Unit 3: Production, Cost and Profit Analysis

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Part A: Production Analysis

Introduction

- Production is the process of transforming inputs into outputs or goods and services.
- Traditionally, production is also defined as the process of creating utility.
- Production is regarded as the mother of all economic activities because there will be no other economic activities, i.e. consumption, exchange and distribution in absence of production.
- The aim of all the firm is to maximize profit or sales revenue.
- The profit maximization or sales revenue maximization is possible only through efficient production of goods and services.
- The efficient production of goods and services is possible only through optimum combination of inputs or factors of production.

Concept of Total Product (TP), Average Product (AP), and Marginal Product (MP)

Total Product (TP)

- Total product is defined as the total quantity of output produced by the producer employing all the available units of inputs in the given period of time.
- TP is the sum of marginal product, i.e.

$$\mathbf{TP = MP_1 + MP_2 + \ldots + MP_n = SMP}$$

where

TP = Total product

MP = Marginal product

TP can also be obtained by multiplying average product (AP) by units of labour or any variable factor used in production process, i.e.

$$\mathbf{TP = AP \times L}$$

where

L = Labour or variable input

Concept of Total Product (TP), Average Product (AP), and Marginal Product (MP) Contd…

Average Product (AP)

- Average product is obtained by dividing total product by number of variable input or factor used in production process.
- In other words, it is the output per unit variable factor. Thus,

$$AP = \frac{TP}{L}$$

where

AP = Average product

TP = Total product

L = Units of labour or variable input or factor

Concept of Total Product (TP), Average Product (AP), and Marginal Product (MP) Contd…

Marginal Product (MP)

- Marginal product is defined as the addition in total product as a result of an additional unit of available factor, i.e. labour.
- In other words, it is the ratio of change in total product and change in units of labour or any variable input. Thus,

$$MP = TP_n - TP_{n-1}$$

$$= \frac{\Delta TP}{\Delta L}$$

where

MP = Marginal product

ΔTP = Change in total product

ΔL = Change in variable input or labour

TP_n = Total product of 'n' units of labour

TP_{n-1} = Total product of 'n – 1' units of labour

Production Function

- Production function is defined as functional relationship between physical inputs and physical output of a firm.
- In other words, production function shows the maximum possible output which can be produced by the given quantities of inputs.

Q = f(L_d, L, K, O, T) … (i)

where

Q	= Output	L_d	= Land
L	= Labour	K	= Capital
O	= Organization	T	= Technology

the general equation of this simple production function is expressed symbolically as

Q = f(L, K) … (ii)

Types of Production Function

1. **Short Run Production Function**

- Short run production function is the technical or functional relationship between inputs and output where quantities of some inputs are kept constant and quantities of some inputs are varied.
- The input and output relationship in the short run is studied under the law of variable proportions.

$$Q = f(L, \overline{K}) \quad \ldots \text{(iii)}$$

where

f = Function

Q = Output

L = Labour which is variable factor

$\overline{K}$ = Capital, which is fixed factor

- The short-run production function is also expressed as

$$Q = f(N_{Vt}, \overline{K})$$

where

N_{Vt} = Units of variable input

Types of Production Function Contd…

2. Long Run Production Function

- Long run production function is defined as the production function in which all inputs are variable.
- In other words, long run production function is the technical or functional relationship between inputs and output when quantities of all inputs are variable.

$$\mathbf{Q = f(L, K) \quad \ldots (iv)}$$

where

Q = Quantity of output

L = Units of labour

K = Units of capital

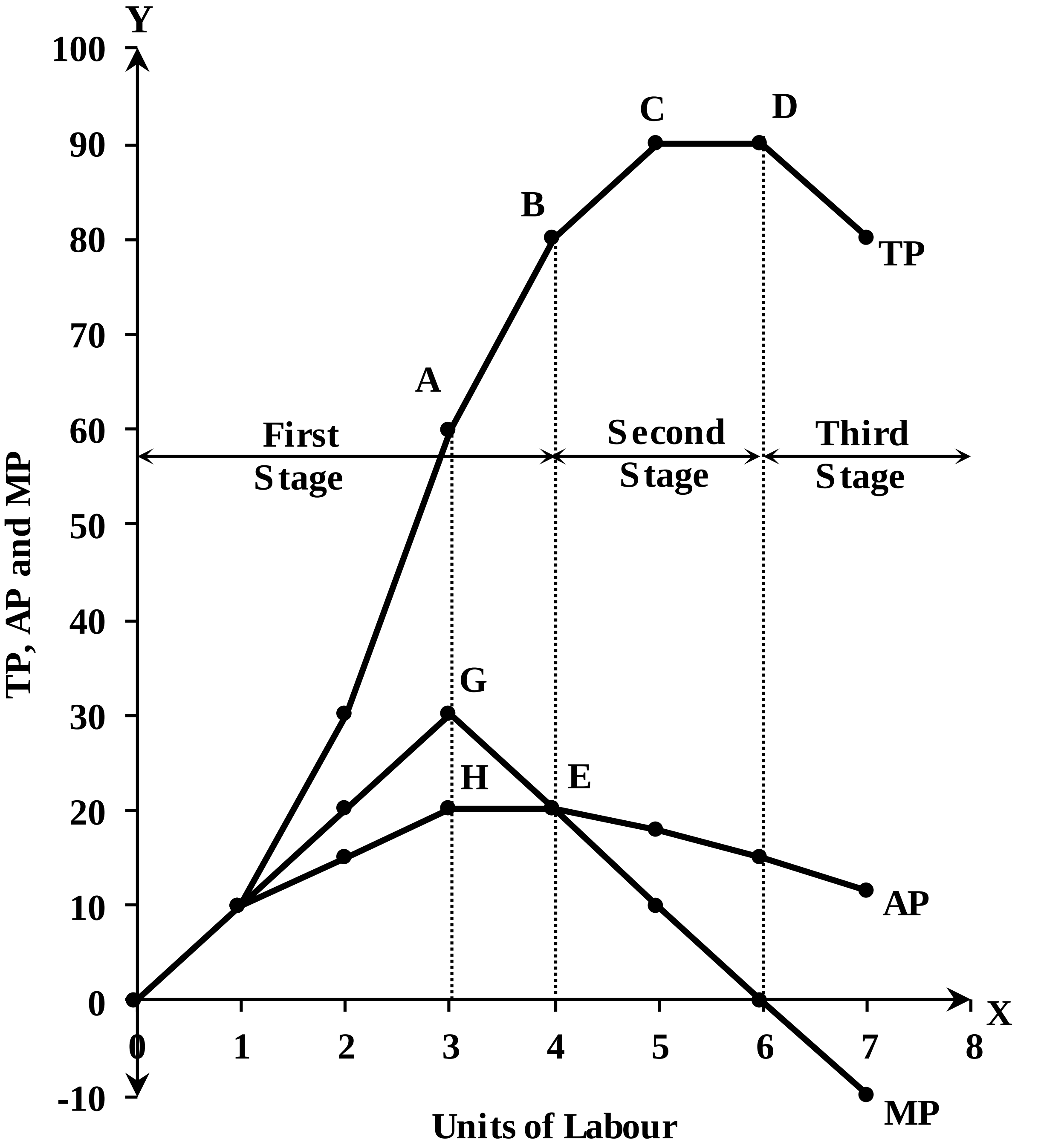
Law of Variable Proportions

The law of variable proportions is concerned with the short run production function. It examines production with single variable factor keeping quantities of other factors constant. This law was propounded by the economists like **Joan Robinson, Alfred Marshall, P.A. Samuelson,** etc. This law is also known as the law of diminishing returns.

Assumptions

- There is no change in technology.
- At least, one factor of production is fixed.
- There must be possibility of varying the proportion of factors of production.
- Labour is only a variable factor.
- All units of labour are homogeneous.

Land (in Ropanies)	Units of Labour	TP	AP	MP	Stage of Production
10	0	0	0	0	First stage
10	1	10	10	10	
10	2	30	15	20	
10	3	60	20	30	
10	4	80	20	20	
10	5	90	18	10	Second Stage
10	6	90	15	0	
10	7	80	11.4	–10	Third Stage



Y
TP, AP and MP
100
90
80
70
60
50
40
30
20
10
0
-10
C
D
B
TP
A
First Stage
Second Stage
Third Stage
G
H
E
AP
MP
X
0
1
2
3
4
5
6
7
8
Units of Labour

Law of Variable Proportions Contd.

Causes of Operation of Stages

1. **First Stage (Stage of Increasing Returns)**
   i. Increase in efficiency of fixed factor
   ii. Increase in the efficiency of variable factor
2. **Second Stage (Stage of Decreasing Returns)**
   i. Scarcity of fixed factor
   ii. Indivisibility of fixed factor
   iii. Imperfect substitutability of the factor
3. **Third Stage (Stage of Negative Returns)**
   i. Inefficient utilization of variable factor
   ii. Over utilization of fixed inputs
   iii. Complexity of management
   iv. Over utilization of fixed inputs

Law of Variable Proportions Contd.

Stage of Operation

(Which stage of production does a rational producer choose?)

- A rational producer does not choose first and third stage.
- In the first stage, TP increases at the increasing rate and MP of the variable factor also increases; and there is no full utilization of fixed factors of production. Thus, there is opportunity of increasing production by increasing quantity of variable factor.
- In the third stage, TP declines, AP also declines and MP becomes negative.
- Thus, the rational producer will choose second stage where both AP and MP of variable factors are diminishing; and there is full utilization of fixed factor.
- At which particular point of this stage, the producer will choose to produce depends upon the prices of factors.

Law of Variable Proportions Contd.

Application of the Law of Variable Proportions

The law of variable proportions specially applies to the agriculture. There are some reasons why agriculture is subject to this law, which are as follows:

- The agricultural operations spread out over a wide area. Therefore, it cannot be effectively supervised.
- Scope for the use of specialized machinery is also very limited in the agricultural sector.
- Agricultural operations are affected by rain fall and climate change.

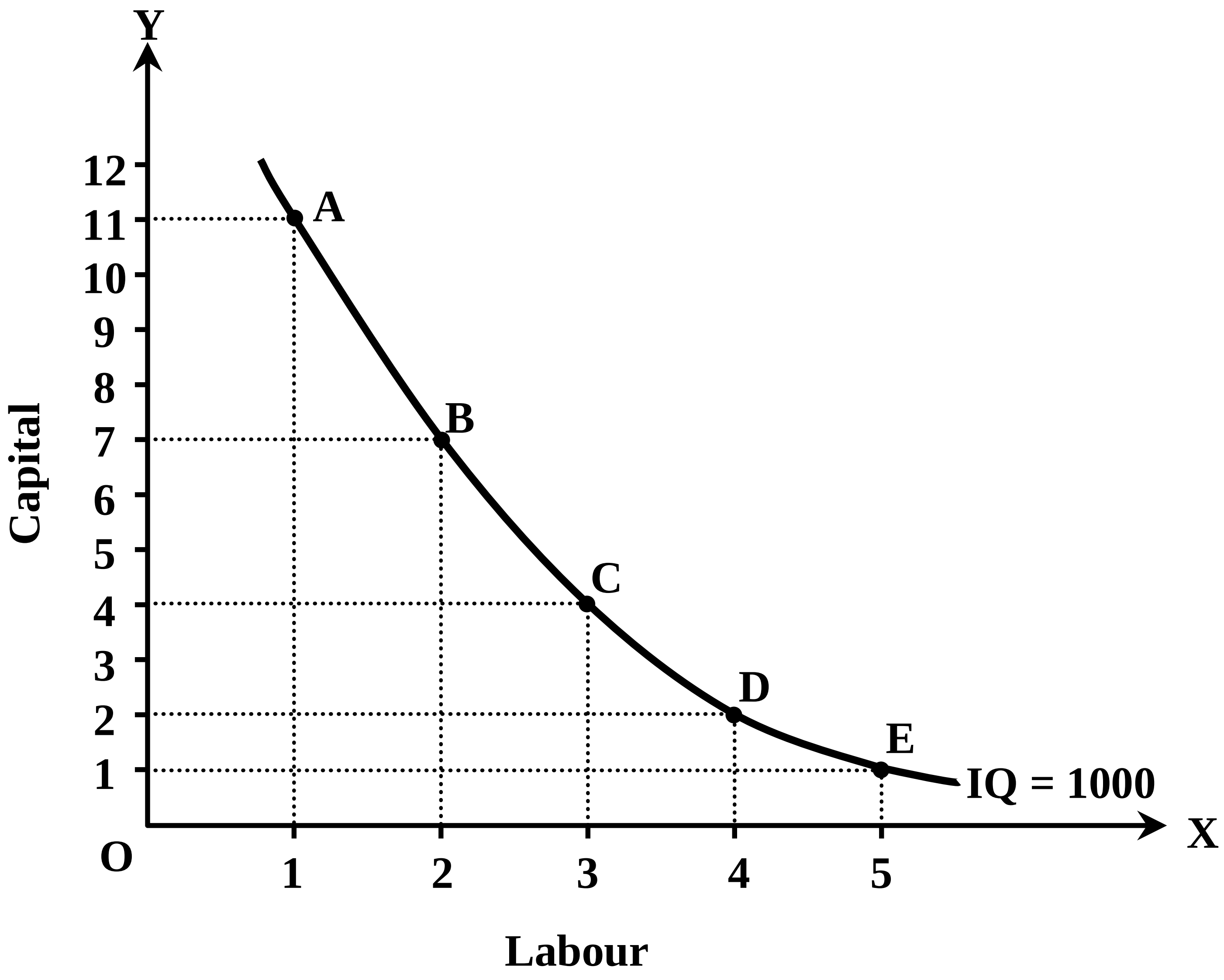
Isoquant

- Isoquant is defined as the locus of different combinations of any two inputs (labour and capital) which yield same level of output.
- This term 'isoquant' has been derived from a Greek word *'iso'* meaning equal and a Latin word *'quant'* meaning quantity.
- Therefore, the isoquant curve is also known as the *equal product curve* or *production indifference curve*.

Assumptions

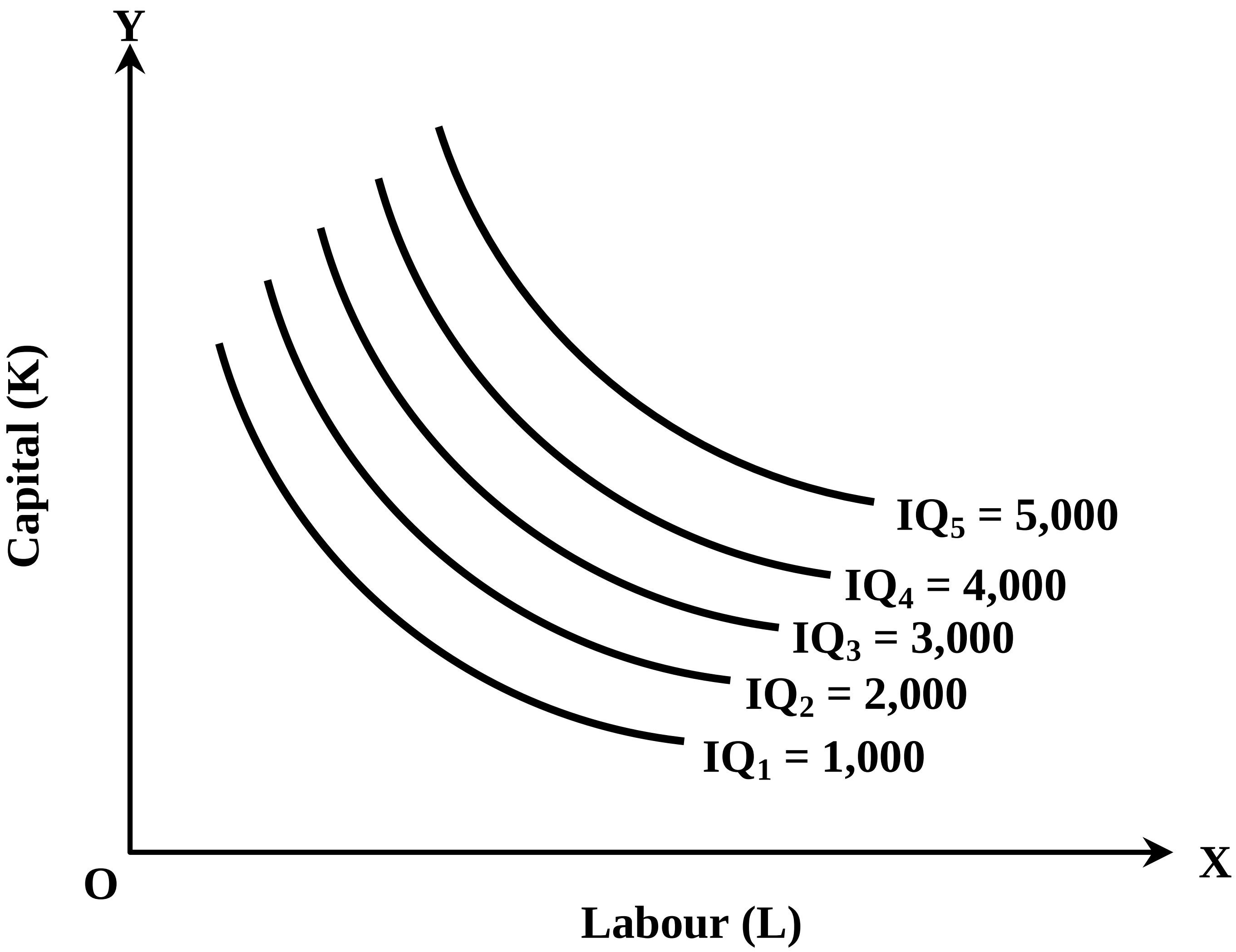
- The two inputs are imperfect substitute.
- Labour and capital can be substituted for one another only up to a certain limit.
- Production function is continuous, i.e. labour and capital are perfectly divisible and can be substituted in any small quantity.

Combinations	Labours	Capital	Output
A	1	11	1,000
B	2	7	1,000
C	3	4	1,000
D	4	2	1,000
E	5	1	1,000


Y
12
11
10
9
8
7
6
5
4
3
2
1
Capital
A
B
C
D
E
IQ = 1000
X
O
1
2
3
4
5
Labour

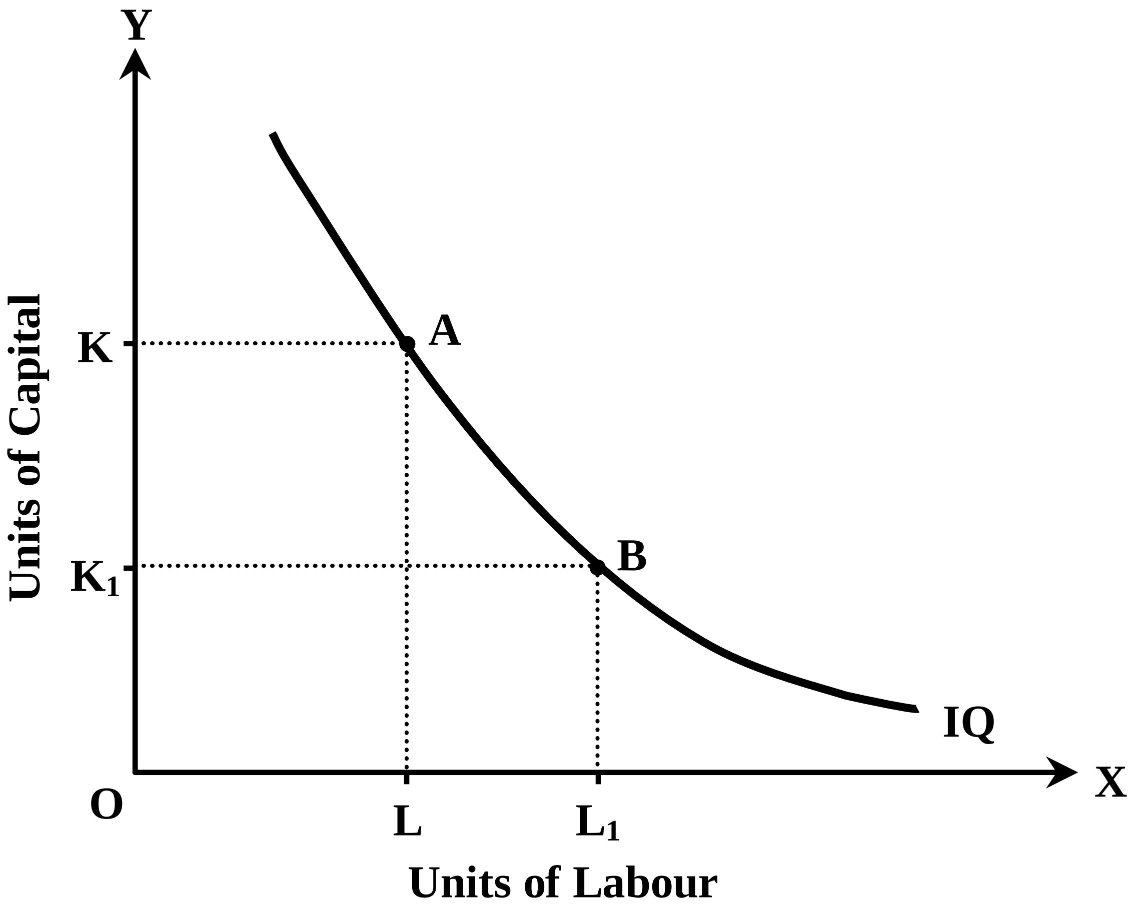
Isoquant Map

The set of isoquants is called isoquant map. A higher isoquant represents higher level of output and lower isoquant represents a lower level of output.



