Salt From Poison: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/salt (two pages, 14 questions; a low-write version has the same numbers). Chemistry: ionic bonding, ion formation and formulas, conservation of mass, limiting reactant, and properties of ionic compounds. © 2026 Ryan Sajdak. Free to use, share and change under CC BY-NC-SA 4.0 (creativecommons.org/licenses/by-nc-sa/4.0): give credit, do not sell it, share your version the same way.

Why a virtual demo

Burning sodium in chlorine gas is the classic way to show an ionic compound forming from its elements. Many schools no longer allow it, because chlorine gas is toxic even at low levels and the reaction is violent. The lab keeps what the demo shows (a soft metal and a green gas become a white solid, with heat and a yellow flame) and adds what the real demo can't: a balance students can read, any amount of sodium they like, and a zoom down to one electron.

Objectives

The same two statements are printed at the top of the worksheet and the low-write worksheet, each with a box to tick.

Day	I can	Questions
1	use the masses in a reaction to show that mass is conserved and to name the limiting reactant.	1 to 5
1	explain how moving electrons from a metal to a nonmetal makes ions, and use that to write a salt's formula and explain its properties.	6 to 14

Performance expectations: building toward

The lab and worksheet give students evidence for these performance expectations. They are one step on the way, not a full assessment of any one of them.

> **HS-PS1-1**
> *"Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms."* Worksheet link: outer electrons set each ion's charge (Q10), and students use the pattern to predict $CaCl_2$ without the model (Q11).

> **HS-PS1-2**
> *"Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties."* Worksheet link: sodium gives up its one outer electron and chlorine fills its outer shell (Q6, Q7); a second electron would cost 9.2 times as much, because it sits in a full shell close to the nucleus (Q7, Q8); the CER (Q14).

> **HS-PS1-3**
> *"Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles."* Worksheet link: melting points of 98, –101 and 801 °C and conductivity as solid, melted and dissolved (Q12, Q13).

> **HS-PS1-4**
> *"Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy."* Worksheet link: the energy bar graph (a rounded Born-Haber cycle) shows that taking the electron costs energy overall, and the pull between ions in the crystal pays it back with 411 kJ to spare (Q9).

> **HS-PS1-7**
> *"Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction."* Worksheet link: sodium used + chlorine used = salt made, and the sealed flask reads the same before and after (Q1, Q5); a fixed amount of chlorine makes the salt level off, and students name the limiting reactant (Q2 to Q4).

DCI PS1.A: *“Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.” “The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.”* DCI PS1.B: *“The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.”*

Part by part

Part	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	What students do
1. The demo Q1 to 5	SEP 5 Using mathematics SEP 4 Analyzing and interpreting data	PS1.B conservation of atoms	Energy and Matter	React 0.1 to 3.0 g of sodium with a fixed 2.95 g of chlorine in a sealed flask on a balance. Add up the masses, graph salt against sodium, and find where the limiting reactant switches (between 1.9 and 2.0 g; 1.91 g exactly).
2. One electron Q6 to 9	SEP 2 Developing and using models SEP 5 Using mathematics	PS1.A atomic substructure PS1.B energy in reactions	Structure and Function; Energy and Matter	Move one electron from Na to Cl. Read protons, electrons, charge and radius before and after (Na 186 to 102 pm, Cl 99 to 181 pm). Try for a second electron (4,562 kJ). Read the energy steps and check the net 411 kJ against Tab 1.
3. Other salts Q10 to 11	SEP 2 Developing and using models	PS1.A periodic patterns	Patterns	Move electron dots from metal to nonmetal atoms, adding atoms until every metal is empty and every nonmetal has 8. The model checks the smallest whole-number ratio and gives the formula and name.
4. Test all three Q12 to 13	SEP 3 Planning and carrying out investigations SEP 4 Analyzing and interpreting data	PS1.A bulk structure and electrical forces	Structure and Function	Run five tests on sodium, chlorine and salt: appearance, melting point, conductivity as a solid and when melted, and a drop in water. Use the crystal from Tab 2 to explain why melted salt conducts.
Wrap it up Q14	SEP 6 Constructing explanations SEP 7 Engaging in argument from evidence	PS1.A, PS1.B	Energy and Matter	Claim, evidence and reasoning that salt is a new substance, with evidence from two tabs.

Using it in class

- **As the whole period:** show the real demo on video first (a short clip of sodium burning in chlorine), then the lab in pairs, about 35 to 40 minutes. Tab 1 makes a good whole-class start on the board: let students predict the mass after before you run it.
- **Split over two days:** Tabs 1 and 2 with the ionic bonding lesson; Tabs 3 and 4 with formulas and properties of ionic compounds.
- **Misconceptions it targets:** “mass is lost when something burns” (the balance does not move); “sodium gives away an electron because it wants a full shell” (pulling the electron costs 496 kJ; the crystal pays it back); “salt is NaCl molecules” (the crystal is a 1-to-1 stack of ions).
- **Links:** the yellow flame is sodium's 589 nm light, so the Atomic Spectra lab (mrsajdak.com/spectra) follows on well. The Elements page (mrsajdak.com/elements) shows the Bohr and Lewis models for every element in Tab 3.

Also in play

- **Explore, then explain, then apply:** each part starts with data questions (Q1 to 3, Q6 and 7, Q12). A READ FIRST line on the sheet then sends students to the **Learn It** box in the lab, which opens once they have the data, before the questions that use the ideas (Q4 and 5, Q8 and 9, Q13 and 14). The slideshow has a matching Learn It slide at each of those points. Taught there: reactants and products, conservation of mass, open against sealed containers and the limiting reactant (Part 1); shells, why close electrons are held tighter, noble gases and where the heat really comes from, exothermic (Part 2); electricity as moving charge, particles in solids and liquids, why strong pulls mean high melting points, and mixtures against compounds (Part 4). Part 3 has no Learn It: the Build a salt box states the rules (metals give away all their outer electrons, nonmetals fill to 8, charges add to zero) as students use them, and Q11 asks them to find the pattern in their own table.
- **Key terms:** ion, cation, anion, ionic bond, valence (outer) electron, noble gas configuration, crystal lattice, formula unit, limiting reactant, conservation of mass, exothermic, conductivity.
- **Real numbers:** 1.00 L of Cl_2 at 20 °C and 1 atm is 0.0416 mol, or 2.95 g (PV = nRT). Molar masses 22.99, 70.90 and 58.44 g/mol. Heat of formation of NaCl −411 kJ/mol. Energy steps (kJ/mol, rounded): sublimation of Na +107, half the Cl–Cl bond +122, first ionization of Na +496, electron affinity of Cl −349, lattice energy −787; second ionization of Na 4,562. Radii: Na metallic 186 pm, Cl covalent 99 pm, Na^+ 102 pm and Cl^- 181 pm (Shannon, six-coordinate). Melting points 98 °C, −101 °C, 801 °C.
- **Simplified on purpose:** the flask is sealed and on a balance the whole time, which the real demo is not. The reaction goes to completion with no side products. The atoms are drawn as Bohr shells. Tab 3 covers only binary salts of main-group metals and nonmetals, up to three atoms of each.

Standards text quoted from the New York State P-12 Science Learning Standards, High School Physical Sciences (NYSED). The answer key is a separate file, kept off the public site.