Northern Borders University	IE 453 Facilities Planning
Faculty of Engineering	Mid Term Exam
Industrial Engineering Department	Date: 25/6/1436 Time Allowed: 1:30

Solve the following Problems:

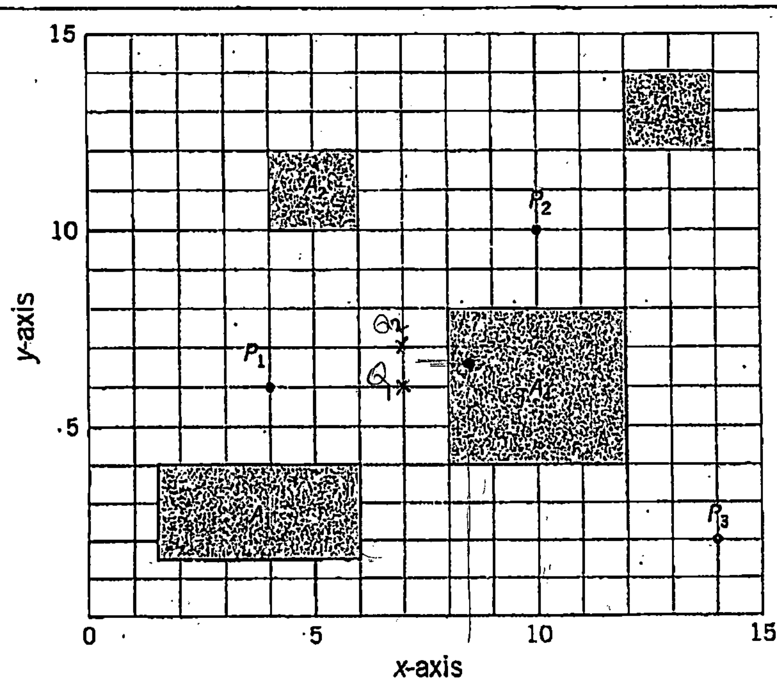
Problem #1 **(5 Points)**

(a) List 5 components of a football stadium facility
(b) List 5 Applications of Facilities Planning
(c) Explain the Facilities Planning Hierarchy with a simple drawing
(d) How can the facility location problems be classified?
(e) What are the reasons for considering Location Problems

Problem #2 **(15 Points)**

1. The city council of Fayetteville has decided to locate an emergency response unit within the city. This unit is responsible for four housing sectors (A) and three major street intersections (P) as shown in the figure below. Assume that the weights are uniformly distributed over the housing sectors.
   a. Determine the minisum location based on the weights given in the table below, assuming no restrictions apply to the location of the emergency response unit.
   b. Determine the minisum location assuming the new facility cannot be located within a housing sector.
   c. Determine the minimax location by measuring distances to the centroids of areas and using the weights given in the table below.

Housing Sector	Weight	Intersection	Weight
A_1	10	P_1	30
A_2	15	P_2	15
A_3	20	P_3	5
A_4	30		



Problem #1 Answer **(5 Points)**

(a) List 5 components of a football stadium facility

Ten components of a football facility are:

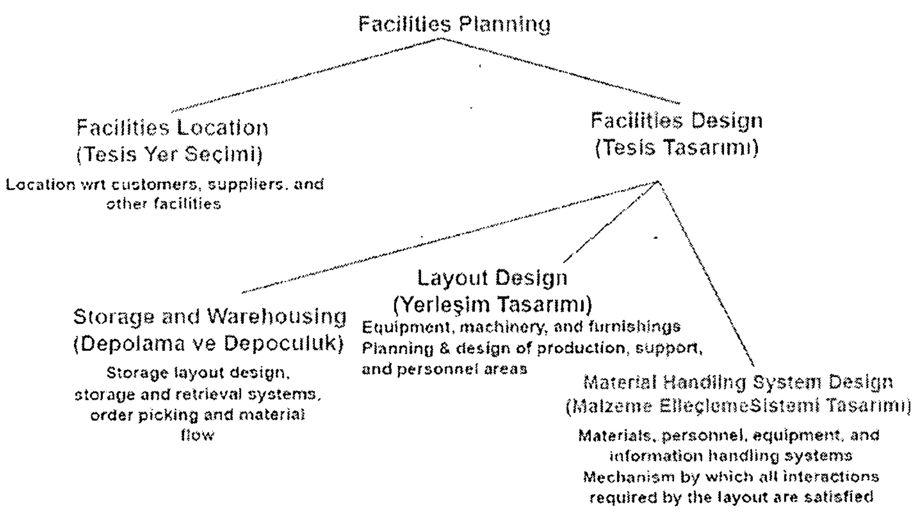
- The stadium structure
- Parking lots around the stadium
- Vendor selling areas
- Maintenance components
- Grounds-keeping equipment and personnel
- Security
- Customers
- Athletic team personnel
- Locker rooms
- Vending equipment and supplies

