Blog Entry © Thursday, December 4, 2025, by James Pate Williams, Jr., Seven Methods to Solve the N-Queens Puzzle and Electron Scattering by a Hydrogen Atom

References: Arc-consistency lookahead 1 algorithm applied to the N-Queens CSP. Algorithm from ***Foundations of Constraint Satisfaction*** by E. P. K. Tsang Chapter 5 page 127. Uses AC-3 from page 83.

N-Queens Puzzle Solvers:

1. AC-3
2. Back Jumping
3. Back Marking
4. Back Tracking
5. Brute Force
6. Evolutionary Hill Climber
7. Sosic-Gu Algorithm

The first five methods were illustrated in my Tuesday, December 2, 2025, blog entry.

Rebuild started at 7:55 PM...
1>------ Rebuild All started: Project: NQueensMethods, Configuration: Release x64 ------
1>pch.cpp
1>Arc3.cpp
1>Common.cpp
1>HillClimber.cpp
1>NQueensMethods.cpp
1>NQueensSolvers.cpp
1>SosicGu.cpp
1>Generating code
1>Previous IPDB not found, fall back to full compilation.
1>All 559 functions were compiled because no usable IPDB/IOBJ from previous compilation was found.
1>Finished generating code
1>NQueensMethods.vcxproj ->
C:\Users\James\source\NQueensMethods\x64\Release\NQueensMethods.exe
========== Rebuild All: 1 succeeded, 0 failed, 0 skipped ==========
========== Rebuild completed at 7:55 PM and took 06.371 seconds ==========

Method	n	Checks	Time (s)	SD	# Sol
AC-3	20	3925	0.285	0.315	50
Backjump	20	142	0.014	0.019	50
Backmark	20	NA	0.001	0.002	50
Backtrack	20	52	0.023	0.025	50
Hill Climb	20	4000	0.324	0.037	50
Sosic-Gu	20	NA	0.000	0	50

Method	n	Checks	Time (s)	SD	# Sol
AC-3	25	18478	1.200	1.582	50
Backjump	25	379	0.063	0.077	50
Backmark	25	NA	0.005	0.017	50
Backtrack	25	596	0.088	0.111	50
Hill Climb	25	5000	0.550	0.012	50
Sosic-Gu	25	NA	0.000	0	50

Method	n	Checks	Time (s)	SD	# Sol
Sosic-Gu	100	NA	0.002	0.001	50
Sosic-Gu	1000	NA	0.115	0.011	50
Sosic-Gu	10000	NA	12.582	1.148	50

Reference: Physics 342: Useful Constants, Electron Scattering from Hydrogen

Electron Scattering by Hydrogen - Elastic Collison

$$q = 2k_a \sin\left(\frac{\vartheta}{2}\right)$$

$$f_1(q) = -\frac{2\mu e^2}{(4\pi^2 h^2 q^2)}, e = electronic\ charge, h\ Planck's\ constant$$

