Question 1:

Dear Cheap Astronomy – If we want a lunar orbiting space station, couldn't we just send the ISS there?

Well we could, but whether it would work is another question. There's a fundamental principle that things are built-for-purpose. Of course, you can re-purpose things, but that's only worthwhile if it makes practical and economic sense. The ISS was built for the purpose of orbiting Earth as a science laboratory. A lunar space station is more likely to work as a depot for lunar missions and potentially other space missions. It may still be a science laboratory, but that probably won't be its primary purpose. A lot of the science on the ISS involves Earth observations. On Earth you have weather and oceans and geothermal activity – and we've got complex ecosystems, not to mention a global civilisation. So while the Moon is jolly interesting, which we keep discovering from our orbiting robotic spacecraft, even with a crewed station in orbit, we might not find ourselves needing to observe it with such intensity, nor in so many different ways as we currently observe the Earth.

It's also the case that a lunar-orbiting space station will be well outside the Earth's magnetosphere, so it will need additional shielding to protect both crew and electronic systems from a level of cosmic ray bombardment that the ISS doesn't have to deal with. Furthermore, the ISS communication systems are only designed to handle two-way communication from low-Earth orbit, which is essentially a distance of 400 kilometres rather than the 384,000 kilometres distance between the earth and the Moon. And ISS life support systems are based on receiving regular resupply from 400 km away. While it's likely a lunar station would also receive regular resupplies, the added distance, travel time and cost means they might not be as regular or reliable. So to manage that risk, you'd want the lunar station to have a lot more storage and redundant systems – which translates to more infrastructure that serves a smaller crew.

And of course, if you are going to fly the ISS to the Moon you lose an Earth-orbiting space station. There is talk of retiring the ISS in 2030, at least the US side of it, but that's mostly because it's just getting old and needs to be replaced. Given we've already said a lunar space station is a riskier proposition, being exposed to higher intensity cosmic rays and it's three days travel-time for resupply or rescue so why add to the risk by using ageing infrastructure that was never meant to operate in that environment anyway.

And of course, getting the ISS to the Moon is not all that straight forward. There are currently thrusters on board capable of gently raising its orbit by tens of kilometres. If you want to get the ISS to the Moon in a matter of days, you would need to apply a much greater amount of thrust – applying thrust from one point puts stress on the whole structure to move it as a unit.

It might work better if you distribute the thrust across the whole structure, using multiple strapped on engines. This might also assist in manoeuvring, remembering the Moon is only tilted 5 degrees from an Earth equatorial orbit, while the ISS is tilted 56 degrees. So you not only have to get it to the Moon but also manage a complex orbital insertion manoeuvre once you are there. In any case, it would probably be best to use only gentle thrust - meaning the trip would likely take months rather than days. And while all this technically feasible, there'd be a lot of testing required using engines that may not be available off-the-shelf and to keep those engines fuelled you need to either carry the fuel with you – which means more mass and structural stress – or you need resupply craft to keep the ISS fuelled up throughout the journey.

The alternative to all that is Moon is to build on existing, or at least planned, lunar mission platforms. So, a heavy lifting rocket like the SLS or the Falcon Heavy could launch brand-new modular components of a lunar station, getting them to lunar orbit in a matter of days where they could be subsequently be put together by crew that has flown there with them. While we couldn't do this tomorrow, there are at least existing funded programs that do have these specific objectives. You couldn't fly the ISS to the Moon tomorrow either and such a high-risk strategy would divert attention and resources away from what is currently the main game plan in getting back to the Moon. While the whole Artemis lunar program does still does mostly look like a mission on paper, it is at least that much.

Question 2:

Dear Cheap Astronomy – Could bacteria have hopped aboard the Venera probes and seeded Venus' atmosphere?

So, as you may have heard there's phosphine in them there clouds of Venus and the astronomical community is cautiously excited, but also ready for a gentle let down if it turns out not to be such a big deal after all.

The apparent big deal is that phosphine is produced on Earth by anaerobic bacteria in substantial quantities and is not otherwise produced in substantial quantities on Earth by non-life processes. So, prima facie the Venus finding is interesting, but we've known for a while that phosphine is also produced on Jupiter and Saturn, where it's never been considered to be produced by life. Instead it's generally accepted that the ongoing synthesis of phosphine in the gas giants is because of the enormous energies generated in massive convective storms in their atmospheres.

But, hang on, doesn't Venus have an energetic atmosphere? It has a surface atmospheric pressure 90 times that of Earth and a lead melting surface temperature of 465 Celsius. Venus doesn't rotate fast, generating the lateral convection forces in Jupiter and Saturn's atmospheres, we know there is a super-rotation of the upper Venusian atmosphere due to movement from the hot sunlit side to the cold dark side. And there's also a lot of vertical convection from the hot surface upwards – all of which drives some pretty substantial hurricanes across the planet. And the phosphine chemistry of Jupiter and Saturn also has a photochemical component. So, it's not just about the atmospheric convection energies, but also about photons – and Venus' upper atmosphere is exposed to a lot more photon flux than Jupiter's or Saturn's, given it's the 2nd rock out from the Sun.

So yep, once again Cheap buzzkill Astronomy enters the debate and smothers all optimism with its whining negativity. OK, there's phosphine , but although no-one knows of a non-life process that could produce it, it's hardly implausible that we identify one through further investigation. So jumping to the conclusion that therefore, it must be life is a bit of a stretch. But, what the heck, this time, we'll add our own wild speculation… could it be that the phosphine on Venus is actually the product of microorganisms that were sent from Earth aboard one of the Venera probes?

The first Venera probe to enter Venus atmosphere was Venera 3 in 1966 and landers with varying success continued up to Venera 14 in 1982.There were also the two Vega balloon missions where balloons floated in the upper cloud layers for at least two days until the batteries ran out – meaning they may have stayed floating for quite a while longer.

So, yep we really could have infected Venus atmosphere with Earth bugs, but whether transplanted Earth bugs could survive and reproduce on Venus is whole ‘nother thing. The phosphine on Earth mostly comes from anaerobic bacteria – and most anaerobic bacteria are not extremophiles. Anaerobic bacteria mostly like warm and moist environments, like in your intestines. If you transferred all the species of anaerobic bacteria from your intestines to Venus they’d probably all die in seconds. If you transferred all the anaerobic extremophiles from a nuclear reactor’s cooling pool to Venus, they’d probably die within seconds – because Venus isn’t a nuclear reactor’s cooling pool. Earth’s extremophiles can cope with a lot, but at the end of the day they still need water to grow and reproduce.

Of course, a totally alien kind of life might exist in Venus’ clouds, but if that life is so very different, why should we assume it will still produce phosphines.

And, while we’re airing doubts – there is still some doubt about whether we have actually detected phosphine in the levels reported. The Venus data collected by the James Clark Maxwell submillimeter radio telescope in Hawaii and subsequently confirmed by the Atacama Large Millimeter/submillimeter Array in Chile is very new, deserving of publication to be sure, but it still awaits more review and thought before it achieves general consensus. So, as we like to say here at Cheap Astronomy, right now it’s probably best just to watch this space.