Task 2

Data:

S	The set of all suppliers
H	The set of all hubs
P	The set of all plants

Decision variables:

X_{ih}	*The decision variable representing amount of biomass to transport between i and h*	$i \in S \quad h \in H$
Y_{hj}	*The decision variable representing amount of biomass to transport between h and j*	$h \in H \quad j \in P$
SC_i	The capacity of any given supplier	$i \in S$
HC_h	The capacity of any given hub	$h \in H$
PC_j	The capacity of any given plant	$j \in P$
TP_{ih}	The cost of transportation between i and h, given in \$ per Mg per kilometer of biomass. The total cost of a trip is thus $TP_{ih} * X_{ih}$	$i \in S \quad h \in H$
RP_{hj}	The cost of transportation between h and p, given in \$ per Mg per kilometer of biomass. The total cost of a trip is thus $RP_{hj} * Y_{hj}$	$h \in H \quad j \in P$
D	The total demand, which is 500,000,000 liters of bio-ethanol, requires 2,155,172 Mg of biomass	
LT	The cost of loading and unloading a truck, given as a constant 10000	
RT	The cost of loading and unloading a train, given as a constant 60000	
IP_j	The investment cost for each plant	$j \in P$
IH_h	The investment cost for each hub	$h \in H$
B_j	A binary variable that represents whether or not we've invested in a plant	$B \in \{0,1\} \quad j \in P$
B_h	A binary variable that represents whether or not we've invested in a hub	$B \in \{0,1\} \quad h \in H$
CP_j	The conversion capacity of each plant	$j \in P$
CH_h	The conversion capacity of each hub	$h \in H$
R	The constant conversion rate of bioethanol per Mg of biomass, which is 232 liters/Mg.	

Objective function:

$$Minimize \; Z = \sum_{i \in S} \sum_{h \in H} (TP_{ih} * X_{ih}) + \sum_{h \in H} \sum_{j \in P} (RP_{hj} * Y_{hj}) + \sum_{j \in P} (IP_j * B_j) + \sum_{h \in H} (IH_h * B_h)$$

Constraint to:

$$\sum_{h \in H} \sum_{j \in P} Y_{hj} \geq D \qquad \qquad \text{The sum of flow between all h's and j's meets the production goal}$$

$$\sum_{i \in S} \sum_{h \in H} X_{ih} \leq SC_i \qquad \qquad \text{The sum of the outgoing flow from each supplier is less than or equal to its available supply}$$

$$\sum_{h \in H} \sum_{j \in P} Y_{hj} \leq PC_j \qquad \qquad \text{The sum of incoming flow to each plant is less than or equal to its capacity}$$

$$\sum_{h \in H} \sum_{i \in S} X_{ih} \leq HC_h \qquad \qquad \text{The sum of the incoming flow to each hub is less than or equal to its capacity}$$

$$\sum_{i \in S} \sum_{h \in H} X_{ih} = \sum_{h \in H} \sum_{j \in P} Y_{hj} \qquad \text{The sum of the incoming flow to each hub is equal to its outgoing flow}$$

$$\sum_{i \in S} \sum_{j \in P} X_{ij} = \sum_{h \in H} \sum_{j \in P} Y_{ij} \quad \text{The sum of outgoing flow from all suppliers equals the ingoing flow to all plants}$$