Notes for teachers:

This is a real game you can purchase called “Antimatter Matters”

I would encourage you to purchase the original game (if only to support science games)

The real game is much more complicated – I simplified it for use in class, and this derivative can

be played in a classroom environment

It really helps students understand how atoms are “built”

The Periodic Table is also simplified (rearranged by atomic number) to help students find their

combined group atom

You will need:

One six-sided die

Lots of proton/electron/neutron cards

Some sort of particle markers for:

Down quarks (little squares on the cards)

Up quarks (big squares on the cards)

Electrons (circles on the cards)

Photons (my students call these doggie-bone shapes)

Gluons (Y-shapes)

**How Atoms Are Built Game**

It’s about atoms and subatomic particles

Your goal is to collect the right elementary particles to assemble atoms

Along the way, you'll learn something quantum physics: how a handful of elementary particles

interact in various ways to form the atoms that make up everything we experience in the

world around us

**Good Luck!**

To construct the atoms, you collect the particles you need based on your die rolls:

1 for a gluon, 2 for a photon, 3 for an electron, 4 for a down quark, 5 for an up quark,

6 - you get the particle of your choice

Place the particle markers on your cards to keep track of your progress

**I was able to construct the atoms: (mark with an “x”)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 6 |
| proton | proton | proton | protons | protons | protons | protons | protons | protons |
| **H** | **2H** | **3H** | **3He** | **He** | **LI** | **Be** | **B** | **C** |
| Hydrogen | Deuterium | Tritium | Helium-3 | Helium | Lithium | Beryllium | Boron | Carbon |
| 0 | 1 | 2 | 1 | 2 | 4 | 5 | 6 | 6 |
| neutrons | neutron | neutrons | neutron | neutrons | neutrons | neutrons | neutrons | neutrons |

Notes: Deuterium is called “heavy water” – it is not radioactive but is used in breeder reactors

Tritium is radioactive – it is one of the pollutants leaking into water supplies from the

Fukushima plant

Helium-3 is not radioactive but is used for nuclear fusion; it is more common on the Moon

Helium is a boson while Helium-3 is a fermion!

The person who creates the largest atom wins

At the end of the game, the Assembler combines all the cards and stray pieces into the largest atom that can be constructed