(b) List 5 Applications of Facilities Planning

Planning (FP) can be applied to planning of:

- a new hospital،
- an assembly department،
- an existing warehouse،
- the baggage department in an airport،
- department building of IE in EMU،
- a production plant،
- a retail store،
- a dormitory،
- a bank،
- an office،
- a cinema،
- a parking lot،
- or any portion of these activities etc…

(c) Explain the Facilities Planning Hierarchy with a simple drawing



Facilities Location (Macro Aspect of FP):
Location of the facility refers to its placement with respect to customers, suppliers, and other facilities with which it interfaces.
Facilities Design (Micro Aspect of FP):
Design components of a facility consists of the facility systems, the layout and the handling systems.

Facilities Systems:
Consists of the structural systems, the atmospheric systems, the lighting/electricity/communication systems, the life safety systems and the sanitation systems.
the structure (of building), power, light, gas, heat,
ventilation, air-conditioning, water and sewage needs.

Layout:
Consists of all equipment, machinery and furnishings within the building.
The production areas, related support areas, personnel areas.

Handling Systems:
Consists of the mechanism need to satisfy the required facility interactions. e.g. for a manufacturing system:
The materials- personnel, information, and equipment to support manufacturing.

(d) How can the facility location problems be classified?
Facility Location problems can be classified as:

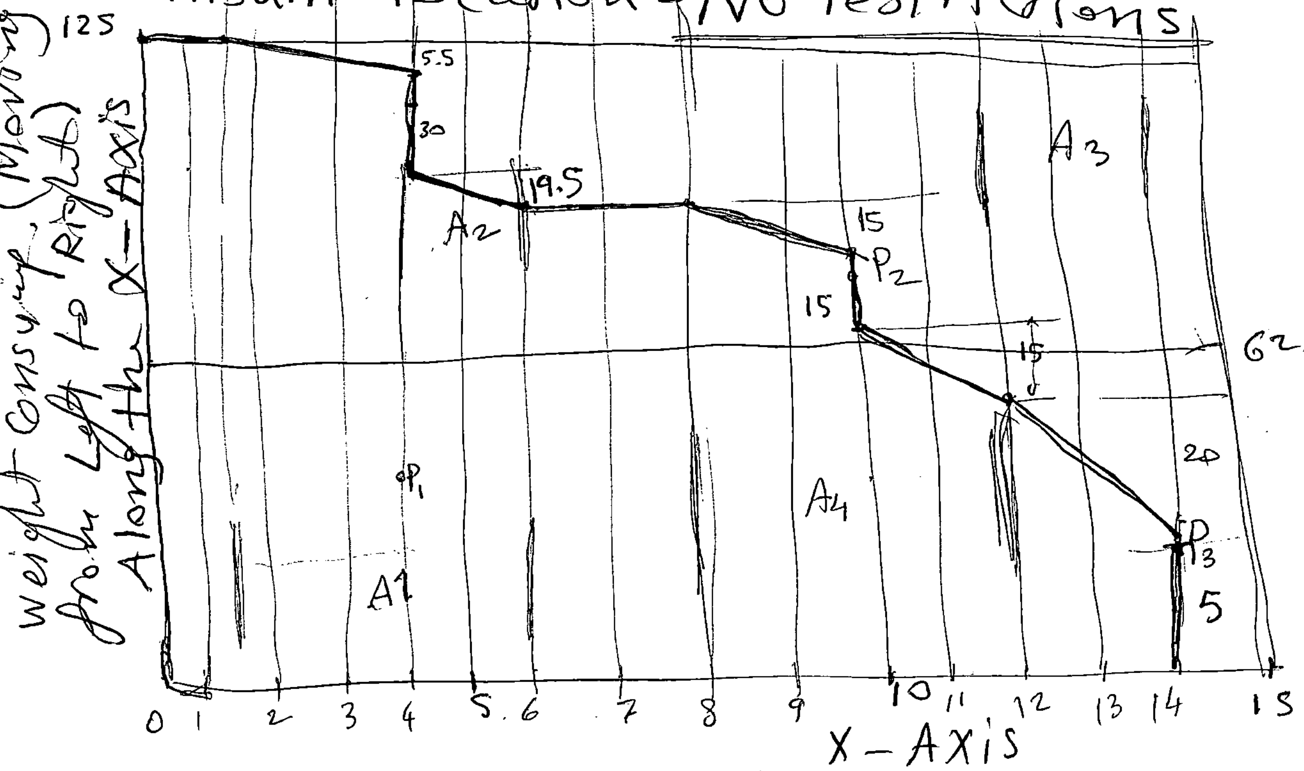
- **Single-Facility Location Problems**
  Single-Facility location problems deal with the optimal determination of the location of a single facility.
- **Multifacility Location Problems**
  Multifacility location problems deal with the simultaneous location determination for more than one facility.

