Methods:
Before selecting our food items, we must establish the required dietary needs as well as the established daily values. The required daily values that our diet must achieve are outlined below:

Component	Maximum/Minimum	Minimum
Sodium	Maximum	5,000 mg
Calories	Minimum	2,000 kcal
Protein	Minimum	50 g
Vitamin D	Minimum	20 mcg
Calcium	Minimum	1,300 mg
Iron	Minimum	18 mg
Potassium	Minimum	4,700 mg

Of the requirements above, many are often depicted as percentage values on labels, specifically Vitamin D, Calcium, Iron, and Potassium, so we must establish the daily amounts in mcg or mg to calculate the real content in the given food. Below are the metrics that will be used for the remainder of this study sourced from the FDA and American Medical Association.

Component	Daily Recommendation
Vitamin D	400 mcg
Calcium	1,000 mg
Iron	18 mg
Potassium	3,500 mg

Upon establishing the metrics by which we will assess the food, we can now examine our food items–Trader Joe's Frozen Potstickers (10 pc), a homemade 3-egg omelet, the infamous Costco Hotdog, half of a chicken breast (86g), and a banana.

Food	Cost	Sodium	Calories	Protein	Vitamin D	Calcium	Iron	Potassium
TJ Potstickers	$1.75	625 mg	325	17.5 g	0 mcg	38 mg	3.5 mg	240 mg
Omelet	$3.92	961 mg	486	41.2 g	27 mcg	456 mg	4.1 mg	426 mg
Hotdog	$1.50	1750 mg	570	23 g	0 mcg	104 mg	4 mg	316 mg
Chicken Breast	$.45	64 mg	142	27 g	4 mcg	10 mg	.7 mg	179 mg
Banana	$.23	1 mg	105	1.3 g	0 mcg	0 mg	.2 mg	422 mg

Costs:

Trader Joe's Potstickers → $3.50 per bag, each containing ~20 potstickers. A serving size of 10 was used.

Omelet → See Addendum

Hotdog → Price from Costco's food court

Chicken Breast → Average price of $2.38 per pound. 86 grams at a cost of $2.38 per pound (454 grams) equates to 45¢ per portion.

Banana → Trader Joe's has bananas for 23¢ per banana.

Based on all of the above information, we can begin to set up the constraint equations.

Decision Variables:

- P: Potstickers
- O: Omelets
- H: Hotdogs
- C: Chicken Breast
- B: Bananas

Cost (Objective Function):

Cost = 1.75P + 3.92O + 1.50H + .45C + .23B

Nutrients:

Sodium = 625P + 961O + 1750H + 64C + 1B
Calories = 325P + 486O + 570H + 142C + 105B
Protein = 17.5P + 41.2O + 23H + 27C + 1.3B
Vitamin D = 23O + 4C
Calcium = 38P + 456O + 104H + 10C
Iron = 3.5P + 4.1O + 4H + .7C + .2B
Potassium = 240P + 426O + 316H + 179C + 422B

Daily Constraints:

Sodium ≤ 5,000 mg
2,000 mg ≤ Calories ≤ 3,000 mg
Protein ≥ 50 g
Vitamin D ≥ 20 mcg
Calcium ≥ 1,300 mg

Iron ≥ 18 mg
Potassium ≥ 3,500 mg

To calculate our weekly constraints, we simply multiply each by 7:
Weekly Constraints:
Sodium ≤ 35000 mg
14,000 mg ≤ Calories ≤ 21,000 mg
Protein ≥ 350 g
Vitamin D ≥ 140 mcg
Calcium ≥ 9,100 mg
Iron ≥ 126 mg
Potassium ≥ 24,500 mg

Results:

