance for possible answers to add to one of the question wave increases or add to answer increases instead of just a completely new random wave

Instead of actually adding together wave structures just add their x values for each point. But it may be more organized to just add the structures, then you know you only need 6 or so structures

Random fluctuate love and lit

Different starting and ending note love and lit, try going backward up

Make it work on mobile (also port zombyard): <https://www.lexaloffle.com/bbs/?tid=30147>

Pressing left or right will very slightly bounce move all the waves horizontally

Just a ~~big green red check mark~~ **big green red check mark and big red x** drawn animatedly from the bottom up

Whether you get it right or wrong an animation shows the two waves merge to get the right answer, this makes it more learnable education (might need a merging wave animation function). The two question waves animate merging, then if you got it right a check appears on the right answer; if you got it wrong an x appears on the answer you chose then a check appears on the right answer

Animating waves merging (added wave + solution wave*x)/(x+1) where x starts at 1 and increases. Fractional x for 1st part of animation? X= 1/4 to 4 eg

Use pget to only draw decorative waves on selection highlight or other surface

Add wave(one wave, second wave, sum wave destination)

Infinite possible power raising

When get wave right. Each point on the right wave turns into a particle with a small random initial velocity that flies to add to your score. When particles hit the score line they add 1 to your score each and add back your time and if you've gotten 7 right in a row add back a life, if you have full health then you get a bonus for your score

Arcade mode/practice mode/information - 7 seconds per question, 3 lives, earn back lives with 7 right in a row/unlimited time, unlimited lives/information about wave interference and how to play

The menu has the main music, the information page has only the love and lit melody, and in-game (practice and arcade) have no music but just sound effects. Maybe, In game same soundtrack but volume is all the way down. maybe no metronome cause that's the select sound

Story mode arcade/endless mode? Arcade/menu has the lit music. In arcade/endless mode you have 10 sec to answer each question and 3 lives, you can earn back lives by getting 10 in a row. Score added is how many secs left when you get a right answer

Perhaps a special mode to be played in a group class setting (practice mode)

Story mode (about brain waves in a hospital on a moon where scientists have gone insane

studying waves that pervade everything. Or not)

Endless arcade mode

Endless practice mode (maybe combine with story mode). Pauses and waits for a x tap to go to next question when displaying the answer

Group play mode

Information/help mode (maybe combine with story)

Score is displayed in multiples of pi

All these modes r too complex; what about just arcade mode and practice mode (which could be utilized in a group game) and just a static document in the help mode. Put the story in the bonus document for \$5, as well as some practice questions, tips, group game ideas like a referee who draws the waves on board

Intro splash screen: two kids tug a war waves spelling the title, animated so title is formed by wave interference. Shows a brief story description about moon scientists

Special \$5 document

- ~~Group play~~

- ~~It is advised to turn off volume in a group so that the room isn't filled with a cacophony (phone volume "luckily" doesn't work)~~
- ~~Draw game: one judge goes to practice mode and draws the question waves on the board. Each team draws what they think the answer is. Judge awards points to the teams who got it most right~~
- ~~Whoever can get the most points in practice mode in 1 minute~~
- ~~Play a game with drawing the waves kind of like telephone, draw wave and pass...~~

- Unabridged Story: scientists studying waves on an anomalous moon go insane and their brain waves all get mashed together and need separating
- How wave interference works, and more in-depth research on wave interference applications

- Sine and cosine
- ~~Alpha waves are actually particles but used to be thought of as waves for having wave like properties (alpha waves are, however, a type of brainwave picked up by EEG)~~
- 3d waves (water)
- Types of waves: sound, light (when these waves interfere and the sound and light they produce), gravitation, liquid. Longitudinal vs transverse

- ~~Practice worksheet~~

- ~~Game strategy guide with insights into how the game works~~

- ~~Dev Diary: inspired by global game jam 2017 (include image~~

~~<https://globalgamejam.org/2017/games/sailors-vs-aliens>), (use of old computer because more expressive despite set in the future reference image) hope to create another (secret for now) game involving trigonometry, and another (also secret) involving physics, both educational~~

- notes: scrapbook scans and copy of this plan list thing, misc garbage

- Downloadable .bin (.exe, .app, etc.) for offline play. Allows full screen; licensed for one person or distributed in an educational setting

- ~~downloadable source (Prca-8 pag)~~

Marketing

- interview at gamkedo Chris delljon: unusual marketing strategy like doom, listened to all your podcasts (some multiple times) like interview format where it's new voices and not

your podcasts (some multiple times) (like interview format where it's new voices and not one voice constant), been making games since I was a kid

- Get a press kit: <http://dopresskit.com/>
- send to any school/physics teachers!? "dear [school], send your physics teachers a new, fun, interactive way to learn about waves! (mention that you plan to make more educational software in the future)" and ask for contract work
 - Schoonover
- **Video:** ...Long YouTube video about doubles as let's play, trailer, and educational video about wave interference, and shows off parts of the game for "From Video"
- **From video:** /r/isaac wave game "plus wave inspired by afterbirth+ logo"
- **From video:** /r/ddlc - stole dreams of love and lit melody (go to information screen for pure melody, skip to this part in the video). (maybe make special video comparing the two musics)
- You tubers: math you tubers (numberphile and <https://examinedexistence.com/10-great-youtube-channels-to-learn-math/>), other (gamers), Jupiter Hadley
- /r/gamedev - developing process, thoughts, and scans of design sketches. Devlog blog of entire process. "bonus document" may be of interest. **include video**
- /r/gaming *give discount or free coupon here?*
- /r/indiegaming
- /r/schizophrenia Story inspired by my experience. You'll have to actually beat the game to get at this aspect of the story; for those who don't want to (spoilers) the gameplay of analyzing waves is tied to a apophenia
- Facebook: inspired by the ggj last year. Also, now trying to make money. *It's also an artistic as well as educational piece on finding patterns in meaningless data, or apophenia*
- Send to jonathan blow: *It's also an artistic piece, listened to many talks*
- Itch.io
 - Game jam(s) it might fit into • devlog • /r/itchio *(inspired by distribution platform to make bonus document)*
- Onegameamonth *• proc Jam*
- Lexaloffle bbs *- random waves
- random music*
- request for zep to feature it because its educational
- Pico8 discord (don't forget @bab_B) *• Game Dev's Quest Discord. • Itchio discord*
- Screenshot Saturday reddit
- "Bonus Document" on GoodReads
- twitter
- /r/pico8
- /r/physics *From video*
- Newgrounds w/ ads
- Send it to microsoft, google, ibm, etc, along with resume
- Handshake unca
- Data structures class (relevant to data structures by how it stores waves, infinitely nested ones), test multiplayer
- Submit Wave Story to Headwaters (w/ link to the web game) *"the game that accompanies this piece can be played online" use font Optimera*
- Send to all email, phone ~~XXXXXX~~, and facebook contacts
- Dad, granddad, josh, grandpa
- /r/writing
- Paul the Roman's high score competition (enter one, then make request)
- Halloween sale 2018, if cut by then
- /r/procgen *"how to random wave. include nepopolitza (cccream G.I.F also random music)*