- **Continuous Space Location Problem**
  If a facility can be located anywhere within the confines of a geographic area, then the number of possible locations is infinite, and such a problem is called a Continuous Space Location Problem.
- **Discrete Space Location Problem**
  Discrete Space Location Problems have a finite feasible set of sites in which to locate a facility.

(e) What are the reasons for considering Location Problems
Reasons for considering Location Problems

- Significant changes in the level of demand,
- Significant changes in the geographical distribution of demand,
- Changes in the cost or quality requirements of critical production inputs (labor, raw materials, energy or others),
- Significant increases in the real-estate value of existing or adjacent sites or in their taxation,
- Need to change as a result of fire or flood for reasons of prestige or improved public relations.

a) minisum location - No restrictions



$\sum W_i = \boxed{125}$ $\qquad \sum W_i / 2 = \boxed{62.5}$

$X \cong 8.3$

$Y \cong 6.3$

inside Housing Sector A4

$\frac{4.5 \times 2.5}{4.5 + 15}$

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b) Minisum location assuming the new facility cannot be located a housing sector A4

assume Two feasible locations

$Q_1 (7, 6)$

$Q_2 (7, 7)$

$$f(7,6) = \overset{90}{(3 \times 30)} + \overset{105}{(7 * 15)} + \overset{55}{(11 * 5)} + \overset{260}{(6+7)20}$$
$$+ \overset{70}{(3.25 + 3.25) * 10} + \overset{105}{(5+2) * 15} + (6+7)20$$
$$+ \overset{90}{(3) * 30} = 775$$

$$f(7,7) = 4*30 + 6*15 + 12*5 + 7.5*10 + 6*15 + 12*20 + 4*30 = \boxed{795}$$

Hense, the best site is

$Q_1 = (7, 6)$

(c) Minimax location by measuring distances to the Centroids of areas.

1.25
1.5

location	Coordinates a_i	b_i	$a_i + b_i$	$b_i - a_i$
A1	3.75	2.75	6.5 *	-1
A2	5	11	16	6
A3	10	6	16	-4
A4	13	13	26	0
P1	4	6	10	2
P2	10	10	20	0
P3	14	2	16	-12 *

To obtain the minimax Solution without weights:

$c_1 = \min(a_i + b_i) = 6.5$

$c_2 = \text{Max}(a_i + b_i) = 26$

$c_3 = \min(-a_i + b_i) = -12$

$c_4 = \max(-a_i + b_i) = 6$

$c_5 = \max(c_2 - c_1, c_4 - c_3)$

$= \max(26 - 6.5, 6 + 12) = \underline{19.5}$

The optimum solution to the minimax location problem are all points on a line segment connecting the point

