Question 1:

Dear Cheap Astronomy – What is the right message to send to the aliens?

Keen listeners may be familiar with Cheap Astronomy's ongoing despair at Earth's lacklustre attempts at communication with the wider Universe. A few episodes back we ran through a history of deliberate communications to date, about 90 per cent of which have been music – well mostly digitized and some analog radio transmissions of music. This assumes aliens have ears and an atmosphere of a roughly equivalent density to Earth's to enable sound conduction. It also assumes that the aliens are going to work out from first principles that the signals we sent are meant to be converted into audio, then build the necessary equipment and then be overwhelmed by hearing music from an alien species.

I mean maybe they would, but imagine the situation reversed, where we received our first clearly alien signal. The best minds in the world spent years working through it before announcing to the world that it turns out the aliens like doing the ooby-dooby and wanted to let everyone know about it. So, yeah that could be profound for some, a genuine handshake across the light years, but surely some of us are going to end up thinking… what, that's it? Couldn't they at least send through the specs for a fusion reactor?

To be fair Frank Drake and others have sought to provide something with more hard-core science. But it all still comes down to a conversation opener. We send some prime numbers to indicate we know maths, a depiction of Earth and the solar system, a DNA molecule and the inevitable picture of a bloke and a shiela. We're inviting a response, which might be more maths, a depiction of their planet, their reproductive coding molecule and some kind of family pic. I mean that's great, but it probably took several hundred years to send the message an equivalent amount of time to send the reply. So, we get the reply – it's all great to not only know we aren't we alone but to know what the neighbors look like. But again, surely someone is going to say what, that's it?

So if we don't want to spend millennia years exchanging business cards then maybe we have to start a more interesting conversation over the next millennia. Skip the niceties and find a way to ask whether they've managed to harness fusion power – or whether they know how to cheaply sequester CO_2 in rocks – or a cheap form of artificial photosynthesis so we can turn CO_2 into glucose on an industrial scale – solving climate change and world hunger in one go. Or do they have some good rocket engine designs to share… that sort of thing.

All the nervousness about identifying ourselves to malevolent aliens is kind of silly. We've already broadcast our presence and provided our favourite song lists, so it's kind of done anyway. The point is that the speed of light means whoever receives it may only do so after it's hundreds of years old. So if it turns out they're evil aliens, all we've done is indicate where our technological development was hundreds of years ago – which is kind of like telling someone we have cannons when we actually have nuclear weapons. So why not move beyond saying here we are, we know about prime numbers and here's our favourite dance mix. Let's start some kind of transactional discussion – show them what we've got and ask them to reciprocate. Of course the question then is what have we got that's really worth anything to an alien species.

We can't actually build a fusion reactor, showing off our nuclear weapons is probably not the way to go – so… uh, 3d printers, high efficiency batteries, planes, trains and automobiles? Whatever we do, we risk the reaction of what, that's it? So why not keep the music, but use it as a backing track to an even richer story – one about sharing.

Question 2:

Dear Cheap Astronomy – Can we drill through the ice and find life on Europa?

Firstly, there are quite a few moons out there with suspected subsurface oceans – Ganymede and Calisto around Jupiter, Enceladus and Dione around Saturn – there's even a suspicion that Ceres, an asteroid rather than a moon, may have one.

Everyone gets excited about Europa, because it's hot. Europa is the second Moon out from Jupiter after Io, then Ganymede and Callisto follow. Io is the most volcanic object in the solar system and would have long ago evaporated away any water it might have had. It's so volcanic because its proximity to Jupiter means its constantly being tidally stretched as it follows an elliptical orbit around the giant planet. Europa, the next moon out manages to retain water beneath a 20 kilometre icy crust, though its surface seems fresh from regular resurfacing, with what looks like discoloured cracks – where the discolouration might may arise from liquid water seeping upwards to the surface leaving some kind of sediment behind. Ganymede and Callisto look more like hard frozen balls of ice and are heavily cratered, so no resurfacing. Ganymede's magnetic field is thought to arise from a circulating subsurface ocean. So it does have one, though it may be under 150 kilometres of ice.

Anyhow, we think the warmer Europa is a prime candidate for life, with a hot rocky core which could mean lots of hydrothermal vents pumping streams of hot nutrients into the subsurface ocean. The wording got strangely procreative just there, but that is kind of the whole idea – if you want life, you don't just need water, you need chemistry.

Europa exploration planning is filled with ideas of drilling into the 20 kilometre crust so as to access the subsurface ocean, but we wouldn't want to suggest these are necessarily good ideas. The surface temperature is minus 160 degrees Celsius, which is more than a bit cold. So while a persistent heat source like say a chunk of plutonium might melt through the ice – if you put that at the base of your robot probe, there's risk the ice would refreeze around the top of the probe and lock it in place. Remember Europa's surface gravity is a bit less than the Moon, so there's not a lot of downward pull. So, you would probably have to encase the entire probe in a plutonium shell to make any headway.

Then, if you hit a sizeable rock on the way down, that could be the end of it, unless the probe can move laterally. You'd need some kind mechanical solution, since firing a rocket thruster in an enclosed space is just going to destroy the rocket, if not the probe. So some kind of push piston maybe, but it's also got to work without getting caught in the refreezing ice, so you'd probably have to make it out of plutonium as well. And if there's a lot of rocks along your 20 kilometre melt descent, all that lateral pushing is going to drain your power reserves.

Of course, these are all just engineering challenges, to be overcome by lots of tests, trials and ingenuity as well as an absolute bleepton of money, time and effort, but even once you are through to the ocean and start exploring there's then the question of how to transmit the data back out through 20 kilometre of ice. So, either the robot has to steadily unreel a 20 kilometre transmission cable as it goes down or its going to have to bore its way back up again to send the data home.

It's about here we should remember those discoloured cracks on the surface and the fact that we might have spotted a Europa water jet with the Hubble Space Telescope, much like the water jets the Cassini mission discovered shooting out from Enceladus. So you could just do to a fly-by a sample a water jet – or land near one of the surface cracks and dig a little. Indeed, maybe it's not such a great idea to drop a huge chunk of plutonium into a pristine potentially life-bearing subsurface ocean, even if it is in the name of science.