

# Finding\_Minima\_Cubic.py

```
01| import sympy as sp
02|
03| def find_cubic_minimum(a, b, c, d, sigma_a, sigma_b,
sigma_c, sigma_d):
04|     # Define symbols
05|     x = sp.Symbol('x')
06|
07|     # Define the cubic function
08|     cubic = a * x**3 + b * x**2 + c * x + d
09|
10|     # Compute the derivative
11|     derivative = sp.diff(cubic, x)
12|
13|     # Solve for critical points
14|     critical_points = sp.solve(derivative, x)
15|
16|     # Evaluate the cubic at the critical points to find
the y values
17|     y_values = [cubic.subs(x, cp) for cp in
critical_points]
18|
19|     # Determine the minimum y value and its
corresponding x value (minimum point)
20|     min_y = min(y_values)
21|     min_x = critical_points[y_values.index(min_y)]
22|
23|     # Uncertainty propagation
24|     sigma_y = sp.sqrt((sigma_a**2 + (sigma_b * min_x)**2
+ (sigma_c * min_x**2)**2).evalf())
25|     sigma_x = sigma_b * (sigma_b * min_x)**2 / (2 *
sp.sqrt(a * (a * min_x**2 + b * min_x + c)))
26|
27|     return (min_x, min_y), (sigma_x, sigma_y)
28|
29| # Example usage:
30| a = 2.6448e-12
31| b = -2.7265e-10
32| c = 9.2552e-09
33| d = -1.0215e-07
34| sigma_a = -3.4909e-10
35| sigma_b = -3.1985e-09
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```
36| sigma_c = -1.5194e-07
37| sigma_d = 7.3801e-11
38|
39| min_point, uncertainties = find_cubic_minimum(a, b, c,
d, sigma_a, sigma_b, sigma_c, sigma_d)
40| print("Minimum point (x, y):", min_point)
41| print("Uncertainties (delta_x, delta_y):",
uncertainties)
```