

## Diet Problems

### Text Reference: Section 1.10, p. 93

The purpose of this set of exercises is to provide examples of vector equations which result from balancing nutrients in a diet.

Section 1.10 shows how use a vector equation

$$x_1\mathbf{a}_1 + x_2\mathbf{a}_2 + \dots + x_n\mathbf{a}_n = \mathbf{b}$$

to model a diet with a specified nutritional intake. Each vector  $\mathbf{a}_i$  lists the nutrient composition of one unit (usually 100 grams) of foodstuff, and the corresponding weight  $x_i$  is the variable that represents the amount (number of units) of that foodstuff to be used in the diet. The vector  $\mathbf{b}$  lists the amount of each nutrient that must be in the diet.

Table 2 below is a listing of the nutritional value of many foods found in a typical kitchen. The nutrients are given per 100 grams of foodstuff. This data is taken from the USDA Nutrient Database for Standard Reference available at the United States Department of Agriculture website (<http://www.nal.usda.gov/fnic/foodcomp>). The columns represent respectively the following foodstuffs: beef, brussels sprouts, carrots, chicken soup, egg, feta cheese, grapefruit, lentils, lettuce, milk, mushrooms, oil, onion, rice, salad dressing, salmon, soy sauce, spinach, tomato, and vanilla ice cream. Table 1 gives the standard serving size for each of these foodstuffs, and also gives a key to the columns in Table 2.

### Questions:

1. Low carbohydrate diets are popular for weight loss. Compute (by hand) the amount of carbohydrates in each of the following dishes, and determine which would be better for such a dieter to choose. You will first need to use Table 1 to convert the kitchen measures into 100 gram units, then use Table 2 to find the amount of carbohydrates in each ingredient.

Spinach omelet: 1/4 cup spinach, 2 eggs, 1/8 cup milk, 1/2 Tbsp. oil

Greek salad: 1 cup lettuce, 1/4 cup feta cheese, 1/2 of a tomato, 1/8 cup salad dressing

2. To make a stir fry, fry beef and onions in a wok with oil, and top it with soy sauce.
  - a) You would like to make a stir fry with a total of 6 g carbohydrates, 50 g protein, and 3.5 mg vitamin C, and you'd like this dish to contain only 575 calories. Use Table 2 to set up a matrix equation which could be used to determine whether it is possible to make such a stir fry. Describe the steps you take to produce the vectors in the equation.
  - b) Find a precise recipe for the stir fry in part a). Convert your amounts to common kitchen measures using Table 1.

3. Table 2 has been incorporated into the matrix  $A$  which accompanies this exercise set. What does the  $j^{\text{th}}$  column in this matrix represent? Which entry in this matrix tells you how much vitamin C is found in 100 g of vanilla ice cream?
4. A particularly math-savvy sumo wrestler wanted to adhere to a strict diet to maintain his weight and strength. Table 3 lists his desired nutritional intake for one day. The entries in Table 3 are stored in the vector  $v_1$  which accompanies this exercise set. Using Table 2 he was able to decide on an optimal diet to give him this combination of nutrients. How much of each of the above foods were in his diet?
5. The United States Food and Drug Administration (FDA) provides Recommended Daily Values for use on food labels. Table 4 gives the FDA's recommendations, which are also stored in the vector  $v_2$  which accompanies this exercise set. Is it possible to combine the foods from the table to approximate these nutritional values?

Key Number	Foodstuff	Serving Size
1	Beef	6 oz=170g
2	Brussels Sprouts	1/2 cup=78g
3	Carrots	1 carrot=61g
4	Chicken Soup	1 cup=240g
5	Egg	1 egg=61g
6	Feta Cheese	1/4 cup=38g
7	Grapefruit	1/2 fruit=123g
8	Lentils	1 cup=198g
9	Lettuce	1/2 cup=28g
10	Milk	1 cup=244g
11	Mushrooms	1/2 cup=35g
12	Oil	1 Tbsp=13.5g
13	Onion	1 onion=110g
14	Rice	1 cup=158g
15	Salad Dressing	1 cup=250g
16	Salmon	1/2 fillet=124g
17	Soy Sauce	1 Tbsp=18g
18	Spinach	1 cup=180g
19	Tomato	1 tomato=123g
20	Vanilla Ice Cream	1/2 cup=66g

