Part I

Food Items & Calculations (See Appendix for Nurition Information):

Vegetable Fried Rice - $2.99 ($1.05 per serving), 2.85 servings per container
Organic Mediterranean Style Salad Kit - $3.99 ($1.14 per serving), 3.5 servings per container
Dozen Eggs - $6.99 ($1.17 per serving), 6 servings per container
Milk - $1.54 ($0.19 per serving), 8 servings per container
Just Chicken - $8.99 ($1.80 per serving), 5 servings per container

Part II

Decision Variables:

x1	servings of Vegetable Fried Rice
x2	servings of Organic Mediterranean Salad
x3	servings of Eggs
x4	servings of Milk
x5	servings of Just Chicken

Objective:

Minimize $Z = 1.05x1 + 1.14x2 + 1.17x3 + 0.19x4 + 1.80x5$

Constraints:

Sodium	$510x1 + 290x2 + 142x3 + 130x4 + 280x5 <= 35000$
Energy	$230x1 + 110x2 + 143x3 + 130x4 + 120x5 >= 14000$
Protein	$6x1 + 2x2 + 12.5x3 + 8x4 + 22x5 >= 350$
Vitamin D	$2x3 + 2.5x4 >= 140$
Calcium	$50x2 + 56x3 + 300x4 + 10x5 >= 9100$
Iron	$0.9x1 + 0.8x2 + 1.8x3 + 0.6x5 >= 126$
Potassium	$190x1 + 280x2 + 138x3 + 400x4 + 130x5 >= 32900$
Non Negativity	$x1, x2, x3, x4, x5 >= 0$

Using the decision variables, subject to the contains we intend to minimize the objective function. We intend to determine which serving sizes of each food we should eat in a week in order to spend the least amount of money while following recommended dietary allowances.

Part III

The solution to the linear programming problem using the Pulp package in Python is as follows:

In a week we should eat:

Eggs: 70 servings
Just chicken: 0 servings
Milk: 58.1 servings

Organic Mediterranean Salad: 0 servings
Vegetable Fried Rice: 0 servings

Minimum Cost Solution (Weekly Spend): $92.94

Part IV

If we wanted to change the problem to require at least one serving of each food, we would change the non-negativity constraint (bolded below).

Decision Variables:

x1	servings of Vegetable Fried Rice
x2	servings of Organic Mediterranean Salad
x3	servings of Eggs
x4	servings of Milk
x5	servings of Just Chicken

Objective:

Minimize Z = 1.05x1 + 1.14x2 + 1.17x3 +0.19x4 + 1.80x5

Constraints:

Sodium	510x1 + 290x2 + 142x3 + 130x4 + 280x5 <= 35000
Energy	230x1 + 110x2 + 143x3 + 130x4 + 120x5 >= 14000
Protein	6x1 + 2x2 + 12.5x3 + 8x4 + 22x5 >= 350
Vitamin D	2x3 + 2.5x4 >= 140
Calcium	50x2 + 56x3 + 300x4 +10x5 >= 9100
Iron	0.9x1 + 0.8x2 + 1.8x3 + 0.6x5 >= 126
Potassium	190x1 + 280x2 + 138x3 + 400x4 + 130x5 >= 32900
Non Negativity	**x1, x2, x3, x4, x5 >= 1**

The solution is as follows:

In a week we should eat:
Eggs: 68.7 servings
Just chicken: 1 servings
Milk: 57 servings
Organic Mediterranean Salad: 1 servings
Vegetable Fried Rice: 1 servings

Minimum Cost Solution (Weekly Spend): $95.23

The change in constraints did not make a major difference in the problem's solution, each food item that had 0 servings previously still only has 1, and the price increased by not even $3. If we wanted to add further variety, we could do a number of things. First, we could continue to increase the minimum servings constraint, or we could add more food items to increase the selection, or we could add additional constraints on other nutrition items, such as cholesterol or fiber.

Part V

I utilized OpenAI's ChatGPT (URL: https://chatgpt.com/) in an attempt to the LLM to specify a model for The Diet Problem. Given how historic and popular the problem is in linear programming, I hypothesized that the GPT was trained on a number of examples from the internet and that it would have minimal difficulty in creating a solution.With very minimal prompting the GPT was able to create a solution with accompanying nutrition information and python code. When asked to include additional constraints it had no difficulty changing it's solution. The full transcript can be found in the DietProblemLLM.pdf file.

