New Scientist

WEEKLY 9 November 2024

WHAT IS THE BEST COOKING OIL FOR YOUR HEALTH?

SCHRÖDINGER'S CAT HELD IN RECORD-BREAKING TRAP

HOW TO STOP A GIGANTIC ASTEROID BEFORE IT HITS EARTH

HAVE WE GOT THE STONE AGE WRONG?

The audacious idea that plants, not rocks, sparked humanity's knack for invention

No3516 £6.95 CAN$9.99

PLUS MYSTERIOUS ROMAN SKELETON / **OLDEST TADPOLE** / **BENDING LIGHT WITH CLOUDS** / HOW TO HELP A NEGATIVE FRIEND


HOW TO KILL AN...
ASTEROID
OPTION D
SPACE SPIKES
Ages
10-Adult
2-8bn Players
KILL THE ASTEROID,
SAVE THE WORLD
JUST LIKE THE EXPERTS!

Asteroid adventure

When a killer asteroid heads towards Earth, what should humanity do? Join a choose-your-own-adventure game to find out, with the help of **Robin George Andrews**

HIDING somewhere in the gloom of space, there is a gigantic asteroid on a collision course with our planet. If we don't spot it and somehow thwart its arrival, it will pierce Earth's atmosphere at 60,000 kilometres per hour and hammer into the ground, vaporising anything it touches.

With millions of asteroids hurtling through the inner solar system, the threat is inevitable: sooner or later, an impact will happen. But that doesn't mean Earth has to be a sitting duck. A global community is engrossed in planetary defence, carefully planning how to fend off these extraterrestrial interlopers when they show up – or at least minimise the carnage.

Among other things, this work has involved scanning the sky for threats and testing missions to knock asteroids off course. But it also includes a surprising amount of role-playing, where teams war-game asteroid impact scenarios. "In the real world, we haven't really gotten to this stage where we actually have to design and build missions, so that's why we need these exercises," says NASA's Paul Chodas, who runs many of the role-plays. "They make you think about details that you would not otherwise think about."

Over the coming pages, you will be in the hot seat in a choose-your-own adventure version of one of these role-playing games. You will decide how to react as the asteroid bears down upon us. Whether you opt to slam a spacecraft into it, use sunlight-absorbing paint to shift its path, or simply blow it to smithereens, you will find we have more options than you might think – but not all of them will save the world.

Before we begin, there are a few things you need to know about planetary defence. When it comes to asteroid impact emergencies, there are two important factors: "How much time do we have, and how big is it?" says Leviticus Lewis, the Federal Emergency Management Agency liaison to NASA's Planetary Defense Coordination Office. The more time you have, the more options that are available to try to prevent the impact. And the asteroid's mass determines not only what sort of mission you would launch to try to combat the threat, but also just how destructive the impact may be should it fail.

A 1-metre-wide asteroid would burn up harmlessly in the atmosphere. A 20-metre asteroid would explode in mid-air, implode windows over a huge radius and cause mild to moderate structural damage. At 140 metres, the asteroid would strike the ground with enough impact to annihilate a large city. Anything a kilometre or more across could cause continental or global-scale devastation.

When it comes to actually protecting Earth from an asteroid, we aren't flying completely blind. In 2022, NASA's Double Asteroid Redirection Test (DART) slammed an uncrewed spacecraft into an asteroid named Dimorphos – which is 160 metres across but not heading towards our planet – and changed its trajectory slightly, suggesting that we could swat a space rock away in a real emergency. Methods other than this have yet to be tested, but the success of DART was a good omen for our chances against a genuine asteroid threat... so long as we have enough time and information to combat it effectively.

Now, let's play. Remember, when you reach an ending, you can start again and explore the other storylines. And don't forget the final debrief on page 43.

An asteroid of unknown size is heading towards the planet, but has yet to be detected.

First, flip a coin.