Table 1: Serving Sizes of Various Foodstuffs

Nutrient (units)	Foodstuff (see key for names)									
	1	2	3	4	5	6	7	8	9	10
Calories (kcal)	215	39	43	73	152	263	30	116	14	61.44
Protein (g)	26	2.55	1.03	5.3	10.33	14.2	.55	9.02	1.62	3.29
Fat (g)	11.5	.51	.19	2.5	11.44	21.3	.1	.38	.2	3.34
Carbohydrates (g)	0	8.6	10.1	7.1	1.04	4.09	7.68	20.14	2.37	4.66
Calcium (mg)	7	36	27	10	42	492.5	11	19	36	119.4
Iron (mg)	3.1	1.2	.5	.6	1.19	.65	.12	3.33	1.1	.05
Magnesium (mg)	27	20	15	4	9	19.2	8	36	6	13.44
Phosphorus (mg)	211	56	44	30	148	337	9	180	45	93.4
Potassium (mg)	367	317	323	45	101	61.8	129	369	290	151.5
Sodium (mg)	69	21	35	354	270	1116	0	2	8	49
Zinc (mg)	5290	.33	.2	.4	.92	2.88	.07	1.27	.25	.38
Copper (mcg)	.143	.083	.047	.1	.013	.032	.044	.251	.037	.01
Vitamin C (mg)	0	62	9.3	0	0	0	38.1	1.5	24	.94
Thiamine (mg)	.11	.107	.097	.03	.044	.154	.034	.169	.1	.038
Riboflavin (mg)	.25	.08	.059	.07	.399	.844	.02	.073	.1	.162
Niacin (mg)	4.63	.607	.928	1.8	.058	.991	.191	1.06	.5	.084
Pantothenic Acid (mg)	.34	.252	.197	15	.934	.967	.283	.638	.17	.314
Vitamin B6 (mg)	.4	.178	147	.02	.109	.424	.042	.178	.047	.042
Vitamin B12 (mcg)	2.27	0	0	.13	.7	1.69	0	0	0	.357
Vitamin A (IU)	0	719	28129	509	654	447	259	8	2600	126

Nutrient (units)	Foodstuff (see key for names)									
	11	12	13	14	15	16	17	18	19	20
Calories (kcal)	25	884	38	130	448.8	149	60	23	21	201
Protein (g)	2.09	0	1.16	2.69	0	25.56	10.51	2.9	.85	3.5
Fat (g)	.42	100	.16	.28	50.1	4.42	.1	.26	.33	11
Carbohydrates (g)	4.65	0	8.63	28.17	2.5	0	5.57	3.75	4.64	23.6
Calcium (mg)	5	.18	20	10	0	17	20	136	5	128
Iron (mg)	1.24	.38	.22	1.2	0	.99	2.38	3.57	.45	.09
Magnesium (mg)	10	.01	10	12	0	33	40	87	11	14
Phosphorus (mg)	104	1.22	33	43	0	295	130	56	24	105
Potassium (mg)	370	0	157	35	7.5	414	212	466	222	199
Sodium (mg)	4	.04	3	1	.5	86	5586	70	9	80
Zinc (mg)	.73	.06	.19	.49	0	.71	.43	.76	.09	.69
Copper (mcg)	.492	0	.06	.069	0	.099	.135	.174	.074	.023
Vitamin C (mg)	3.5	0	6.4	0	0	0	0	9.8	19.1	.6
Thiamine (mg)	.102	0	.042	.163	0	.196	.059	.095	.059	.041
Riboflavin (mg)	.449	0	.02	.013	0	.073	.152	.236	.048	.24
Niacin (mg)	40116	0	.148	1.476	0	8.526	3.951	.49	.628	.116
Pantothenic Acid (mg)	2.2	0	.106	.39	0	.865	.376	.145	.247	.581
Vitamin B6 (mg)	.097	0	.116	.093	0	.231	.2	.242	.08	.048
Vitamin B12 (mcg)	0	0	0	0	0	3.46	0	0	0	.39
Vitamin A (IU)	0	0	0	0	0	136	0	8190	623	409

Table 2: Nutritional Values of Various Foods per 100g of foodstuff

Nutrient	Amount
Calories	8279.12 kcal
Protein	608.81 g
Fat	387.60 g
Carbohydrates	604.48 g
Calcium	4067.42 mg
Iron	93.34 mg
Magnesium	1714.73 mg
Phosphorus	8488.03 mg
Potassium	18023.48 mg
Sodium	8846.38 mg
Zinc	36009.75 mg
Copper	6.67 mcg
Vitamin C	604.06 mg
Thiamine	6.77 mg
Riboflavin	10.61 mg
Niacin	28212.10 mg
Pantothenic Acid	103.11 mg
Vitamin B6	189.81 mg
Vitamin B12	51.78 mcg
Vitamin A	95382.93 IU

Table 3: Sumo Wrestler Diet

Nutrient	Amount
Calories	2000 kcal
Protein	50 g
Fat	65 g
Carbohydrates	300 g
Calcium	1000 mg
Iron	18 mg
Magnesium	400 mg
Phosphorus	1000 mg
Potassium	3500 mg
Sodium	2400 mg
Zinc	15 mg
Copper	2000 mcg
Vitamin C	60 mg
Thiamine	2 mg
Riboflavin	2 mg
Niacin	20 mg
Pantothenic Acid	10 mg
Vitamin B6	2 mg
Vitamin B12	6 mcg
Vitamin A	5000 IU

Table 4: FDA Recommended Daily Values