$$e = 4.8032 \times 10^{-10} in\ cgs\ units$$

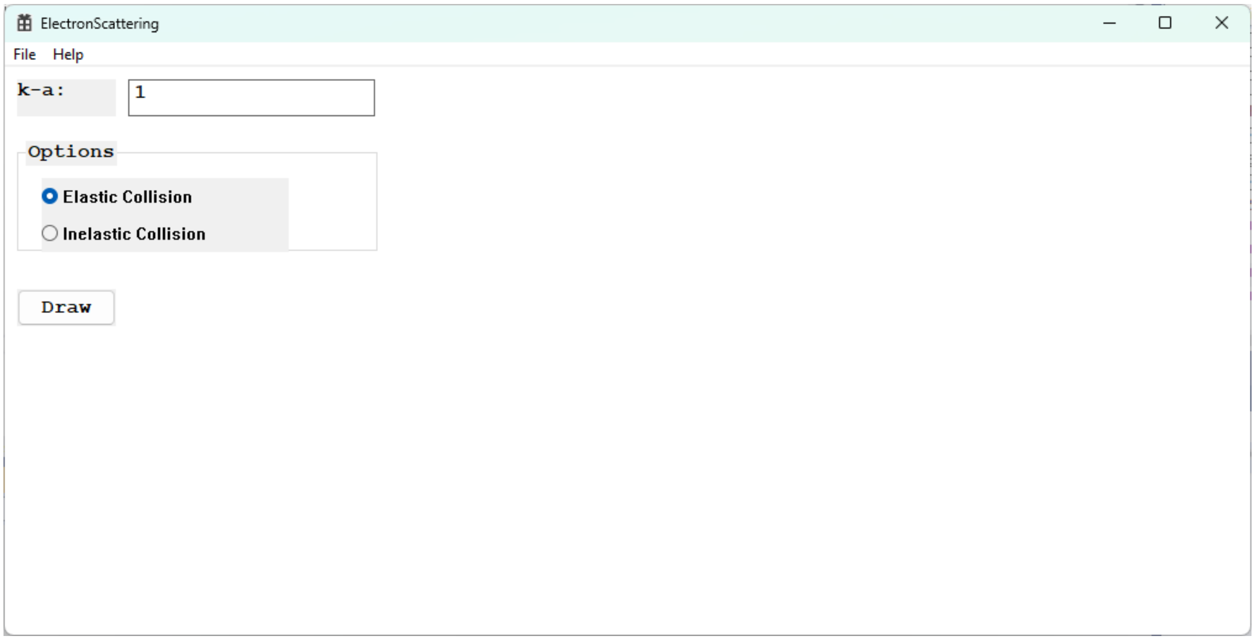
$$h = 6.6261 \times 10^{-27} in\ cgs\ units$$

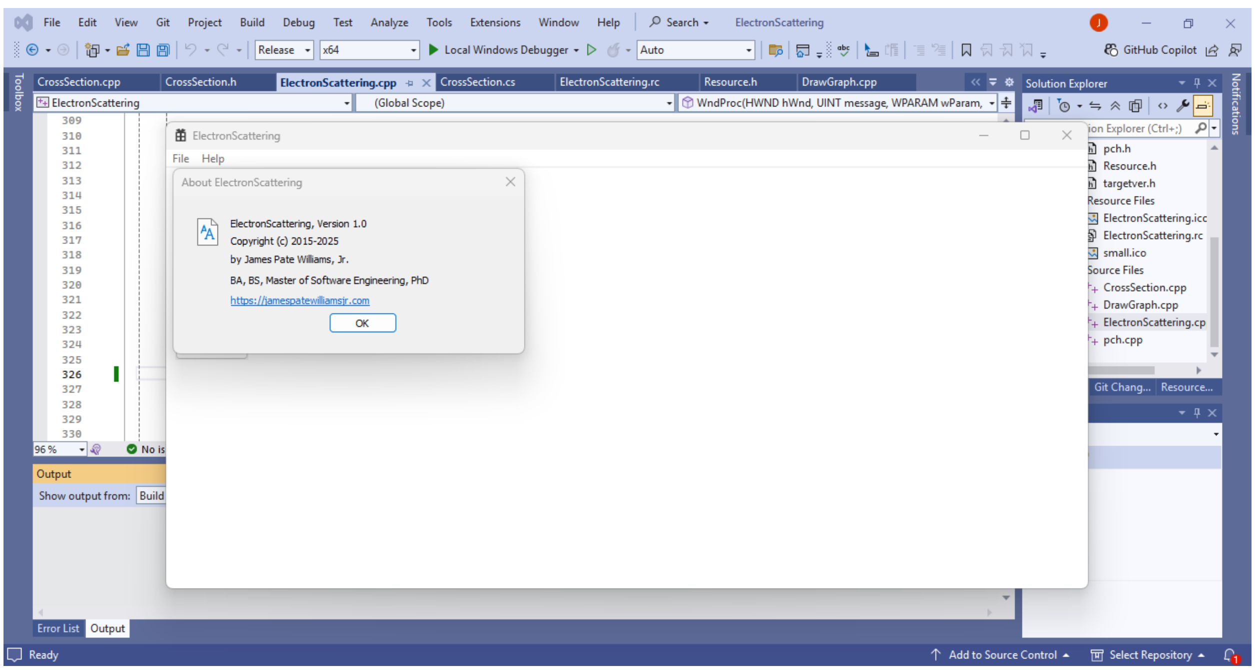
$$\mu = 9.1040446932562806e - 28\ in\ grams$$