If **HEADS**, go to the
ALPHA TIMELINE (page 42)

If **TAILS**, go to the
OMEGA TIMELINE (page 43)

RUPERT GRUBER

It isn't good news. In this timeline, there hasn't been significant investment in observatories that search the sky for potential threats, so you didn't spot the asteroid until just two years before it is projected to hit Earth. It could be anywhere from 40 metres to 400 metres across, making deciding on a mitigation campaign tricky – and it is unclear how much damage an impact will cause.

With so little time before the asteroid hits, you only really have two options. You could try to deflect it so it flies harmlessly past Earth or you could disrupt it with great force, ensuring it fragments into tiny particles, with any larger shards missing the planet.

"It's not going to be like *Armageddon* or *Deep Impact*," says Lewis. Choosing what to do will take time and deliberation, and sending astronauts to battle the asteroid face-to-face will do you no good. "Some hard choices are going to have to be made."

To DISRUPT the asteroid, go to A

To DEFLECT the asteroid, go to B

A: DISRUPTION

To be sure you smash it thoroughly, so that most or all of the asteroid's splintered mass avoids Earth, you opt for a spacecraft armed with a nuclear weapon. Even faced with imminent peril, it still takes months for the world's space agencies and governments to agree to send a nuke. There are concerns that the spacecraft may explode in mid-air, scattering radioactive debris all over the place; certain nations suspect that a nuclear-armed spacecraft could be a pretext for a military attack; and some scientists worry that if the disruption attempt fails, you have just turned the asteroid into a radioactive rocky missile.

Intentional disruption "is less predictable compared to pushing it a little bit. You would want to be sure that there aren't any boulders or components bigger than [around 20 metres] hitting the Earth," says Jason Pearl, a physicist and planetary defence researcher at the Lawrence Livermore National Laboratory in California. But, ultimately, the world's spacefaring nations agree on the nuclear disruption option, rather than standing idly by.

Your scientists quickly calculate how powerful a nuclear explosion might be required to achieve a successful disruption, even though they still can't be sure of the asteroid's exact size. Did they get it right?

Flip a coin.

If **HEADS:** DISRUPTION FAILS

Because you are in a rush, and because of the geopolitical infighting, the nuke you pick is too puny to succeed. When it explodes, the asteroid breaks apart into multiple large fragments. Some miss Earth, but several don't, causing immense damage around the world.

If **TAILS:** DISRUPTION SUCCEEDS

Phew. The nuke is powerful enough, and the asteroid is serendipitously small enough, that almost all the asteroid shatters into minuscule particles that fly away from Earth. The few larger fragments that are left either burn up in the atmosphere as they hurtle towards Earth or land in the ocean. You got lucky this time.

B: DEFLECTION

You are opting to deflect the asteroid, but because you can't get a lock on it with planetary radar until a couple of weeks prior to its impact, and with limited observations, you still can't be sure of its dimensions.

Continuing observations have now shown that it is between 70 and 160 metres across, so it could annihilate a town, or it could damage a whole country.

Do you want to use DART-style spacecraft called kinetic impactors? Given the urgency of the situation, you would need to use a fleet of these craft to even have a chance of shifting the asteroid away from Earth.

Or do you choose a nuclear warhead to deliver a more efficient punch? The idea would be to park the nuke-armed spacecraft near one side of the asteroid and detonate the warhead, causing a violent spray of debris that would propel the asteroid away from Earth.

