

2. Minimize:  $21 \text{ TO} + 17 \text{ LE} + 370 \text{ SP} + 345 \text{ CA} + 883 \text{ OL}$

Constraints:  $p \geq 15$ ,  $2 < f \leq 6$ ,  $4 \leq c$ ,  $s \leq 100$ , Spinach + lettuce  $\leq$  tomato, carrot, oil

A:  $0.85 \text{ TO} + 1.63 \text{ LE} + 12.79 \text{ SP} + 8.38 \text{ CA} \geq 15$   
 B:  $0.33 \text{ TO} + 0.20 \text{ LE} + 1.58 \text{ SP} + 1.39 \text{ CA} + 100 \text{ OL} > 2$   
 B:  $" " " " " \leq 6$   
 C:  $4.65 \text{ TO} + 2.37 \text{ LE} + 73.68 \text{ SP} + 80.7 \text{ CA} \geq 4$   
 D:  $9 \text{ TO} + 8 \text{ LE} + 7 \text{ SP} + 506.4 \text{ CA} \leq 100$

Special:  $\text{TO} \geq 0, \text{LE} \geq 0, \text{SP} \geq 0, \text{CA} \geq 0$   
 E:  $\text{LE} + \text{SP} \leq \text{TO} + \text{CA} + \text{OL}$

Using the above constraints with the Flow Problem code given on Moodle using glpk/glp sol we get an optimal solution of:

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[Ahmeds-MacBook-Pro:Lab8 Misha$ glpsol --math FlowProblem.ampl
GLPSOL: GLPK LP/MIP Solver, v4.52
Parameter(s) specified in the command line:
--math FlowProblem.ampl
Reading model section from FlowProblem.ampl...
33 lines were read
Generating objVal...
Generating c1...
Generating c2...
Generating c3...
Generating c4...
Generating c5...
Generating c6...
Generating c7...
Generating c8...
Generating c9...
Generating c10...
Generating c11...
Model has been successfully generated
GLPK Simplex Optimizer, v4.52
12 rows, 5 columns, 37 non-zeros
Preprocessing...
6 rows, 5 columns, 27 non-zeros
Scaling...
  A: min|aij| = 2.000e-01  max|aij| = 5.064e+02  ratio = 2.532e+03
  GM: min|aij| = 2.071e-01  max|aij| = 4.828e+00  ratio = 2.331e+01
  EQ: min|aij| = 4.407e-02  max|aij| = 1.000e+00  ratio = 2.269e+01
Constructing initial basis...
Size of triangular part is 6
   0: obj = 0.000000000e+00  infeas = 6.420e-01 (0)
*   4: obj = 4.299853372e+02  infeas = 0.000e+00 (0)
*   5: obj = 2.364672216e+02  infeas = 0.000e+00 (0)
OPTIMAL LP SOLUTION FOUND
Time used: 0.0 secs
Memory used: 0.1 Mb (111034 bytes)
Display statement at line 32
objVal.val = 236.467221644121
to.val = 5.88449531737773
le.val = 5.8480749219563
sp.val = 0.0364203954214361
ca.val = 0
ol.val = 0
Model has been successfully processed

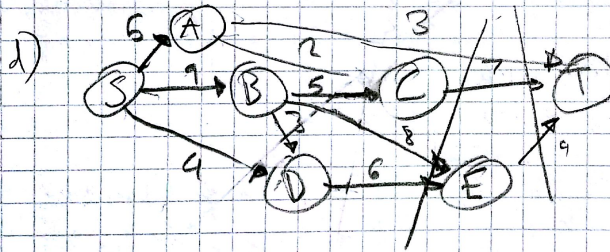
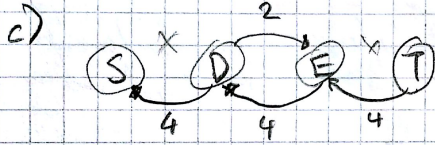
```

236 calories:

5.885 tomatoes, 5.848 lettuce, 0.03642 spinach

3. a) Path:  $S \rightarrow D \rightarrow E \rightarrow T$

b) Maximum flow that can be increased is 14 due to limiting  $E \rightarrow T$



Max flow is 14  $(4 + 7 + 3)$