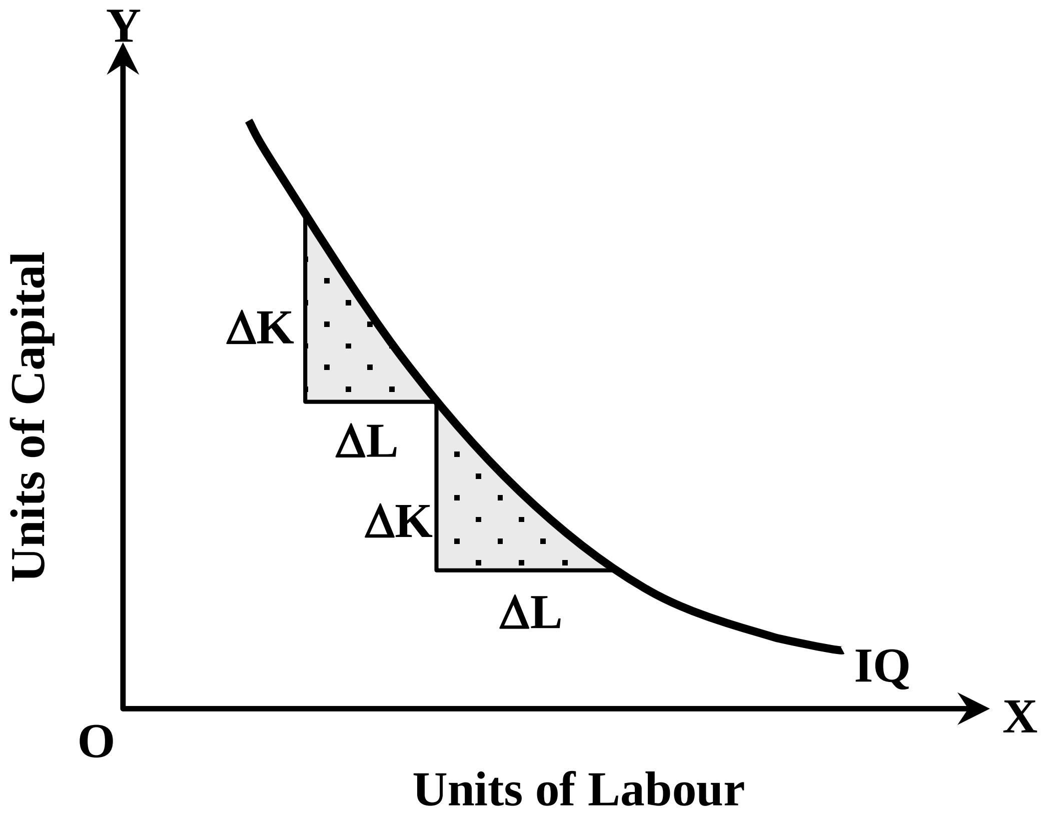
Properties of Isoquant

1. Isoquant has negative slope.



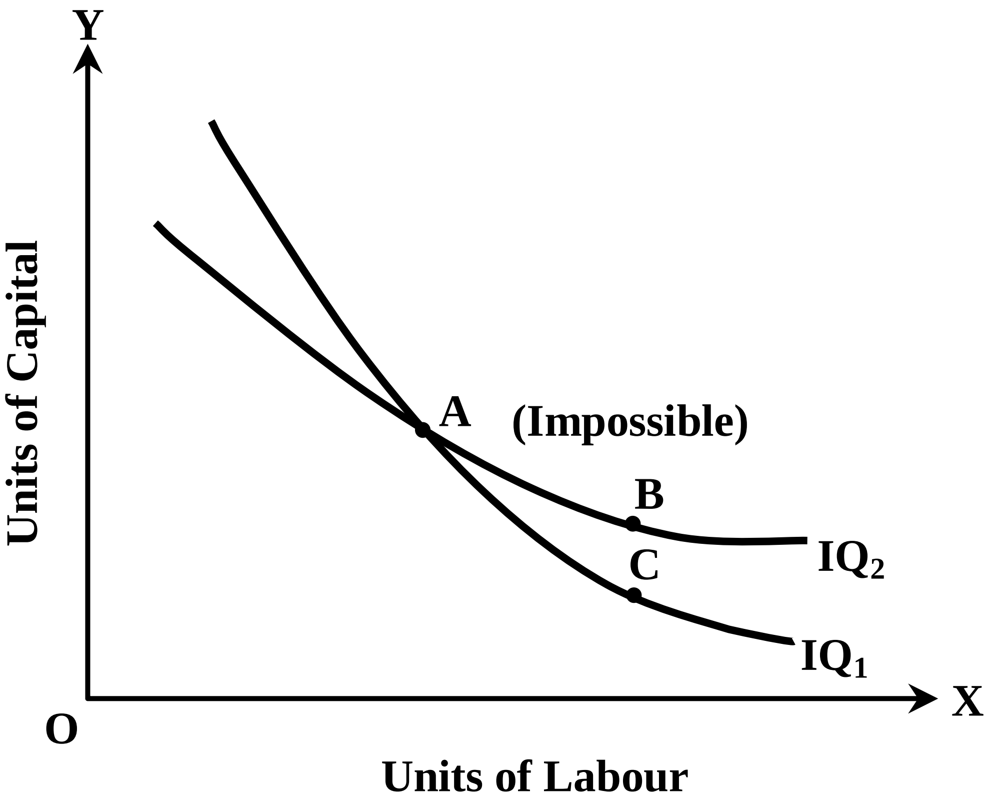
Properties of Isoquant Contd.

2. Isoquant is convex to the origin.



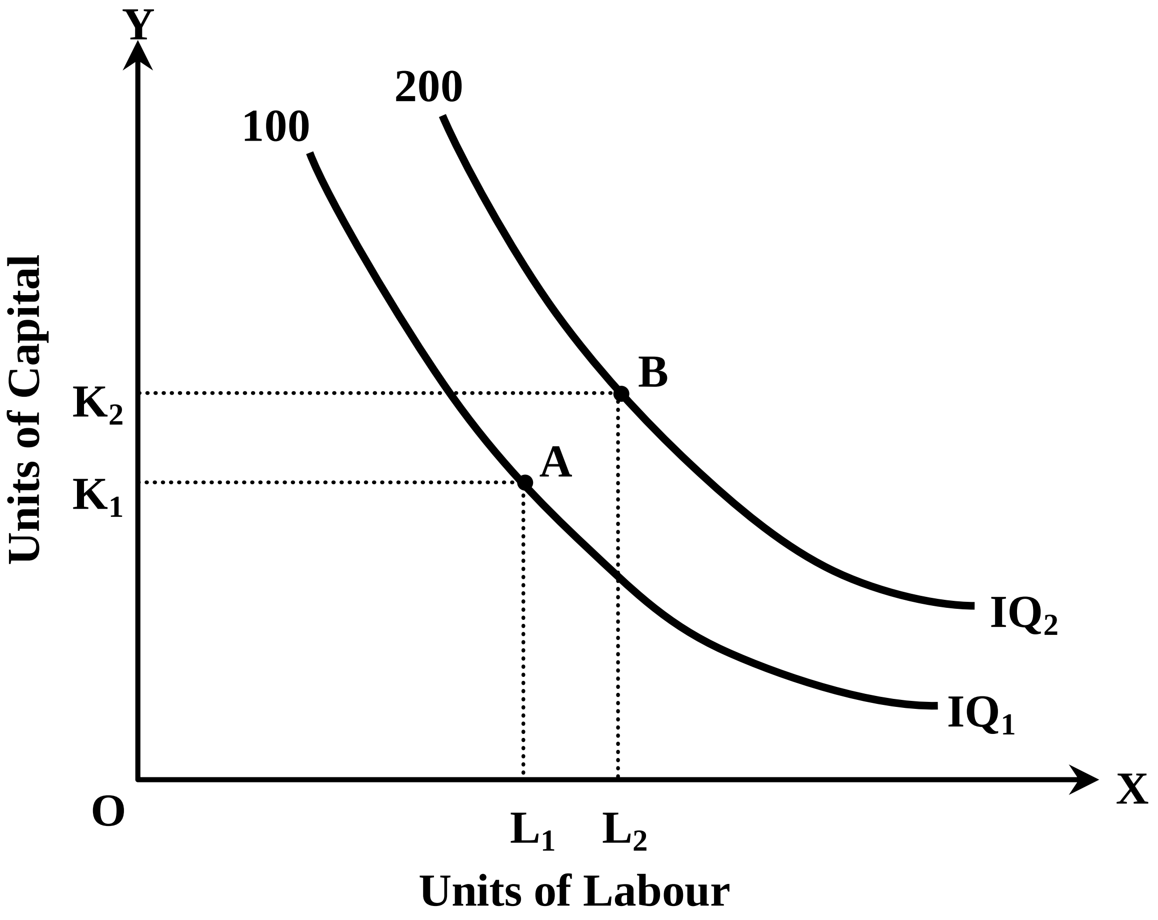
Properties of Isoquant Contd.

3. Isoquants never intersect with each other.



Properties of Isoquant Contd.

4. Higher the isoquant, higher will be output.



Marginal Rate of Technical Substitution (MRTS)

The marginal rate of technical substitution is defined as the rate at which one input can be substituted for another output remaining constant. In other words, marginal rate of technical substitution of labour for capital can be defined as the number of units of capital which can be replaced by one unit of labour keeping the level of output constant. Marginal rate of technical substitution is slope of the isoquant.

$$MRTS_{L,K} = -\frac{dK}{dL} = \frac{MP_L}{MP_K}$$

where

$MRTS_{L,K}$ = Marginal rate of technical substitution of labour for capital

MP_L = Marginal productivity of labour

MP_K = Marginal productivity of capital

Factor Combinations	Units of labor	Units of Capital	$MRTS_{L, K}$ = –
A	1	11	-
B	2	7	**4**
C	3	4	**3**
D	4	2	**2**
E	**5**	**1**	**1**

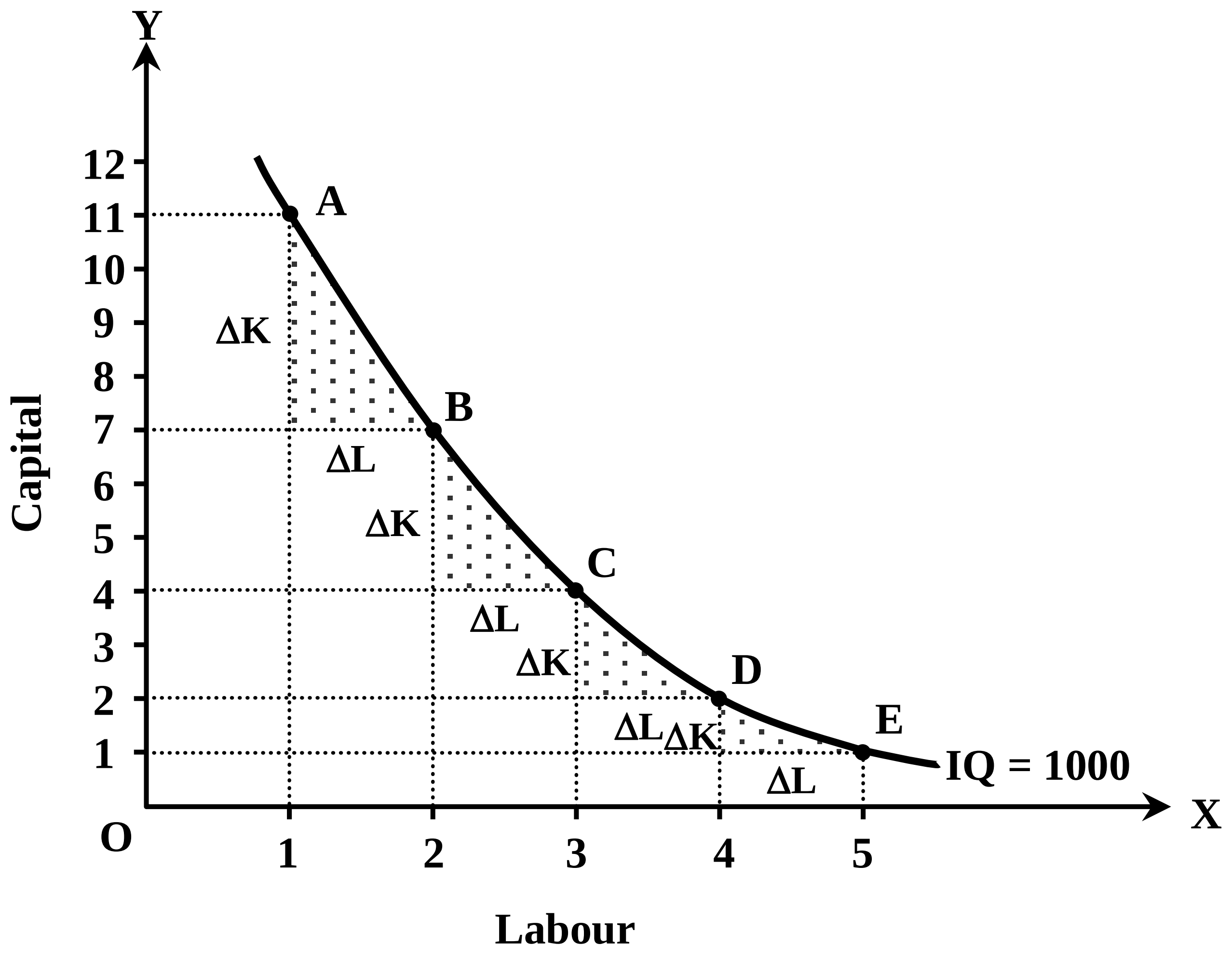
Slope of the Isoquant = $MRTS_{L,K} = -\frac{dK}{dL} = -\frac{MP_L}{MP_K}$

where

$MRTS_{L,K}$ = Marginal rate of technical substitution labour of capital

MP_L = Marginal productivity of labour

MP_K = Marginal productivity of capital



Isocost Line

Isocost line is defined as the locus of various combinations of any two inputs which the producer can get for a certain amount of money at a given prices of the factors of production or inputs. The concept of isocost line is based on the assumptions of two inputs, i.e. labour and capital; and given total cost or money outlay. Total cost or outlay is the sum of total expenditure made to purchase labour and capital. Thus,

Total outlay (C) = Total expenditure on labour + Total expenditure on capital

or, $C = P_L \cdot L + P_K \cdot K$

$\therefore$ $C = w \cdot L + r \cdot K$ **... (i)**

where

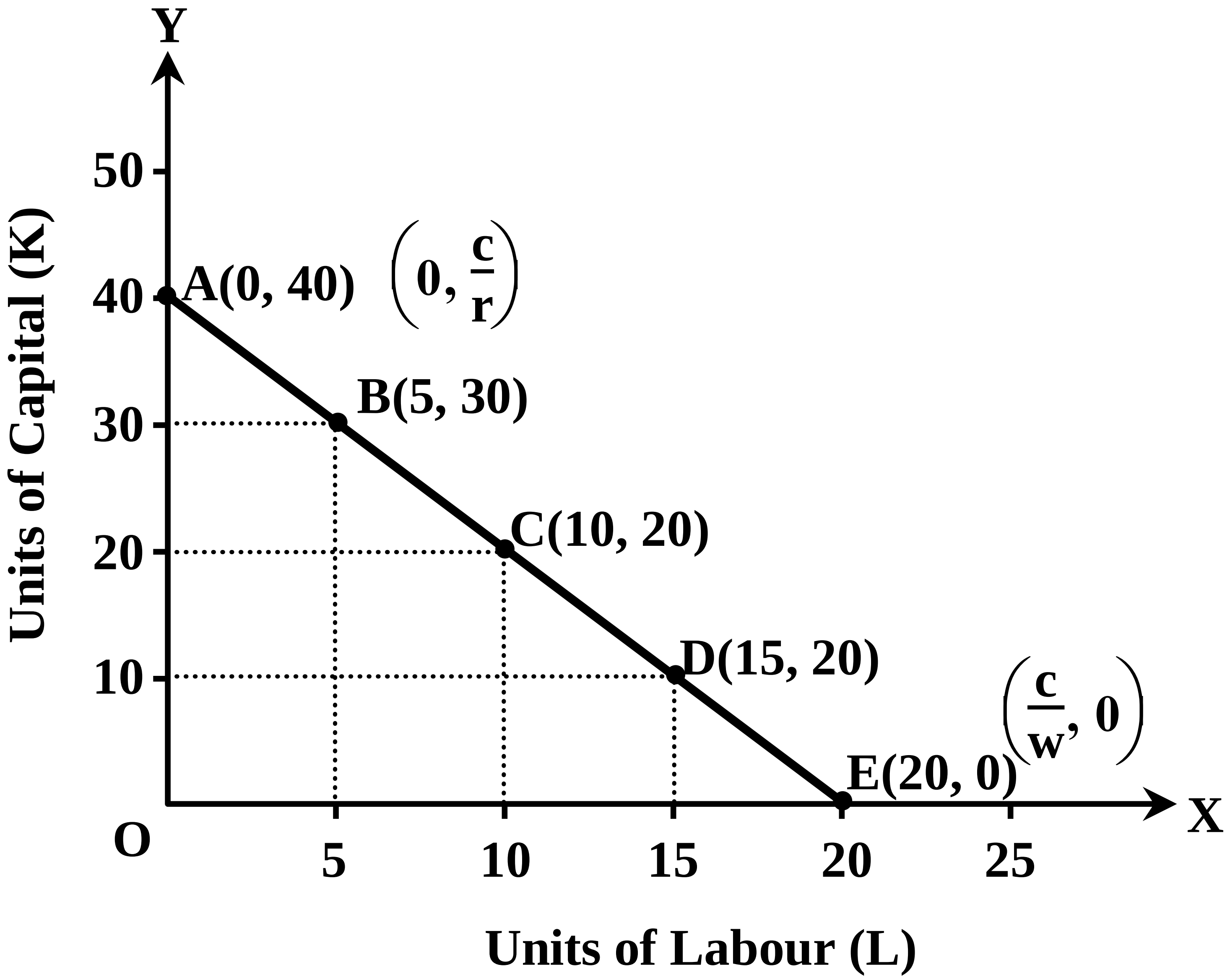
C = Total cost or outlay

w = Wage rage (Price of labour) r = Rate of interest (Price of capital)

L = Units of labour K = Units of capital

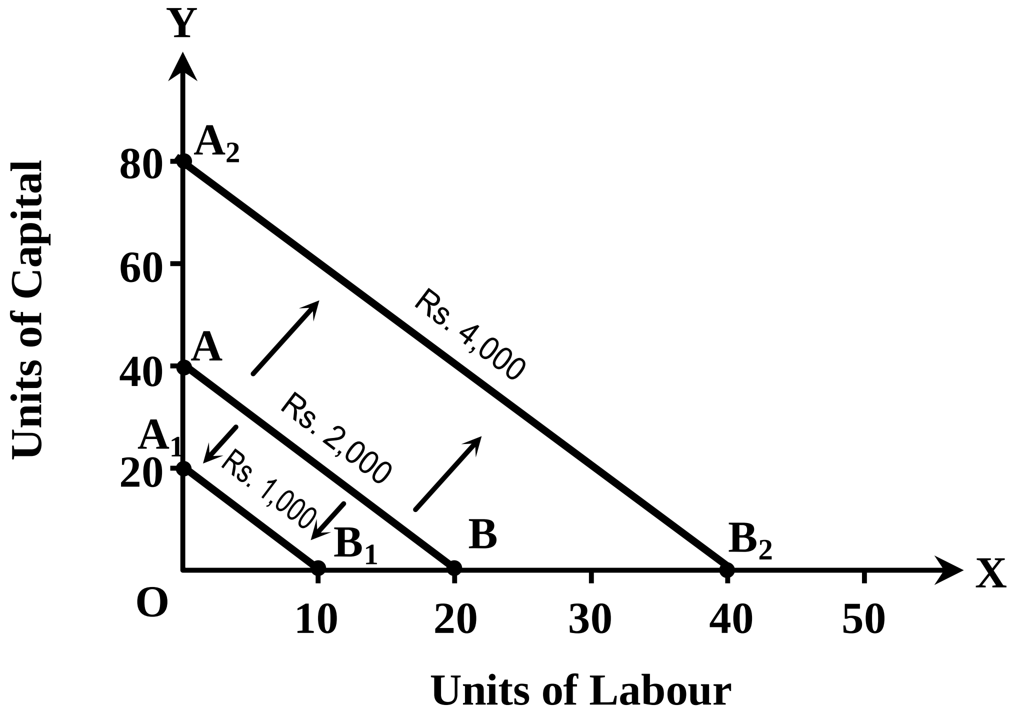
P_L = Price of labour P_K = Price of capital

Combinations	Price of Labour (w)	Units of Labour (L)	Price of Capital (r)	Units of Capital (K)	Cost Outlay ($C = wL + rK$)
A	Rs. 100	0	Rs. 50	40	$100 \times 0 + 50 \times 40$ = Rs. 2,000
B	Rs. 100	5	Rs. 50	30	$100 \times 5 + 50 \times 30$ = Rs. 2,000
C	Rs. 100	10	Rs. 50	20	$100 \times 10 + 50 \times 20$ = Rs. 2,000
D	Rs. 100	15	Rs. 50	10	$100 \times 15 + 50 \times 10$ = Rs. 2,000
E	Rs. 100	20	Rs. 50	0	$100 \times 20 + 50 \times 0$ = Rs. 2,000


Y
50
40
30
20
10
A(0, 40)
$\left(0, \frac{c}{r}\right)$
B(5, 30)
C(10, 20)
D(15, 20)
E(20, 0)
$\left(\frac{c}{w}, 0\right)$
O
5
10
15
20
25
X
Units of Capital (K)
Units of Labour (L)

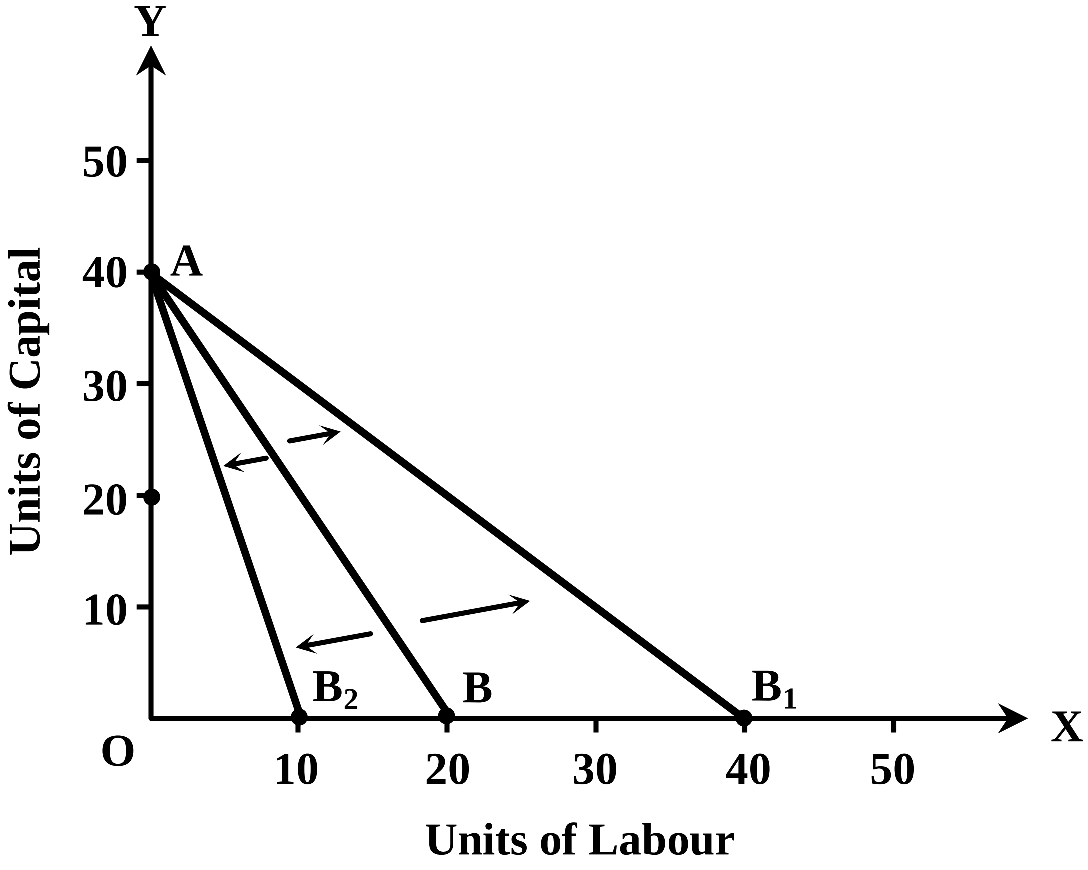
Change in Isocost Line

1. Effect of change in total outlay/ shift in isocost line



Change in Isocost Line Contd.