To use a NUKE, go to C

To use a KINETIC IMPACTOR, go to D

C: NUKE-BASED DEFLECTION

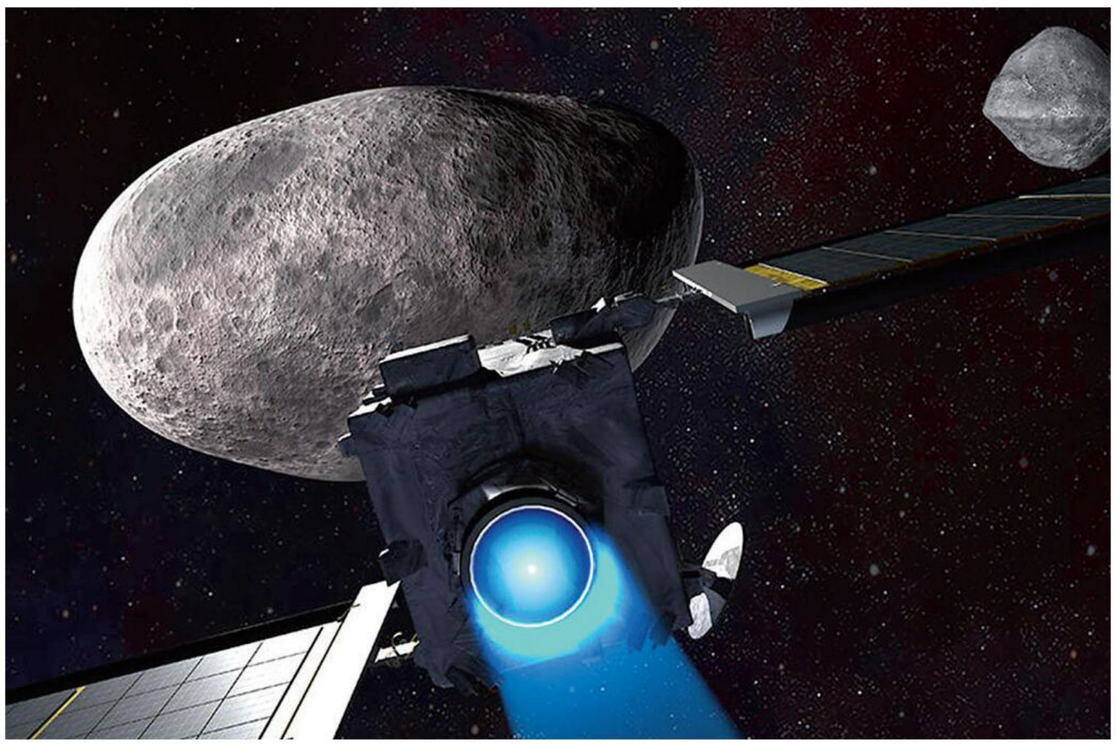
Your attempt is close to working, but no cigar. Although the asteroid is deflected, it isn't by quite enough to push it entirely out of Earth's way. It is still going to hit, only you have accidentally saved one area of the planet to doom another.

In many cases, when facing down an asteroid, spacefaring nations will say "we've got nothing to lose. Let's go for it," says Lewis. But sometimes it may be better to leave the asteroid alone and simply evacuate the area it is expected to hit, once you know where that is.

"If you deflect it slightly, but not enough, then nobody wants to be left holding the responsibility for saving Japan, but destroying eastern Europe or something," says Cristina Thomas, a planetary scientist at Northern Arizona University and DART team member.

Conspiracy theories about the asteroid being purposefully aimed at a particular country abound, and global politics is thrown into pandemonium – not exactly a great outcome.