Based on the nutritional information provided for the nutritional content, pricing, and constraints, the cost-optimal solution has a total cost of $97.74 and consists of 52.2 Bananas, 9.9 Hotdogs, 17.6 Omelets, 1.1 portions of Potstickers, and no Chicken Breast. When we mandate that at least one portion of each item be included in the final weekly diet, our figures only slightly change. The total cost is $97.88, consisting of 51.8 Bananas, 9.8 Hotdogs, 17.6 Omelets, 1.0 portions of Potstickers, and 1.0 portions Chicken Breast. With a cost difference of 14¢ between the two options, that is certainly not too high of a cost to pay to get a bit more variety in my weekly diet by including chicken. Half a chicken breast spread over a week and over 50 bananas is still not much variety, so there is certainly room for improvement in the diversity of the diet. Besides adding more food items, we can manipulate the minimum and maximum constraints regarding the number of portions of each food item. Specifically, I limited it to a minimum of 1 portion and a maximum of 6 portions per day. This came out to a higher cost of $110.06 for the week with a diet consisting of 42 Bananas, 21.9 Chickens, 7 Hotdogs, 17.3 Omelets, and 7 Potstickers. While 2 bananas per meal per day is still a bit excessive, this diet offers much more diversity than the original optimal solution for only $1.76 more per day.

LLM Approach:

I used ChatGPT to solve this problem. I have found that the best way to work with an LLM is to offer it as much context as possible from that outset so as to not confuse the model. based on the information I provided, it came up with the same solution as my approach with PuLP. It was a very straightforward conversation that did not require much finetuning. I find it fascinating that it generated Python code on its own to solve the problem using the Scipy library. I included the generated code in the github repo for reference.

Addendum:
Below are the calculations for the omelet:

3 Large Vital Farms Pasture Raised Eggs (total, not per egg):
Cost: $8.49 per dozen

Cost	Sodium	Calories	Protein	Vitamin D	Calcium	Iron	Potassium
$2.12	210 mg	210	18 g	3 mcg	90 mg	2.7 mg	210 mg

1 Amylu Chicken Sausage:
Cost: $11.99 per dozen

Cost	Sodium	Calories	Protein	Vitamin D	Calcium	Iron	Potassium
$.99	570 mg	160	16 g	0 mcg	155 mg	1 mg	146 mg

¼ Cup Shredded Cheddar Cheese:
Cost: $1.25 for an 8 oz block

Cost	Sodium	Calories	Protein	Vitamin D	Calcium	Iron	Potassium
$.31	175 mg	114	7 g	24 mcg	204 mg	.2 mg	28 mg

¼ Cup Spinach:
Cost: $1.99 for a 4 cup package

Cost	Sodium	Calories	Protein	Vitamin D	Calcium	Iron	Potassium
$.50	6 mg	2	.2 g	0 mcg	7 mg	.2 mg	42 mg

Total:

Cost	Sodium	Calories	Protein	Vitamin D	Calcium	Iron	Potassium
$3.92	961 mg	486	41.2 g	27 mcg	456 mg	4.1	426 mg

Appendix:

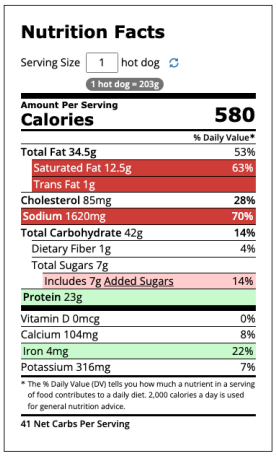
Nutrition Facts

Serving Size: 10 potstickers (200g)

Amount Per Serving	
Calories 325	Calories from Fat 100
	% Daily Value
Total Fat 5g	**8%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 50mg	**17%**
Sodium 625mg	**26%**
Potassium 300mg	**9%**
Total Carbohydrates 50g	**17%**
Dietary Fiber 2.5g	**10%**
Sugars 2.5g	
Protein 17.5g	
Vitamin A	0%
Vitamin C	0%
Calcium	3.8%
Iron	19.5%

* Percent Daily Values are based on a 2000 calorie diet.

