



# SPACECHEM: A GUIDE FOR EDUCATORS

## WHAT IS SPACECHEM?

SpaceChem is an **intriguing, "problem-solving centric" puzzle game** by Zachtronics Industries that combines the **logic of computer programming** with the **scientific domain of chemistry**, set in an original science fiction universe. Players build machines using mechanics similar to visual programming that assemble and transform chemical compounds. Players later connect those machines together to form complex pipelines, and ultimately construct special pipelines to fight back against space-monsters that threaten humanity. In addition to being challenging and mentally stimulating, it's been described as "**one of the year's best indie games**" by *Rock, Paper, Shotgun*, a leading PC gaming website.

## WHY WOULD I WANT TO USE SPACECHEM IN MY CLASSROOM?

As a solid entertainment title that also ties into real-world science and engineering, SpaceChem is unique because it is educational without falling into the trap of other "educational games" that often forget to be fun. While not a replacement for traditional instruction in the areas of computer programming and chemistry, SpaceChem can be used as:

- a reward that keeps students thinking;
- an opportunity to practice problem solving skills;
- an application for statistics using students' scores, with in-game histograms;
- a cross-curricular reinforcement tool; or
- a way to get students excited about computer programming and chemistry.

## WHAT DOES SPACECHEM TEACH?

- In SpaceChem, players must construct molecules, which are made out of atoms that are bonded together.
- Most molecules and atoms are based off of those from real life. For example, one puzzle requires players to build a machine that combines  $H_2$  and  $O_2$  molecules to create  $H_2O_2$  molecules.
- Many molecules have short blurbs of chemistry trivia associated with them.
- The core programming model consists of two "threads" that operate simultaneously, requiring players to explore and master concepts like **in-order execution**, **loops**, **branching**, **synchronization primitives**, and **subroutines** in an organic and comprehensible environment.

## WHAT DOES SPACECHEM NOT TEACH?

- The core gameplay involves programming machines that are able to directly manipulate atoms and molecules, a concept that is not entirely grounded in reality.
- The bonding model in SpaceChem is much simpler than in real life. Instead of being based on electronegativity and orbital levels, bonds are created and removed directly through the use of "bonders".
- The last few puzzles involve imaginary atoms as part of the story. However, they are clearly marked and appear in a special section of the in-game periodic table.

## WHAT AGES IS SPACECHEM APPROPRIATE FOR?

The story in SpaceChem is presented as a 10,000 word novelette, interspersed with the 53 puzzles in the game. While the "battle" scenes of the game depict no blood or gore (and, in fact, very little fighting), the story in an off-the-shelf version contains a few scenes that would most likely be classified as **E10** if rated by the ESRB. Specifically:

- A character's head explodes, described as "sending chunks of flesh and blood flying all over the office". A nostril is described landing on another character's shirt.
- A character discovers a dead body, described as "atop the stack of desks, eyes wide and face drained of color".
- A character, after being possessed by a space-monster, is shot by another character, with the action described as follows: "A bullet pierced through Bruce's forehead, sending blood onto the wall".

**When purchased directly from Zachtronics Industries, the story can be modified to remove objectionable scenes or be removed entirely if desired.**

## WHAT PLATFORMS IS SPACECHEM AVAILABLE FOR?

SpaceChem is available for and supported on the following platforms:

- Windows XP
- Windows Vista
- Windows 7
- Mac OSX 10.5.8 and above
- Ubuntu 10.04 and above

A free demo is available at <http://store.zachtronicsindustries.com> for testing and trial purposes.

## IS AN EDUCATIONAL DISCOUNT AVAILABLE?

Yes! If purchased directly from Zachtronics Industries, SpaceChem is available at an educational discount price of \$10 per license when 10 or more licenses are purchased. If interested, please contact [zach@zachtronicsindustries.com](mailto:zach@zachtronicsindustries.com) for more information.



# SCREENSHOT – INSIDE OF A “REACTOR”, CREATING WATER

The reactor interface is designed for creating water (H<sub>2</sub>O) through a series of steps. It features a central workspace with a grid background. Two main paths are visible: a red path for hydrogen and a blue path for oxygen. The red path starts with an 'IN H' node, followed by 'GRAB DROP' and 'SYNC' nodes, leading to a 'START' node. The blue path starts with an 'IN O' node, followed by 'GRAB DROP' and 'SYNC' nodes, leading to a 'START' node. Both paths converge at a 'BOND' node, which then leads to an 'OUT' node. The output is displayed as a water molecule (H<sub>2</sub>O) on the right. The interface also includes a toolbar with buttons for 'BOND', 'GRAB DROP', 'IN', 'SYNC', 'OUT', and 'START', as well as a 'PAUSE' button. A status panel on the right shows 'Cycles: 0', 'Symbols: 24', and 'Reactors: 1'. A 'Layer Controls' panel is also visible, with options for 'Active', 'Tab', 'Visible', and 'Locked'.