NASA's DART mission showed we can shift an asteroid



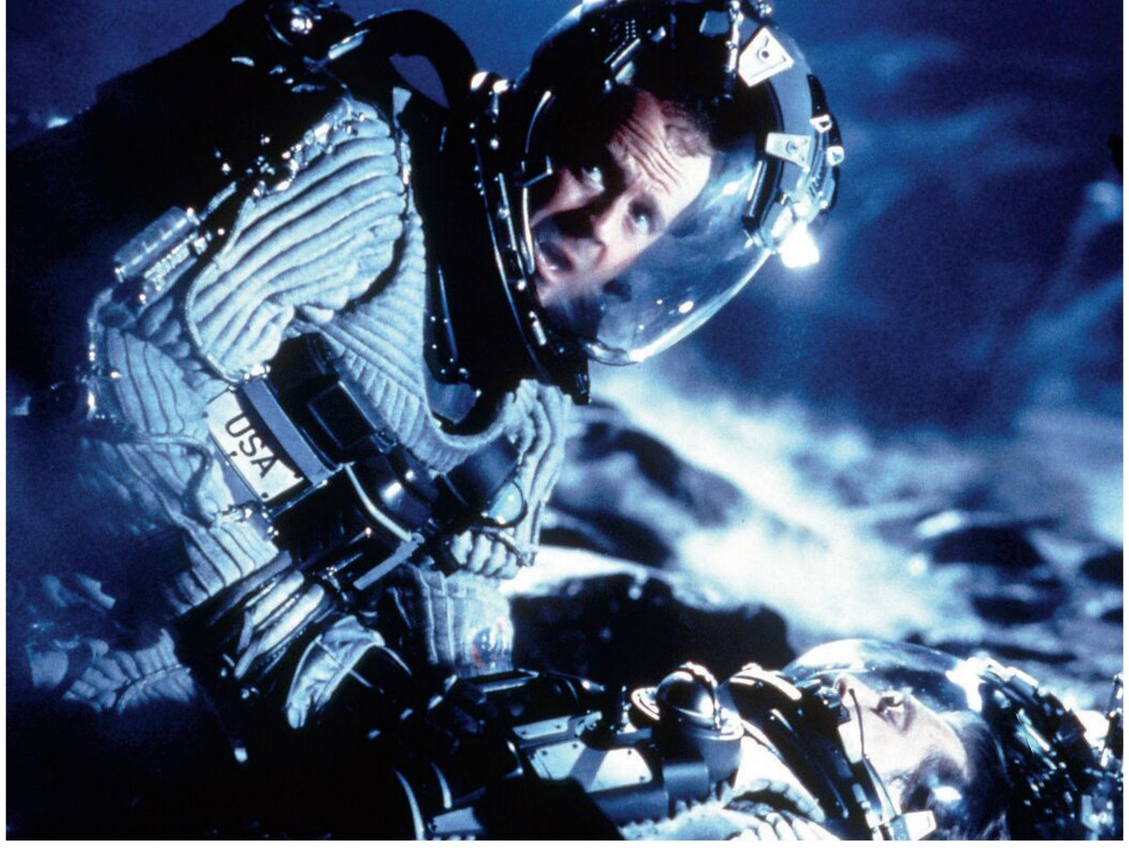
NASA

D: KINETIC IMPACTOR DEFLECTION

Flip a coin.

If **HEADS:** You launch a dozen kinetic impactors, but only five of them reach the asteroid – which turns out to be 100 metres across – only partially deflecting it. The space rock hits a city.

If **TAILS:** Nine of the 12 kinetic impactors hit the asteroid, enough for it to be fully deflected. The asteroid flies between Earth and the moon; astronomers are abuzz for weeks watching it go by, then everything goes back to normal.



AJ PICS/ALAMY

New Scientist video
Watch films about NASA and ESA's asteroid missions at youtube.com/newscientist

Bruce Willis won't be able to save us from an asteroid this time

TAILS: OMEGA TIMELINE

In this universe, the world's powers have proactively invested in an extensive network of ground-based, asteroid-seeking observatories. You also have a space-based infrared asteroid-hunting observatory, the Near-Earth Object Surveyor (which NASA is working on right now in real life). NEO Surveyor finds near-Earth asteroids quickly, plus its infrared eye gets a far better grasp of their size than visible light-based telescopes.

In this case, NEO Surveyor concludes that the asteroid is 140 metres long. Early on, observers can't be certain where on Earth it will hit. Thankfully, your proactive observational work means that impact is 30 years away, giving you time to carefully plan a response.

There is, however, still a lot of geopolitical infighting, as nations disagree on how to handle the emergency and what to prioritise. "If I were the [US] president, I'd want to hear all ideas, no matter how crazy they might be," says Lewis. And all ideas are brought to the table, from the old standard of a kinetic impactor to giant spikes that grind up the asteroid.

