Assignment 3

Question 1

In [1]:
```
import numpy as np
from scipy.optimize import minimize

#obj function
def objective(x):
    x1, x2 = x
    q = 6 * x1 + 4 * x2 - 0.25 * x1**2 - 0.125 * x2**2
    return -q

#constraints
def budget_constraint(x):
    x1, x2 = x
    return 180 - (8 * x1 + 5 * x2)

#variable bounds
bounds = [(0, None), (0, None)]

constraints = {'type': 'ineq', 'fun': budget_constraint}

initial_guess = [0, 0]

#optimization
result = minimize(objective, initial_guess, method='SLSQP', bounds=bounds, constraints=constraints)

#solve
x1_opt, x2_opt = result.x
q_opt = -result.fun

#print results
print(f"Optimal amount of raw material 1: {x1_opt:.4f} units")
print(f"Optimal amount of raw material 2: {x2_opt:.4f} units")
print(f"Maximum quantity of fertilizer: {q_opt:.4f} units")
```

```
Optimal amount of raw material 1: 12.0000 units
Optimal amount of raw material 2: 16.0003 units
Maximum quantity of fertilizer: 68.0000 units
```

In [2]:
```
import numpy as np
from scipy.optimize import minimize
def objective(x):
    x1 = x[0]
    x2 = x[1]
    q = -1 * (6*x1 + 4*x2 - 0.25*x1**2 - 0.125*x2**2)
    return q

def constraint1(x):
    x1 = x[0]
    x2 = x[1]
    return 8*x1 + 5*x2 - 180


#intial
x0 = [0, 0]

#initial obj
print('Initial Objective: ' + str(objective(x0)))

#optimize
b = (0.0,None)
bnds = (b, b) ## greater than 0 constraints
con1 = {'type': 'ineq', 'fun': constraint1}
cons = ([con1])
solution = minimize(objective,x0,method='SLSQP', bounds=bnds,constraints=cons)
x = solution.x

#print
print('Final Objective: ' + str(objective(x) * -1))

#solve
print('Solution')
print('x1 = ' + str(x[0]))
print('x2 = ' + str(x[1]))
```

```
Initial Objective: -0.0
Final Objective: 67.96491228070157
Solution
x1 = 12.280702337058102
x2 = 16.350876260707032
```

Question 2

In [8]:
```
import numpy as np
from scipy.optimize import minimize

def objective_function(x):
    x1, x2, x3 = x
    x1 = x2 + x3
    return -(x2 / 2 * x3 / 2)

#constraints
def constraint1(x):
    x1, x2, x3 = x
    x1 = x2 + x3
    return 120 - x1

def constraint2(x):
    x1, x2, x3 = x
    x1 = x2 + x3
    return 25 - np.sqrt(x1)

def constraint3(x):
    x1, x2, x3 = x
    x1 = x2 + x3
    return 150 - ((3 * x2 - np.sqrt(x1)) + (2 * x3 - np.sqrt(x1)))
```

```
#initial guess
x0 = [1, 1, 1]

#constraints, bounds
constraints = [
    {'type': 'ineq', 'fun': constraint1},
    {'type': 'ineq', 'fun': constraint2},
    {'type': 'ineq', 'fun': constraint3},
   # {'type': 'ineq', 'fun': constraint4}
]
bnds = [(0, 120), (0, None), (0, None)]

#solve
solution = minimize(objective_function, x0, method='SLSQP', bounds=bnds, constraints=constraints)
x1, x2, x3 = solution.x

x1 = x2 + x3
if x1 > 120:
    x1 = 120


print(f'Optimal length of fencing purchased (x1): {x1}')
print(f'Optimal number of East-West fence length (x2): {x2}')
print(f'Optimal number of North-South fence length (x3): {x3}')
print(f'Maximized Area Covered (Z): {-objective_function([x1, x2, x3])}')
```

```
Optimal length of fencing purchased (x1): 69.59819968327108
Optimal number of East-West fence length (x2): 27.48870772728332
Optimal number of North-South fence length (x3): 42.109491955987764
Maximized Area Covered (Z): 289.3838792306339
```

Question 5

In [4]:

```
import pulp
from pulp import LpVariable, LpProblem, LpMaximize, LpStatus, value, LpMinimize

prob = LpProblem("Maximize Profit", LpMaximize)

#variables
x1 = LpVariable("x1", 0, None)
x2 = LpVariable("x2", 0, None)
x3 = LpVariable('x3', 20, 40 )
y = LpVariable('y', cat='Binary')

#obj
prob += 10 * x1 + 11 * x2 + 20 * x3

#constraints
prob += 5 * x1 + 6 * x2 + 8 * x3 <= 750
prob += x1 <= 50
prob += x3 >= 20 * y
prob += x3 <= 40 * y


#solve
prob.solve()

#print
print("Optimal Solution:")
print("Orchard 1 Bushels:", value(x1))
print("Orchard 2 Bushels:", value(x2))
print("Orchard 3 Bushels:", value(x3))
print("Optimal values:")
for v in prob.variables():
    print(v.name, "=", v.varValue)
print("Maximized Profit: $", value(prob.objective))
```

```
Optimal Solution:
Orchard 1 Bushels: 50.0
Orchard 2 Bushels: 30.0
Orchard 3 Bushels: 40.0
Optimal values:
x1 = 50.0
x2 = 30.0
x3 = 40.0
y = 1.0
Maximized Profit: $ 1630.0
C:\Anaconda\Lib\site-packages\pulp\pulp.py:1316: UserWarning: Spaces are not permitted in the name. Converted to '_'
  warnings.warn("Spaces are not permitted in the name. Converted to '_'")
```