**Input:** H (100%), O (100%)

**Output:** Water (H<sub>2</sub>O), 0/10

**Toolbar:** Story & Info, Exit Level, Undo, Redo, BOND, GRAB DROP, IN, SYNC, OUT, START, PAUSE

**Status:** Cycles: 0, Symbols: 24, Reactors: 1, Current Progress: 1

# SCREENSHOT – INSIDE OF ANOTHER “REACTOR”, BREAKING UP CARBON CHAINS

The screenshot displays a complex molecular reactor interface. The main workspace is a dark grid where a network of red and blue paths connects various nodes. The nodes include 'GRAB DROP', 'START', 'SYNC', 'BOND', and 'DROP'. The paths are color-coded: red for primary connections and blue for secondary or specific functional connections. On the left side, there are three small grid-based visualizations, each labeled 'C (33%)', showing different carbon chain configurations. On the right side, there are two larger grid-based visualizations, also labeled 'C', with the text 'Open Reactor' below them. At the bottom of the screen, there is a control panel with several buttons: 'BOND +', 'GRAB DROP', 'IN C', 'START', 'SYNC', 'H', 'PAUSE', and a set of directional arrows. To the right of these buttons is a 'Layer Controls' section with 'Active', 'Visible', and 'Locked' indicators. Further right is a text box that says 'Mouse over an atom to view it in more detail.' On the far right, there is a status panel with a star-shaped icon and the following statistics: 'Cycles: 0', 'Symbols: 116', and 'Reactors: 2'. The current progress is indicated as '2'.

SCREENSHOT – A PIPELINE, COMPRISED OF MULTIPLE “REACTORS”

The screenshot displays a top-down view of a game level with a brown, rocky terrain. A pipeline of three reactors is connected by silver pipes. The first reactor on the left is connected to a drilling rig. The second reactor is in the middle, and the third is on the right, connected to two smaller units. Three chemical structure diagrams are overlaid on the scene:

- Methane:** A central carbon atom (C) bonded to four hydrogen atoms (H) in a cross shape. Below it, the text reads "CH<sub>4</sub> (100%)".
- Hydrogen:** Two hydrogen atoms (H) bonded together. Below it, the text reads "H<sub>2</sub>" and "0/40".
- Ethane:** Two carbon atoms (C) bonded together, each also bonded to three hydrogen atoms (H). Below it, the text reads "C<sub>2</sub>H<sub>6</sub>" and "0/40".

The bottom control panel includes the following elements:

- Buttons for "Story & Info" and "Exit Level".
- A "HYDROGEN" button with a large "H" symbol.
- "Undo" and "Redo" buttons.
- "Assembly Reactor" and "Disassembly Reactor" buttons with reactor icons.
- A "Reactor Quota" button with three red vertical bars.
- A "Current Progress" button with a gear-like symbol and the following statistics:
  - Cycles: 0
  - Symbols: 68
  - Reactors: 3

# SCREENSHOT – ANOTHER PIPELINE, THIS TIME WITH FUSION

The screenshot displays a game interface for a pipeline puzzle. The main area shows a complex network of grey pipes connecting various components on a blue, grid-based background. Two 'Fusion Reactor' units are present: one at the top center and one at the bottom center. The bottom reactor is labeled 'WAITING (∞)'. A 'Sensor Reactor' is located on the left side. Three production stations are on the right, each with a progress indicator: 'Yttrium' (0/20), 'Zirconium' (0/20), and 'Niobium' (0/20). Each station has a 3x3 grid with a single element symbol (Y, Zr, Nb) highlighted in green. A large circular component is visible in the top right corner.

**Bottom Toolbar:**

- Story & Info
- Exit Level
- Hydrogen (H)
- Undo
- Redo
- Sensor Reactor
- Fusion Reactor

**Status Panel (Right):**

- Yttrium: 0/20
- Zirconium: 0/20
- Niobium: 0/20
- Current Progress: 2
- Cycles: 48
- Symbols: 78
- Reactors: 2

**Instructions:** Mouse over a molecule to view it in more detail.

# SCREENSHOT – A BOSS BATTLE

The screenshot displays a complex reactor system on a grid-based map. The system includes three 'Sensor Reactor' units, two 'Capacity' units, a 'Voltage' unit, and a 'Status' unit. Each reactor unit shows a circuit diagram with red and blue lines and symbols like  $\Psi$ ,  $\alpha$ , and  $\beta$ . The reactors are interconnected by a network of white pipes. A large, grey pyramid with a glowing eye on its top is positioned on the right side of the map. The background features green trees and a body of water at the bottom.

