**Question 1:**

*Dear Cheap Astronomy_Light slows down when it goes through glass, but how come it speeds up again when it comes out? Where does it get the energy from to regain that speed?*

Light, or electromagnetic radiation, moves at 300,000 kilometres a second when it's in a vacuum. But, in any other medium like glass, water or air, it goes slower. Indeed, the denser the medium, the slower it goes. For example, it's slower in glass than in water and it's slower in water than in air. Now that might sound logical, but in fact it isn't. Any other type of energy transmission will moves faster in a denser medium.  For example, sound travels faster in water than in air, faster in glass than in water – and it travels a heck of a lot faster through solid iron.

So, it's hard to find useful analogies to properly describe the physics of light waves, because there is nothing else in the Universe that moves like light waves do. But, if you think of light as particles, that is photons, it becomes easier to understand what's happening. While a photon can move freely in a vacuum, if it has to move through a medium – like air, water or glass – the medium gets in the way and it slows the photon down.

The effect of the medium depends upon what it's made of and the wavelength of the light passing through it. Assuming the medium is a cool material built of atoms, photons passing through it interact with the electron shells of atoms – and the particles do a kind-of hand shake.

It's this hand shaking that slows photons down and during these interactions a number of things may happen. The electron, might absorb the photon and be raised to a higher energy shell – in which case that is the end of the photon's journey. But, as we know from quantum mechanics, an electron can only absorb a discrete and very-specific quanta of energy. If a photon's energy-level, which is really its wavelength, doesn't match what the electron can absorb, then it won't be absorbed – and after a short delay that photon will continue on its journey.

Materials that allow photons to pass through them like this are called transparent, while materials that absorb photons are called opaque – but, all that depends on the wavelength – that is the energy levels, of those photons. So, materials that are transparent or opaque to optical light are not necessarily transparent or opaque to other wavelengths of light.

For example, while water is mostly transparent to optical light, but it's mostly opaque to radio waves – which is why your microwave oven heats water so well (all the photons are absorbed) and it's why submarines usually have to go to periscope depth if they want to send a radio message. Similarly, while glass is fully transparent to optical light, it is mostly opaque to infrared and ultraviolet light, which is why glass gets hot on a sunny day.

So, now going back to your question – if you position a window out in space, optical light will reach it at the speed of light in a vacuum, get slowed down while it's inside the glass – and then emerge out on the other side without having lost any energy to the glass, and so it carries on at the same speed, when it's back in a vacuum.

I hope that answers your question.

**Question 2:**

*Dear Cheap Astronomy_When a machine runs in an atmosphere – some of the energy put into it is lost in the form of sound waves. So would that same machine run more efficiently in a vacuum where that energy is not lost as sound waves?*

It's true that in space no-one can hear you working. But before we think about mechanical efficiency, first, imagine an explosion in space. It's true that in a vacuum there will be more energy concentrated at the point of the explosion since there's no opportunity for energy to be removed by oscillations in an atmosphere, in the form of shock waves.

But, nonetheless, that concentrating effect maybe only momentary, since if more energy remains at its source, the explosion may become visibly brighter, or hotter, or more ionising. In other words, excess energy will still be dissipated away, although in the form of electromagnetic radiation, rather than sound.

So, let's now take this thinking back to the operation of a machine that is able to operate in a vacuum. Work, from a technical physics perspective, involves energy input that is converted into mechanical, chemical, electrical or even gravitational action. The efficiency of the energy conversion into action may depend on the precision of engineering used, the volatility of the compounds involved – and also general principles of friction and conductivity. By the second law of thermodynamics, energy conversion can never be 100% efficient, so there is always some degree of thermodynamic loss in the form of free energy, being energy that can't contribute to any useful work – it's just lost as heat.

But for a machine that doesn't operate anywhere near 100% efficiency, there may be all kinds of energy losses in the form of friction, vibration, noise – or just an awful lot of heat loss, all representing forms of energy loss that you might not have lost if you had built your machine more efficiently and maintained it better. Shame on you.

Anyway, how a machine operates in a vacuum depends on what kind of work it is doing and what kind of machine it is. But, for this thought experiment, let's assume it's some kind of old clunky, machine that makes lots of whirring and clanking sounds when it's running.

If you now put the same machine in a vacuum and run it, the same mechanical inefficiencies still exist. So, even though the machine may seem silent to a distant observer, the gears are still grinding, the levers are rubbing and the pistons are still knocking.

In a vacuum, all this vibrational energy lost is not lost in the form of sound, but since the objects are still vibrating, they get hotter. So, in a vacuum, your machine will get hotter than it would if it was running in an atmosphere. It's unlikely that getting hotter will make it run more efficiently. Indeed, it's quite likely to run less efficiently – for example because its hotter pistons become more prone to seizing.

I hope that answers your question.