2. Effect of change in price of factors of production or inputs/ swing in isocost line



Optimum Employment of Inputs (Least Cost Combination of Two Inputs)

- Optimum employment of two inputs is also known as the least cost combination of two inputs or producer's equilibrium.
- It is assumed that a rational firm or producer always seeks to maximize profit.
- For profit maximization, the firm seeks to minimize cost of production for producing a given quantity of output or maximize output for the given level of cost outlay.
- The choice of particular combination of factors or inputs depends upon the technical possibilities of production and prices of factors of production or inputs used for the production of the particular product.
- The technical possibilities of production are represented by the isoquant map and prices of inputs used for the production of the particular products is represented by the isocost line.

Optimum Employment of Inputs (Least Cost Combination of Two Inputs) Contd.

Assumptions

- The producer is rational, i.e. he/she seeks to maximize profit.
- The producer uses two inputs: labour and capital.
- The price of both inputs (labour and capital) is fixed or constant.
- All units of inputs are homogeneous.
- The total cost or money outlay is given.
- There is existence of perfect competition in the factor market.
- Marginal rate of technical substitution must diminish.
- There exists isoquant map in case of output maximization and family of isocost line in case of cost minimization.

Optimum Employment of Inputs (Least Cost Combination of Two Inputs) Contd.

Conditions for Equilibrium

1. First order condition (Necessary condition): Isoquant must be tangent to the isocost line. In other words, the slope of isoquant should be equal to slope of isocost line.

Slope of isoquant = Slope of isocost line

or, $MRTS_{L,K} = \left(-\frac{w}{r}\right)$

or, $\left(-\frac{MP_L}{MP_K}\right) = \left(-\frac{w}{r}\right)$

or, $\frac{MP_L}{MP_K} = \frac{w}{r}$

$\therefore \quad \mathbf{\frac{MP_L}{w} = \frac{MP_K}{r}}$

where

$MRTS_{L,K}$ = Marginal rate of technical substitution of labour for capital

w = Wage rate or price of labour

r = Interest rate or price of capital

MP_L = Marginal productivity of labour

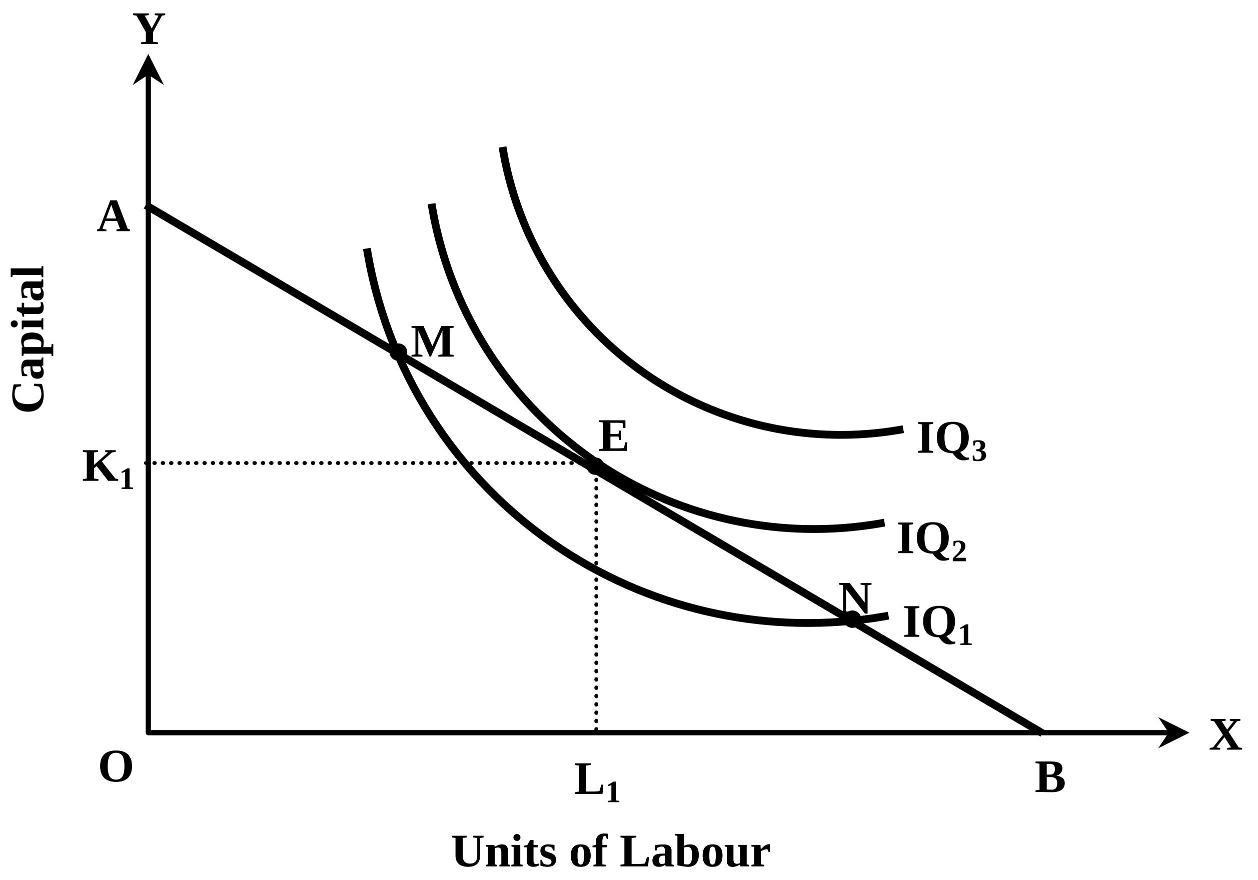
MP_K = Marginal productivity of capital

Optimum Employment of Inputs (Least Cost Combination of Two Inputs) Contd.

2. **Second order condition (Sufficient condition):** Isoquant must be convex to the origin at the point of tangency.

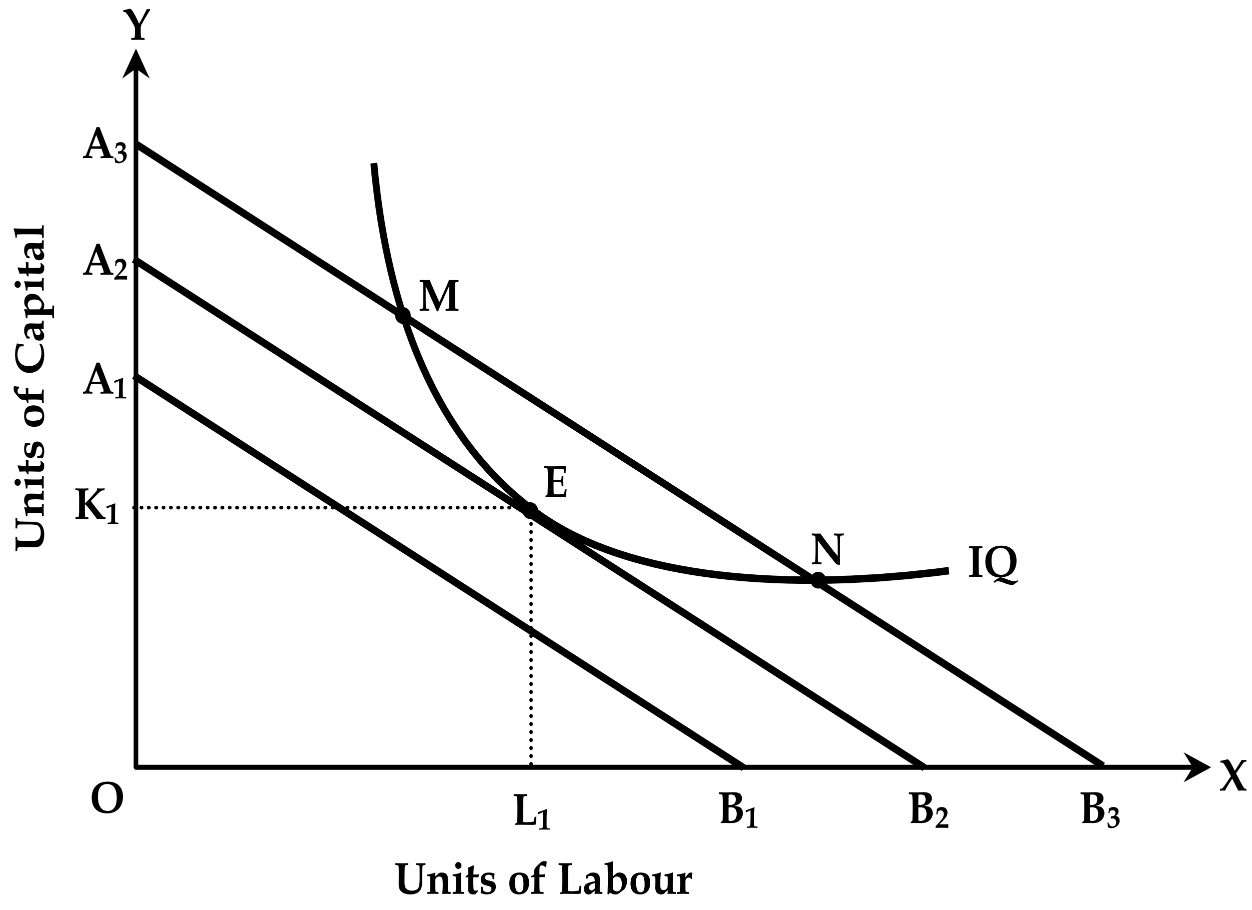
Approaches of Optimum Employment of Inputs

1. Maximization of output for the given cost outlay (Output maximization subject to cost constraint or financial constraint): A rational firm or producer seeks to maximize output at the given cost outlay. This is the situation in which the firm or producer is fixed with the resource constraint and seeks to maximize the output.



Optimum Employment of Inputs (Least Cost Combination of Two Inputs) Contd.

2. Minimization of cost for the given level of output (Cost minimization subject to output constraint): A rational firm or producer seeks to minimize cost at the given level of output. This is the situation in which producer or firm is faced with output constraint.



Laws of Returns to Scale

- Laws of returns to scale refers to long run input output relationship which explains how output changes when all inputs are varied in the equal proportions.
- In the returns to scale all factors of production are varied simultaneously at the same proportion.

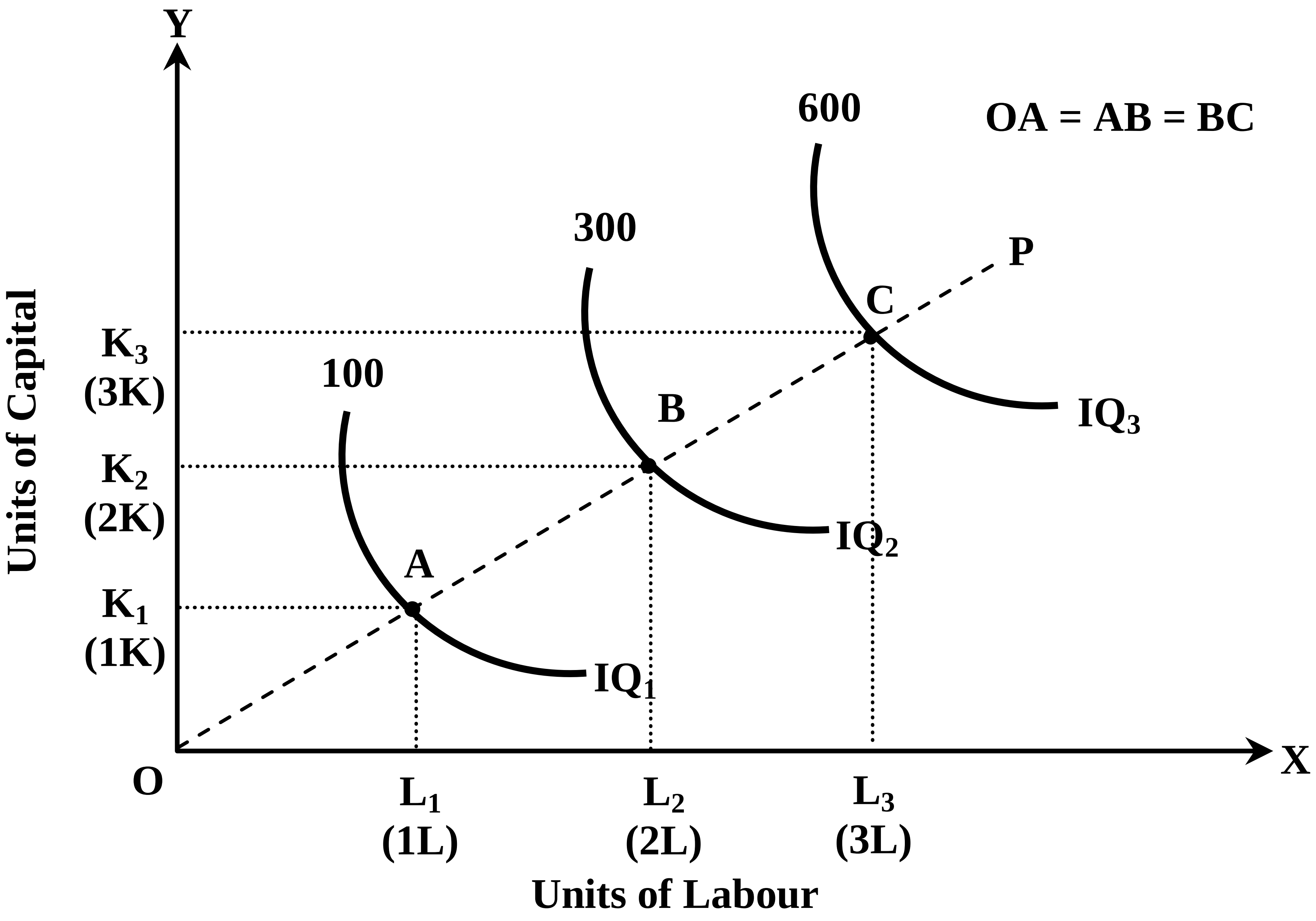
Types of Laws of Returns to Scale

1. Increasing Returns to Scale
2. Constant Returns to Scale
3. Decreasing Returns to Scale

Increasing Returns to Scale

- Increasing returns to scale refers to the increase in output at a greater proportion (percentage) than the proportionate or percentage increase in inputs.
- It means that if inputs are doubled, output will be more than double and if inputs are tripled, output will be more than triple.

Combinations	Labors (L)	Capital (K)	Total Product (TP)
A	1	1	100
B	2	2	300
C	3	3	600



Y
600
OA = AB = BC
300
P
C
K3
(3K)
100
B
IQ3
K2
(2K)
IQ2
A
K1
(1K)
IQ1
Units of Capital
O
X
L1
(1L)
L2
(2L)
L3
(3L)
Units of Labour

Increasing Returns to Scale Contd.

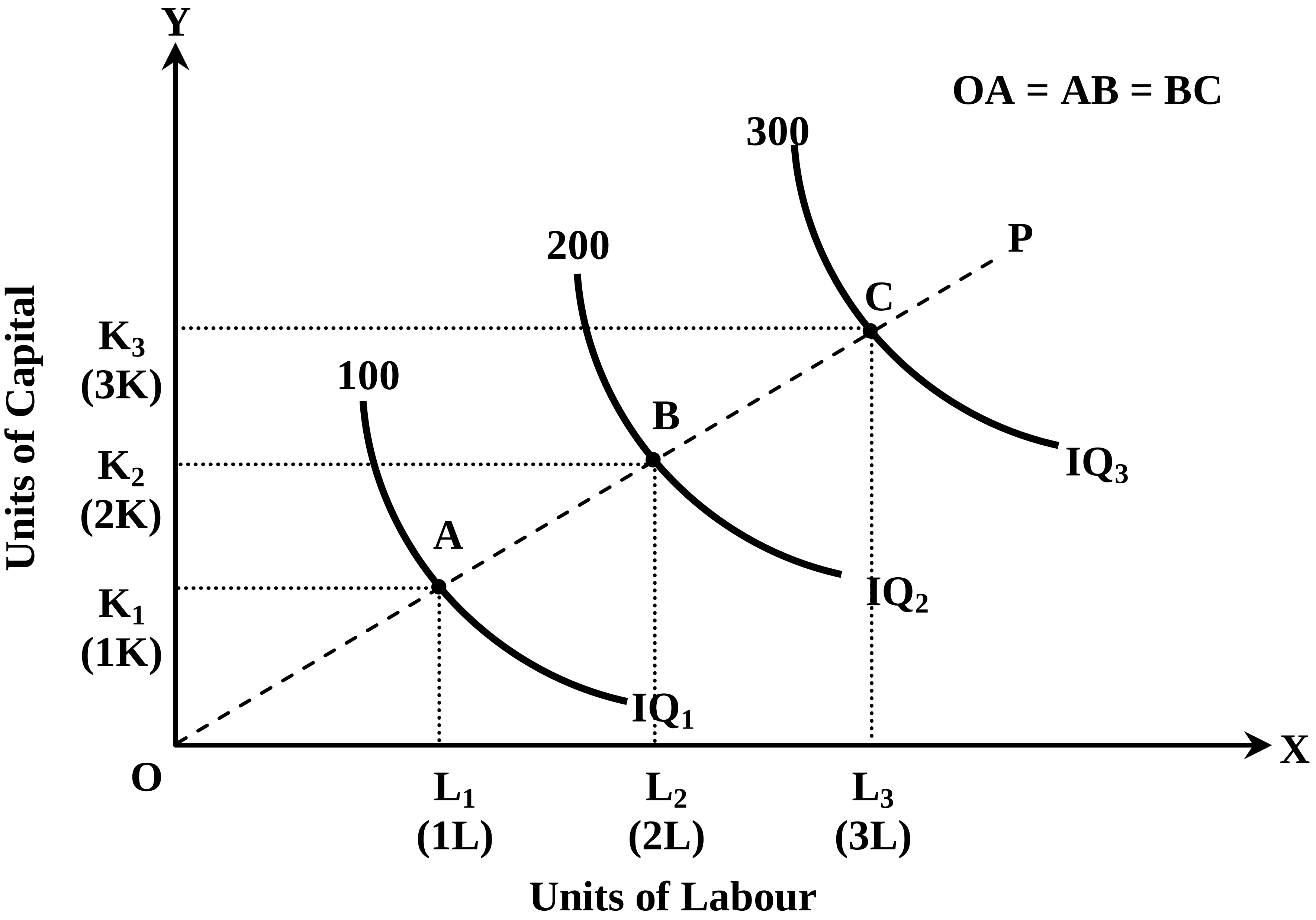
Causes of Increasing Returns to Scale

1. Technical and managerial indivisibilities
2. Higher degree of specialization
3. Dimensional relations

Constant Returns to Scale

- Constant returns to scale refers to the equal proportionate or percentage change in output and inputs.
- It means that if inputs are doubled, output will be also double and if inputs are tripled, output will be also triple and so on.

