$$E = mc^2$$

One of the most popular explosive compounds is TNT (trinitrotoluene). The energy released in an explosion of 1 gram of TNT is approximately 4000 Joules. It is common to measure the power of an explosion by asking how much TNT would be needed to produce an explosion as powerful. This is called a TNT equivalent of an explosion. For example, the atomic bomb dropped on Hiroshima had a TNT equivalent of 15 kilotons, i.e. it produced an explosion as powerful as an explosion of 15000 tons=15000000 kg of TNT.

1. Imagine that somewhere in the Universe there exists a galaxy made of antimatter (i.e. its atoms are really anti-atoms made of anti-electrons, anti-neutrons, and anti-protons). Humans receive a radiosignal from this anti-galaxy and arrange a meeting between a human astronaut and the alien astronaut, somewhere in the intergalactic void halfway between our Galaxy and the anti-galaxy. Unfortunately, neither side knows that the other side is made of anti-stuff (photons are no different from anti-photons, so a radiosignal from the anti-galaxy looks indistinguishable from a radiosignal from a normal galaxy). Thus when the astronaut and the alien astronaut try to shake hands, they instantly annihilate and turn into radiation, which results in a huge explosion. Compute the TNT equivalent of this explosion, assuming that astronauts weigh 80 kg each.

2. Let us try to estimate how much uranium exploded in the bomb dropped on Hiroshima. The energy of the explosion comes from a nucleus of uranium splitting into two smaller nuclei (so called daughter nuclei). This process is called nuclear fission. The mass of the uranium nucleus is slightly larger than the total mass of the daughter nuclei, with the excess mass and energy producing the explosion. This mass difference is relatively small, only about 1/1000 of the mass of the uranium nucleus. Nevertheless, it is enough to produce an explosion of a tremendous force.

First, compute the energy (in Joules) released from 1 kg of uranium undergoing nuclear fission.

Second, express the energy of a 1kg uranium bomb as a TNT equivalent.

Third, compare with the TNT equivalent of the Hiroshima bomb and determine how much uranium actually exploded there.

(Note: the total amount of uranium in the Hiroshima bomb was 64 kg, but only a relatively small fraction of it "worked".)