$(x_1^*, y_1^*) = 0.5(c_1 - c_3, c_1 + c_3 + c_5)$

$= 0.5(18.5, 6.5 - 12 + 19.5)$

$= 0.5(18.5, 14)$

$= \underline{(9.25, 7)}$

and the point

$(x_2^*, y_2^*) = 0.5(c_2 - c_4, c_2 + c_4 - c_5)$

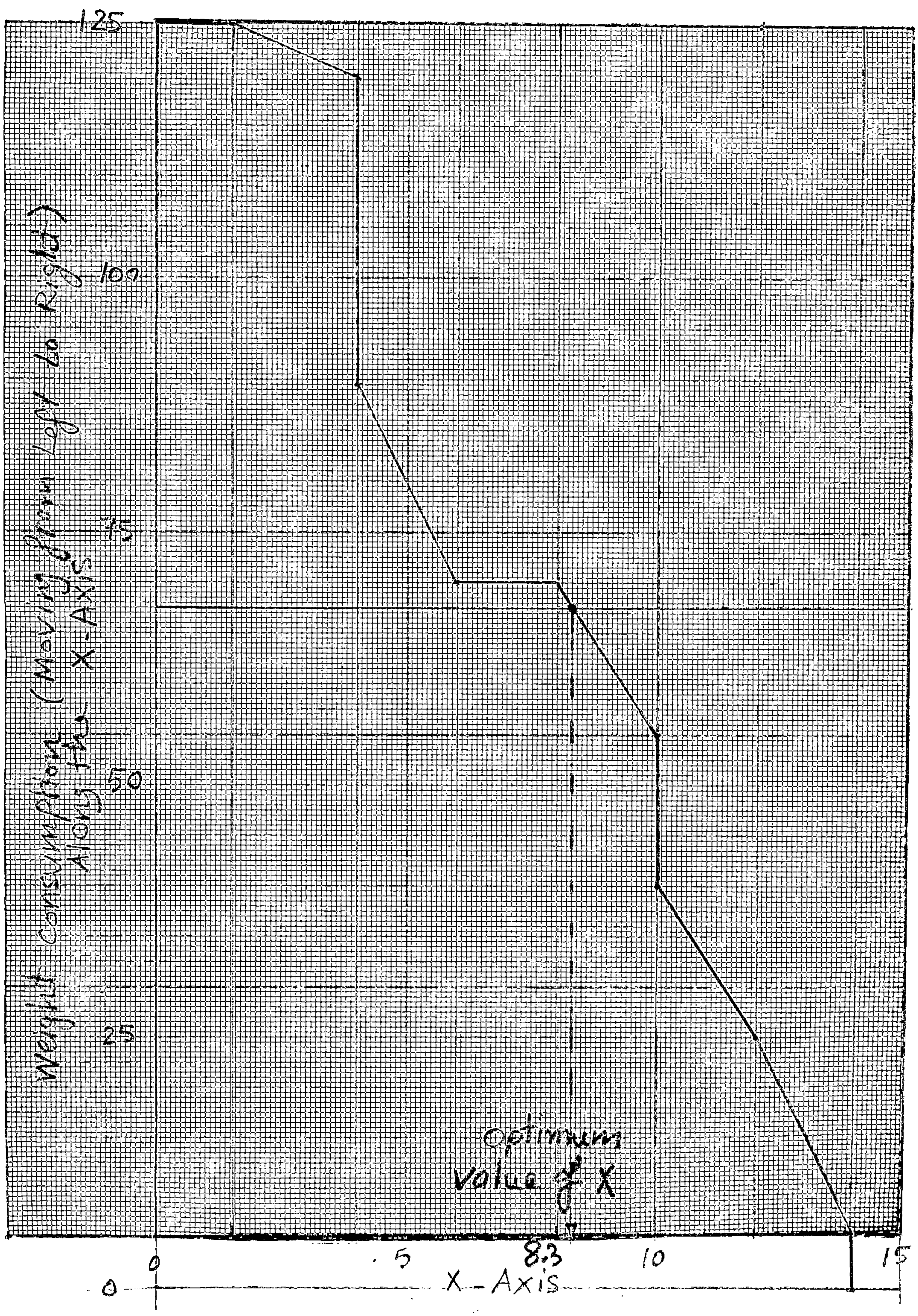
$= 0.5(26 - 6, 26 + 6 - 19.5)$

$= 0.5(20, 12.5)$

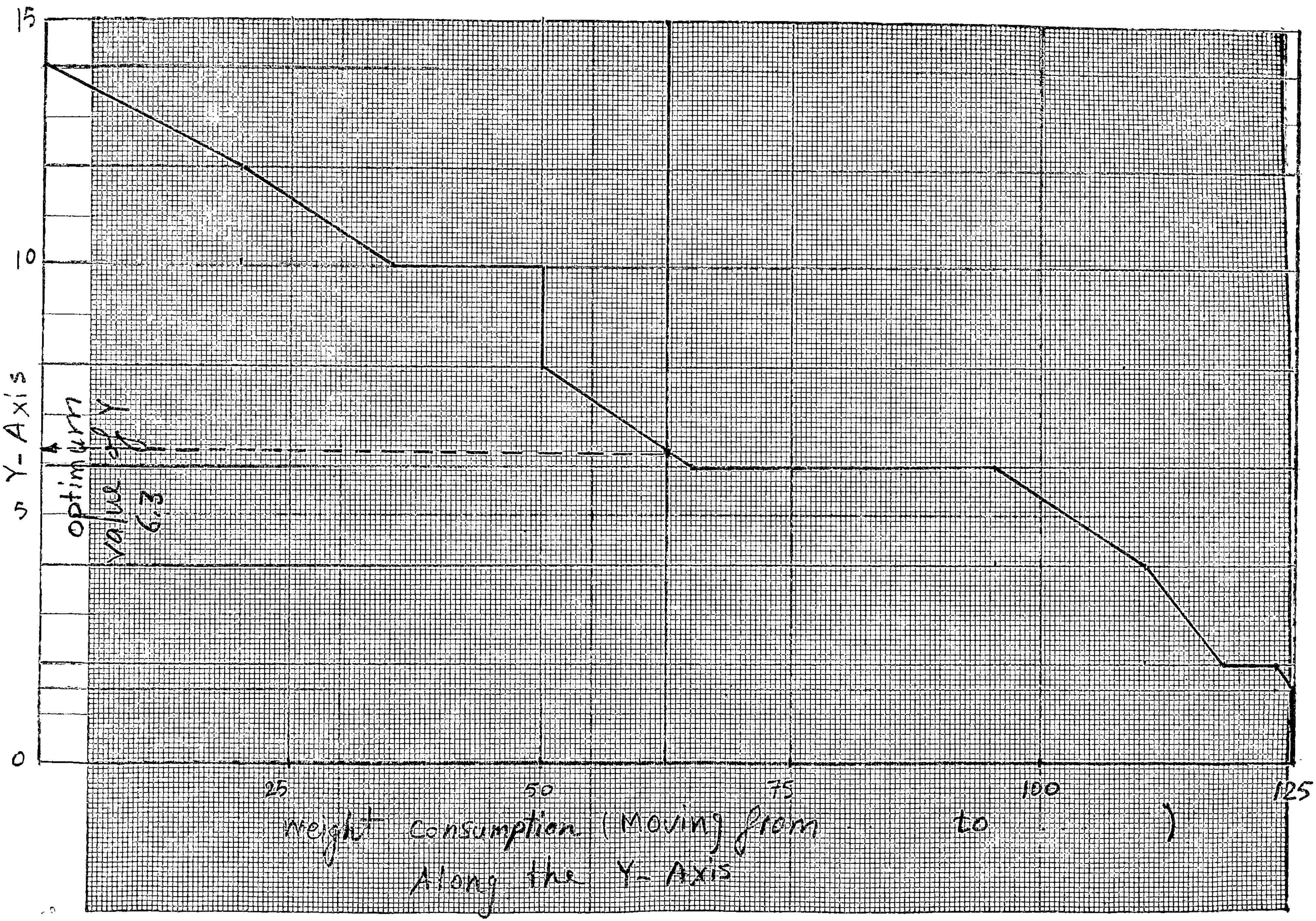
$= \underline{(10, 6.25)}$

The max. distance equals

$$C_s/2 = 19.5/2 = \underline{9.75}$$



Weight Consumption (Moving from Left to Right) Along the X-Axis
125
100
75
50
25
0
optimum value of X
0
5
8.3
10
15
X-Axis


15
10
5
0
Y- Axis
optimum of Y
value
6.3
25
50
75
100
125
weight consumption (Moving from to)
Along the Y- Axis