PART 1:

ITEM 1: Italian Artisan Pasta, Organic, Striped Farfalline
Price: $3.49 per 16 oz
Adjustment: $3.49/8 = $0.436 per serving

ITEM 2: Amy's Gluten Free Bean & Cheese Frozen Burrito
Price: $3.79 per unit/serving

ITEM 3: Mango Chunks (Frozen)
Price: $3.49 per package
Adjustment: $3.49/5 = $0.698 per serving

ITEM 4: Ahi Tuna Steaks
Price: $8.99 per pound (package contains 1 pound)
Adjustment: $8.99/4 = $2.248

ITEM 5: Vegetable Panang Curry (with Jasmine Rice)
Price: $3.49 per unit/serving

PART 2:

The goal of this linear programming scenario is to find the minimized cost of expenses for the above five items that satisfies specific nutrition requirements. As always for linear programming tasks, we must consider the objective function, decision variables, and constraints. First, we must define the decision variables (number of servings) as follows:

$x1$= number of servings of pasta
$x2$= number of servings of burrito
$x3$= number of servings of mango
$x4$= number of servings of tuna
$x5$= number of servings of curry

Next, we must consider the objective function and whether we must proceed with minimization or maximization. The cost coefficients were calculated above. Accordingly, the objective function becomes a cost minimization problem such that

MINIMIZE: $0.436x1 + 3.79x2 + 0.689x3 + 2.248x4 + 3.49x5$

For the first part, we have seven nutritional constraints that help pinpoint the optimal solution. According to the nutrition facts, the constraints are

SUBJECT TO:

0x1 + 580x2 + 0x3 + 50x4 + 760x5 <= 5000 **SODIUM (mg)**
210x1 + 280x2 + 80x3 + 120x4 + 470x5 >= 2000 **CALORIES (kcal)**
6x1 + 9x2 + 1x3 + 28x4 + 9x5 >= 50 **PROTEIN (g)**
0x1 + 0x2 + 0x3 + 2x4 + 0x5 >= 20 **VITAMIN D (mcg)**
20x1 + 150x2 + 20x3 + 0x4 + 50x5 >= 1300 **CALCIUM (mg)**
0.7x1 + 2x2 + 0.2x3 + 0.72x4 + 1.3x5 >= 18 **IRON (mg)**
170x1 + 300x2 + 240x3 + 0x4 + 430x5 >= 4700 **POTASSIUM (mg)**
x1, x2, x3, x4, x5 >= 0 **NON-NEGATIVITY**

PART 3:

See Code

PART 4:

PuLP calculated the necessary values of each decision variable the user should consume to both save money and satisfy all nutritional requirements. The program outputted the optimal solution as 65 servings of pasta (x1) and 10 servings of tuna (x4). Before plugging these values back into the objective function, it is worthwhile to address the reasons why we must consume an egregious number of calories and disregard eating any burrito, mango, or curry. The lack of balance in the diet comes from the calcium requirement because none of the foods selected have very much calcium to begin with. Because pasta is extremely cheap compared to the other foods, the model found it optimal to stack the diet with high amounts of pasta to achieve the 1300 mg calcium requirement. Since tuna was the only food with vitamin D, we were forced to include it in the optimal bundle also. To calculate the minimal cost, we plug in x1 = 65, x2=0, x3=0, x4= 10, x5= 0, such that

Min_cost = 0.436*65 + 2.248*10 = $50.82

PART 5:

We will add a new block of code that incorporates saturated fat and dietary fiber constraints from FDA guidelines
0x1 + 2x2 +0x3 + 0x4 + 9x5 <= 20 **SATURATED FAT (g)**
1x1 + 5x2 + 2x3 + 0x4 + 9x5 >= 28 **DIETARY FIBER (g)**

The two extra constraints did not affect the overall solution to our minimization problem, so we still only need to spend $50.82 to satisfy the requirements. We did not need to add new food items or spend more money on food compared to the previous PuLP calculation. Because none of the chosen foods have nutrition information on vitamins and minerals beyond Vitamin D, Calcium, Iron, and Potassium, we are forced to use larger macronutrients like saturated fat and dietary fiber to convey new information. Perhaps, the allocated servings would have been more balanced if I had purchased cheaper and basic foods to meet the nutrition requirements.