1. (15 points) Schrijver Problem 1.3 on p. 14. Draw the associated
directed graph, and the last Bellman-Ford function on its vertices.

2. (15 points) In Schrijver’s knapsack problem example (Application
1.3), assume that object 2 is no longer available, so one has
\[
\begin{array}{ccc}
\text{article} & \text{volume} & \text{value} \\
1 & 5 & 4 \\
3 & 2 & 3 \\
4 & 2 & 5 \\
5 & 1 & 4 \\
\end{array}
\]
Solve this new knapsack problem by drawing an appropriate directed
graph and using the Bellman-Ford algorithm.

3. (15 points) Give an example of a directed graph \( D = (V, A) \) and a
length function on the arcs \( \ell : A \to \mathbb{Z} \) with these properties:
- \(|V| = 3\), i.e. there are exactly 3 vertices, labelled \( V = \{s, r, t\} \),
- there are no directed cycles of negative length,
- Dijkstra’s algorithm fails to find an \( s \to t \) directed path of min-
imum length, but the Bellman-Ford algorithm works. (Write
down the output from both algorithms)
4. Consider the following LP problem:

\[
\begin{align*}
\text{minimize} & \quad x_2 \\
\text{subject to} & \quad x_1 + x_2 \geq 1 \\
& \quad 3x_1 + 2x_2 \leq 6 \\
& \quad x_1, x_2 \geq 0
\end{align*}
\]

(a) (5 points) Rewrite this problem in Chvátal’s standard form.

(b) (20 points) Solve this problem using the two-phase simplex method. Be sure to write down each dictionary in both Phase I and II, and the entering/leaving variables at each pivot step. You do not need to show the algebra used in rewriting the dictionaries.

5. (15 points) Chvátal problem 1.5 on page 10.

6. (15 points) Chvátal problem 3.10 on page 44.