

Misconceptions in Physics

It is a comfort to be right and interesting to be wrong.

A web-search brings up lists of strange ideas (misconceptions) commonly held by school children. The lists are mostly the same, reflecting widely held beliefs in the society and the similarity of young minds when exposed to the same partial information. Perhaps, because a firmly held misconception is difficult to override in a classroom, the situation is viewed with alarm by beginning teachers, unaware that they teach errors and half-truths copied from one science text to the next. For instance: “*The rate of a nuclear reaction is not affected by temperature.*” If that were true the Sun would be unstable and we would not be here at all. Authors seem to regard the situation as a problem and invariably report the shortcomings of others. It is rare to find a list of misconceptions they themselves have harbored as children and in later life.

To begin a discussion I will divide misconceptions into just two categories: *widely held beliefs* (including text book errors, political nonsense, false advertising, folk law and superstitions), and *muddled self-generated concepts*: in this way avoiding the construction of a diagram in four or five divisions, fearing that it might be copied, inflicted on children and become dignified by authority.

Widely held beliefs

History is littered with beliefs that were once given truths. Prior to 1860 (according to science) heat was a fluid and a gas was held apart by repulsive forces. Until 1950 light was a wave carried by the ether (quoting the British Admiralty). Before 1920 all scientists believed that X-rays were harmless and before 1960, continents were not thought to drift about and as you probably know, background radiation lowers life expectancy. That too is a myth but still widely believed.

The nature of science itself is a misconception. Scientists do not rely on data exclusively with no creative thought or imagination, and strict peer review does not guarantee that information is distributed without bias. The list of steps in the scientific method is useful as school homework, not as a job description, and is not based on the results of documented research.

Humility is a precious thing when contemplating a child’s supposed lack of intelligence, so, breaking with the traditional approach I will recall a few of my own experiences.

Muddled self-generated concepts

At six and seven I watched birds sitting on telephone and power wires and deduced two things. Telephone wires are not electrified, and the insulation covering power wires protects birds from electrocution. I informed my friends who were impressed by these truths. *Observations not supported with additional information.*

At 10 when asked to name the colours of the rainbow in a radio quiz I went outside with my father and looked at a bright large-drop rainbow. We agreed: red, yellow, green, blue and violet. Five colours. Being determined to get it right I added orange as red transitioned to yellow. We were marked wrong. I was reading Physics at university before I realized that we had actually been right. *Observation and correct conclusion, contradicted by a defective text.*

In High School I had a Physics text that featured a full page glossy photograph of white-light diffraction in the shadow of a razor blade by a named photographer. I had not seen this image elsewhere and assumed that it was featured and attributed because it had been difficult to take. Years later, when writing and illustrating my own text I took the lens off a camera and cast the shadow from a point source directly on the film. *My assumption was untrue.*

When mentioning the use of the near point to estimate image distance I reached for a ruler and a lens to find that my near point was at 22 cm, clearly defined to within one cm. I distinctly remembered being puzzled at age 13 to find that my near 'point' was in the 3-5 cm range, contradicting the text, that had it at 22 cm. *Authors should not report age dependent data without qualification.*

When I came to write a chapter on standing waves I drilled a line of holes in a metal pipe, closed one end, covered the other end with balloon-rubber, put a small speaker close to the rubber, lit flames along the top, turned on the signal generator, varied the driving frequency and took photographs. It was soon apparent that a node or an anti-node could be established at the speaker end. Texts have it that energy is supplied to the standing wave through a node. Some teachers argue that the diaphragm is in motion and there will be an anti-node at that end. *Both may be correct.*

The human mind

A computer is an adding machine. A number is taken from a register, added to a number from a second register, and returned to a register. The rest is a complex sequence of additions done by software and hardware: very fast and very often. The human mind is not like that. Generalizations, legends, muddled thinking and superstitions are entertained by all of us throughout our lives. That is what we are like: we form solid opinions on partial information. Given that, a person without misconceptions is a person without the capacity for independent thought. Misconceptions are an integral part of the learning process that defines us as a species.