Appendix:

Vegetable Fried Rice:

CALORIES PER SERVING

230

SERVES ABOUT 3	AMOUNT	%DV
Total Fat	2.5 g	3%
Saturated Fat	0 g	0%
Trans Fat	0 g	
Cholesterol	0 mg	0%
Sodium	510 mg	22%
Total Carbohydrate	45 g	16%
Dietary Fiber	3 g	11%
Total Sugars	3 g	
Includes	1 g Added Sugars	2%
Protein	6 g	
Vitamin D	0 mcg	0%
Calcium	0 mg	0%
Iron	0.9 mg	6%
Potassium	190 mg	4%

Organic Mediterranean Salad:

CALORIES PER SERVING

110

SERVES ABOUT 3.5	AMOUNT	%DV
Total Fat	7 g	9%
Saturated Fat	1.5 g	8%
Trans Fat	0 g	
Cholesterol	Less than 5 mg	1%
Sodium	290 mg	13%
Total Carbohydrate	9 g	3%
Dietary Fiber	2 g	7%
Total Sugars	3 g	
Includes	2 g Added Sugars	4%
Protein	2 g	
Vitamin D	0 mcg	0%
Calcium	50 mg	4%
Iron	0.8 mg	4%
Potassium	280 mg	6%

Dozen Eggs:

Nutrition Facts

Serving Size:

2 **large (100g)**
Large Eggs

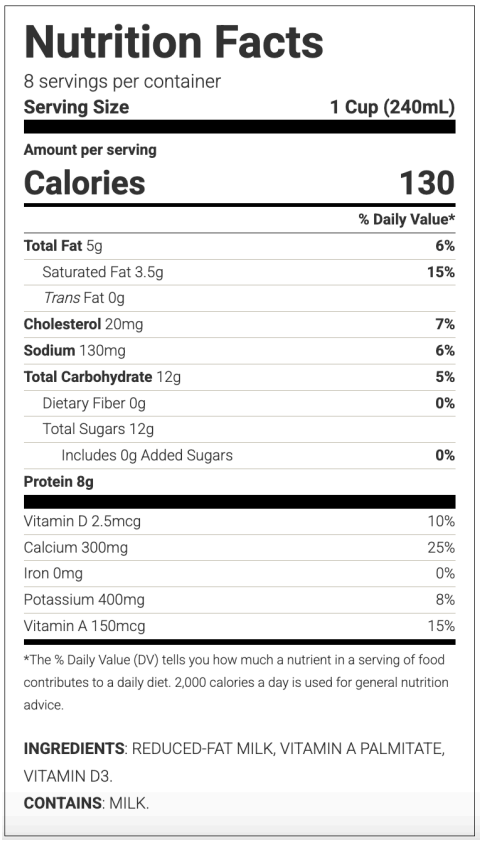
Amount Per Serving

Calories **143**

	% Daily Value*
Total Fat 9.5g	**12%**
Saturated Fat 3.2g	**16%**
Trans Fat 0g	
Polyunsaturated Fat 1.8g	
Monounsaturated Fat 3.7g	
Cholesterol 372mg	**124%**
Sodium 142mg	**6%**
Total Carbohydrates 0.7g	**0%**
Dietary Fiber 0g	**0%**
Sugars 0.4g	
Protein 12.5g	
Vitamin D 2mcg	**10%**
Calcium 56mg	**4%**
Iron 1.8mg	**10%**
Potassium 138mg	**3%**
Caffeine 0mg	

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2000 calories a day is used for general nutrition advice.

Milk:



Nutrition Facts

8 servings per container

Serving Size **1 Cup (240mL)**

Amount per serving

Calories **130**

	% Daily Value*
Total Fat 5g	**6%**
Saturated Fat 3.5g	**15%**
Trans Fat 0g	
Cholesterol 20mg	**7%**
Sodium 130mg	**6%**
Total Carbohydrate 12g	**5%**
Dietary Fiber 0g	**0%**
Total Sugars 12g	
Includes 0g Added Sugars	**0%**
Protein 8g	
Vitamin D 2.5mcg	10%
Calcium 300mg	25%
Iron 0mg	0%
Potassium 400mg	8%
Vitamin A 150mcg	15%

*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.

INGREDIENTS: REDUCED-FAT MILK, VITAMIN A PALMITATE, VITAMIN D3.

CONTAINS: MILK.

Just Chicken:

Nutrition Facts

about 5 servings per container

Serving size **3 oz (84g)**

Amount per serving

Calories 120

	% Daily Value*
Total Fat 4g	**5%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 60mg	**20%**
Sodium 280mg	**12%**
Total Carbohydrate 0g	**0%**
Dietary Fiber 0g	**0%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 22g	

Vitamin D 0mcg 0% • Calcium 10mg 0%

Iron 0.6mg 4% • Potassium 130mg 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.