Question 1:

Dear Cheap Astronomy – What are the different types of mass.

Some say there are just two, others five or even seven types of mass, though most are contextual whereby the same mass may have different effects in different situations and when viewed from different perspectives. But those differences are measurable and they can matter, small astronomy joke there.

So firstly, there's Inertial mass. If you push against something it will resist moving, even if it's floating in the vacuum of space. That resistance will be greater the more inertial mass it has. This is the mass used in Newton's formula F=ma. So the more inertial mass something has the more force you'll need to accelerate it. It's why we try to minimize the mass of anything that we launch into space. The more mass, the more fuel you'll need to launch it.

Then there's gravitational mass – of which there are two types. Active gravitational mass is mass that generates gravity, so for example the mass of the Earth generates an apparent force G at sea level where that G is equivalent to an acceleration of 9.8 metres squared. There's also passive gravitational mass, which essentially represents the effect of gravity as measured by the weight of things in a gravity field. So it's harder to lift a heavy thing than a light thing. That is a reflection of the things inertial mass, but the gravitational field is also significant. So it's harder to lift the same mass off the surface of the Earth, than it is off the surface of the Moon – with that effect reflecting the greater inertial mass of the Earth compared to the Moon, although the exact gravitational force at the surface of each body is also influenced by the distance of their surfaces from their centres – that is, their radii.

This might all seem like semantics – since in any context, gravitational mass is entirely a consequence of inertial mass. But the context in which you want to consider the contribution of mass will influence the particular way you either measure it, or mathematically estimate what it is. For example, while we have great confidence in figures we've calculated for the mass of other planets, as well all the asteroids and comets we know about and even the Sun itself – all those are measurements of gravitational mass, based on observations of orbital velocities and distances. In most cases, we've made no attempt to measure what those objects inertial mass actually is – we just have an extremely high level of confidence that their inertial and gravitational masses are the same.

However, there's also relativistic mass, where things aren't always the same. In accordance with Einstein's relativity, a spacecraft approaching the speed of light will have a measurable increase in mass – or at least we know that at those speeds more force will be required to achieve the same acceleration that had been achievable at lower speeds, so we assume it's because the spacecraft's mass has increased. Nonetheless, if you were actually on that spacecraft, you would not measure any such change in its mass, the increase in mass is a relativistic measurement. The spacecraft always has a proper or invariant mass, also known as its rest mass. So, if the ship is at rest relative to you, you'll be measuring its rest mass, which will be the same as its inertial mass. But if the spacecraft whooshes past you at close to the speed of light it will appear to have acquired more mass. Nonetheless, if you know your Einstein

Lorentz transformations you can still calculate what its proper mass would be if it was at rest relative to you – which is why we refer to it as invariant mass. So again, it's all about context.

The equivalence of mass and energy, e= mc2 also falls out of the math of special relativity. Any mass in motion has momentum energy and since no mass is ever not in motion, relative to some other frame of reference, it works out that some of the energy of any system in motion must be attributed to mass itself. It might seem like a mathematical trick, but that math ends up accurately describing the outcome of processes like nuclear fission and fusion and has otherwise passed every test we've thrown at it so far. So there's yet another definition of mass, it's energy – or as some like to say 'frozen' energy.

Question 2:

Dear Cheap Astronomy – Just how bad is it?

It's not like we're the first generation who's been convinced the human race is doomed. We are perhaps the first generation to have such a population-wide appreciation of how we are impacting on ecosystems and environments on a planetary scale – and we clearly won't be the last to have that perspective. We may already be on a slow and steady downhill trajectory, but a sudden apocalypse is not on the horizon. We have scanned the skies and a big rock with our name on it is not approaching any time soon. We've mostly eradicated the diseases that have plagued us for thousands of years in the past and we do seem to be managing any new ones that emerge relatively well. Any zombie or fungal apocalypses are both physically and biologically implausible.

It is also faintly possible we are getting better at avoiding world wars, given the first two officially named ones were separated by just over 20 years, but it's been 80 years since that second one – and let's hope it stays that way. Sadly, continental wars are still fairly routine and the needs of the many do not outweigh the needs of the few or the one. Some say that all wars are ultimately fought over food and water, both of which are dependent upon territory. So, it is a worry that it does look as though we are getting close to the carrying capacity of all the arable land left on the planet and it's not a matter of opinion that we are unsustainably exploiting the oceans. Maybe we can effectively manage a switch to lab grown meat and hydroponics – but their current contribution to world consumption is miniscule, they would need to be ramped up by orders of magnitude to rescue the situation.

Energy production has a good though problematic future, since we can and probably will keep producing it from fossil fuels until those resources are exhausted – and it seems that we will willingly swallow all the consequences that will come from following that path. All the world's problems could be solved in a trice by the invention of a cost-effective fusion reactor, but it's more likely we'll eventually invent a huge and fairly cost-ineffective fusion reactor that can't be readily deployed in multiple locations and will just add to the mix of energy-generating solutions that remain after the coal and oil run out.

Anyhow, if our doom approaches it is coming at us at glacial speed. So, it's neither appropriate to give up in the face of imminent destruction, nor rest on our laurels with the conviction that all will be well. As a population of now 8 billion we face the increasingly diluted reality that one individual makes very little difference, which is undoubtedly true. Those who do rise above are either skilled or fortunately predisposed to a position of influence where whatever power they yield is given to them by a mass of individuals who have chosen, in some miniscule and individual fashion, to proffer their support – either wisely or impulsively.

So, as we've said before, you might just be the person that's flips the burger, that feeds the Uber driver of the Nobel Prize winner's diary manager – but you are still a part of it all. And hey, maybe you are part of the team that cracks the engineering solution for the world's first cost-effective fusion reactor. Who knows? There are a great many of us and it's probably true that most of the world's truly great deeds are done without the slightest recognition of them having being done – or otherwise they get attributed to someone who just happened to be walking past at the time.

All of which is to say that yes, the future does looks grim, but it probably always has in one way or another for as long as anyone has been around to contemplate the future. But OK, yes you're right it really really does look grim right now and all we can really say is that it's up to each and everyone one of us to make it better. And the only advice we can give is that you should do what's right, but don't do it with the slightest expectation that anyone will notice, nor do it with any certainty that it is actually right.