Question 1:

Dear Cheap Astronomy – Why did the Universe inflate?

To coin a phrase, in the beginning there was inflation. Within a tiny fraction of the first second, the volume of the universe expanded exponentially, apparently by a factor of 10 to the 78th power – equivalent to something of one nanometer in length expanding to nearly 11 light years in length. This is not to say the early Universe had a radius of 11 light years at the end of inflation. We don't really know how big the Universe was then, since we don't really know how big the Universe is now. If we wind the clock back 13.8 billion years our observable universe was maybe just a soccer ball in size, although other estimates are between a grain of sand and a volume with the diameter of a skyscraper. In any case, compared to what it is now, the post-inflation Universe wasn't that big, although still vastly huger that its proposed beginning at an unimaginably-tiny quantum scale.

It's important to acknowledge all this is totally hypothetical since our earliest observable information about the Universe's past comes from the cosmic microwave background, which was emitted when the Universe was really becoming universal in scale at 380,000 years of age when it had an even temperature throughout of 3,000K. Now, 13.8 billion years down the track, we can still see that even temperature everywhere we look, although it's now reduced to just 2.7 Kelvin) and we also find everywhere we look there's galaxies and clusters and superclusters of galaxies – which all have similar composition, density, distribution and age. It's this remarkable consistency throughout the Universe that lends credence to the idea that the very early Universe must have gone phoom, inflating faster than light speed from quantum to macroscale in a split second, leaving no time for anything to clump, skew or misalign the outward spread of the early Universe's constituents. It is just a hypothesis – but it's a hypothesis that seems to fit the data and until something better comes along, it's the best we've got and so is currently considered a fundamental part of our standard working model of the Universe.

Of course this makes inflation, and the reason for it, is yet another unknown in our standard working model that's already full of unknowns, notably dark energy and dark matter. Our understanding of particle physics leads us to the conclusion that the reason the cosmic microwave background was released in one big flash was because the Universe became cool enough for it to do so, that is at 3000 Kelvin, which is the minimum temperature at which protons and electrons can combine to form atoms. So above, 3000 Kelvin, you have a plasma filled universe, below 3000 Kelvin hydrogen atoms can form, allowing all the photons that had been caught up in the plasma to shoot off in a straight line for the first time. So, as hypotheses go, this one is quite plausible, the cosmic microwave background certainly looks like the long-cooled remnant of one big universal flash and in a laboratory we can replicate the combination of protons and neutrons to form hydrogen atoms below 3000 Kelvin and then reverse that again by raising the temperature above 3000 Kelvin.

But from there, establishing the Universe's earlier history requires a lot more supposition. From particle accelerator experiments we know that at much higher temperatures particles will breakdown further into quarks and on the basis of such data we propose that if there really was Big Bang from a single point followed by a split-second inflation and then a steadier period of expansion then it should have taken 380,000 years for the early Universe to get big enough to cool down to 3000 Kelvin. So, the Big Bang is really a hypothesis built on a hypothesis, where the only real data we have and are ever likely to have is the cosmic microwave background, which is not so much an echo of the Big Bang but instead is the first observational data we have of a Universe that was already well-established, although it was much a smaller and hotter Universe than the one we live in today.

So, it's best to remember that what we have at the moment is a working model. Given the substantial changes in cosmological thought we've seen over just the last century, it's not unreasonable to assume our current working model of the Universe lies somewhere between being a bit wrong and being really quite wrong. But hopefully, it's just a bit wrong.

Question 2:

Dear Cheap Astronomy – Why does the Universe expand?

Here at CA we think is the question that everyone should be asking – that is why, rather than how is the Universe expanding. The question of how the Universe is expanding is generally answered with the waffly concept of dark energy – even though dark energy was brought in fairly recently when it became apparent the Universe's expansion had been accelerating over time. It was as though everyone had been OK with the idea that the Universe was steadily expanding, but as soon as we knew the expansion was accelerating we needed to conjure up a mysterious force to explain it.

Before the acceleration finding cosmologists were already anticipating the universe's expansion rate was either constant, accelerating or decelerating. The fact that we've now qualified it's accelerating is an important finding, but there's still the underlying question of why the Universe expands at all.

What we know is that it's expanding now – and when we look father out into the Universe and hence farther back in time, it's apparent the expansion rate that's happening now has increased from what it was in the past. These findings imply the Universe was much smaller earlier in its lifetime, but that's about all it implies. The clinching evidence for the Big Bang model of the Universe's origin is really the cosmic microwave background, which possesses the same temperature everywhere we look. The cosmic microwave background implies that the whole Universe must have once existed at very high and very uniform temperature and since then it has since cooled substantially, by virtue of it expanding – so it hasn't actually lost any of that heat, it's just spread it out.

This then is one possible answer to the question of why the Universe expands – in order to cool. It's not much of an answer, since if you then asked why does it have to cool, the answer would just be because that's what hot things do. A fundamental feature of the Universe as we know it is that energy will naturally disperse rather than concentrate, which is essentially the second law of thermodynamics.

Another thing to consider is that time always moves forward. If you ask why - there's no clear answer beyond pointing out that time clearly and obviously does move forward. What's important here is that we don't hear a lot of people saying that therefore there must be some kind of mysterious force driving it forward – well OK, there probably are some people saying that, but not many.

So, consider then that time is not something that it exists in isolation, it's just one aspect of spacetime. Isn't it strange then that we're fine with the idea that time goes forward because that's what it does, but as soon as we learn that space is expanding we insist that there must something driving it to expand.

At least in the current Universe, space (or more correctly spacetime) only expands in intergalactic voids where there is insufficient mass-energy density to exert a gravitational holding together of that volume of space. So, if it is that case that spacetime just naturally expands in the absence of matter telling it how to curve there is a certain logic in finding that the expansion of voids accelerates as those voids get bigger and emptier.

Anyway, if this is starting to sound like Cheap Astronomy has all the answers, no – we don't why the Universe expands, haven't a clue. We are just suggesting a different perspective on the problem, where you don't leap to the conclusion that there's an all-powerful force controlling everything, to quote Han Solo. Nor are we encouraging anyone to just accept that things are what they are and stop asking questions. Indeed, that is one of the problems with dark energy, it sounds like an answer, so people stop asking questions and just wait until someone figures out what dark energy is. So, all we are saying here at Cheap Astronomy is that we should at least entertain the possibility that dark energy isn't actually anything.