Combinations	Labors (L)	Capital (K)	Total Product (TP)
A	1	1	100
B	2	2	200
C	3	3	300


Y
OA = AB = BC
300
200
P
C
K3
(3K)
100
B
IQ3
K2
(2K)
A
IQ2
K1
(1K)
IQ1
X
O
L1
(1L)
L2
(2L)
L3
(3L)
Units of Capital
Units of Labour

Constant Returns to Scale Contd.

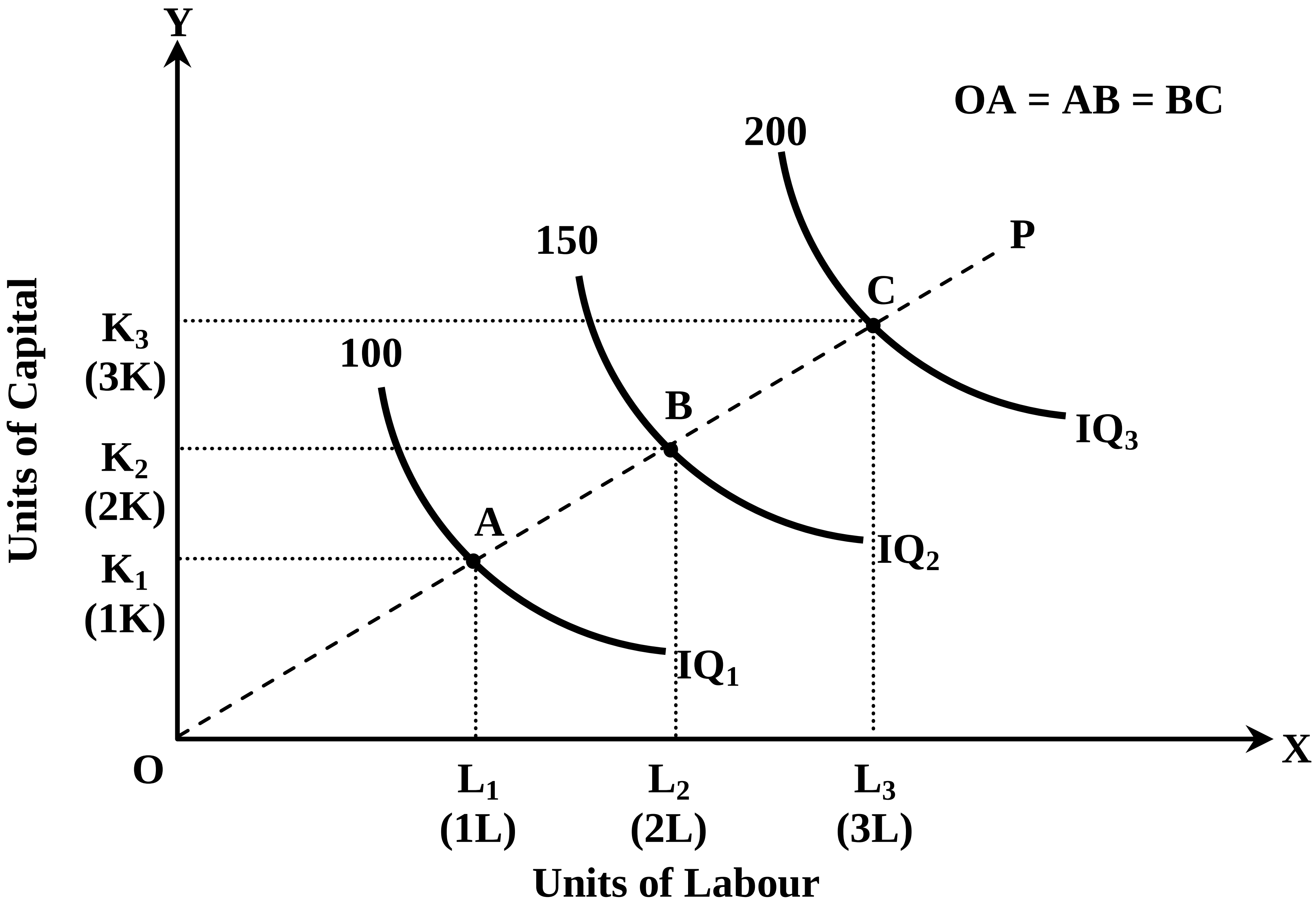
Causes of Constant Returns to Scale

1. Limitations of economies of scale
2. Divisibility of inputs

Decreasing Returns to Scale

- Decreasing returns to scale refers to increase in output at a smaller proportion or percentage than the proportionate or percentage increase in inputs.
- It means that if inputs are doubled, output will be less than double and if inputs are tripled, output will be less than triple and so on.

Combinations	Labors (L)	Capital (K)	Total Product (TP)
A	1	1	100
B	2	2	150
C	3	3	200


Y
OA = AB = BC
200
150
P
C
K3
(3K)
100
B
IQ3
K2
(2K)
A
IQ2
K1
(1K)
IQ1
Units of Capital
O
X
L1
(1L)
L2
(2L)
L3
(3L)
Units of Labour

Decreasing Returns to Scale Contd.

Causes of Decreasing Returns to Scale

1. Managerial diseconomies
2. Limitedness of the natural resources
3. Labour diseconomies
4. Entrepreneurship as a fixed factor

Numerical Examples 1

Consider the following data

No. of Labour (L)	1	2	3	4	5	6	7	8
Total Output	40	100	180	240	280	300	310	300

a. Compute AP and MP.

b. Graph TP, AP and MP and explain their relationship in reference to law of variable proportions.

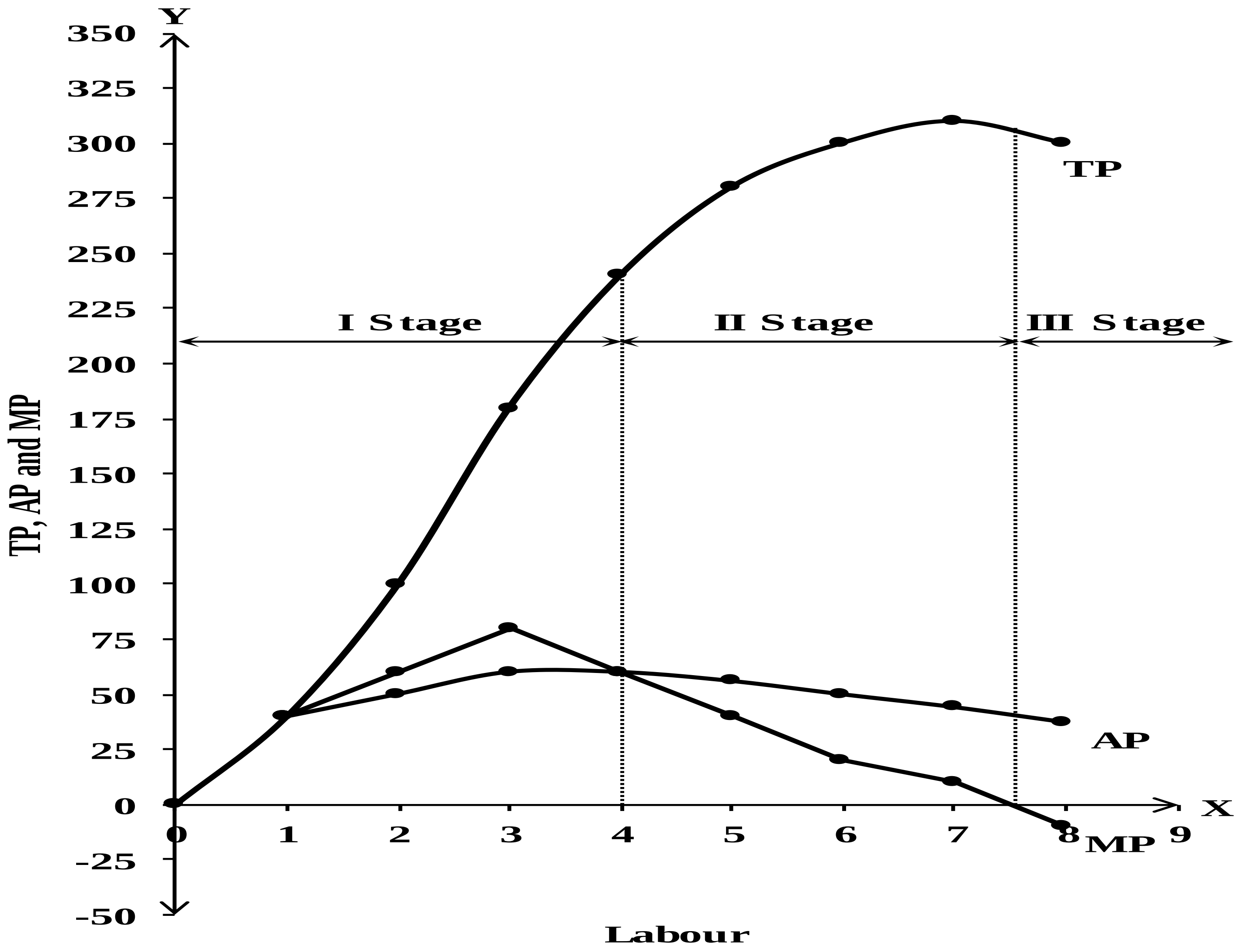
c. Using schedule, explain the relationship between (i) TP and MP and (ii) AP and MP.

SOLUTION

a. **Computation of AP and MP**

Labour (Units)	TP	AP	MP
0	0	-	-
1	40	40.0	40
2	100	50.0	60
3	180	60.0	80
4	240	60.0	60
5	280	56.0	40
6	300	50.0	20
7	310	44.3	10
8	300	37.5	-10

b. Graphical Representation of TP, AP and MP.



There are three stages of the law of variable proportions which are explained below:

Stage I: In this stage, TP first increases at an increasing rate up to the 3^{rd} unit of labour and increases at a diminishing rate up to the 4^{th} unit of labour. AP is increasing throughout the stage. MP first increases and after reaching its maximum starts, falling. This stage ends at the point where AP = MP. AP and MP are equal at 4^{th} unit of output.

Stage II: In this stage, TP increases at a diminishing rate. AP and MP both are decreasing. This stage ends at the point where MP = 0 or TP is the maximum.

Stage III: In this stage, TP is decreasing. Both AP and MP are decreasing. AP remains positive but MP is negative.

c. i. The relationship between AP and MP are as follows:

When AP < MP, AP increases

When AP = MP, AP is the maximum

When AP > MP, AP is decreasing.

ii. The relationship between TP and MP are as follows:

When MP > 0, TP is increasing.

When MP = 0, TP is at its maximum.

When MP < 0, TP is decreasing.

Numerical Examples 2

Using the production function, $Q = 16L + 8L^2 – L^3$, answer the following:

a. Compute TP, AP and MP schedules.

b. Draw TP, AP and MP and explain the three stages of production or law of variable properties.

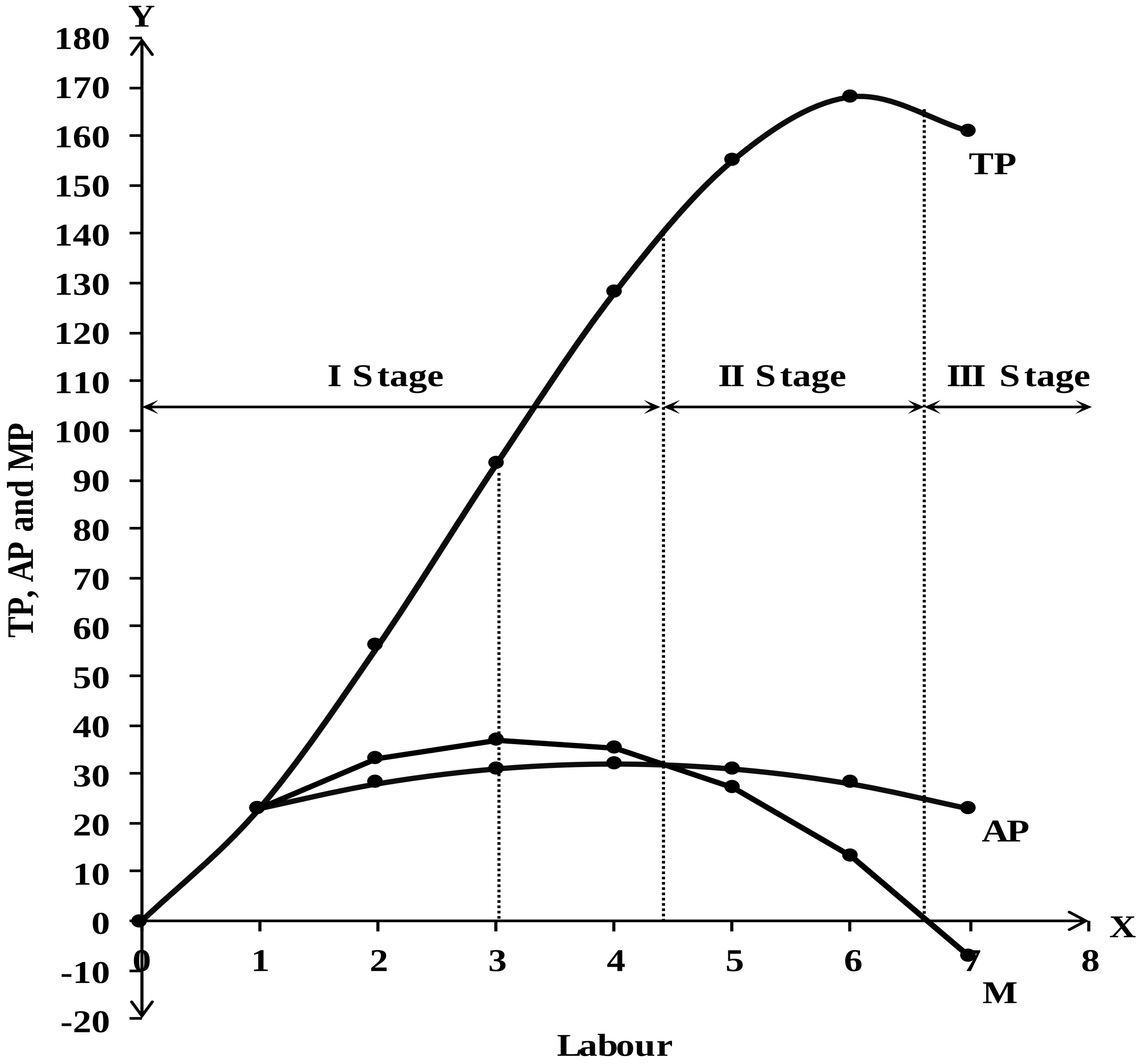
c. Using production schedule, explain the relationship between AP and MP.

SOLUTION

a. TP, AP and MP schedules has been computed as follows:

Labour (Units)	$TP = Q = 16L + 8L^2 - L^3$	AP	MP	Stages of Production
0	$16 \times 0 + 8 \times 0^2 - 0^3 = 0$	-	-	I Stage
1	$16 \times 1 + 8 \times 1^2 - 1^3 = 23$	23	23	
2	$16 \times 2 + 8 \times 2^2 - 2^3 = 56$	28	33	
3	$16 \times 3 + 8 \times 3^2 - 3^3 = 93$	31	37	
4	$16 \times 4 + 8 \times 4^2 - 4^3 = 128$	32	35	II Stage
5	$16 \times 5 + 8 \times 5^2 - 5^3 = 155$	31	27	
6	$16 \times 6 + 8 \times 6^2 - 6^3 = 168$	28	13	
7	$16 \times 7 + 8 \times 7^2 - 7^3 = 161$	23	-7	III Stage

b. Based on the above schedule, TP, AP and MP curves can be drawn as follows:



Based on the above table and schedule, three stages of production can be explained as follows:

i. **First stage (Stage of increasing returns):** In this stage, TP increases at an increasing rate up to 3rd unit of labour and increases at the decreasing rate with increase in units of labour. AP increases throughout the stage. MP increases up to 3rd unit of labour and thereafter, it declines. This stage ends when AP = MP.

ii. **Second stage (Stage of diminishing returns):** In this stage, TP increases at the diminishing rate. At 6th unit of labour, TP is maximum. Both AP and MP are decreasing. At the end of the stage, when TP is maximum, MP = 0.

iii. **Third stage (Stage of negative returns):** In this stage, TP is continuously decreasing. AP is also continuously decreasing but never becomes zero and negative. MP is negative.

c. The relationship between AP and MP is as follows:

- When AP > MP up to 3rd unit of output, AP is increasing.
- At the labour range of 3rd unit to 4th unit, AP increasing but MP is decreasing.
- At the labour range of 4th unit to 7th unit, both AP and MP are declining. MP is negative at 7th unit of labour.

Numerical Examples 3

Consider the following three production preference schedules:

Schedule I				Schedule II				Schedule III			
Combina-tions	K	L	Out-put	Combina-tions	K	L	Out-put	Combina-tions	K	L	Out-put
A	1	20	1000	E	1	22	1200	M	1	27	1500
B	2	16	1000	F	2	17	1200	N	2	22	1500
C	3	13	1000	G	3	14	1200	O	3	18	1500
D	4	12	1000	H	4	13	1200	P	4	17	1500

Suppose, a producer has fixed total cost outlay equal to Rs. 2000. Prices of labour per units and capital per unit are Rs. 100 and Rs. 200 respectively.

a. Compute total cost for each combinations containing in each production preference schedule and identify least cost combination which maximize output at given total cost outlay.

b. Sketch an iso-cost line and IQ map and identify that which combination of capital and labour will put the producer at an optimum point.

SOLUTION

Given

Total cost outlay (C) = 2000

Price of labour (P_L or w) = Rs. 100

Price of capital (P_K or r) = Rs. 200

a. Calculation of Total Cost

Schedule	Combination	K	P_K	L	P_L	Total Outlay ($P_K . K + P_L . L = C$)
i	A	1	200	20	100	200 × 1 + 100 × 20 = 2200
	B	2	200	16	100	200 × 2 + 100 × 16 = 2000
	C	3	200	13	100	200 × 3 + 100 × 13 = 1900
	D	4	200	12	100	200 × 4 + 100 × 12 = 2000
ii.	E	1	200	22	100	200 × 1 + 100 × 22 = 2400
	F	2	200	17	100	200 × 2 + 100 × 17 = 2100
	G	3	200	14	100	200 × 3 + 100 × 14 = 2000
	H	4	200	13	100	200 × 4 + 100 × 13 = 2100
iii.	M	1	200	27	100	200 × 1 + 100 × 27 = 2900
	N	2	200	22	100	200 × 2 + 100 × 22 = 2600
	O	3	200	18	100	200 × 3 + 100 × 18 = 2400
	P	4	200	17	100	200 × 4 + 100 × 17 = 2500

As shown in the above schedule least cost combinations of two inputs are C, G and O respectively. However, given the total outlay combinations G is the optimal combination. It is the highest possible combinations producing 1200 units at the given prices of two inputs that is P_K = Rs. 200 and P_L =Rs. 100.

b. If L = 0, $K = \frac{C}{P_K} = \frac{2,000}{200} = 10$ units

Hence, A(0, 10)

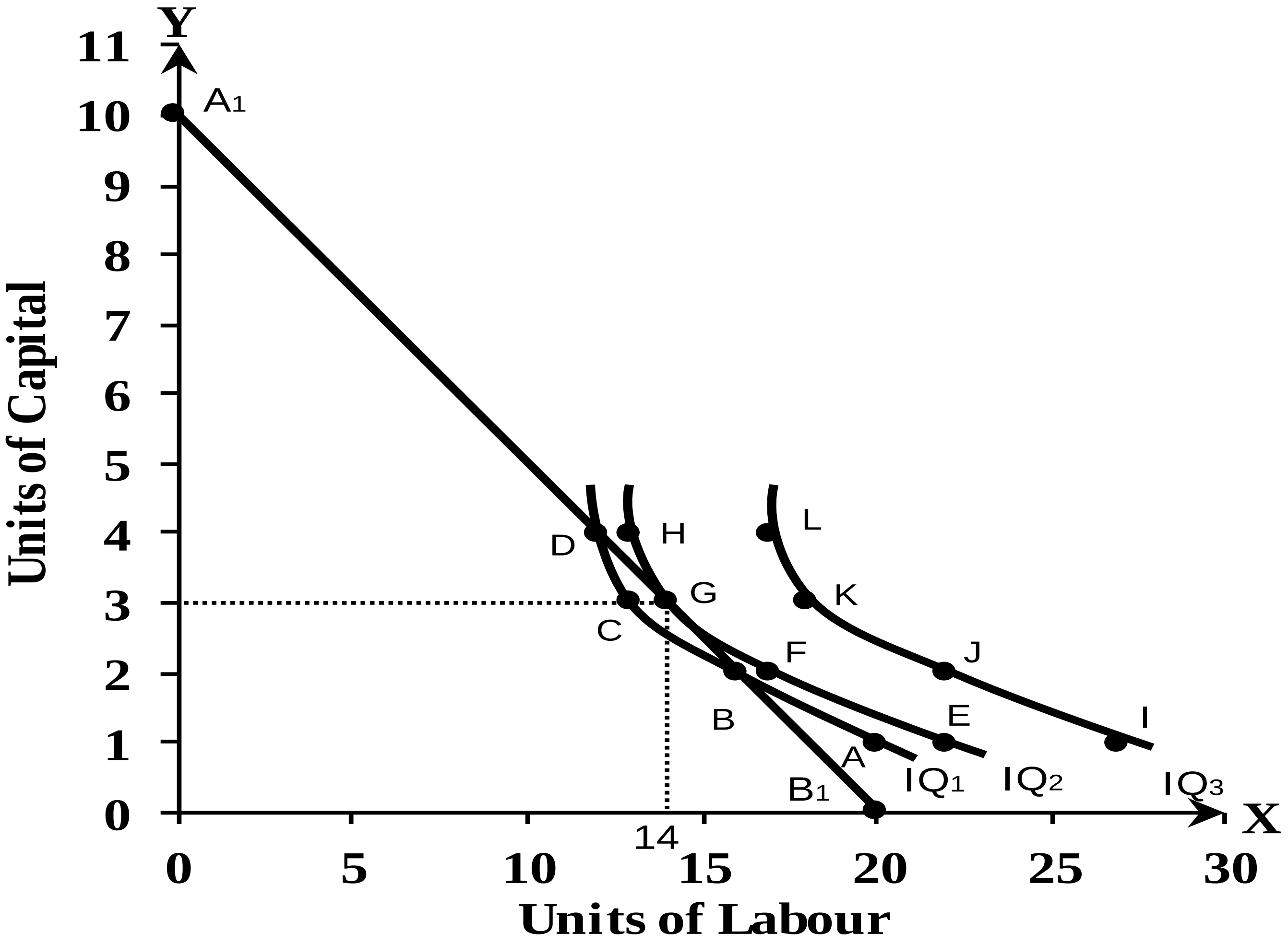
If K = 0, $L = \frac{C}{P_L} = \frac{2,000}{100} = 20$ units

Hence, B (20, 0)

This gives isocost cost line A_1B_1, which is shown in the following figure.:

Now, plotting these points and the given production schedules, we get equilibrium point as show in the following figure.

