1. a) \[
EOQ_A = \sqrt{\frac{2 \times 50 \times 1200}{20 \times 0.2}} = 173
\]
\[
EOQ_B = 283 \quad EOQ_C = 387
\]
\[
\Rightarrow \sum Q_i \cdot EOQ_i = 20 \times 173 + 15 \times 283 + 20 \times 387 = 15445
\]
\[
\Rightarrow \sin \sum Q_i \cdot EOQ_i < 20000 = \text{Budget const.}
\]
Optimal order quantities will be \( EOQ \) of each item.

b) Now \( \sum Q_i \cdot EOQ_i > 10000 = \text{Budget constraint.} \)
It is observed that the assumption \( \frac{c_A}{h_A} = \frac{c_B}{h_B} = \frac{c_C}{h_C} \)
holds. So, \( Q_i^* = m \cdot EOQ_i \), where

\[
m = \frac{C}{(c_A \cdot EOQ_A + c_B \cdot EOQ_B + c_C \cdot EOQ_C)}
\]
\[
\Rightarrow m = 10005 / 15445
\]
\[
\Rightarrow Q_A^* = m \times 173 = 112 \quad Q_B^* = m \times 283 = 183 \\
Q_C^* = m \times 387 = 257
\]
\[
\sum Q_i \cdot 10005
\]
\( \sum w_i \leq 20 \Rightarrow 16450 \), \( \frac{w_i}{h_i} \) condition doesn't hold

To find an initial point:
\[ m = \frac{15000}{16450} = 0.912 \]

\( Q_a = 173 \times 0.912 = 158 \)
\( Q_b = 258 \quad Q_c = 353 \)

\( 158 = \sqrt{\frac{2 \times 50 \times 1200}{4 + 2 \times \theta_a \times 60}} \Rightarrow \theta_a = 0.01 \)

\( 258 = \sqrt{\frac{2 \times 50 \times 2400}{3 + 2 \times \theta_b \times 20}} \Rightarrow \theta_b = 0.015 \)

\( 353 = \sqrt{\frac{2 \times 50 \times 6000}{4 + 2 \times \theta_c \times 10}} \Rightarrow \theta_c = 0.04 \)

\( 0.01 - 0.015 - 0.04 \)

\( \Rightarrow \text{try} \quad \frac{0.01 + 0.04}{2} = 0.025 \)

For \( \theta = 0.025 \Rightarrow Q_a = 141 \)
\( Q_b = 245 \quad \sum w_i \cdot q_i = 14190 \)
\( Q_c = 365 \) sc, decrease \( \theta \)

\( \Rightarrow \text{try} \quad \theta = \frac{0.025 + 0.01}{2} = 0.0175 \)

\( \Rightarrow \text{continue in the same manner:} \)
\( a_1 = 152, \quad \theta_2 = 259, \quad Q_3 = 374 \)
\( \sum w_i \cdot q_i = 15000 \)
Question 2)

a) The handling of inbound logistics at a plant is frequently based on first-come first-served basis. In many cases this is not efficient and can lead to much wasted time by vehicles queuing at busy sites. Unregulated arrivals can cause congestion and make excessive demands on the loading and materials handling process. Simple solutions based on limiting vehicle arrivals per hour can spread the work, but this does not take into account the nature of the loads arriving and the processes that have to take place upon arrival. At automotive plants, the whole manufacturing process requires the smooth flow of incoming parts and subassemblies to the production line. Some items only need to go to stores whereas just-in-time and just-in-sequence deliveries must go directly to specific locations in the right order.

b) The cars at Audi Ingolstadt factory are built to order, a customer may choose more than 700 wheel and tire combinations, engine type, color, etc. This leads to an enormous number of variants of the basic models. As a result, the material requirements are complex and material transports must be precisely synchronized with the production schedule.

c) VW Mexico faces up to the challenge of two production types: cars for the European market are mostly built-to-order (BTO) whereas cars for North America and Mexico are mainly built-to-stock (BTS). The demands are therefore quite different: The BTO car has to arrive on the agreed delivery date in the right country and at the correct dealer. Dealers in North America, on the other hand, want to have enough attractive cars in stock so the customer can choose from a wide variety of models and configurations.