Question 1:

Dear Cheap Astronomy – is the Moon visible from the north and south poles.

Yes indeed – and much like everywhere else on Earth, the Moon is visible from the poles for around two weeks out of every four weeks in the year – although that's an average measure. Around polar winters, at either pole, if you see the Moon at all, it's more likely to be a full Moon, while around polar summers it will be new, waxing or waning. To understand this, remember that the Moon's orbit is only five degrees off the ecliptic – the apparent path of the Sun in the sky.

So, if you can see the Sun at all from the poles, you'll only be able to see the Moon when its orbit brings it around to the same side of the Earth that the Sun is shining on. But during polar winters, when you generally won't see the Sun at all, the Moon will appear in the sky when its orbit brings it around to the opposite side of the Earth from where the Sun is shining. And of course when the Moon is exactly opposite the Sun, it's a full Moon – whereas when it's on the same side of the Earth that the Sun's shining on, it's either new, waxing or waning.

But, like the Sun, the Moon will never get very high in the polar skies at any time of year. Around the summer solstices at either pole, there is 24 hours of daylight and the Sun can get as high as 23.5 degrees above the horizon. But as the days pass and the next equinox approaches, the duration of daylight you get each day declines as the Sun progressively drops lower and lower in the sky until equinox and then everything will get progressively darker until - by the winter solstice, the Sun will be at 23.5 degrees below the horizon at noon – meaning there will be 24 hours of darkness.

However, what the Moon does over a year is a bit different. While the Moon' orbit always roughly aligns with the Ecliptic, the Moon orbits the Earth thirteen times in one year – so there are thirteen times when the Moon will be on the opposite side of the Earth from where the Sun is. At those times we see it as a full Moon - and if you are at the poles and its mid-winter and 24 hours night there will still be times when the Moon appears above the horizon. And, during polar winters, since the Sun can be as much as 23.5 degrees below the horizon at winter solstice and the Moon orbits five degrees off the ecliptic, its position in the polar skies at winter solstice can range between 18.5 degrees above the horizon and 28.5 degrees above the horizon, depending on where it is in its nearly 9 year cycle of orbital progressions around the Earth. But that's it – at the poles the Sun never gets higher than 23.5 degrees and the Moon never gets higher than 28.5 degrees – or to be exact 28.64 degrees, since the Moon's orbit is exactly 5.14 degrees off the ecliptic.

Now, all of this brain-stretching geometry is actually linked to the greatest animal migration on Earth. Diel vertical migration (or DVM) describes the daily shift of zooplankton, which are tiny microscopic herbivores – protozoans, jellyfish, small crustaceans like krill and even juvenile fish. This huge mass of zoo plankton is found across 70 per cent of the Earth's surface – that is, the seas and the oceans – and every night the whole mass rises to the surface to feed – mostly on phytoplankton – and then it sinks back down again to about 50 metres during the daytime, to avoid being seen by predators.

In the seas and oceans experiencing polar winters, so-called werewolf zooplankton still maintain this behaviour, but they rise and sink back down again in response to moonlight

rather than sunlight. This means their diel vertical migration follows a lunar 24.8 hour diurnal pattern, rather than the usual solar 24 hour diurnal pattern. To understand this, remember what dominates any diurnal cycle is really the Earth's rotation, but since the Moon orbits from west to east at about 12 degrees a day, the Earth rotates a bit further (about 50 minutes further) between one moonrise and the next moonrise.

This werewolf behaviour only lasts over the polar winters. When the Sun once again appears over the horizon, high latitude zooplankton recalibrate their movement to it. Because, after all, once the sun is in the polar skies, you want get any more full Moons and you won't get any more werewolf plankton.

Question 2:

Dear Cheap Astronomy – Does the recent announcement that there are ten times more galaxies than we had previously thought change the balance of dark energy, dark matter and visible matter?

Quick answer – no. The longer answer now follows. In October 2016, a team from Leiden Observatory in the Netherlands announced a new estimation of the number of galaxies in the known Universe. The older estimation of around 100 billion galaxies was mostly based on the Hubble space telescope ultra-deep field observations – where the telescope was pointed at an apparently black and empty part of the sky, but long exposure imaging under high magnification revealed that such an apparently empty part of the sky was actually filled with thousands of galaxies. What the telescope was really doing was peering through a small gap between the 100 billion stars in our galaxy to gain a view of the wider universe – and from such spot-in-the-sky observations we calculated that if you did image the whole sky at the same high magnification without all the 100 billion stars of our galaxy in the way, then you would be able to count over 100 billion galaxies across the visible Universe.

But the Leiden team went back to those images and reprocessed them across different wave lengths, particularly for the purpose of capturing more galaxies that may have been red-shifted into partial invisibility. Based on the enhanced view they gained, they then theoretically extrapolated from what was detected to propose that even more galaxies could have been observed if they hadn't already have been red-shifted into complete invisibility – or at least hadn't been red-shifted beyond the resolving power of the Hubble space telescope.

So, this theoretical extrapolation of between 1 to 2 trillion galaxies awaits positive confirmation by a real observation, something the James Webb space telescope might manage after its launch in 2018. But in any case, although the Leiden team reported ten times more observable galaxies in the Universe than previously reported, they were really reporting that if you look way, way out you are really looking way, way back into the Universe's past – and if you do look way, way back then you will find a lot more galaxies than seem to be around in the Universe's present.

So really the Leiden team were confirming what most astronomers had generally assumed anyway. The first generation of galaxies in the Universe were probably quite small – and as

the Universe evolved those small galaxies merged to form bigger galaxies – or in other words they increased in size by reducing in number.

So, it is correct to say the Leiden team reported finding ten times more galaxies in the observable Universe than had previously been observed in the Universe, although this was more a reinterpretation of existing data than a new observation. However, it is not correct to say that we know there are now ten times more galaxies in the Universe than we previously thought there were. In cosmology you need to be very careful about how you use the word now.

Now, like today now, all you can really see is what's right in front of your face. Once you look out to any appreciable distance you are looking back into the past so you can't reliably report anything about what is there now. But at the same time, it's totally awesome that we can look out and see the past, seeing things that happened in an era that's long gone and even gaining insight into how everything that is now originally came to be. This is why astronomy is the awesome science that it is.

But anyway, the standard cosmology model of 68% dark energy, 27% dark matter and 5% visible matter remains valid – at least, it's as valid as any working model that says we have no idea what 95% of anything is. So, the Leiden team didn't discover there is ten times more visible matter than we previously thought there was, they just found indications of how the 5% visible matter component has evolved over the lifetime of the Universe.