In the figure, a producer is in equilibrium at point F. In this situation, he produces 1200 units of output by employing 3 units of capital and 14 units of labour.



Part B: Cost Analysis

Meaning of Cost

- Cost is defined as the money expenditure incurred on factors of production while producing a commodity.
- In order to produce goods and services, a firm uses raw materials and various factors of production, which are called inputs.
- The expenditure incurred on these inputs is called cost.
- In other words, cost refers to all sorts of monetary expenditures incurred in the production of a commodity.

Various Concepts of Cost

1. Opportunity Cost
2. Implicit and Explicit Cost
3. Accounting and Economic Cost
4. Fixed Cost and Variable Cost
5. Short Run and Long Run Costs

Cost Function

- Cost function shows that relationship between cost of production and the level of production.
- Cost of production is influenced by various variables like level of output, price of inputs, technology, etc.

$$\mathbf{C = f(Q, P_f, T, \ldots)}$$

where

C = Cost of production

T = Technology

P_f = Price of inputs or factors of production

Q = Quantity of output

Although, cost of production is influenced by various factors, for simplicity, we assume that cost of production is the function of level of output.

$$\mathbf{C = f(Q)}$$

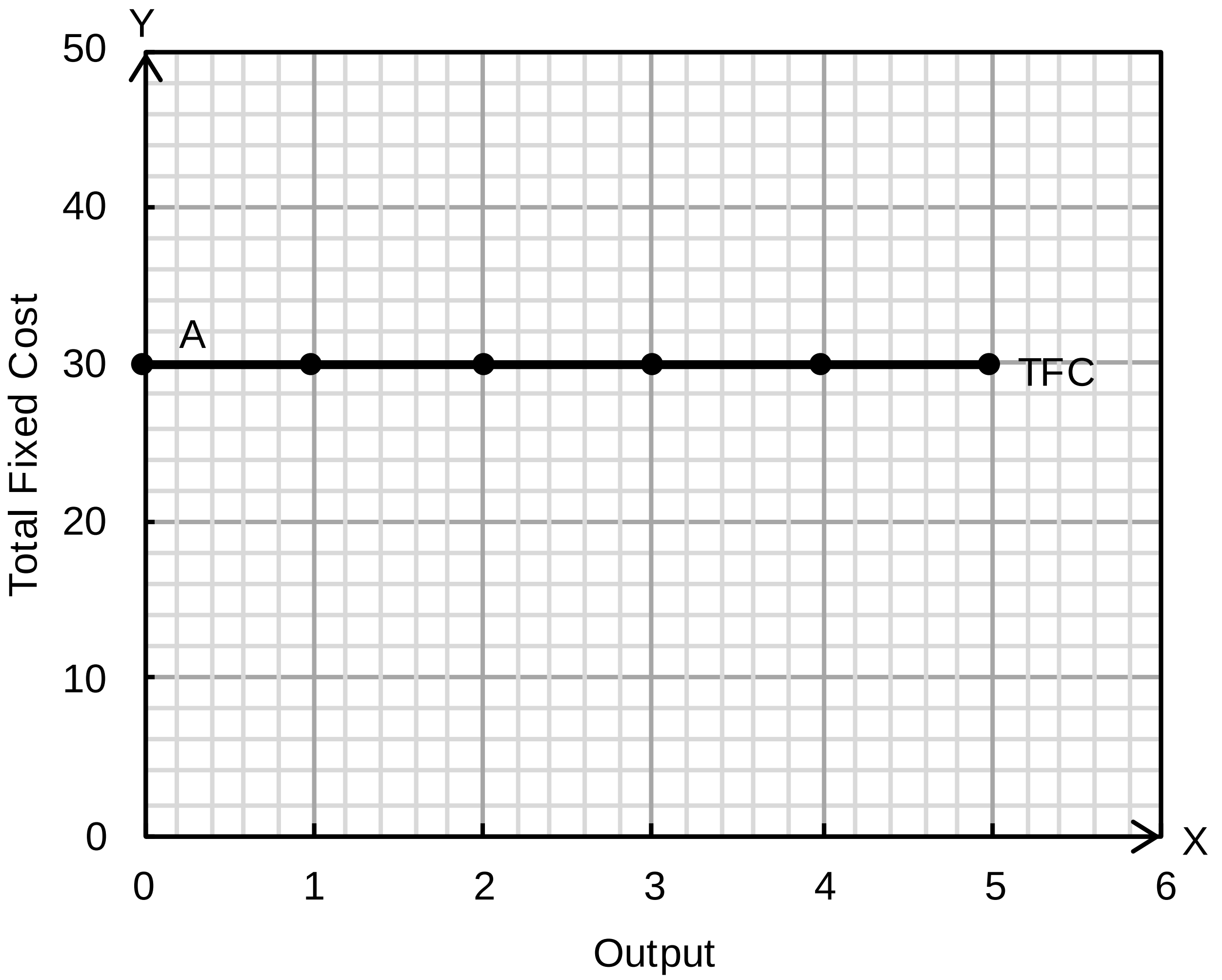
Derivation of Short run Cost Curves: Short run Total Cost Curves

1. **Total Fixed Cost (TFC)**

- Total fixed cost is defined as the total expenses incurred by fixed factors of production.
- The fixed cost remains unchanged, whatever be the level of output.
- Even if there is no output at a time, this cost will have to be incurred.
- Fixed cost includes rent of factory, salaries payment of permanent employees, interest on capital, insurance premium, license fee, etc.

Derivation of Short run Cost Curves: Short run Total Cost Curves Contd.

Output (in units)	TFC (in Rs.)
0	30
1	30
2	30
3	30
4	30
5	30



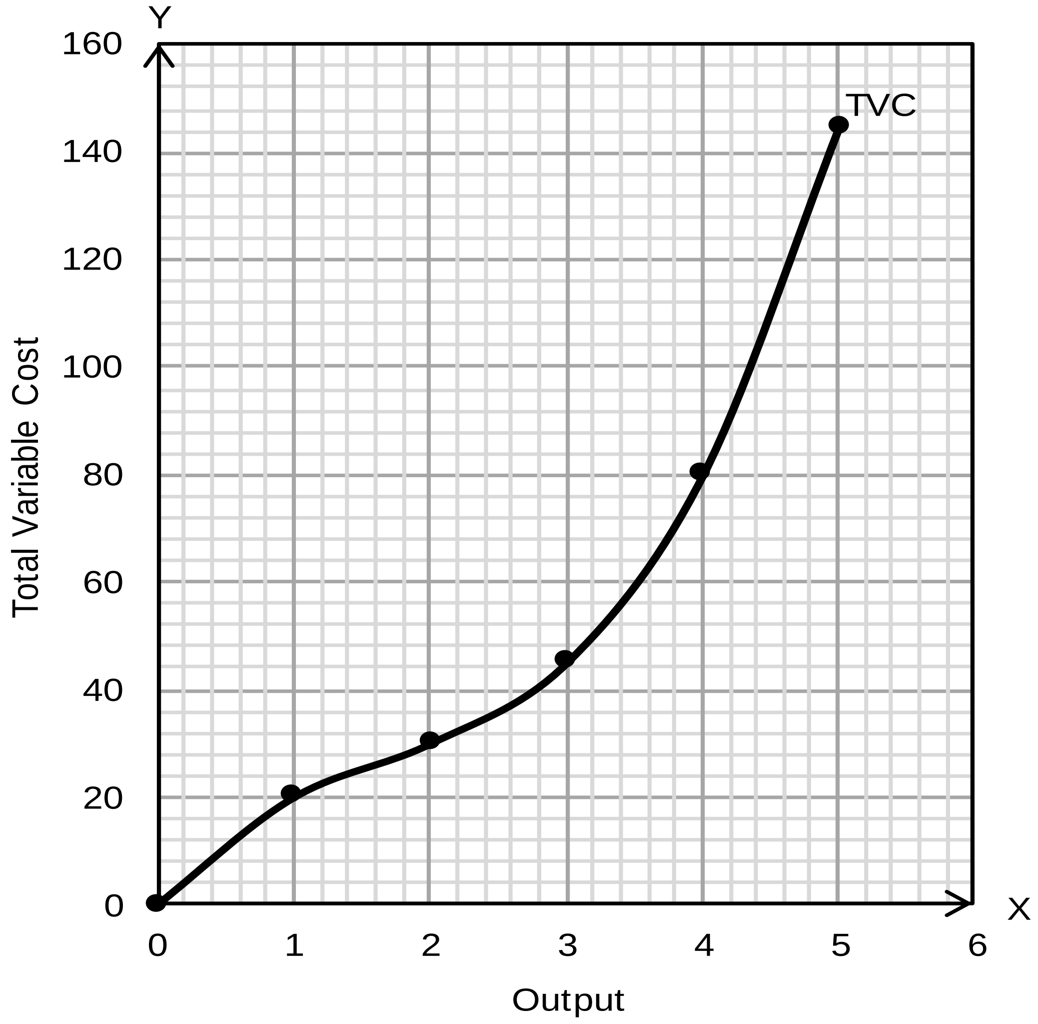
Derivation of Short run Cost Curves: Short run Total Cost Curves Contd.

2. Total Variable Cost (TVC)

- Total variable cost is defined as the total expenses incurred by variable factors of production.
- Variable factors are the factors, which change with the change in output.
- Thus, variable cost is that cost which changes with the change in output.
- Variable cost includes the cost of raw materials, wages of labour, cost of fuel, etc.
- If the output increases, the total variable cost will increase.
- If the output decreases, the total variable cost will decrease.
- If the output is zero, the total variable cost will also be zero.

Derivation of Short run Cost Curves: Short run Total Cost Curves Contd.

Output (in units)	TVC (in Rs.)
0	0
1	20
2	30
3	45
4	80
5	145



Derivation of Short run Cost Curves: Short run Total Cost Curves Contd.

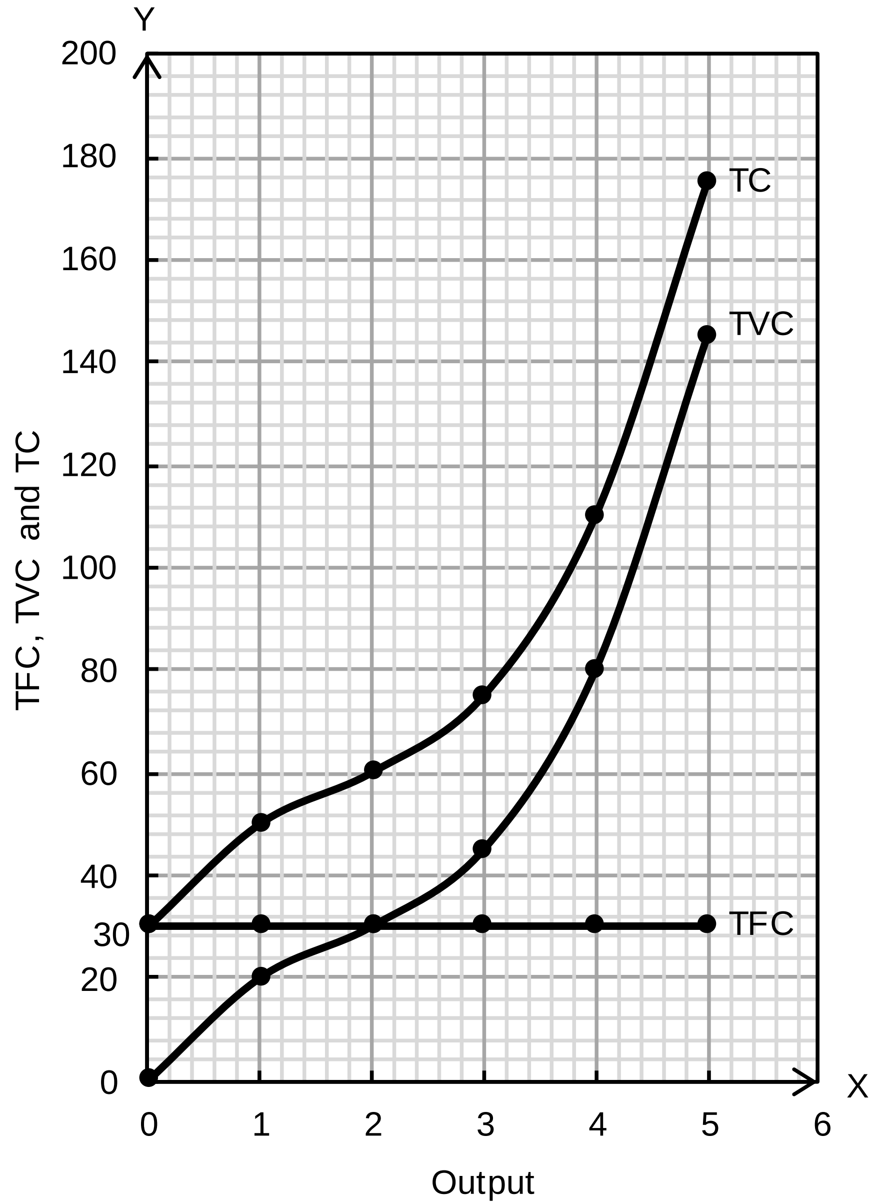
3. Total Cost (TC)

- Total cost is defined as the total monetary expenditures incurred in the production of a commodity.
- In other words, it is the sum of total fixed cost and total variable cost.
- When quantity of output is zero, total cost will be equal to total fixed cost because total variable cost will be zero.

TC = TFC + TVC

Derivation of Short run Cost Curves:
Short run Total Cost Curves (

Output (in units)	TFC (in Rs.)	TVC (in Rs.)	TC
0	30	0	30
1	30	20	50
2	30	30	60
3	30	45	75
4	30	80	110
5	30	145	175



Derivation of Short run Cost Curves: Short run Average Cost Curves

1. **Average Fixed Cost (AFC)**

- The average fixed cost is defined as the total fixed cost divided by the total quantity of output produced.

AFC =

where

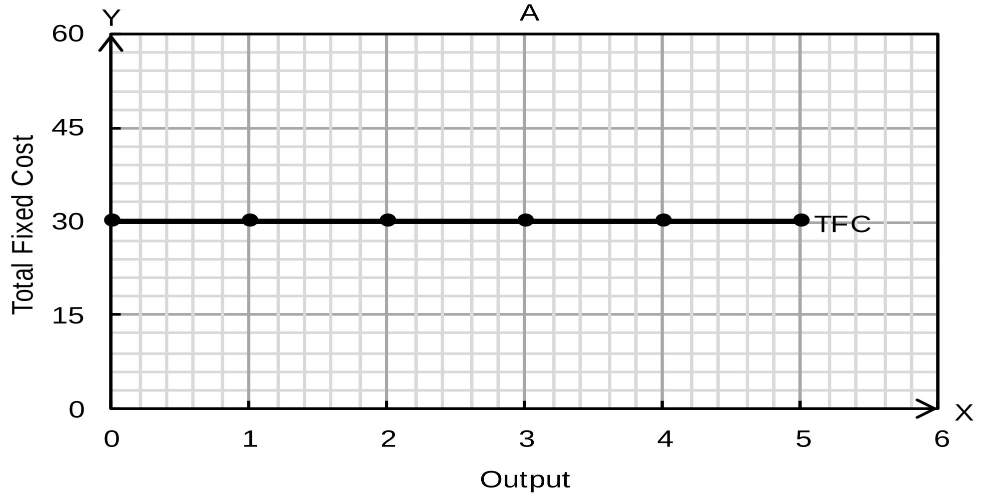
AFC = Average fixed cost

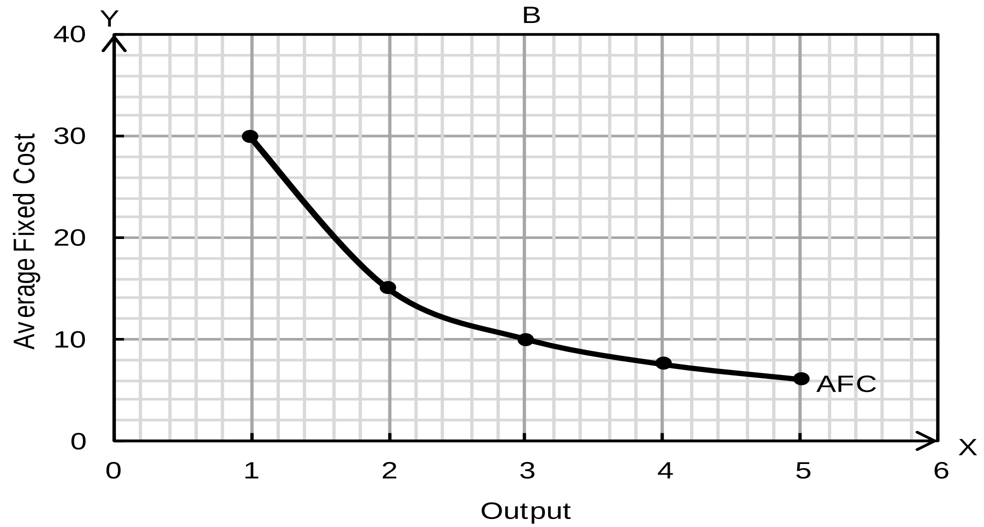
TFC = Total fixed cost

Q = Total quantity of output produced

Derivation of Short run Cost Curves: Short run Average Cost Curves Contd.

Output	Total Fixed Cost	Average Fixed Cost
0	30	-
1	30	30
2	30	15
3	30	10
4	30	7.5
5	30	6





Derivation of Short run Cost Curves: Short run Average Cost Curves Contd.

2. Average Variable Cost (AVC)

- Average variable cost is defined as the total variable cost divided by total quantity of output produced.

AVC =

where

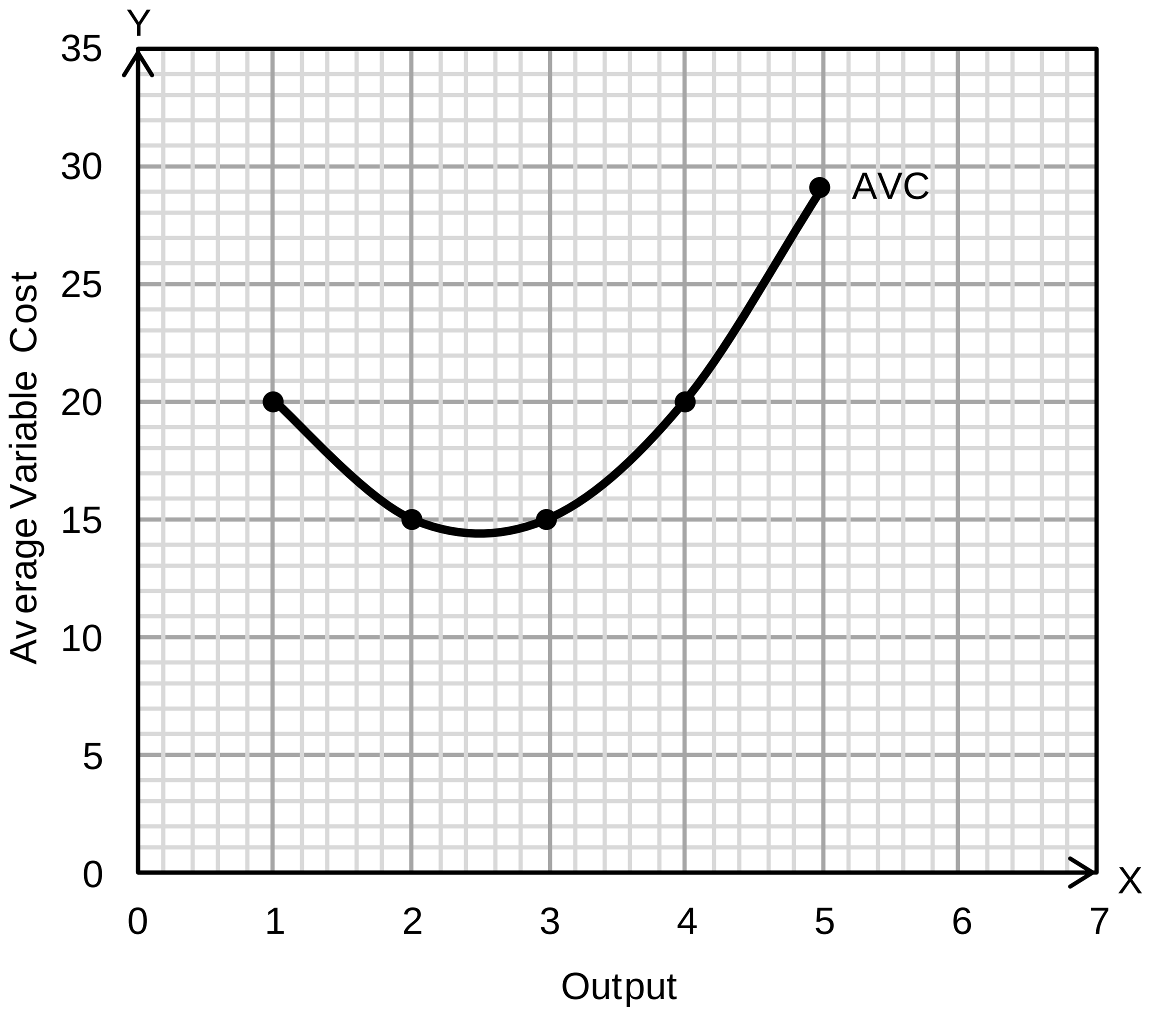
AVC = Average variable cost

TVC = Total variable cost

Q = Total quantity of output produced

Derivation of Short run Cost Curves: Short run Average Cost Curves Contd.