Figure 1: Nutrition facts for Trader Joe's Chicken Potstickers. One bag is ~400 g and $3.50 so a serving is 200g and $1.75. Source: Nutritionix



Nutrition Facts

Serving Size 1 hot dog

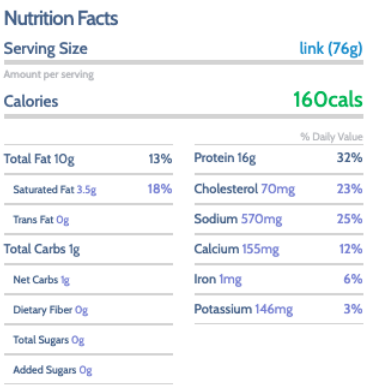
1 hot dog = 203g

Amount Per Serving	
Calories	**580**
	% Daily Value*
Total Fat 34.5g	53%
Saturated Fat 12.5g	63%
Trans Fat 1g	
Cholesterol 85mg	**28%**
Sodium 1620mg	**70%**
Total Carbohydrate 42g	**14%**
Dietary Fiber 1g	4%
Total Sugars 7g	
Includes 7g Added Sugars	14%
Protein 23g	
Vitamin D 0mcg	0%
Calcium 104mg	8%
Iron 4mg	22%
Potassium 316mg	7%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

41 Net Carbs Per Serving

Figure 2: Nutrition facts for the Costco Food Court Hotdog. Source: Costcohotdog.com



Nutrition Facts

Serving Size	link (76g)
Amount per serving	
Calories	160cals
	% Daily Value
Total Fat 10g	13%
Saturated Fat 3.5g	18%
Trans Fat 0g	
Total Carbs 1g	
Net Carbs 1g	
Dietary Fiber 0g	
Total Sugars 0g	
Added Sugars 0g	
Protein 16g	32%
Cholesterol 70mg	23%
Sodium 570mg	25%
Calcium 155mg	12%
Iron 1mg	6%
Potassium 146mg	3%

Figure 3: Nutrition facts for 1 Amylu Chicken Sausage used in the Omelet. Source: Nutritionix.com

Nutrition Facts

12 servings per container
Serving size
1 egg (50g)

Calories per serving **70**

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

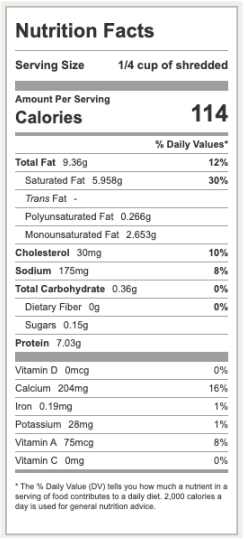
Amount/Serving	% Daily Value*
Total Fat 5g	**6%**
Saturated Fat 1.5g	8%
Trans Fat 0g	
Polyunsaturated Fat 1g	
Monounsaturated Fat 2g	
Cholesterol 185mg	**62%**

Amount/Serving	% Daily Value*
Sodium 70mg	**3%**
Total Carbohydrate 0g	**0%**
Dietary Fiber 0g	0%
Total Sugars 0g	
Includes 0g Added Sugars	0%
Protein 6g	**12%**

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Vitamin D 1mcg 6% • Calcium 30mg 2% • Iron 0.9mg 4% • Potassium 70mg 0%
Vitamin A 80mcg 8% • Vitamin E 0.5mg 4% • Riboflavin 0.2mg 15% • Niacin 1.4mg 8%
Vitamin B6 0.1mg 6% • Folate 25mcg DFE 6% • Vitamin B12 0.5mcg 20%
Biotin 11mcg 35% • Pantothenic Acid 0.8mg 15% • Phosphorus 100mg 8%
Iodine 28mcg 20% • Zinc 0.7mg 6% • Selenium 15mcg 25% • Choline 150mg 25%

Figure 4: Nutrition facts for 1 Vital Farms Egg used in the Omelet. Source: Vitalfarms.com



