Question 1:

Dear Cheap Astronomy – News about the Juno spacecraft has been a bit subdued – are things still going according to plan?

Well, no. A few problems have arisen which have led to the original plan being pretty-much trashed. But, it's still looking like a pretty good mission that will deliver some pretty good science. So, in a nutshell, things still looks pretty good. The problems Juno has experienced may reduce the total hoped for close-up observation time of Jupiter, but there still will be a fair bit of close-up observation time.

To recap, Juno launched in August 2011 and slotted itself into a Jovian orbit in July 2016. Juno's mission involves conducting repeated close passes of Jupiter by following a highly-elliptical polar orbit, which allows it to quickly whizz in for a quick peek and then whizz away again before its electronics get fried. Planets with strong magnetic fields can quickly fry the electronics of any orbiting spacecraft, which is why we've never flown Cassini this close to Saturn. Juno's polar orbit will help protect it, since any planets with magnetic fields do have holes around each of their poles.

So, this first part of the Juno mission plan totally worked. Juno is now in a 53 day elliptic polar orbit around Jupiter. The next step though, didn't work quite so well. Juno was scheduled to perform what was called a "period reduction manoeuvre" in October 2016, which would have reduced its orbit from a period of 53 days to a period of just 14 days. That would have then enabled 37 very close-in approaches at the periapsis of each of those 37 orbits, which would have completed Juno's 20 month nominal science mission.

But, something's not right with the propulsion system – specifically, the helium valves. To burn fuel in the microgravity of space – spacecraft rocket engines have to be pressure-primed. You can't just open a valve to allow fuel to flow down into the combustion chamber because nothing flows down, or up, in microgravity. So, we use pressurised helium to push fuel around rocket engines, since helium is light and chemically inert, so it won't react with the fuel or interfere with the combustion process. But some of the helium valves on Juno aren't working properly so although the rocket engines can still fire, their thrust is has become unpredictable, so it's too risky now to try and adjust Juno's orbit further, given a misfire might send it spiralling into Jupiter.

But all is by no means lost. All the science instruments on Juno are working just fine. The original mission planned to do 37 science orbits and we may still achieve that, it'll just take a lot longer. The 53 day orbits will bring Juno in about as close as the 14 day orbits would have done, it's just those 14 days orbits would have seen the nominal mission completed in 2018, while doing 37 53-day orbits will stretch the mission out well into the 2020s.That's a lot of added cost to keep all the Earth-based monitoring activities going. But then, who's to say the mission wouldn't have been extended anyway if the spacecraft had managed 37 14-days orbits and was still going strong.

What will ultimately determine the duration of Juno's mission is confidence that we retain enough control and enough fuel to manage a suicidal plunge into Jupiter's atmosphere, since the alternative is to risk crashing into Europa or some other potentially life-harbouring moon. The moment we don't have that confidence any more, the mission will be concluded.

The helium valves aren't a problem in this regard since although the rockets may fire unpredictably, they do still fire, sufficient to send Juno on a death spiral into Jupiter.

So, for now, everything is just fine. Juno's funding was only guaranteed until July 2018 – and with the revised orbital strategy there would have been around 12 science orbits. But it's not like anyone's going to shut down such a significant science mission if it's still delivering science. As with most 21st century space missions, the scientists, the engineers, the administrators and the politicians will weigh up all the pros and cons of how far they can extend the mission. If there is any risk of it crashing into a life-harbouring moon then that's that. But, if not, well… Juno is what business managers call an asset. If there's no reason to trash your asset – and a little bit of maintenance-funding will keep it as an asset – well, that's probably the best thing to do.

Question 2:

Dear Cheap Astronomy – FRBs: WTF

FRBs, or fast radio bursts, are millisecond long bursts of radio wavelength light that appear to come from extragalactic sources and no-one is quite sure why - although it's probably not aliens. It's more to be likely to be some kind of high-energy phenomenon associated with black holes or neutron stars – or something else of that exotic ilk.

We have made some headway on what FRBs aren't. FRBs aren't perytons, which were identified by Parkes radio telescope staff as short millisecond bursts of microwave energy associated with impatient people opening the door of a microwave oven before the timer had reached zero.

Real FRBs are quite hard to detect since they come from seemingly random parts of the sky – so most of them have been found in archived data from radio telescope sky surveys. And it's very hard to identify what the exact source of such a burst is when it's collected from wide field views of the sky by radio telescopes. By definition, radio light has relatively low resolution, meaning it's hard to pinpoint the exact source of a radio signal, particularly when it comes from outside our galaxy.

Over the last ten years, we've found about 20 FRBs. The first one, the Lorimer burst, was announced in 2007 – although the burst itself was identified in archived data originally collected in 2001. In any case, no-one thinks you only get 20 FRBs every ten years. Because they are so darned hard to pin point, it's possible there could be hundreds or thousands of bursts happening across the sky every day.

The output of an FRB may be the equivalent of 500 million Suns – and it is speculated that FRB sources probably also broadcast in other light wavelengths. So, you might think these extragalactic millisecond bursts are caused by some kind of catastrophic event – say, two black holes colliding or some other hugely-big thing going kabloohey. But, there's least one instance of a repeating signal – although it only repeated for a while and it didn't repeat regularly like, say, a pulsar would.

FRB 121102 was discovered in 2012 archive data from the giant Arecibo dish as a repeating radio burst, which led astronomers to focus the Very Large Array – a group of 27 coordinated radio dishes – on that part of the sky. The VLA collected another ten bursts and was able to provide a pinpoint location – so an optical telescope the Gemini North Telescope at Mauna Kea could then look at that point. The Gemini telescope identified that the repeated bursts originated from a dwarf galaxy about 3 billion light years away.

But, it's hard to draw that much from this one observation. Do all FRBs come from dwarf galaxies – don't know. Is it really about dwarf galaxies, or is it an event that occurred frequently in the early universe when most galaxies were dwarf galaxies. Don't know. The FRB121102 Gemini observation suggested the signal didn't come from the centre of the dwarf galaxy, so a central supermassive black hole may not have been involved – even though this is what causes all the high energy extragalactic sustained radio bursts – which are also known as quasars.

So, it is all a bit mysterious. But isn't it great that no-one is calling these dark bursts. It's a genuine mystery, but it's one that we are confident of nailing down soon using conventional physics and astrophysics, so there's no need to resort to fudgy hand-waving terminologies like 'dark'. So, let us be grateful for that much.