$$f_2(q) = \frac{1}{4} q^2 a_0^2, a_0\ is\ the\ Bohr\ radius = 5.291772083 \times 10^{-9} cm$$

$$m_h = m_e + m_p \equiv mass\ of\ the\ hydrogen\ atom$$

$$\mu = \frac{1}{m_e} + \frac{1}{m_h} = \frac{m_e m_h}{m_e + h_h} \equiv reduced\ mass\ of\ the\ system$$


ElectronScattering
File Help
k-a:
1
Options
Elastic Collision
Inelastic Collision
Draw


File Edit View Git Project Build Debug Test Analyze Tools Extensions Window Help
Search
ElectronScattering
Release
x64
Local Windows Debugger
Auto
GitHub Copilot
CrossSection.cpp
CrossSection.h
ElectronScattering.cpp
CrossSection.cs
ElectronScattering.rc
Resource.h
DrawGraph.cpp
(Global Scope)
WndProc(HWND hWnd, UINT message, WPARAM wParam,
About ElectronScattering
ElectronScattering, Version 1.0
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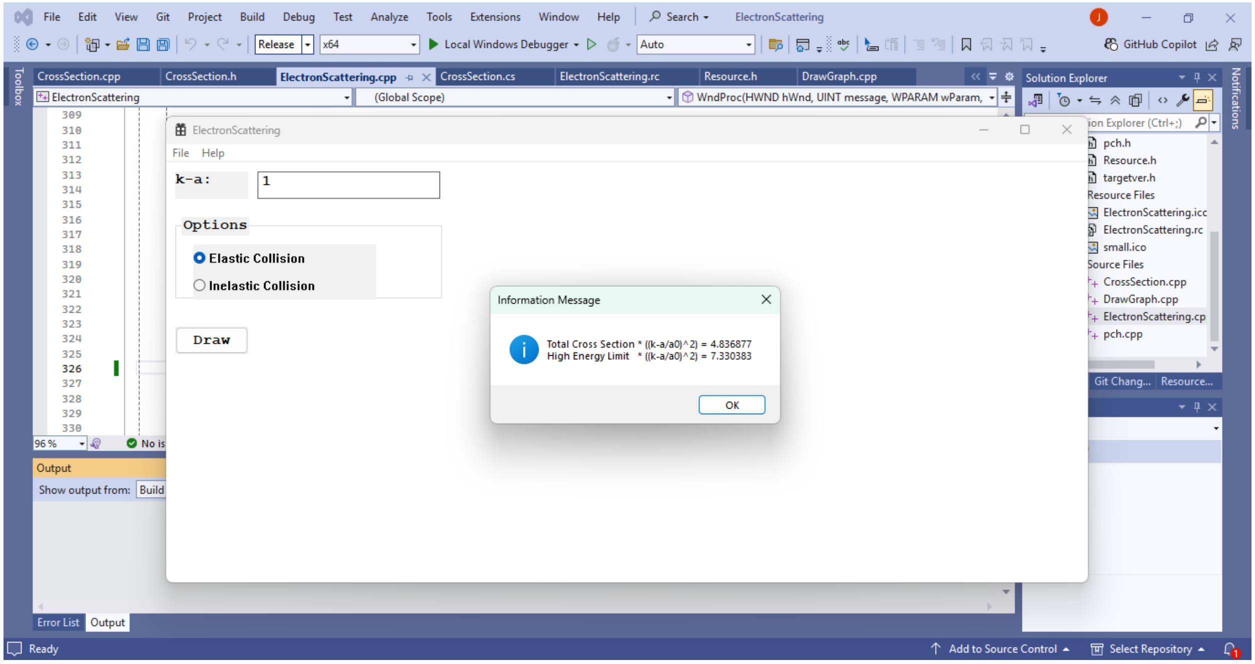
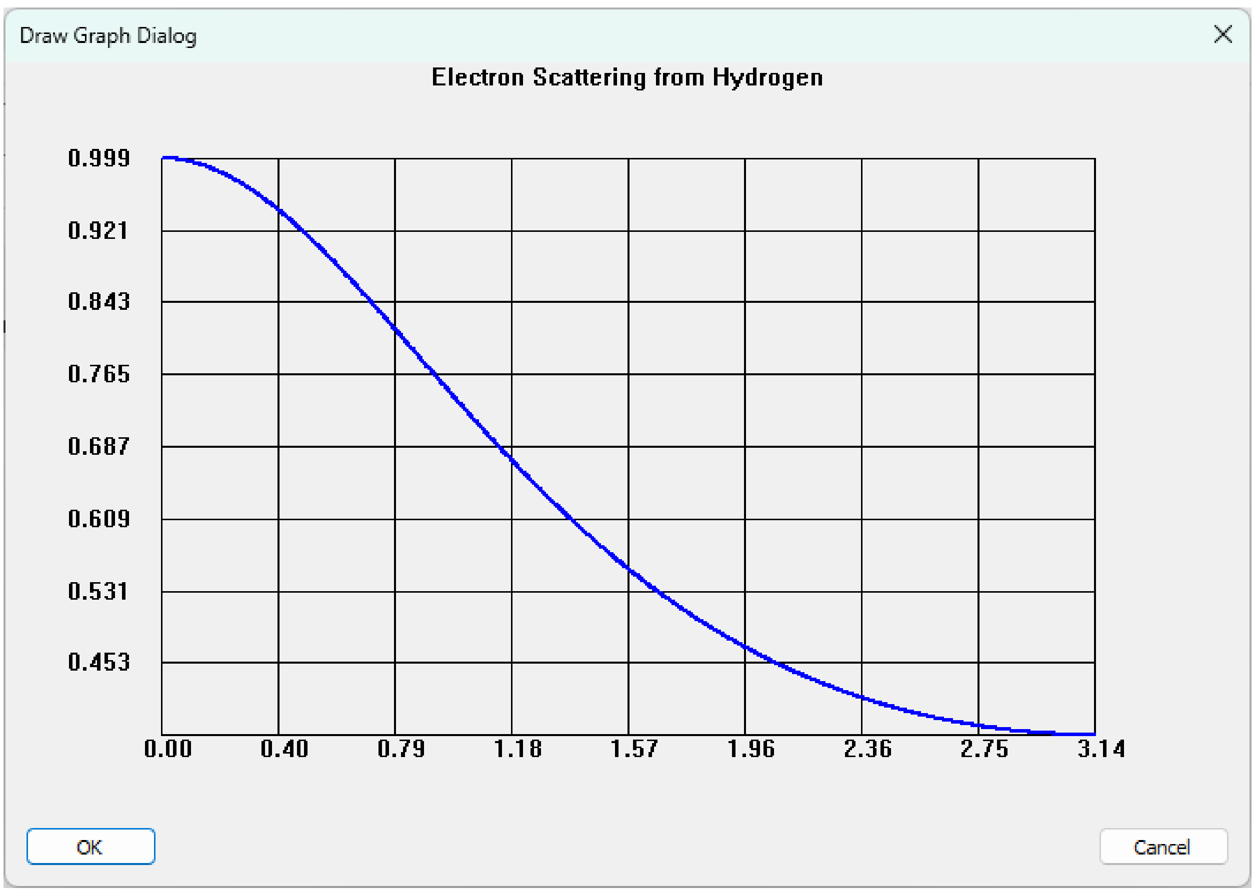
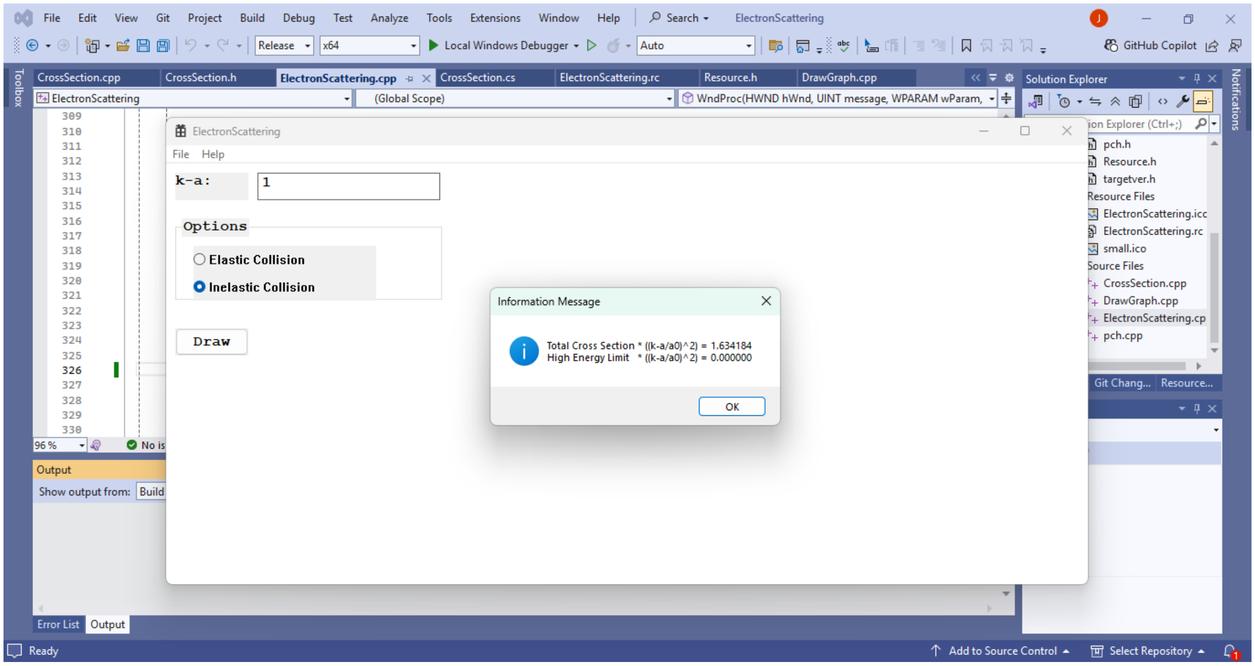