**Together, the class made the atom: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

I managed the Up Quarks \_\_\_\_\_\_\_\_\_\_\_\_\_\_

I managed the Down Quarks \_\_\_\_\_\_\_\_\_\_\_\_\_\_

I managed the Electrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_

I managed the Gluons \_\_\_\_\_\_\_\_\_\_\_\_\_\_

I managed the Photons \_\_\_\_\_\_\_\_\_\_\_\_\_\_

I managed the Cards \_\_\_\_\_\_\_\_\_\_\_\_\_\_

I was the Assembler \_\_\_\_\_\_\_\_\_\_\_\_\_\_



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |
| protons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | protons |
| **H** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **He** |
| Hydrogen |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Helium |
| 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |
| neutrons |  | **Periodic Table of the Elements**  **(rearranged by atomic number)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | neutrons |
| 3 | 4 |  |  |  |  |  |  |  |  |  |  | 5 | 6 | 7 | 8 | 9 | 10 |
| protons | protons |  |  |  |  |  |  |  |  |  |  | protons | protons | protons | protons | protons | protons |
| **LI** | **Be** |  |  |  |  |  |  |  |  |  |  | **B** | **C** | **N** | **O** | **F** | **Ne** |
| Lithium | Beryllium |  |  |  |  |  |  |  |  |  |  | Boron | Carbon | Nitrogen | Oxygen | Fluorine | Neon |
| 4 | 5 |  |  |  |  |  |  |  |  |  |  | 6 | 6 | 7 | 8 | 10 | 10 |
| neutrons | neutrons |  |  |  |  |  |  |  |  |  |  | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |
| 11 | 12 |  |  |  |  |  |  |  |  |  |  | 13 | 14 | 15 | 16 | 17 | 18 |
| protons | protons |  |  |  |  |  |  |  |  |  |  | protons | protons | protons | protons | protons | protons |
| **Na** | **Mg** |  |  |  |  |  |  |  |  |  |  | **Al** | **Si** | **P** | **S** | **Cl** | **Ar** |
| Sodium | Magnesium |  |  |  |  |  |  |  |  |  |  | Aluminum | Silicon | Phosphorus | Sulfur | Chlorine | Argon |
| 12 | 12 |  |  |  |  |  |  |  |  |  |  | 14 | 14 | 16 | 16 | 18 | 22 |
| neutrons | neutrons |  |  |  |  |  |  |  |  |  |  | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons |
| **K** | **Ca** | **Sc** | **Ti** | **V** | **Cr** | **Mn** | **Fe** | **Co** | **Ni** | **Cu** | **Zn** | **Ga** | **Ge** | **As** | **Se** | **Br** | **Kr** |
| Potassium | Calcium | Scandium | Titanium | Vanadium | Chromium | Manganese | Iron | Cobalt | Nickel | Copper | Zinc | Gallium | Germanium | Arsenic | Selenium | Bromine | Krypton |
| 21 | 20 | 24 | 26 | 28 | 28 | 30 | 30 | 31 | 30 | 35 | 35 | 39 | 41 | 42 | 45 | 45 | 48 |
| neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |
| 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons |
| **Rb** | **Sr** | **Y** | **Zr** | **Nb** | **Mo** | **Tc** | **Ru** | **Rh** | **Pd** | **Ag** | **Cd** | **In** | **Sn** | **Sb** | **Te** | **I** | **Xe** |
| Rubidium | Strontium | Yttrium | Zirconium | Niobium | Molybdenum | Technetium | Ruthenium | Rhodium | Palladium | Silver | Cadmium | Indium | Tin | Antimony | Tellurium | Iodine | Xenon |
| 48 | 50 | 50 | 51 | 52 | 54 | 55 | 57 | 58 | 60 | 61 | 64 | 66 | 69 | 71 | 76 | 74 | 77 |
| neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |
| 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 |  |
| protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons |  |
| **Cs** | **Ba** | **La** | **Ce** | **Pr** | **Nd** | **Pm** | **Sm** | **Eu** | **Gd** | **Tb** | **Dy** | **Ho** | **Er** | **Tm** | **Yb** | **Lu** |  |
| Cesium | Barium | Lanthanum | Cerium | Praseodymium | Neodymium | Promethium | Samarium | Europium | Gadolinium | Terbium | Dysprosium | Holmium | Erbium | Thulium | Ytterbium | Lutetium |  |
| 78 | 81 | 82 | 82 | 82 | 84 | 84 | 88 | 89 | 93 | 94 | 97 | 98 | 99 | 100 | 103 | 104 |  |
| neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |  |
|  |  |  | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 |
|  |  |  | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons |
|  |  |  | **Hf** | **Ta** | **W** | **Re** | **Os** | **Ir** | **Pt** | **Au** | **Hg** | **Tl** | **Pb** | **Bi** | **Po** | **At** | **Rn** |
|  |  |  | Hafnium | Tantalum | Tungsten | Rhenium | Osmium | Iridium | Platinum | Gold | Mercury | Thallium | Lead | Bismuth | Polonium | Astatine | Radon |
|  |  |  | 106 | 108 | 110 | 111 | 114 | 115 | 117 | 118 | 121 | 123 | 125 | 126 | 125 | 125 | 136 |
|  |  |  | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |
| 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |  |
| protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons |  |
| **Fr** | **Ra** | **Ac** | **Th** | **Pa** | **U** | **Np** | **Pu** | **Am** | **Cm** | **Bk** | **Cf** | **Es** | **Fm** | **Md** | **No** | **Lr** |  |
| Francium | Radium | Actinium | Thorium | Protactinium | Uranium | Neptunium | Plutonium | Americium | Curium | Berkelium | Californium | Einsteinium | Fermium | Mendelevium | Nobelium | Lawrencium |  |
| 136 | 138 | 138 | 142 | 140 | 146 | 144 | 150 | 148 | 151 | 150 | 153 | 153 | 157 | 157 | 157 | 159 |  |
| neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |  |
|  |  |  | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 |
|  |  |  | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons | protons |
|  |  |  | **Rf** | **Db** | **Sg** | **Bh** | **Hs** | **Mt** | **Ds** | **Rg** | **Cn** | **Uut** | **Fl** | **Uup** | **Lv** | **Uus** | **UUo** |
|  |  |  | Rutherfordium | Dubnium | Seaborgium | Bohrium | Hassium | Meitnerium | Darmstadtium | Roengenium | Copernicium | Ununtrium | Flerovium | Ununpentium | Livermorium | Ununseptium | Ununoctium |
|  |  |  | 157 | NA | 157 | 157 | 161 | 159 | 162 | 162 | 165 | 173 | 175 | 173 | 176 | 175 | 175 |
|  |  |  | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons | neutrons |