(a) If Uuo didn’t immediately decay into Uuh, but lasted long enough to form an atom, write down the complete electronic configuration (1s²…) for the ground state of Uuo.

(b) Element 118 has 175 neutrons and element 116 has 173. Write down the correct symbol for these two elements, as in 20\(^{40}\)Ca for Calcium-40.

(c) When the Berkeley scientists made their atoms of Uuo, they (the atoms, not the scientists) immediately decayed into element Uuh. Write down the nuclear equation, using all the appropriate symbols and using the correct decay mode(s). My guess is that the Uuh formed would be in a nuclear excited state (\(\text{Uuh}^*\)), so “for full marks”, as the British would say, you should take this fact into consideration in some manner.

(d) That one Element 114 event we’ve seen before was made by bombarding Ca isotopes with Pu isotopes. Identify the isotope of Element 114 (\(\text{Uuq}, \text{Ununquadium}\)) that would be created by using the most common isotopes of calcium and plutonium.
2.) A new set of VW commercials for the Turbo New Beetle claims that there is a new element called Turbonium. The 2833.00 in the Periodic Table entry for Trb refers to the 2833.00 lb. weight of the car – mass of 1287.73 kg. The Turbo New Beetles in the commercial are orbiting about some sort of nucleus with a radius of 10.00 Å.¹

(a) Assuming that Turbonium follows as much of the Laws of Physics as a silly television commercial possibly can, use the equation for the radius \( r_n \) that we developed for the Bohr hydrogen atom. Replace \( Z e^2 \) with \( q_{VW}^2 \), and find the identical charge \( q_{VW} \) of the Turbo New Beetle and whatever the nucleus of this “atom” is. Assume that the radius 10.00 Å is the ground state radius, \( r_1 \).

(b) Find the Energy, \( E_1 \), of the ground state of Turbonium, using your new values for the charge.

(c) Following the lead of our Bohr atom, the kinetic energy of the Turbo New Beetles in the ground state of Turbonium should be \( K = -E_1 \). What is the speed, \( v \), of the Turbo New Beetle?

(d) Find the deBroglie wavelength of a Turbo New Beetle in the ground state of Turbonium.

(e) Use the Heisenberg Uncertainty Principle to find \( \Delta x \), using the momentum of the Turbo New Beetle as \( \Delta p \), and find \( \Delta t \), using the kinetic energy as \( \Delta E \).

1 As originally written, we tried \( r = 10.00 \) m and that doesn’t work on most calculators.

(b) You fire your self-defense lasers the moment you first see the aliens. Of course, what you saw was the light from when the RBNA’s were a million miles away. While the photons of light traveled that distance to get to your eyes, the RBNA’s were still moving at 90% the speed of light. So how far away were the RBNA’s actually, at the moment you detected the light from a million miles away?

(c) Unfortunately, even if you hit the starship, the wreck still has its kinetic energy. Find the relativistic K.E. of the RBNA ship. Compare this energy to the energy released in a nuclear bomb: 1 ton TNT = 4.5 \times 10^9 J; the Hiroshima \(^{239}\)U bomb = 13 kilotons TNT = 5.85 \times 10^{13} J. You don’t want to be underneath when it hits!

(d) For the RBNA’s to get their starship up to 90% the speed of light, it is necessary to do work equal to the final K.E. If this ship is powered by D-T fusion (deuterium-tritium fusion: \(^1\)H + \(^2\)H \rightarrow \(^3\)He + \(^1\)n + 17.59 MeV), how many of these 17.59 MeV fusions does it take to create this energy?² (e) Each mole of these fusions (\( N_A = 6.02 \times 10^{23} \)) uses up 5 grams of D-T (0.00503 kg). What is the mass of the fuel? How does it compare to the mass of the ship?

2 If you can’t find the answer to (c), calculate the classical K.E. = \( \frac{1}{2}mv^2 \).
Barnum & Bailey’s Circus and Particle Zoo (50,000 points)

4.) The bubble-chamber event shown in Serway M&M Figure 15.4 breaks down to the following chain of reactions:

\[ p + \pi^- \rightarrow \Lambda^+ + K^- \rightarrow (p + \pi^-) + (\bar{\Lambda} + \pi^+) + (v_\mu + \nu_\mu) + (\pi^- + \nu_\mu) \]

Using the information in Serway M&M Table 15.2, which is reproduced on the next page… (a) Verify that all Baryon, Lepton and Strangeness numbers, as well as charge, are conserved.

(b) Add up the masses (MeV/c²) for each grouping. Estimate how much kinetic energy (MeV) that the proton + pion-minus must have, ignoring any kinetic energy that the particles at the end might have.

(c) Make a rough estimate of the time it takes for all this to happen.

(d) If the incoming proton were to have a kinetic energy of 500 MeV, is this proton relativistic? It shouldn’t matter whether you do the calculation using SI units or MeV, c, and MeV/c² for energy, speed of light, mass. In SI units, 1 MeV = \(1.602 \times 10^{-13}\) J and \(m_p = 1.673 \times 10^{-27}\) kg.