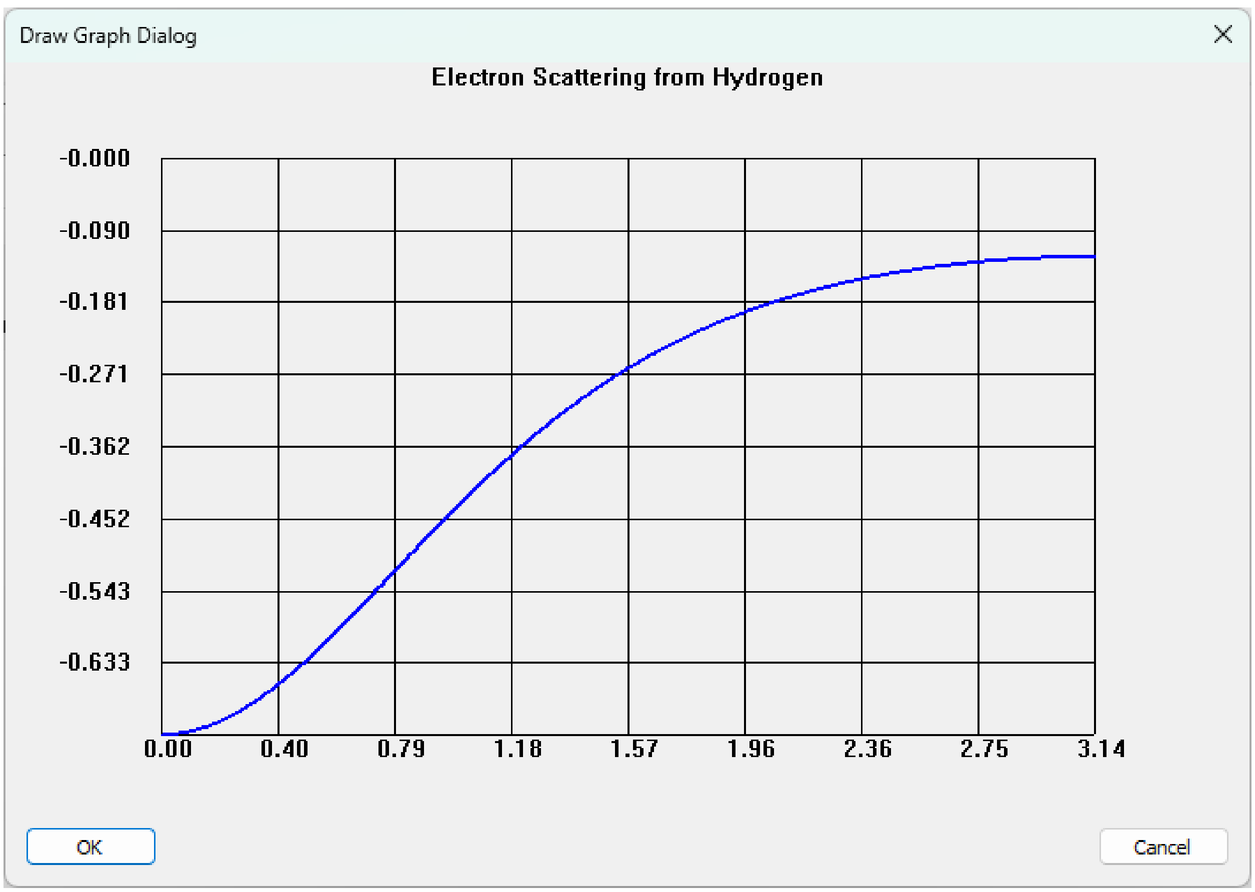
by James Pate Williams, Jr.
BA, BS, Master of Software Engineering, PhD
https://jamespatewilliamsjr.com
OK
Solution Explorer
pch.h
Resource.h
targetver.h
Resource Files
ElectronScattering.ico
ElectronScattering.rc
small.ico
Source Files
CrossSection.cpp
DrawGraph.cpp
ElectronScattering.cpp
pch.cpp
Output
Show output from: Build
Error List
Output
Ready
Add to Source Control
Select Repository


