Question 1:

Decision Variables: x = Number of Collegiate backpacks to produce per week. y = Number of Mini backpacks to produce per week.

Objective Function: Maximize $Z = 32x + 24y$

Constraints: 1. Material constraint: $3x + 2y \leq 5000$ 2. Sales forecast constraint for Collegiate: $x \leq 1000$ 3. Sales forecast constraint for Mini: $y \leq 1200$ 4. Labor constraint: $45x + 40y \leq 35 \times 40 \times 60$

Non-negativity constraints: $x \geq 0$ $y \geq 0$

Linear Programming model as :

$$Max\ Z = 32b_c + 24b_m$$

#tried solving the problem using LP model by defining the coeficients and #installing lpsolve and using library lpsolve.

```r
# Load the lpSolve library
library(lpSolve)

# Define the objective coefficients
obj_coef <- c(32, 24)

# Define the constraint coefficients and types
const_coef <- matrix(c(3, 2, 45, 40), nrow = 2, byrow = TRUE)
const_dir <- c("<=", "<=")

# Define the right-hand side of constraints
rhs <- c(5000, 35 * 40 * 60)  # Material and labor constraints

# Create an LP model
lp_model <- lp("max", obj_coef, const_coef, const_dir, rhs)

# Add variable bounds as constraints
var_bounds <- matrix(c(0, 1000, 0, 1200), nrow = 2, byrow = TRUE)
colnames(var_bounds) <- c("Collegiate", "Mini")
rownames(var_bounds) <- c("Lower", "Upper")

# Add variable bounds as constraints
const_coef_bounds <- rbind(const_coef, diag(2))  # Adding bounds as constraints
const_dir_bounds <- c(const_dir, "<=", "<=")
rhs_bounds <- c(rhs, c(0, 1000, 0, 1200))

# Solve the LP problem
solution <- lp("max", obj_coef, const_coef_bounds, const_dir_bounds, rhs_bounds)
```

```
## Warning in rbind(const.mat, const.dir.num, const.rhs): number of columns of
## result is not a multiple of vector length (arg 3)
```

```r
# Print the results
cat("Number of Collegiate backpacks to produce per week:", solution$solution[1], "\n")
```

```
## Number of Collegiate backpacks to produce per week: 0
```

```r
cat("Number of Mini backpacks to produce per week:", solution$solution[2], "\n")
```

```
## Number of Mini backpacks to produce per week: 1000
```

```r
cat("Optimal profit:", solution$objval, "\n")
```

```
## Optimal profit: 24000
```

Question 2

```r
#defining the matrix to table
table=matrix(c(20,900,420,15,1200,360,12,750,300), nrow = 3, ncol = 3, byrow = TRUE)
#Assigning colnames and row names
colnames<-(c('Space Required', 'Sales Forecast(PerDay)', 'Profit'))
rownames<-(c('Large', 'Medium','Small'))
table
```

```
##      [,1] [,2] [,3]
## [1,]   20  900  420
## [2,]   15 1200  360
## [3,]   12  750  300
```

```r
#Second matrix
table=matrix(c(750,900,450), nrow = 3, ncol = 1, byrow = TRUE)
#Assigning colnames and rownames
colnames<-(c('Excess Capacity Units/Day'))
rownames<-(c('Plant1', 'Plant2','Plant3'))
table
```

```
##      [,1]
## [1,]  750
## [2,]  900
## [3,]  450
```

Suppose, Assume Size of the large product

$$= L$$

Assume Size of the medium product

$$= M$$

Assume size of the small product

$$= S$$

Plant1 is assignes as

$$= P1$$

Plant2 is assignes as

$$= P2$$

Plant3 is assignes as

$$= P3$$

(a) Decision Variables for the problem:

$$L, M, S, P1, P2 \ and \ P3$$

(b) Objective Function:

$$Max\ Z\ =\ 420(P1L + P2L + P3L) + 360(P1M + P2M + P3M) + 300(P1S + P2S + P3S)$$

(c) Constraints:

1. Storage capacity (sq ft.):

$$20P1L + 15P1M + 12P1S \leq 13000$$
$$20P2L + 15P2M + 12P2S \leq 12000$$
$$20P3L + 15P3M + 12P3S \leq 5000$$

2. Excess Capacity Storage:

$$P1L + P1M + P1S \leq 750$$
$$P2L + P2M + P2S \leq 900$$
$$P3L + P3M + P3S \leq 450$$

3. Sales forecast per day for every product: For Large

$$P1L + P2L + P3L = 900$$

For Medium

$$P1M + P2M + P3M = 1200$$

For Small

$$P1S + P2S + P3S = 750$$

4. Same Percentage of their excess capacity is being used:

$$1/750(P1L + P1M + P1S) = 1/900(P2L + P2M + P2S)$$
$$1/750(P1L + P1M + P1S) = 1/450(P3L + P3M + P3S)$$

5. Non-negativity:

$$L \geq 0$$
$$M \geq 0$$
$$S \geq 0$$
$$P_1 \geq 0$$
$$P_2 \geq 0$$
$$P_3 \geq 0$$