Output	Total Variable Cost	Average Variable Cost
0	0	0
1	20	20
2	30	15
3	45	15
4	80	20
5	145	29



Derivation of Short run Cost Curves: Short run Average Cost Curves Contd.

3. Average Total Cost/ Average Cost (ATC/ AC)

- Average total cost is defined as the total cost divided by total quantity of output. In other words, it is the sum of AFC and AVC.

$$\mathbf{ATC = \frac{TC}{Q} = \frac{TFC + TVC}{Q} = \frac{TFC}{Q} + \frac{TVC}{Q} = AFC + AVC}$$

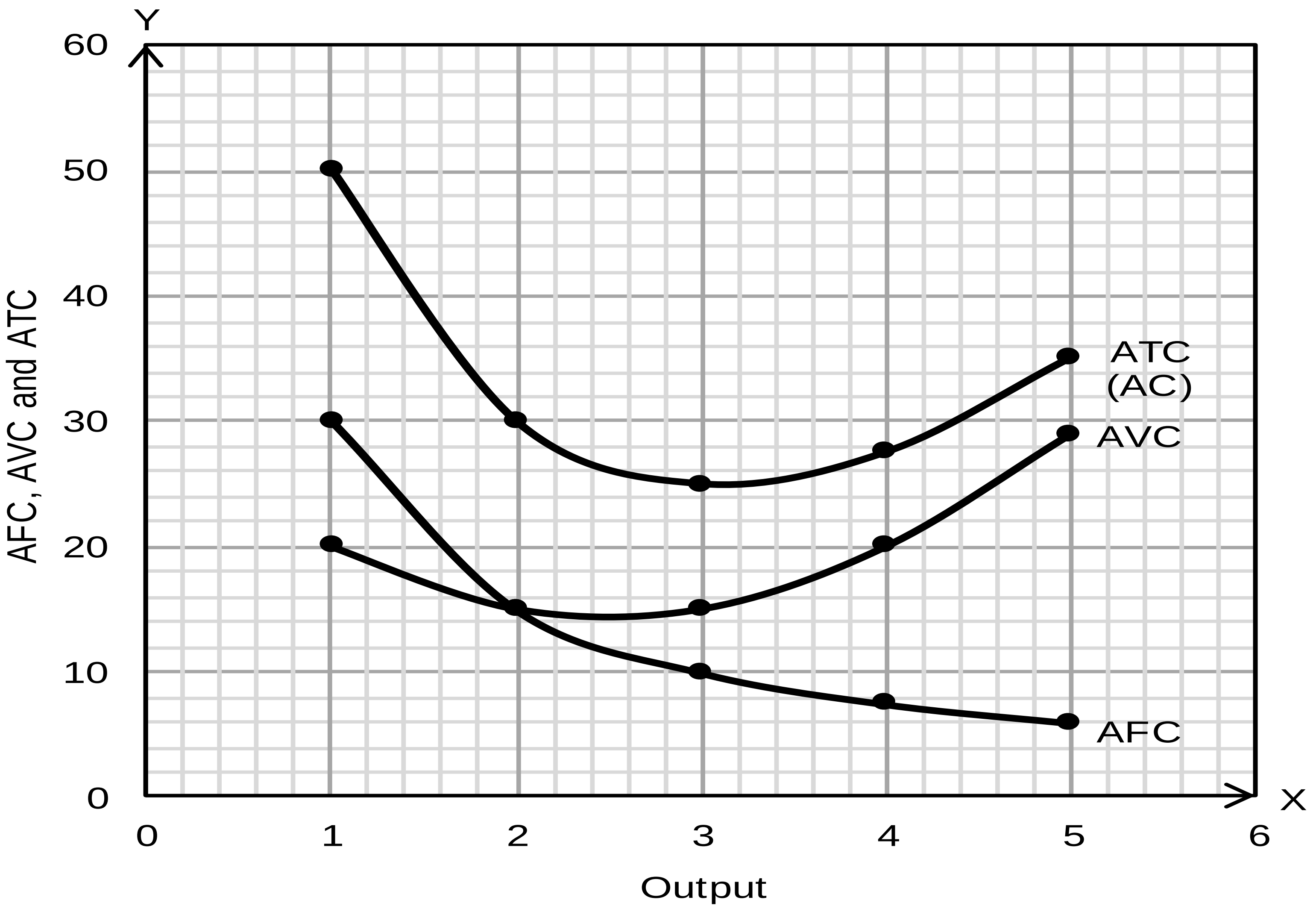
where

ATC	= Average total cost	Q	= Output
TFC	= Total fixed cost	TVC	= Total variable cost
AFC	= Average fixed cost	AVC	= Average variable cost

Derivation of Short run Cost Curves: Short run Average Cost Curves Contd.

Output	Total Fixed Cost (TFC)	Total Variable Cost (TVC)	Total Cost (TC)	Average Fixed Cost (AFC)	Average Variable Cost (AVC)	Average Cost (AC/ ATC)
0	30	0	30	-	-	-
1	30	20	50	30	20	50
2	30	30	60	15	15	30
3	30	45	75	10	15	25
4	30	80	110	7.5	20	27.5
5	30	145	175	6	29	35

Derivation of Short run Cost Curves: Short run Average Cost Curves Contd.



Derivation of Short run Cost Curves: Marginal Cost (MC)

Marginal cost is defined as the change in total cost due to a unit change in output.

In other words, marginal cost is the ratio of change in total cost to the change in total output.

$$\mathbf{MC} = \frac{\Delta \mathbf{TC}}{\Delta \mathbf{Q}}$$

or, $$\mathbf{MC} = \mathbf{TC_n} - \mathbf{TC_{n-1}}$$

where

MC = Short run marginal cost

ΔTC = Change in total cost

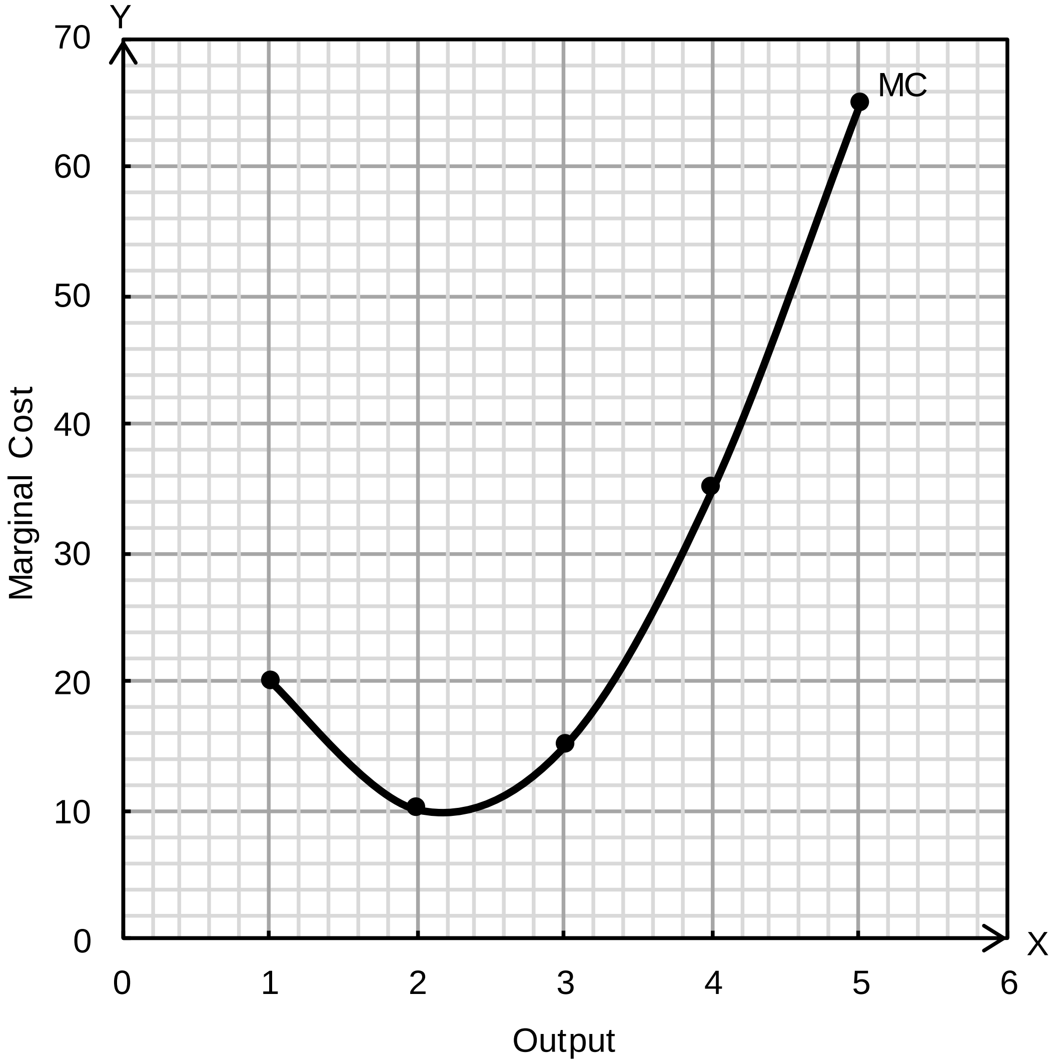
ΔQ = Change in quantity of output produced

TC_n = Total cost of n^{th} unit

TC_{n-1} = Total cost of $(n-1)^{th}$ unit

Derivation of Short run Cost Curves: Marginal Cost (MC) Contd.

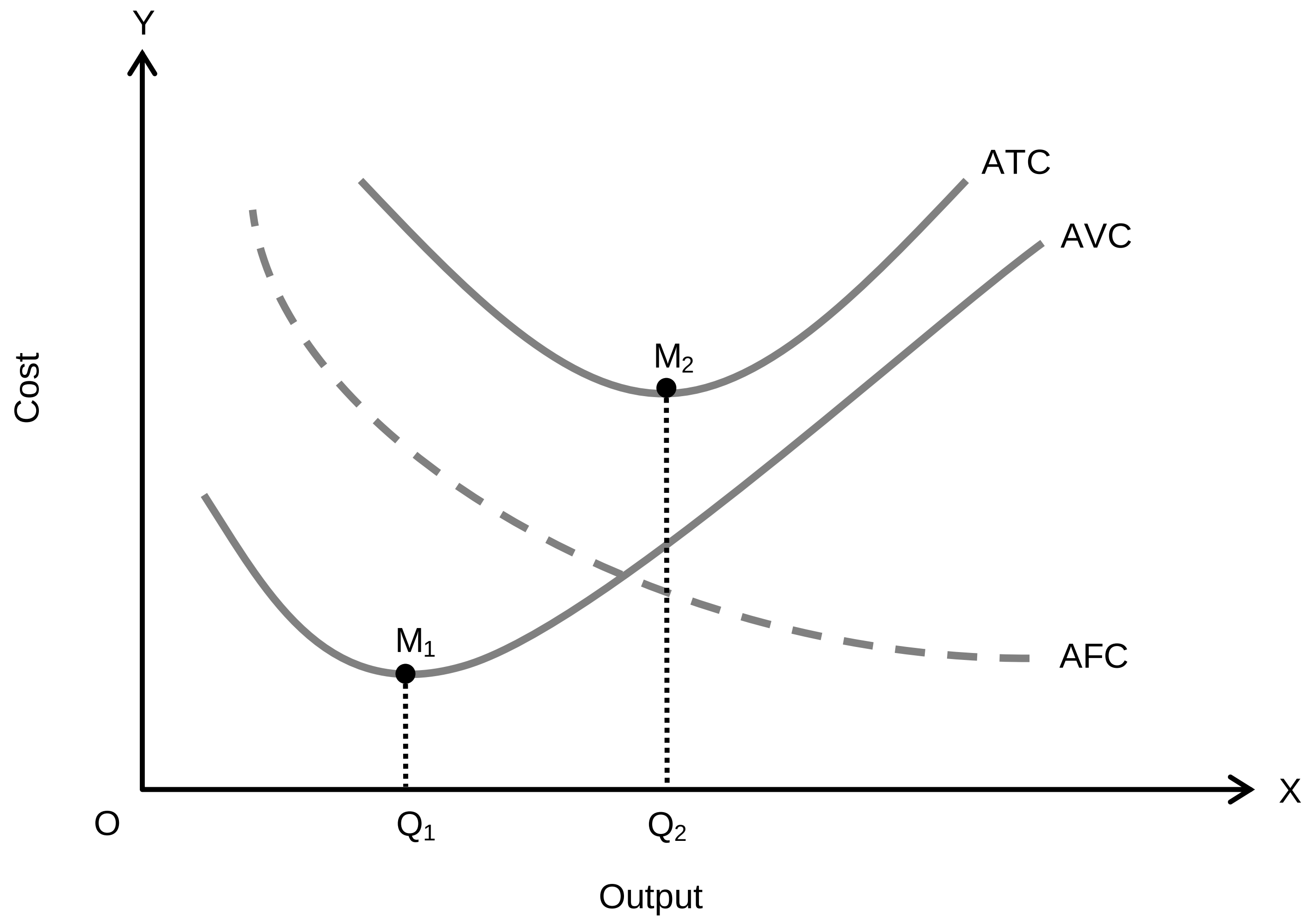
Output	Total Cost	Marginal Cost
0	30	-
1	50	20
2	60	10
3	75	15
4	110	35
5	175	65



Why ATC Curve is 'U' shaped?

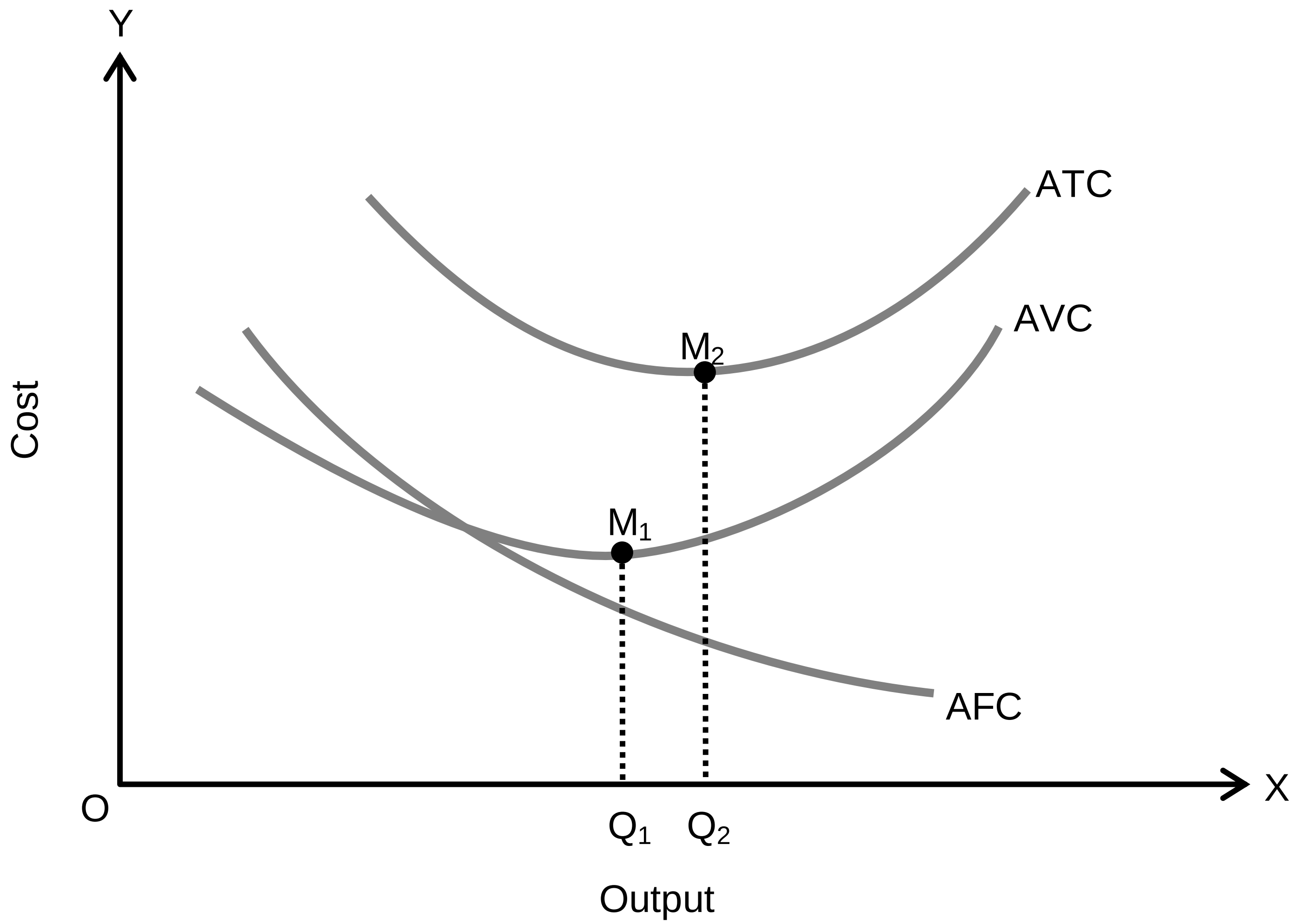
- Average total cost curve (ATC) is 'U' shaped.
- It means that in the beginning, it falls and after reaching the minimum point, it starts to rise upward.
- It gets U shaped due to the following reasons:

    1. Basis of AFC and AVC
    2. Basis of the law of variable proportion
    3. Indivisibility of the factors



Relationship between ATC, AVC and AFC

- Both ATC and AVC curves are U-shaped.
- ATC is the TC divided quantity of output and AVC is the TVC dividend by total quantity of output.
- The AVC is a part of ATC, given ATC = AFC + AVC.
- The main reason behind U-shape is the operation of the law of variable proportion.
- The minimum point of the ATC occurs to the right of the minimum point of the AVC.



Relationship between ATC, AVC and AFC Contd.

The relationship between ATC and AVC is pointed out as follows:

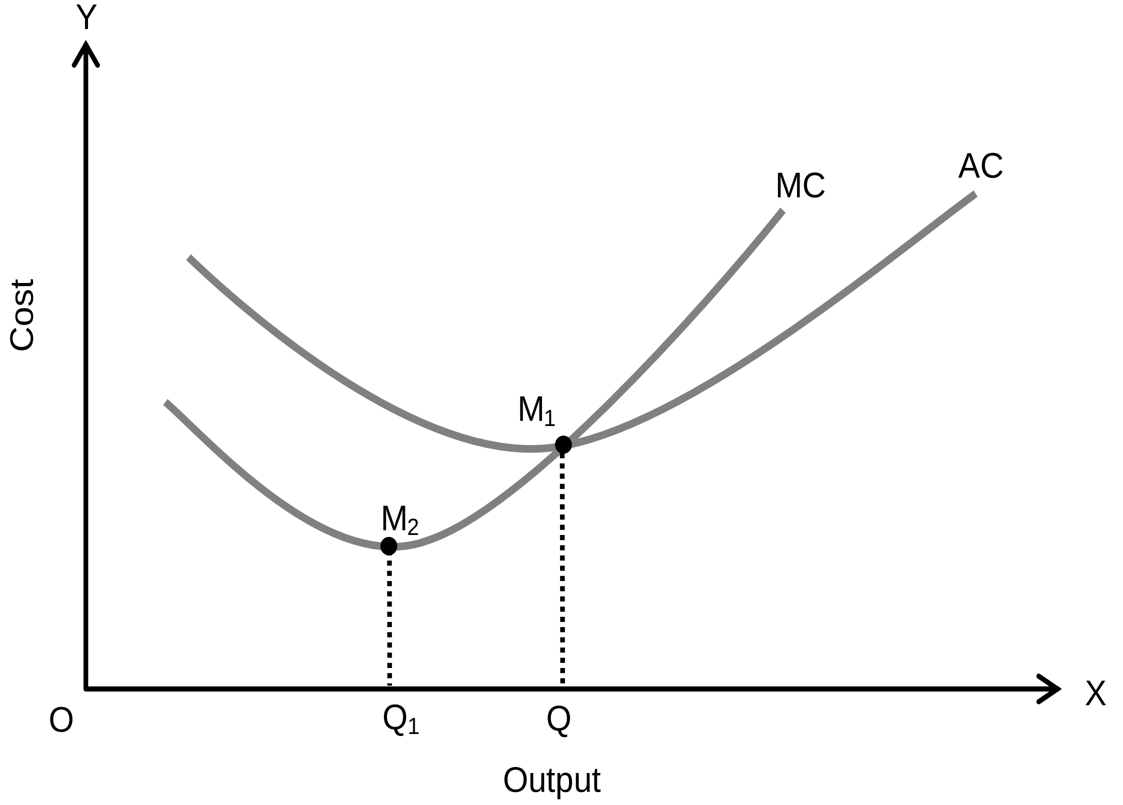
- Both AVC and ATC curves are U-shaped, reflecting the law of variable proportions.
- The minimum point of ATC is at right of minimum point of AVC.
- ATC is above AVC (ATC > AVC) because AVC is a part of ATC. In other words, ATC is derived by the sum of AVC and AFC.
- At the beginning, both ATC and AVC decline. After reaching the minimum point, both increase.
- Since AFC falls continuously with increase in output, AVC approaches nearer to ATC. In other words, distance between AVC and ATC decreases as output increase because of decline in ATC.