ElectronScattering
File
Help
k-a:
1
Options
Elastic Collision
Inelastic Collision
Draw
Information Message
Total Cross Section * ((k-a/a0)^2) = 4.836877
High Energy Limit * ((k-a/a0)^2) = 7.330383
OK
Solution Explorer
pch.h
Resource.h
targetver.h
Resource Files
ElectronScattering.rc
small.ico
Source Files
CrossSection.cpp
DrawGraph.cpp
pch.cpp
Output
Show output from:
Error List
Ready
Add to Source Control
Select Repository


Draw Graph Dialog
Electron Scattering from Hydrogen
0.999
0.921
0.843
0.765
0.687
0.609
0.531
0.453
0.00
0.40
0.79
1.18
1.57
1.96
2.36
2.75
3.14
OK
Cancel


ElectronScattering
File Help
k-a:
1
Options
Elastic Collision
Inelastic Collision
Draw
Information Message
Total Cross Section * ((k-a/a0)^2) = 1.634184
High Energy Limit * ((k-a/a0)^2) = 0.000000
OK
Solution Explorer
pch.h
Resource.h
targetver.h
Resource Files
ElectronScattering.ico
ElectronScattering.rc
small.ico
Source Files
CrossSection.cpp
DrawGraph.cpp
ElectronScattering.cpp
pch.cpp
Output
Show output from: Build
Error List Output
Ready
Add to Source Control
Select Repository


Draw Graph Dialog
Electron Scattering from Hydrogen
-0.000
-0.090
-0.181
-0.271
-0.362
-0.452
-0.543
-0.633
0.00
0.40
0.79
1.18
1.57
1.96
2.36
2.75
3.14
OK
Cancel