The bottom interface contains several elements:

- Navigation:** Story & Info, Exit Level, Undo, Redo.
- Graphs:** VITAL SIGNATURE, TESLA SHIELDING, REPULSION GENERATOR.
- Reactor Controls:** F1 (CTRL A), F2 (CTRL B), F3 (CTRL C), F4 (CTRL D).
- Control Center:** Cycles: 2810, Symbols: 125, Reactors: 3.
- Tip:** Mouse over a molecule to view it in more detail.

# Periodic Table of the Elements

1 1	H Hydrogen																	2 0	He Helium																
3 1	Li Lithium	4 2																	5 3	B Boron	6 4	C Carbon	7 5	N Nitrogen	8 2	O Oxygen	9 1	F Fluorine	10 0	Ne Neon					
11 1	Na Sodium	12 2																	13 3	Al Aluminum	14 4	Si Silicon	15 5	P Phospho...	16 6	S Sulfur	17 7	Cl Chlorine	18 0	Ar Argon					
19 1	K Potassi...	20 2	21 3	Sc Scandium	22 4	Ti Titanium	23 5	V Vanadium	24 6	Cr Chromium	25 7	Mn Mangane...	26 6	Fe Iron	27 5	Co Cobalt	28 4	Ni Nickel	29 4	Cu Copper	30 2	Zn Zinc	31 3	Ga Gallium	32 4	Ge Germani...	33 5	As Arsenic	34 6	Se Selenium	35 7	Br Bromine	36 0	Kr Krypton	
37 1	Rb Rubidium	38 2	39 3	Y Yttrium	40 4	Zr Zirconium	41 5	Nb Niobium	42 6	Mo Molybde...	43 7	Tc Technet...	44 8	Ru Rutheni...	45 6	Rh Rhodium	46 4	Pd Palladium	47 3	Ag Silver	48 2	Cd Cadmium	49 3	In Indium	50 4	Sn Tin	51 5	Sb Antimony	52 6	Te Tellurium	53 7	I Iodine	54 0	Xe Xenon	
55 1	Cs Cesium	56 2	*	71 3	Lu Lutetium	72 4	Hf Hafnium	73 5	Ta Tantalum	74 6	W Tungsten	75 7	Re Rhenium	76 8	Os Osmium	77 6	Ir Iridium	78 6	Pt Platinum	79 5	Au Gold	80 4	Hg Mercury	81 3	Tl Thallium	82 4	Pb Lead	83 5	Bi Bismuth	84 6	Polonium	85 7	At Astatine	86 0	Rn Radon
87 1	Fr Francium	88 2	**	103 3	Lr Lawrenc...	104 4	Rf Rutherf...	105 5	Db Dubnium	106 6	Sg Seaborg...	107 7	Bh Bohrium	108 8	Hs Hassium	109 6	Mt Meitner...																		

  

*	57 3	La Lanthan...	58 4	Ce Cerium	59 4	Pr Praseod...	60 3	Nd Neodymi...	61 3	Pm Prometh...	62 3	Sm Samarium	63 3	Eu Europium	64 3	Gd Gadolin...	65 4	Tb Terbium	66 3	Dy Dyspros...	67 3	Ho Holmium	68 3	Er Erbium	69 3	Tm Thulium	70 3	Yb Ytterbium
**	89 3	Ac Actinium	90 4	Th Thorium	91 5	Pa Protact...	92 6	U Uranium	93 7	Np Neptuni...	94 7	Pu Plutonium	95 6	Am Americium	96 4	Cm Curium	97 4	Bk Berkelium	98 4	Cf Califor...	99 3	Es Einstei...	100 3	Fm Fermium	101 3	Md Mendele...	102 3	No Nobelium

  

84      6

Atomic      Maximum  
Number      Bonds

Po

Polonium

Back



SCREENSHOT – LEVEL SELECT, WITH SCORE HISTOGRAMS

**Sernimir IV**

Research  
Best Left Unanswered

163 163  
BEST LAST

Elapsed Cycles

1 1  
BEST LAST

Reactors Used

18 18  
BEST LAST

Symbols Used

Return to Menu

The screenshot displays a level select interface for 'Sernimir IV'. On the left, three histograms provide performance data: 'Elapsed Cycles' (0-1k, best/last 163), 'Reactors Used' (0-10, best/last 1), and 'Symbols Used' (0-50, best/last 18). The central moon map shows a network of research nodes, with a tooltip for 'Research Best Left Unanswered'. A 'Return to Menu' button is at the bottom left, and a planet selection bar is at the bottom right.