Relationship between AC and MC in the Short run

There is close relationship between AC and MC. MC is the change in TC resulted from the change in production of one unit of output where as AC is total cost divided by the output. It means that both AC and MC are derived from TC. Thus,

$$MC = \frac{\Delta TC}{\Delta Q}, \; AC = \frac{TC}{Q}$$

In general, both AC and MC are U-shaped and MC = AC when AC is minimum.



Relationship between AC and MC in the Short run Contd.

i. Both AC and MC are calculated from total cost.

ii. Both AC and MC are U shaped.

iii. When AC is falling, the MC curve is always below the AC curve and the MC falls faster than AC.

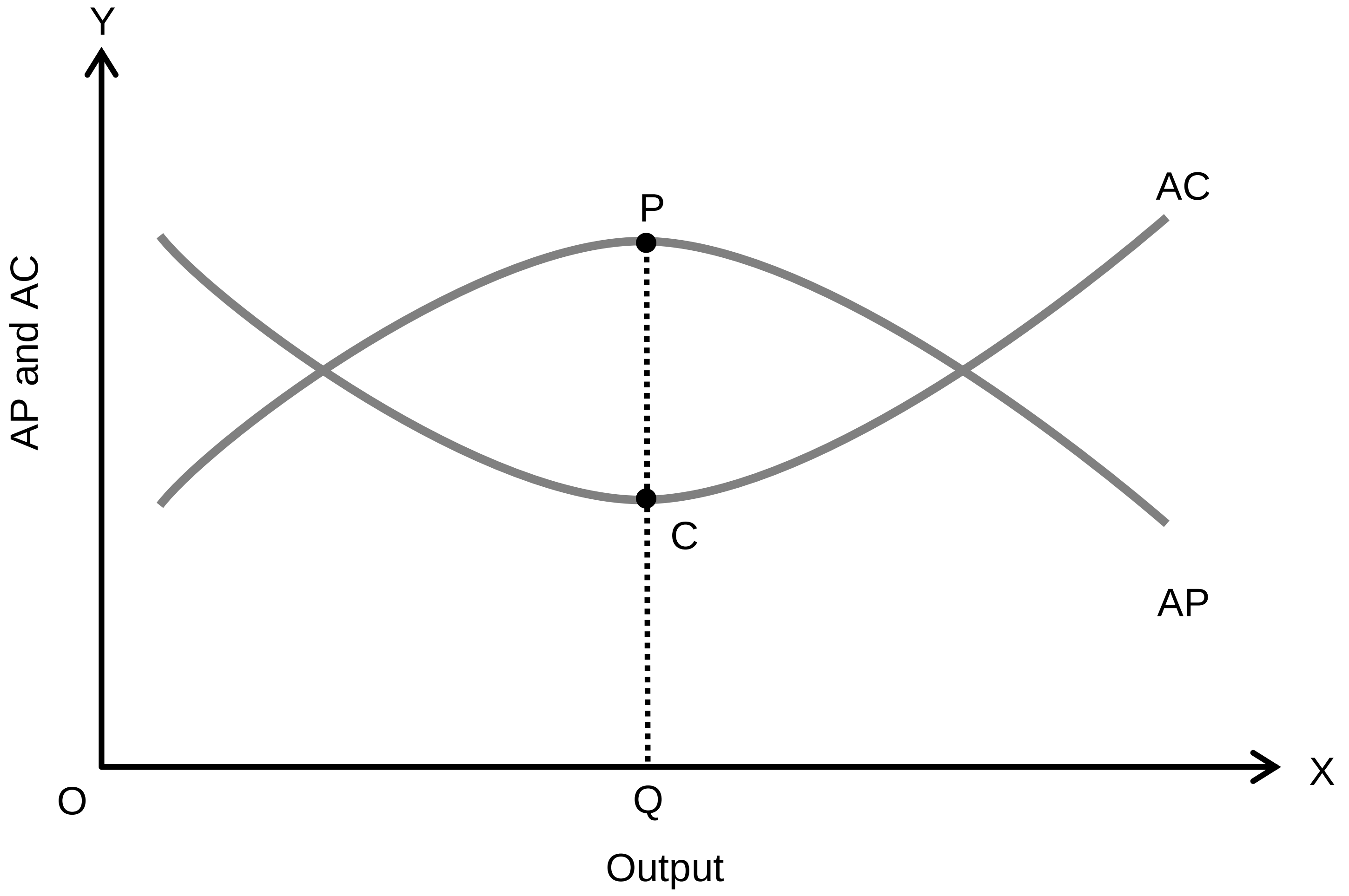
iv. When the AC is rising, the MC curve lies above the AC curve and the MC rises faster than the AC.

v. When the AC is minimum, the MC equals to AC.

vi. MC intersects at the minimum point of AC.

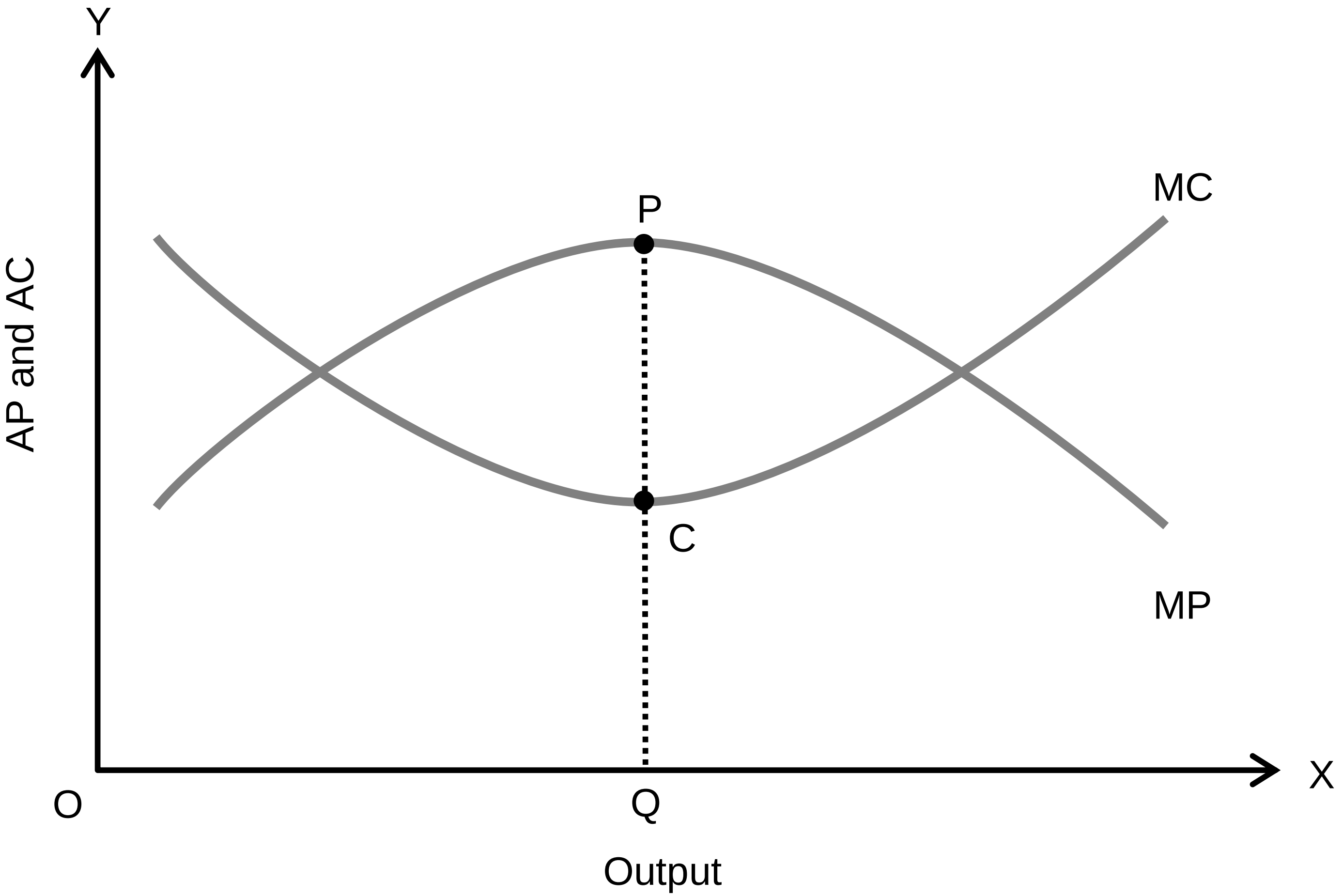
Relationship between AP and AC

There is an inverse relationship between AP and AC. When AP increases or increasing returns operates, AC declines. Then when AP becomes maximum, AC becomes minimum. Finally, when AP declines or diminishing returns operates, AC increases.



Relationship between MP and MC

- There is also an inverse relationship between MP and MC.
- When MP increases or increasing returns operates, MC declines.
- Then, when MP becomes maximum, MC becomes minimum.
- Finally, when MP declines, MC increases.



Long run Cost Curves

Long run Cost of the Traditional Theory

- In the long- run, all factors of production are assumed to be variable.
- There are no any fixed factors in the long run.
- Long run cost curve is a planning curve in the sense that it is a guide to the entrepreneur in his decision to plan the future expansion of his or her output.

LAC =

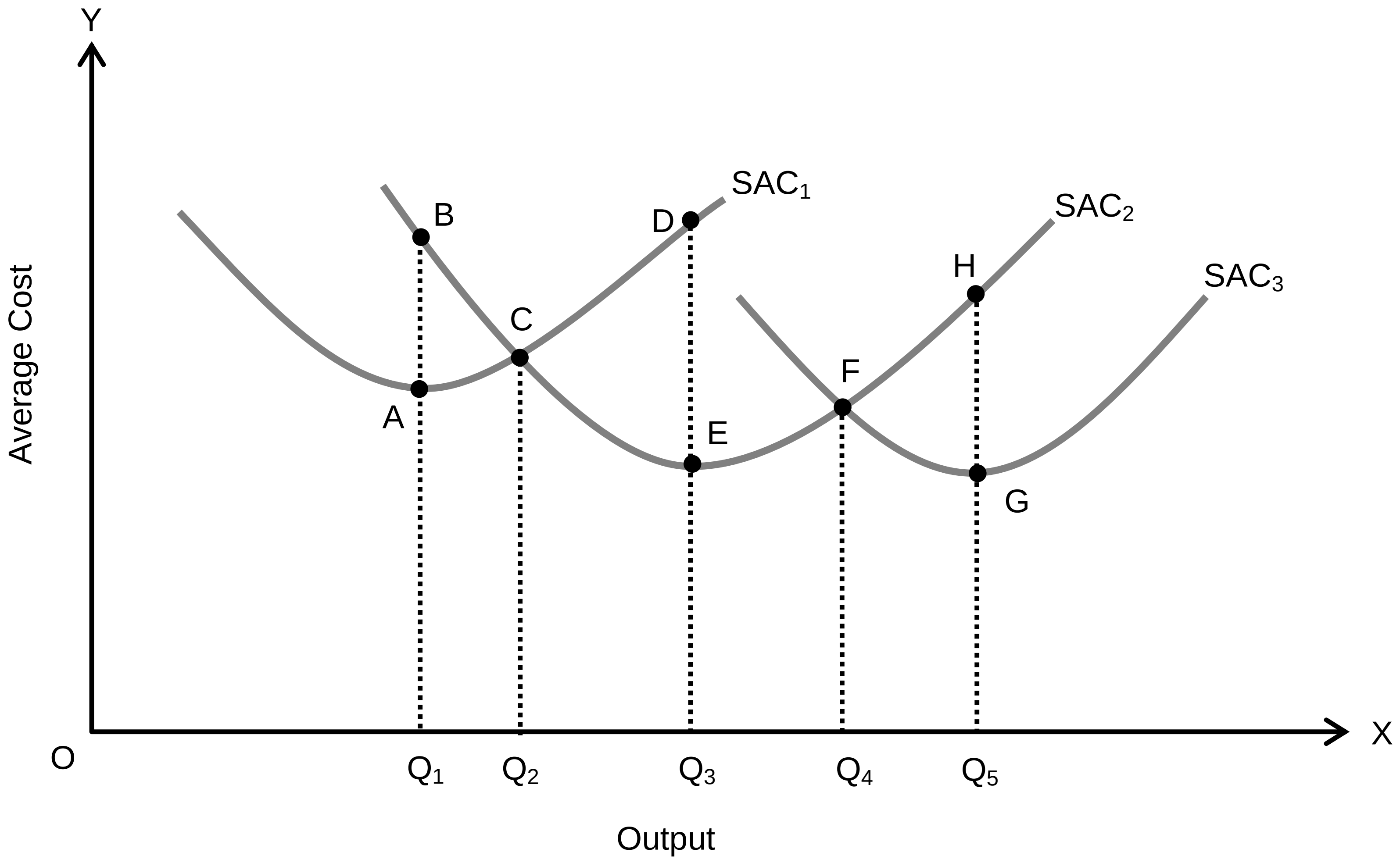
where

Q = Output

LAC = Long run average cost

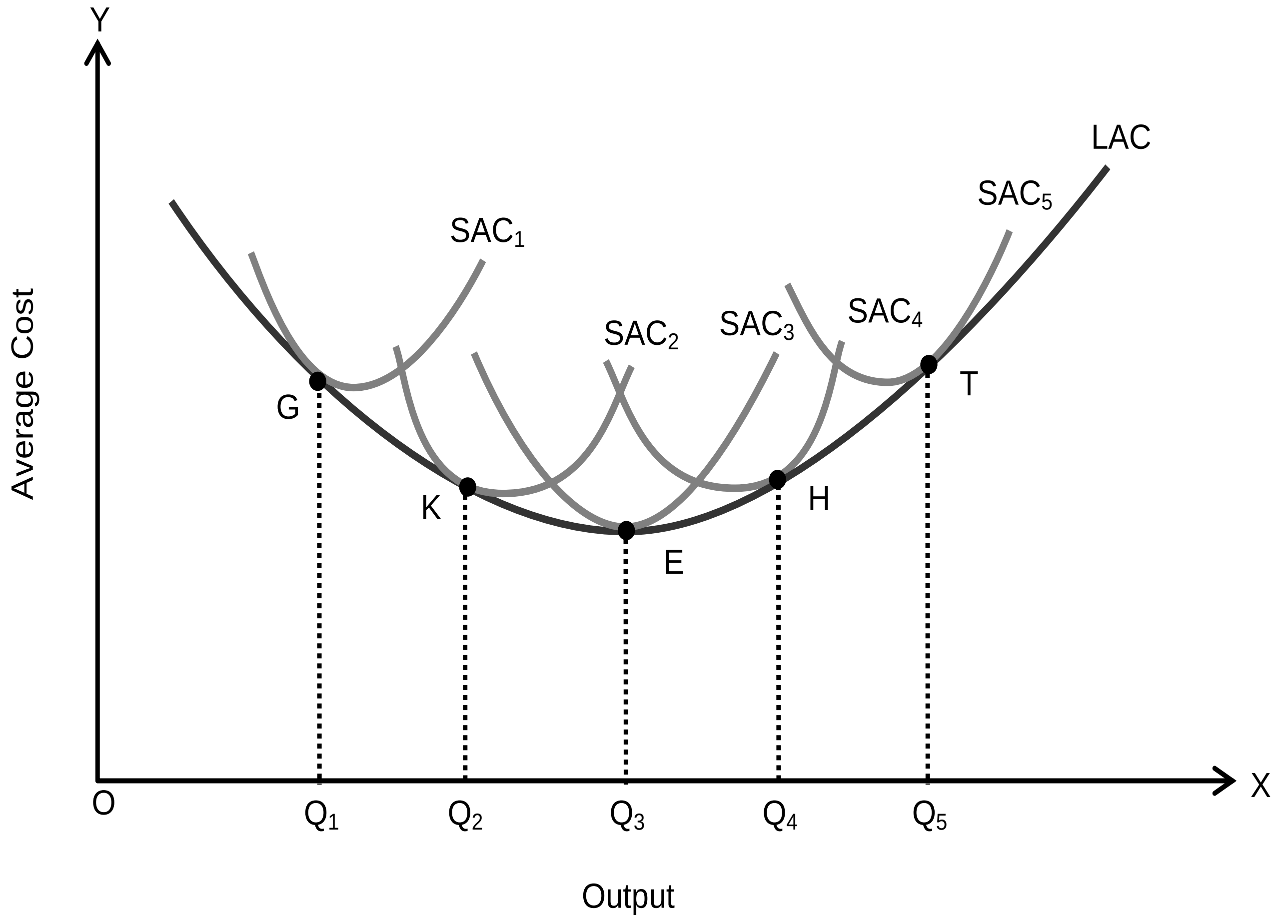
LTC = Long run total cost

Long run Average Cost Curve (LAC) (Derivation of U-shaped LAC) Contd.



Long run Average Cost Curve (LAC) (Derivation of U-shaped LAC) Contd.

- In the long run, a firm can change the size of its plant.
- It can choose any size of plant according to its requirements.
- Therefore, the number of plants as well as the number of SAC_S is infinite in the long run.
- In such case, long run average cost curve (LAC) will be a regular and smooth line without any scallops.

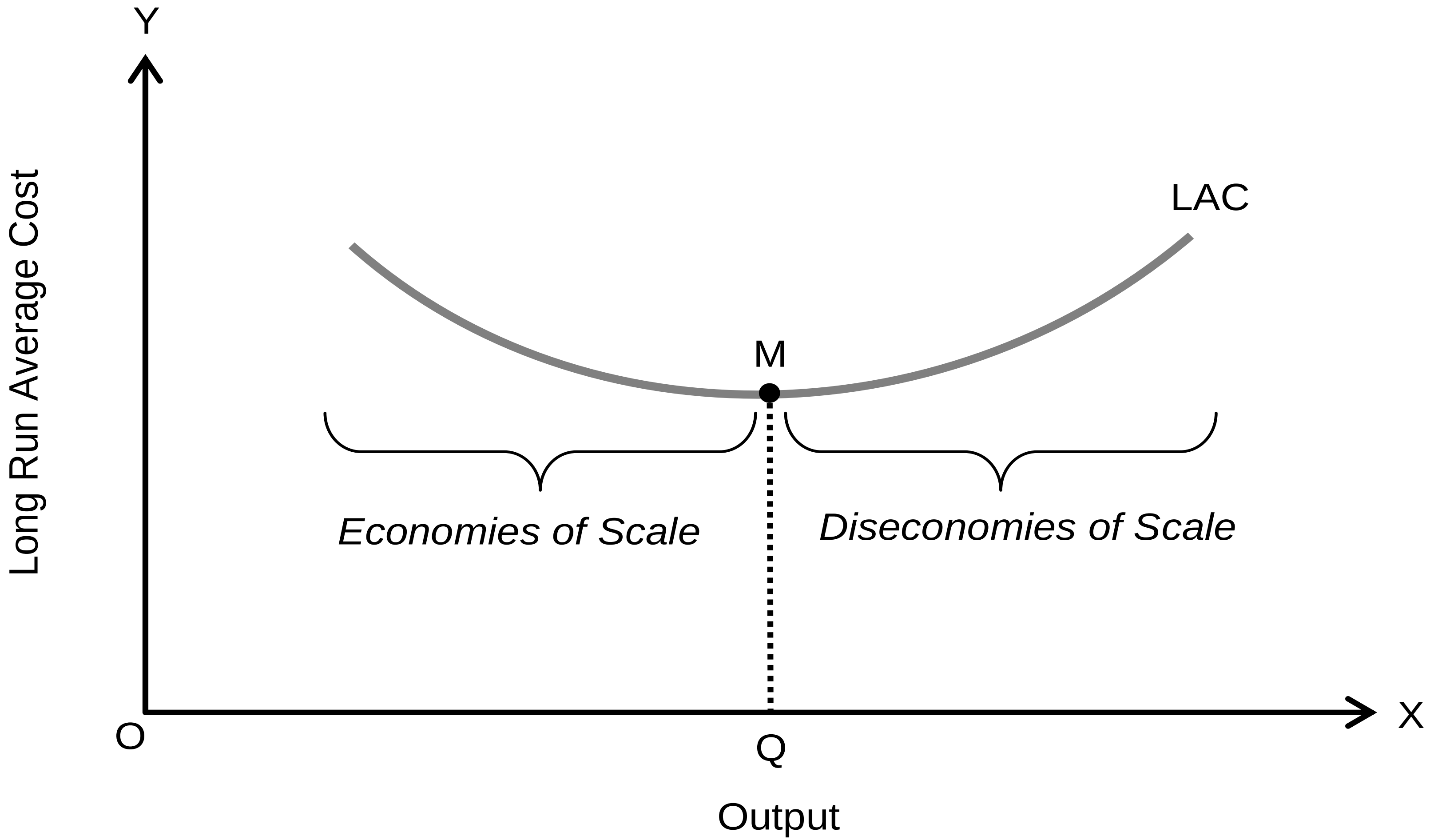


Why is SAC_3 Optimum Size Plant?

