Question 1:

Dear Cheap Astronomy – Why is the abundance of elements not ranked by atomic number?

So, the most abundant element in the Universe is hydrogen, atomic number 1, the second most abundant element is helium, atomic number 2. But are lithium, atomic number 3, and beryllium atomic number 4 the next most abundant? No – not even a little bit. After helium it's oxygen, atomic number 8, carbon, atomic number 6 neon, atomic number 10 and then iron atomic number 26.

Indeed, hydrogen and helium are ridiculously abundant, making up 98% of all the elements in the universe, where hydrogen alone is 73% and helium is another 25%. This is why astronomers refer to anything other than helium and hydrogen as 'metals', meaning they are pretty much an afterthought in the grand universal scheme of things.

Within the first three minutes after the Big Bang the proto-Universe expanded and cooled until protons and neutrons, the building blocks of matter became possible, but in the still hot dense Universe their fusion into helium also became possible, so a lot of hydrogen fusion into helium took place until the Universe had expanded and cooled further to prevent that from continuing.

Since then stars have been the main reason why there is a huge diversity though scant abundance of elements other than hydrogen and helium in the Universe. Even moderate sized stars like our Sun can fuse helium into carbon and oxygen and big stars that go supernova can also do that and more. If you follow through the steps in helium fusion, beryllium appears briefly but there's already enough heat and pressure available to fuse it further to carbon. Also, most higher-level fusion steps, involve the partial break down of elements like carbon, oxygen and even iron into alpha particles – which are essentially helium nuclei. Thus any additive fusion processes generally involve the addition of these alpha particles, that is the addition of two protons, So you commonly see stellar fusion products like helium atomic number 2, carbon 6, oxygen 8, neon 10 and so on up to iron 26, but lithium 3 and boron 5 don't get a look in. In any case, what happens in a big star before it goes supernova doesn't matter that much, since once it does goes supernova a lot of its core elements are destroyed as they are mashed into what becomes either a neutron star or a black hole. It's the explosion itself that generates a whole bunch of new elements. So everything from oxygen 8 to Rubidium 37 mostly comes from supernova explosions, where's there still some preference for even numbered products due to alpha particle fusion and you get proportionally more smaller elements like oxygen than you do bigger elements like Rubidium.

Type 1a supernovae, which are white dwarves that accumulate enough new mass to take them over the Chandrasekhar limit also contribute significant amount of elements like Calcium 20 up to Zinc 30 making many of these elements abundant enough to play minor roles in life on Earth.

The substantial over-abundance of oxygen and carbon is also contributed to by low mass stars like the Sun, which release much of their core contents in a planetary nebula after they swell up into a red giant. These low mass stars also release elements like Strontium 38, hafnium 72 and others even lesser-known all the way up to lead 82.

As for anything smaller than oxygen, as we said before most hydrogen, helium and also lithium and a teeny bit of beryllium arose from the Big Bang, but most beryllium and boron and also some extra lithium comes from cosmic rays striking larger elemental nuclei and breaking them up into smaller nuclei. Then at the other end of the spectrum heavy elements like silver 47, gold 79 all the way up to Uranium 92 and plutonium 94 mostly arise from colliding neutron stars. Most of these elements are rare so don't play a role in life on Earth, indeed some are toxic to life since we've just never had to deal with them during our metabolic evolution. Lastly, anything heavier than Plutonium, like Americium 95 up to Lawrencium 103 are just made in human laboratories. You could still argue they are the products of stars since we are the products of stars.

Question 2:

Dear Cheap Astronomy – What's involved in 'clearing the tower'.

The announcement that (insert mission name here) has cleared the tower mostly derives from NASA mission protocols and some Hollywood embellishment. With most human crewed missions NASA Launch Control in Florida has been in charge of the mission up and including the launch, which may include mission aborts due to bad weather or even launch malfunctions that might require activating the escape system that rescues the astronauts. But once the rocket has cleared the tower the announcement goes out that (insert mission name here) has cleared the tower, because that's the point at which Mission Control in Houston, takes over.

So, clearing the tower is a procedural matter – it's not like everyone breathes a sigh of relief because the most dangerous part of the mission is behind them. A whole bunch of other most dangerous parts of the mission are still to come.

Mind you getting your rocket to clear the tower is no small matter, indeed getting it an inch of the ground is no small matter either. And that is a good place to begin. At the bottom of most rockets are those conical rocket engine nozzles, which really don't look like they could hold the full weight of a fuelled rocket – and indeed they can't. Nor can they fire effectively without an empty space underneath them. Most Soyuz launch rockets are actually held off the ground by four support arms before launch. If you watch a video of a Soyuz launch you can see those arms let go and spread outwards as the rocket takes off. Most other big rockets rest on the bottom of their tubular fuselage and their rocket nozzles sit within cavities underneath, their initial blast being directed down and then sideways and out through a flame trench. A Saturn V's fuselage was supported at four points, each support incorporating hold-downs, which wouldn't let the rocket move until all the engines were at full thrust. Once they did let go the rocket immediately lifted off.

In most respects lifting off is a much bigger deal than clearing the tower. Once a rocket has lifted off, you can't just throttle back on your launch engines and land again, there's way too much mass in a fully-fuelled rocket to manage that kind of fine manoeuvring. Space X is doing amazing things with retrorocket technology, but that still involves landing mostly-empty component parts of the original launch vehicle. So when the announcer exclaims lift-off, that's a genuine exclamation – it means the launch vehicle is totally committed to launching.

Anyhow, the tower that hopefully does get cleared is often called an umbilical tower because it’s mostly involved with feeding the rocket rather than holding it up. The tower loads the rocket with both fuel and crew – and also allows maintenance personnel to access different parts of the rocket. With the Saturn V, and other large rockets, there are various arms or bridges that feed fuel to each of the rocket’s stages and an elevator that takes maintenance personnel up to various points, as well as taking the crew right up to the top. The Saturn V’s tower had nine such arms, including the access arm that the astronauts walked across to enter the command module. At the end of the access arm is what NASA calls the White Room, where a number of support personnel help the astronauts enter the cabin and strap in. One of those support personnel was Guenter Wendt who gets a mention in the Apollo 13 movie.

We mentioned escape systems earlier. In the event something went wrong at a Saturn V launch there were three options. A rocket mounted on top of the command module could launch the module, astronauts included, away from the rocket and then the command module’s parachutes would be deployed to land safely. Or, prior to lift-off, the astronauts could exit the module and attach themselves to a zip line extending from the tower which would take them from over 100 metres altitude down to ground level several hundred metres away from the pad. Another option was to get in the elevators, which take about 30 seconds to go down then jump, Thunderbirds-style, into a 60 metre slide tube down to the Rubber Room, an underground bunker which could protect ground crew and astronauts from the force of a fully-fuelled Saturn V exploding directly above them.