



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 for more information.



SCREENSHOT – INSIDE OF A “REACTOR”, CREATING WATER

The screenshot displays a molecular assembly reactor interface. The main workspace is a dark grid where atoms and bonds are placed. Two input tracks are visible: a red track for Hydrogen (H) and a blue track for Oxygen (O). The red track starts with an 'IN H' atom, followed by a 'GRAB DROP' node, a 'SYNC' node, and another 'IN H' atom. The blue track starts with an 'IN O' atom, followed by a 'GRAB DROP' node, a 'SYNC' node, and another 'IN O' atom. Both tracks lead to a central 'BOND +' node. From there, the red track continues through a 'GRAB DROP' node to an 'OUT H' atom, and the blue track continues through a 'GRAB DROP' node to an 'OUT O' atom. The final output is a water molecule (H₂O) shown in a grid on the right. The interface includes a toolbar at the bottom with various control buttons (BOND, GRAB DROP, IN, SYNC, OUT, PAUSE) and a status panel on the right showing 'Cycles 0', 'Symbols 24', and 'Reactors 1'. A 'DISABLED' warning is present on the right side of the workspace.

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

Output: Water (H₂O)
0/10

DISABLED
This output is disabled.

Layer Controls:
Active: Tab (blue), Visible (red), Locked (blue)
Mouse over an atom to view it in more detail.

Story & Info
Exit Level
Undo
Redo

Buttons: BOND (+), GRAB DROP, IN (H/O), SYNC, OUT (H/O), PAUSE (K)

Stats: Cycles 0, Symbols 24, Reactors 1, Current Progress 1

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 at the bottom right. Each reactor has a control panel next to it. The top-left panel shows the chemical structure for Methane (CH_4) with a 100% completion indicator. The middle-right panel shows the chemical structure for Hydrogen (H_2) with a 0/40 completion indicator. The bottom-right panel shows the chemical structure for Ethane (C_2H_6) with a 0/40 completion indicator. The bottom control panel includes buttons for 'Story & Info', 'Exit Level', 'Undo', 'Redo', 'Assembly Reactor', 'Disassembly Reactor', 'Reactor Quota', and 'Current Progress'. The 'Current Progress' panel shows 0 Cycles, 68 Symbols, and 3 Reactors.

Methane
 CH_4 (100%)

Hydrogen
 H_2 0/40

Ethane
 C_2H_6 0/40

Story & Info
Exit Level
Undo
Redo
Assembly Reactor
Disassembly Reactor
Reactor Quota
Current Progress
Cycles: 0
Symbols: 68
Reactors: 3

SCREENSHOT – ANOTHER PIPELINE, THIS TIME WITH FUSION

The screenshot displays a complex pipeline system on a blue grid background. Two 'Fusion Reactor' units are connected to a 'Sensor Reactor' unit. The pipeline includes various pipes, valves, and a large circular component on the left. On the right, three production panels are visible, each with a 3x3 grid and a progress indicator (0/20):

- Yttrium:** Grid shows 'Y' in the top-left cell.
- Zirconium:** Grid shows 'Zr' in the top-left cell.
- Niobium:** Grid shows 'Nb' in the top-left cell.

The bottom interface contains several panels:

- Story & Info:** Includes 'Exit Level' and a 'HYDROGEN' icon.
- Navigation:** Includes 'Undo' and 'Redo' buttons.
- Reactor Selection:** Includes 'Sensor Reactor' and 'Fusion Reactor' icons.
- Progress Panel:** Shows 'Cycles 48', 'Symbols 78', 'Reactors 2', and 'Current Progress' with a progress indicator.
- Help:** A box with the text 'Mouse over a molecule to view it in more detail.'

SCREENSHOT – A BOSS BATTLE

WAITING (β)
Sensor Reactor

Capacity

Capacity

WAITING (α) WAITING (β)
Sensor Reactor

Voltage

Status

WAITING (β)
Sensor Reactor

Story & Info

Exit Level

Undo

Redo

VITAL SIGNATURE

TESLA SHIELDING

REPULSION GENERATOR

Reactor Controls

CTRL F1

CTRL F2

CTRL F3

CTRL F4

Mouse over a molecule to view it in more detail.

Control Center

Cycles 2810

Symbols 125

Reactors 3

Periodic Table of the Elements

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

84

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Atomic Number Maximum Bonds

Po

Polonium

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

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SCREENSHOT – LEVEL SELECT, WITH SCORE HISTOGRAMS

The screenshot displays a level select interface for 'Sernimir IV'. On the left, three histograms provide performance data:

- Elapsed Cycles:** Shows a distribution of scores from 0 to 1k. The 'BEST' score is 163 and the 'LAST' score is 163.
- Reactors Used:** Shows a distribution of reactor counts from 0 to 10. The 'BEST' score is 1 and the 'LAST' score is 1.
- Symbols Used:** Shows a distribution of symbol counts from 0 to 50. The 'BEST' score is 18 and the 'LAST' score is 18.

The central part of the screen features a large image of the moon with a network of orange lines connecting various points. A tooltip for the 'Research' node reads 'Best Left Unanswered'. At the bottom, there is a 'Return to Menu' button and a progress indicator consisting of a row of seven circles, with the first two being filled and the others empty.