Which of them are you going for?

To deflect with a KINETIC IMPACTOR, go to W

To deflect with a GRAVITY TRACTOR, go to X

To deflect using REFLECTIVE PAINT, go to Y

To disrupt using GIANT SPACE SPIKES, go to Z

W: KINETIC IMPACTOR

Flip a coin.

If **HEADS:** SEND A SCOUT FIRST

Because you have 30 years or so before impact, you can deploy a bonus mission. Spacefaring nations agree to send a reconnaissance spacecraft to check out the asteroid in advance, getting a very precise measure of its size and an idea of its internal structure.

If the asteroid is found to be a monolithic, rigid object, it will require more of a punch by a kinetic impactor to deflect it. A series of rocks weakly bound together by their own gravity, known as a rubble pile, requires a gentler prod: they are easier to deflect, but more prone to being chaotically disrupted, potentially turning a cannonball into a shotgun spray.

You discover that this particular asteroid is a rubble pile. You fly your kinetic impactor into it at a modest speed, giving it a decent wallop and deflecting it away from Earth with years to spare. Good work.

If **TAILS:** TAKE A SLIGHT GAMBLE

The world decided it wasn't worth sending a recon mission in advance. The 140-metre size of the asteroid, along with measurements of near-Earth asteroids Bennu and Ryugu that were taken (for real) in recent years, suggests that it will be a rubble pile like them – so you send the kinetic impactor in for a relatively gentle collision.

However, lacking some of the precision afforded by a recon mission, you hit the asteroid a little too emphatically and some of it breaks away. Although the surviving larger fragment is successfully deflected, a smaller one evades detection and hits Earth, blowing up above a small town.

X: GRAVITY TRACTOR

This method isn't as sci-fi as it sounds: you launch an extremely massive spacecraft towards the asteroid, using the craft's gravitational pull to tow it out of the way. It is still deflection, but it is less aggressive than an impact and unlikely to fragment the asteroid – it is also slower. By the time you construct your gleaming behemoth and fly it to the asteroid, you only have 15 years left to shift it. It isn't long enough, and you accidentally drag the space rock into a rather angry nation that was never going to be affected in the first place. YOU LOSE.

Y: REFLECTIVE PAINT

Spacefaring nations build and launch an interplanetary vandal at the asteroid to spray-paint one side of it silvery white. That boosts how much sunlight bounces off it, which gradually nudges the asteroid off its original orbit. This seems like it is going to work, but the asteroid spins quite fast, making its deflection by the sunlight hitting its shiny side somewhat unpredictable. It misses Earth on its original impact date, but it crashes into the planet two centuries later, delighting no one.

Z: GIANT SPACE SPIKES

A spacecraft rushes to greet the asteroid but stops short of doing so, instead deploying 100 huge titanium rods in its path, arrayed like a bed of nails. When the asteroid careens into them, it is shredded into a thousand pieces. All of them miss Earth, but one of the bigger shards zips off into orbit around the sun, comes back around and crashes into Mars 400 years from now. You have saved Earth, but put any future human settlement on the Red Planet in grave danger.

THE DEBRIEF

So, did you save the world, or doom it? The choices aren't as easy as they may seem at first blush. That's why it is so crucial for experts to play games like this – so they can figure out all the possible choices and potential obstacles.

The sting in any globe-defending tale is that, no matter how well-prepared spacefaring nations are, many difficult-to-control elements will factor into the effectiveness of a response. Perhaps chief among those is the possibility that spacefaring nations may act unilaterally, rather than working together – try choosing an adventure again, but this time with a group who must agree unanimously on every decision. When confronted with a real asteroid emergency, will world leaders be able to face an asteroid threat as a united front?

"I think so," says Lewis, before pausing. "I hope so." ▮

Robin George Andrews is an award-winning science journalist and author. His new book, *How to Kill an Asteroid*, is out now