

EQUIPMENT BUILD PLAN

MATTER

Chemical Dice

Wooden cubes cut from a 2×4 are labeled on every face with ions and their charges: one set of dice carries positive ions, the other negative ions. Students roll a pair and use the crisscross method to write the formula, then name the compound. Turning drill into a game makes practice far less painful.

Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.



DIFFICULTY

Beginner

BUILD TIME

1-2 hours

COST

**About \$5, or free
from scrap**

SAFETY

**Adult build /
supervision**

GOOD FOR

Teachers, Families

What it shows

Roll a positive die and a negative die, and whatever comes up, write the compound's formula and name.

Key ideas: ions, oxidation numbers, chemical formulas, naming compounds, polyatomic ions

Safety (Adult build / supervision).

Cutting small cubes on a power saw is adult work; use a stop block and push stick, never fingers near the blade.

Unfinished wooden craft cubes from a craft store are a no-saw alternative.

CONSTRUCTION

Build it

Materials

- ☐ **2×4 lumber** · about 2 ft
A 2×4 is 1 1/2 in thick, so cutting 1 1/2 in pieces from a ripped strip gives cubes
- ☐ **Clear varnish** · small can
Optional

Tools

Saw (miter saw or table saw with stop block)

Sandpaper

Fine-point permanent markers

1

Cut the cubes

Rip a strip of 2×4 to 1 1/2 in wide, then cut it into 1 1/2 in pieces to make cubes. Make an equal number of positive and negative dice.

2

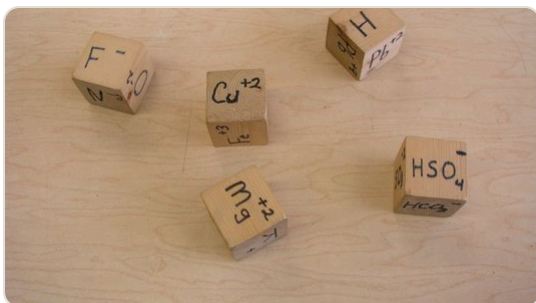
Sand them

Sand all faces and soften the edges. Do not varnish yet; marker writes best on bare wood.

3

Choose the ions

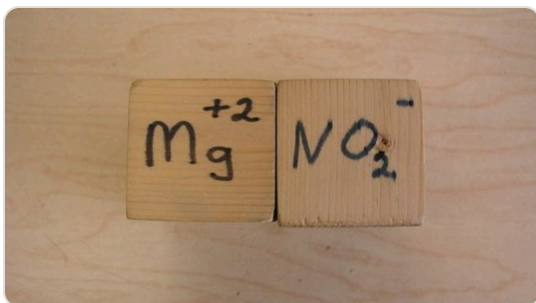
List positive ions such as H^+ , Na^+ , K^+ , NH_4^+ , Mg^{2+} , Ca^{2+} , Cu^{2+} , Zn^{2+} , Pb^{2+} , Fe^{3+} and Al^{3+} , and negative ions such as F^- , Cl^- , OH^- , NO_2^- , NO_3^- , HSO_4^- , SO_4^{2-} , CO_3^{2-} , O^{2-} and PO_4^{3-} .



4

Label the dice

Write one ion on each face, with its charge as a superscript. Every face of a positive die carries a positive ion and every face of a negative die a negative ion. Mix charges of 1, 2 and 3 on each die.



5

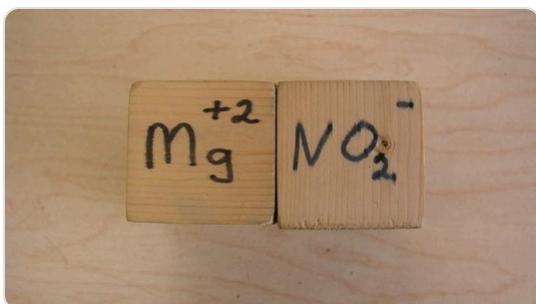
Seal them

Once all faces are labeled, varnish the dice if you like, so the writing does not rub off.

6

Play

Roll one positive and one negative die. Write the formula using the crisscross method, then write the compound's name.

**THE PHYSICS****How it works**

Ionic compounds are electrically neutral, so the total positive charge must equal the total negative charge.

The crisscross method is a shortcut: the number of each charge becomes the subscript of the other ion. For Mg^{2+} and NO_2^- , the 2 from magnesium goes to nitrite and the 1 from nitrite goes to magnesium, giving $\text{Mg}(\text{NO}_2)_2$, magnesium nitrite.

Using it

- Pairs of students take turns rolling and writing formulas; their partner checks and names the compound.
- Score points: one for the correct formula and one for the correct name.
- Roll several pairs and have students sort the results by type, such as

Subscripts are always reduced to the simplest ratio, so Ca^{2+} and O^{2-} give CaO , not Ca_2O_2 . Polyatomic ions stay together in parentheses when more than one is needed.

binary compounds or compounds with polyatomic ions.

- Advanced: ask which rolled combinations would form a precipitate in water, or which are acids.

GO FURTHER

Variations

- Make color-coded sets, for example red dice for positive ions and blue for negative ions.
- Make a beginner set with only single-charge ions, then add $2+$ and $3-$ ions later.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

Marker bleeds into the wood grain.

TRY THIS

Sand the faces smoother, or seal them with a thin coat of varnish or shellac before writing.

IF THIS HAPPENS

Students forget to reduce subscripts.

TRY THIS

Include ions like Ca^{2+} and SO_4^{2-} that produce a reducible ratio, and discuss them.