Nutrition Facts

Serving Size **1/4 cup of shredded**

Amount Per Serving
Calories **114**

	% Daily Values*
Total Fat 9.36g	**12%**
Saturated Fat 5.958g	**30%**
Trans Fat -	
Polyunsaturated Fat 0.266g	
Monounsaturated Fat 2.653g	
Cholesterol 30mg	**10%**
Sodium 175mg	**8%**
Total Carbohydrate 0.36g	**0%**
Dietary Fiber 0g	**0%**
Sugars 0.15g	
Protein 7.03g	
Vitamin D 0mcg	0%
Calcium 204mg	16%
Iron 0.19mg	1%
Potassium 28mg	1%
Vitamin A 75mcg	8%
Vitamin C 0mg	0%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Figure 5: Nutrition facts for ¼ cup of Kraft Shredded Cheese. Source: Nutritionix.com

Food database and calorie counter

1/4 Cup
Spinach

Nutrition Facts

Serving Size **1/4 cup**

Amount Per Serving
Calories **2**

	% Daily Values*
Total Fat 0.03g	**0%**
Saturated Fat 0.005g	**0%**
Trans Fat -	
Polyunsaturated Fat 0.012g	
Monounsaturated Fat 0.001g	
Cholesterol 0mg	**0%**
Sodium 6mg	**0%**
Total Carbohydrate 0.27g	**0%**
Dietary Fiber 0.2g	**1%**
Sugars 0.03g	
Protein 0.21g	
Vitamin D -	
Calcium 7mg	1%
Iron 0.2mg	1%
Potassium 42mg	1%
Vitamin A 35mcg	4%
Vitamin C 2.1mg	2%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Figure 6: Nutrition facts ¼ cup of spinach. Source: Nutritionix.com

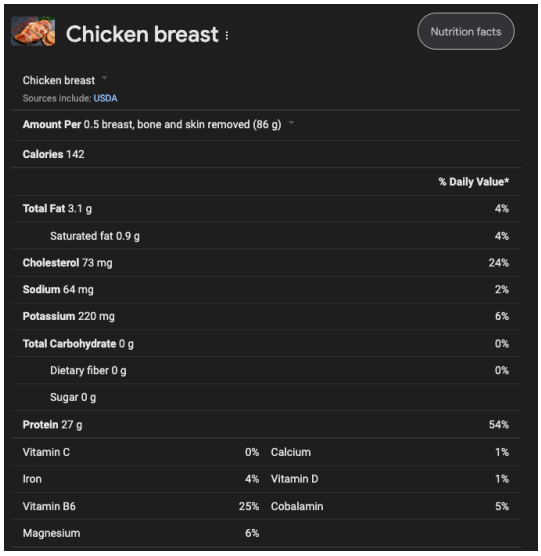


Figure 7: Nutrition facts for ½ a chicken breast. Source: Google AI Assistant

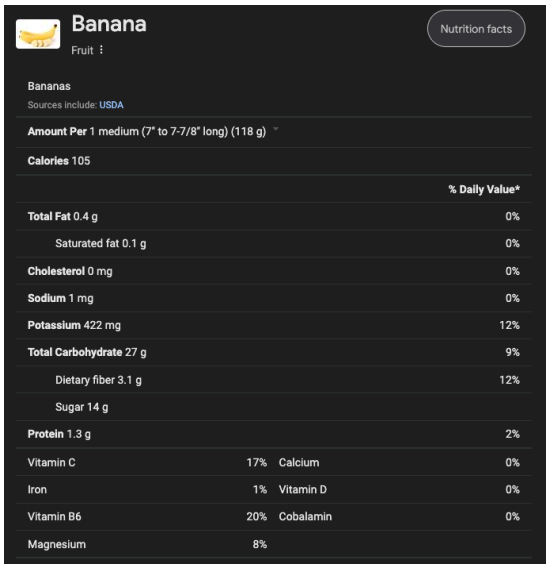


Figure 8: Nutrition facts for 1 medium banana. Source: Google AI Assistant