- In figure, the plant SAC_3 is optimum plant because its minimum cost of production is the lowest.
- If the size of plants is increased beyond SAC_3, it results in higher average cost of production.
- Similarly, if the size of the plant is smaller than SAC_3, average cost of production is higher.
- Thus, the optimum output (least cost output) of the plant SAC_3 is OQ_3.
- Now if the firm produces output OQ_3 with the optimum plant SAC_3, it is said to have achieved the optimum size.
- Thus, an optimum firm is that firm which is producing optimum output with the optimum plant. The firm is of optimum size if it employs plant SAC_3 and uses it to produce OQ_3 output.
- The output OQ_3 is also regarded as the socially optimum output.

Why U-shape of LAC is Less Pronounced or Flatter than SAC?

- Though the LAC curve is ‘U’ shaped, it is less pronounced (flatter) than SAC curves.
- It means that the LAC curve first falls slowly and then rises gradually after a minimum point is reached.



Why is LAC Curve called Planning Curve?

- Long run average cost curve is often called the planning curve of the firm by the some economists because firm plans to produce any output in the long run by choosing a plant on the long run average cost curve corresponding to the given output.
- The long run average cost curve reveals to the firm that how large should be the plant for producing a certain output at the least possible cost.

Derivation of Long run Marginal Cost Curve (LMC)

Long run marginal cost (LMC) is the change in long run total cost as a result of one unit change in output.

LMC =

where

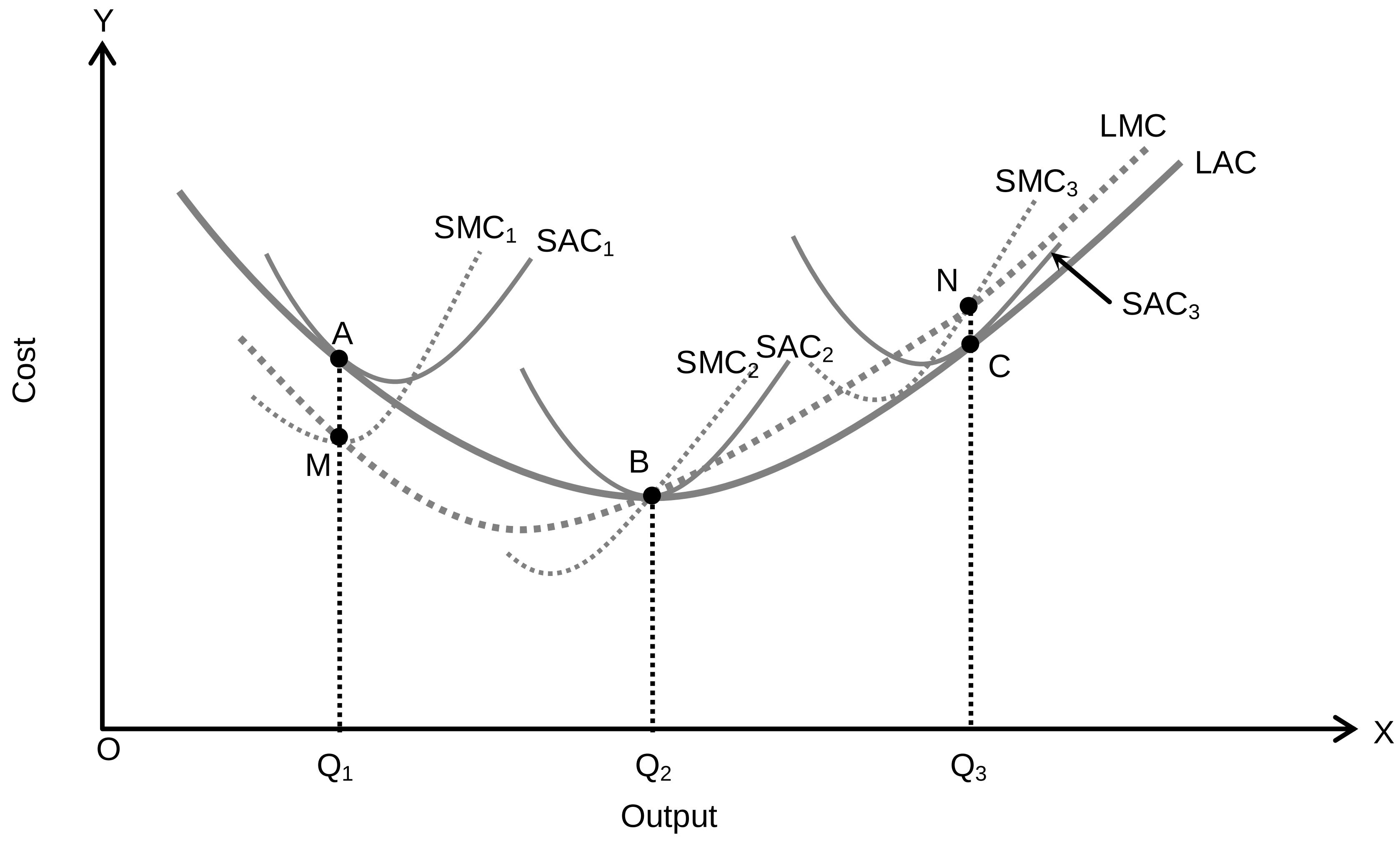
LMC = Long run marginal cost

ΔQ = Change in total output

ΔLTC = Change in long run total cost

Long run marginal cost curve is derived from short run marginal cost curves.

Derivation of Long run Marginal Cost Curve (LMC) Contd.

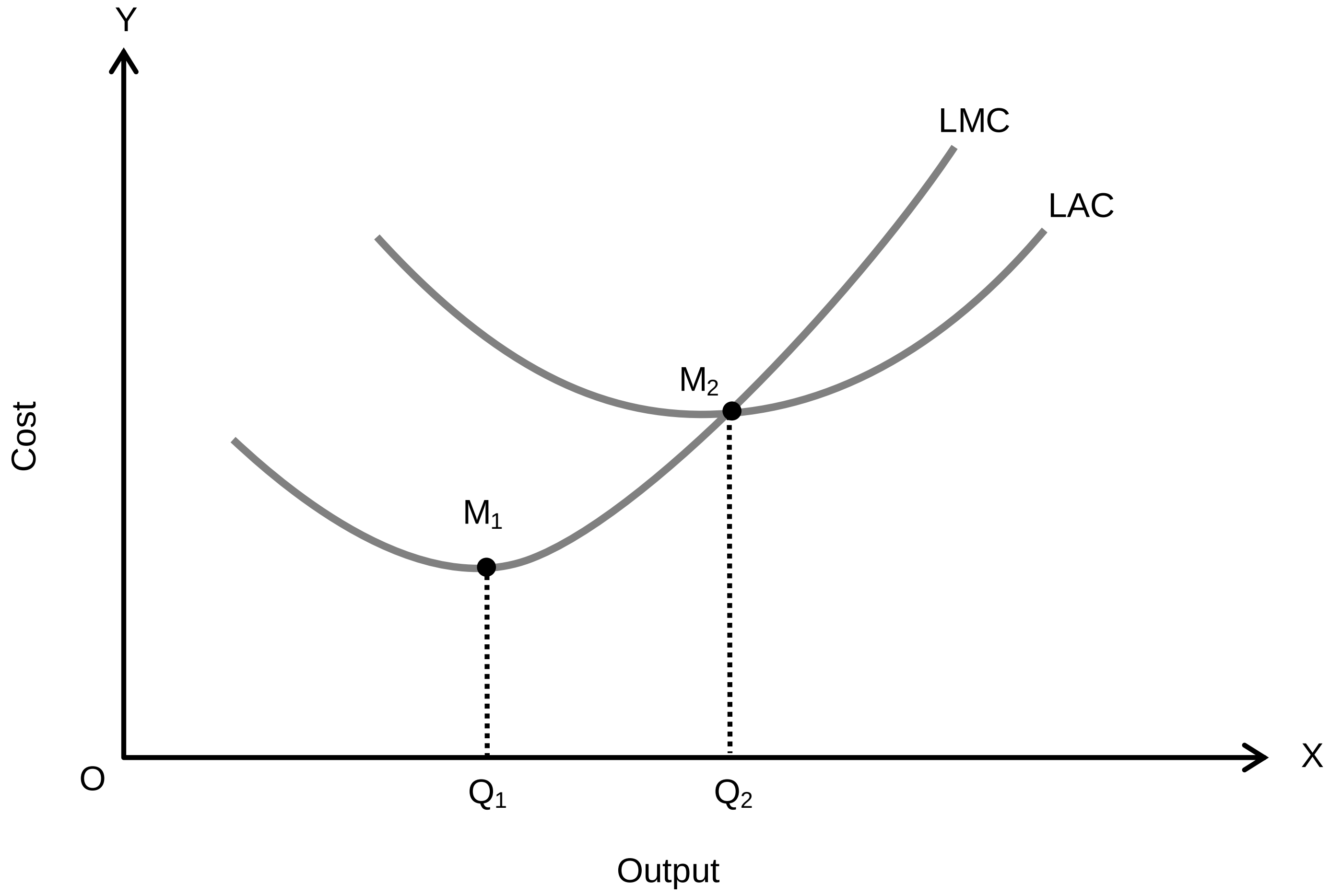


Relationship between LAC and LMC

- Both LAC and LMC are derived from long run total cost (LTC).

LAC = and **LMC =**

- The relationship between LAC and LMC can be explained by help of figure.



Economies and Diseconomies of Scale

- A firm experiences economies and diseconomies of scale when it increases its level of production.
- The LAC curve is 'U' shaped due to economies and diseconomies of scale.

Economies of Scale

- Economies of scale are defined as the decrease in long run average cost of production due to increase in size of the firm.
- In other words, it refers to the property whereby long run average total cost falls as the quantity of output increases.
- In the initial stage of production, when output increases by increasing variable factors of production, the different types of economies of scale accrue in production.

Economies and Diseconomies of Scale Contd.

Types of Economies of Scale

1. **Internal Economies**

Internal economies of scale arise due to expansion of the firm independently of what is happening to the other firms. It is not due to technological innovation and monopoly power of the firm.

The internal economies may be of following types:

i. Economies in production
   a. Technical economies
   b. Labour economies
ii. Marketing economies
iii. Managerial economies
iv. Economies in transportation and storage cost

Economies and Diseconomies of Scale Contd.

2. **External Economies**

- External economies of scale are defined as the advantages in the form of lower average cost of production, which a firm gains from the growth of the size of the industry.
- These economies accrue to all firms in the industry independently change in output of individual firms.

The Causes of External Economies of Scale

- Localization of industries and co-operation among the firms,
- Specialized facilities and places to bring buyers and sellers in contact,
- Establishment of subsidiary industries catering services to the main industry,
- Manufacturing of single component and specialization in production.

Economies and Diseconomies of Scale Contd.

Diseconomies of Scale

Diseconomies of scale refer to the property whereby long run average total cost rises as the quantity of output increases. As a result, LAC starts to increase.

Types of Diseconomies of Scale

1. **Internal Diseconomies**

Internal diseconomies appear due to increase in size of the firm. The following factors cause internal diseconomies of scale:

i. Managerial inefficiency

ii. Labour inefficiency

Economies and Diseconomies of Scale Contd.

2. External Diseconomies

External diseconomies refer to the increase in average cost of production due to increase in the size of the industry. It originates from outside the firm especially in the input markets. The following factors cause external diseconomies of scale:

i. Natural limitations

ii. Discount and concession that are available on bulk purchase of input end

iii. The increase in demand for inputs creates shortage, which results rise in price of inputs. Consequently, average cost of production increases.

Theory of Revenue

Concept of Revenue

- Money receipt of a firm from the sale of its product is called revenue.
- According to Dooley, *"The revenue of a firm is its sales receipts or money receipts from the sale of a product."*
- There are three concepts of revenue:

1. Total revenue
2. Average revenue
3. Marginal revenue.

Concept of Revenue Contd.

1. Total Revenue (TR)

- Total revenue is the total amount of money received by the firm from the sales of its own product at the given period of time.
- In other words, total revenue is the sum of marginal revenue.
- Total revenue is the product of price and quantity sold.

$$TR = P \times Q$$

where

P = Price

Q = Quantity sold

TR = Total revenue

Concept of Revenue Contd.

2. Average Revenue (AR)

Average revenue is the price per unit. It is obtained dividing total revenue by the number of units sold.

Symbolically, $AR = \frac{TR}{Q} = \frac{P \times Q}{Q} = P$. Thus, average revenue is always equal to the price of the commodity. For example, If the total revenue of a firm from sale of 5 chairs is Rs. 500, then AR will be equal to $\frac{500}{5}$ = Rs. 100.

Concept of Revenue Contd.

3. Marginal Revenue

Marginal revenue is the addition to total revenue from the sales of an additional unit of the commodity. Marginal revenue is obtained by dividing the change in total revenue change in quantity sold

$$MR = \frac{\text{Change in total revenue}}{\text{Change in quantity sold}} = \frac{\Delta TR}{\Delta Q}$$

or, $MR = TR_n - TR_{n-1}$

where

MR = Marginal revenue Q = Quantity sold

TR_n = Total revenue of 'nth' product ΔQ = Change in quantity sold

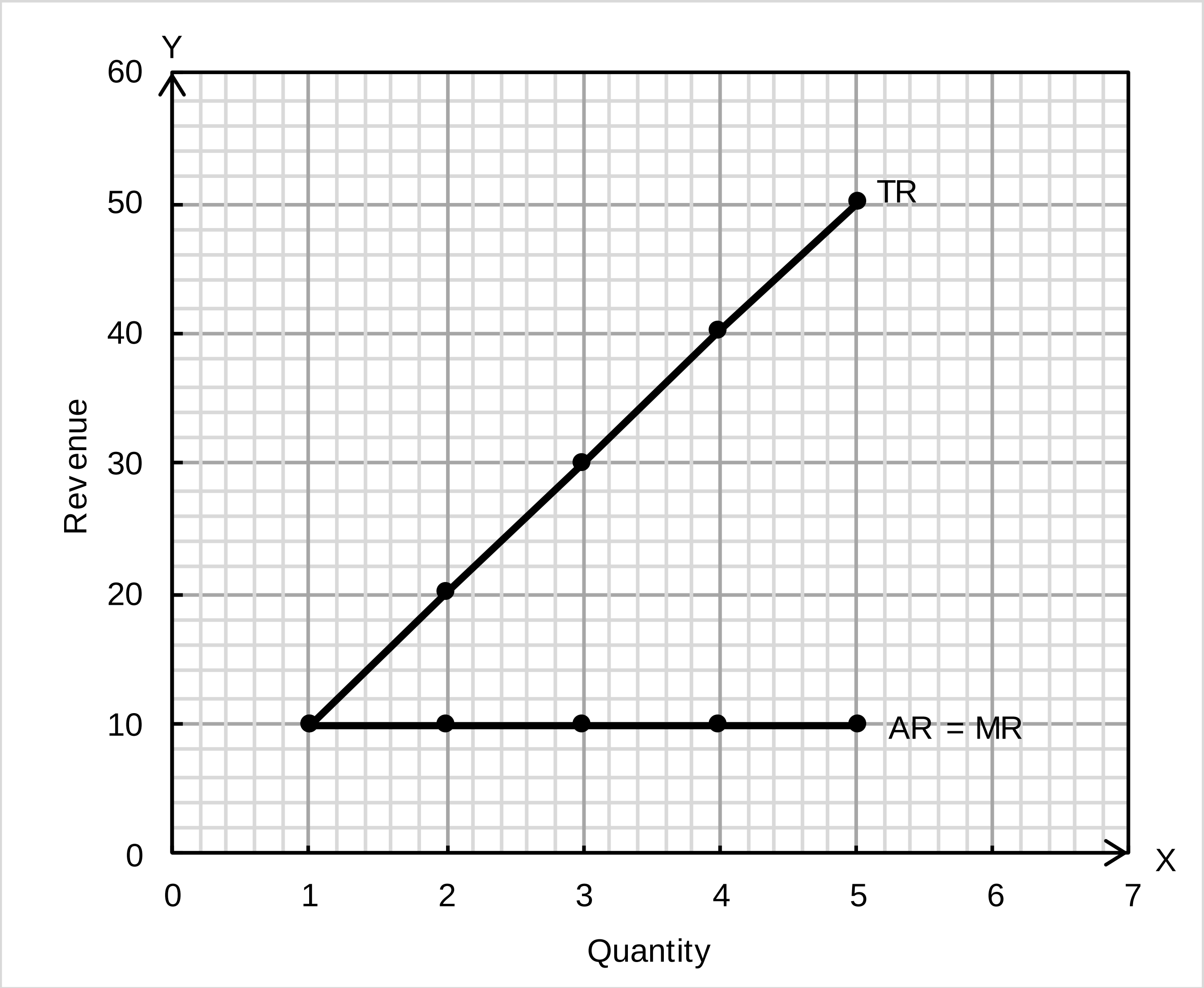
TR_{n-1} = Total revenue of 'n – 1'th product ΔTR = Change in total revenue

Derivation of Revenue Curves under Perfect Competition

- Perfect competition is the market structure where there are a large number of buyers and sellers producing a homogeneous product.
- In the perfect competition, firm is a 'price-taker'.
- A firm can sell whatever output it produces at the given price. Therefore, price remains constant at any level of output.
- The price is determined the intersection between of market demand and supply curves.

Derivation of Revenue Curves under Perfect Competition Contd.

No. of Units Sold (Q)	Price (P)	TR = P × Q	AR	MR
1	10	10	10	10
2	10	20	10	10
3	10	30	10	10
4	10	40	10	10
5	10	50	10	10

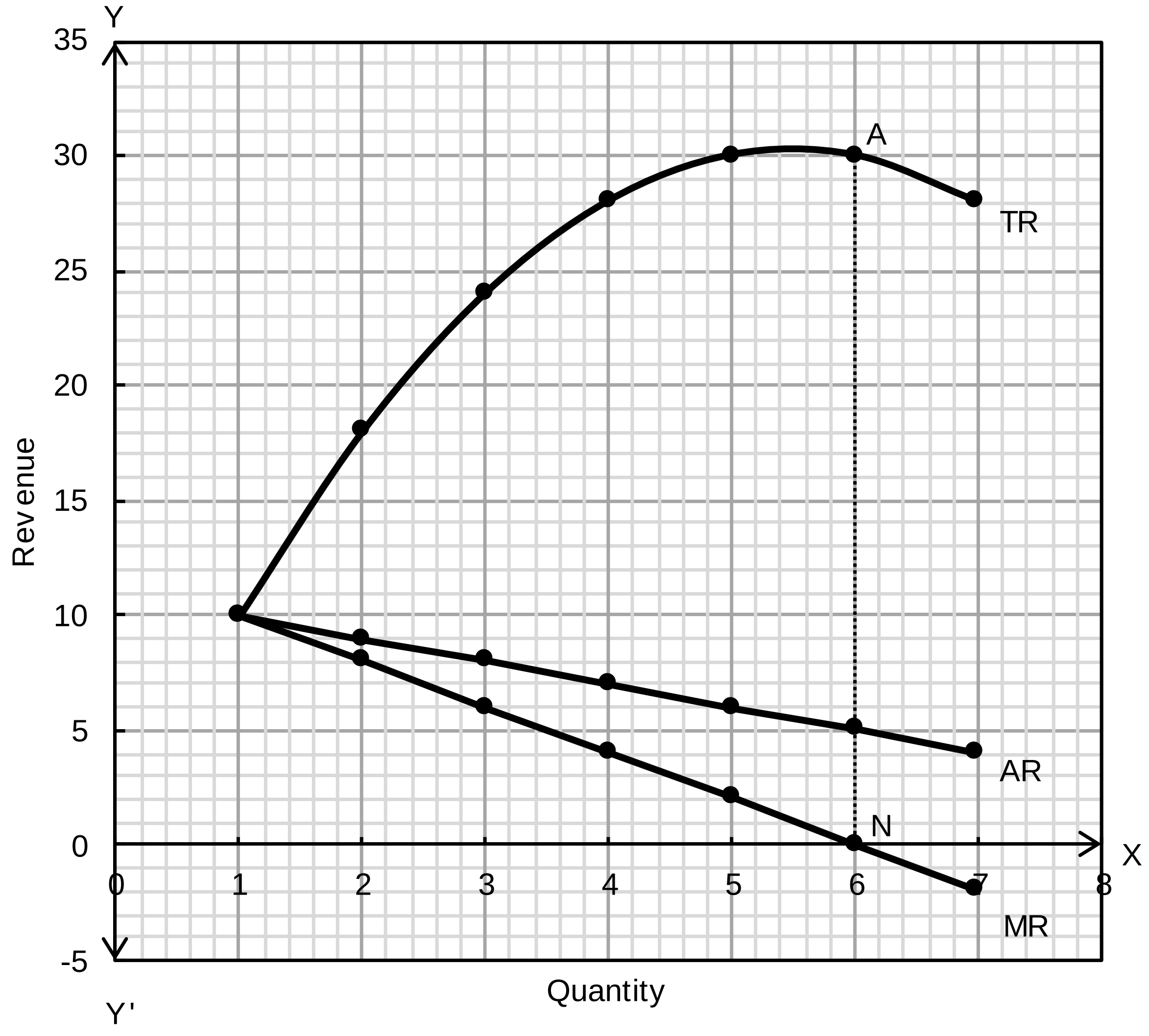


Derivation of Revenue Curves under Imperfect Competition or Monopoly

- Monopoly is a market in which there is a single seller or producer, there are no close substitutes for the commodity it produces and there are barriers to entry of new firm in the market.
- In imperfect competition or monopoly, the firm is itself a 'price maker'. Therefore, it reduces prices in order to increase the sales.
- Consequently, both the average and marginal revenue curves slope downward from left to right.
- It means that if a monopolist desires to sell more units of the output, he will have to reduce the price.
- On the other hand, if the monopolist desires to charge high price, he will have to sell less units of output.

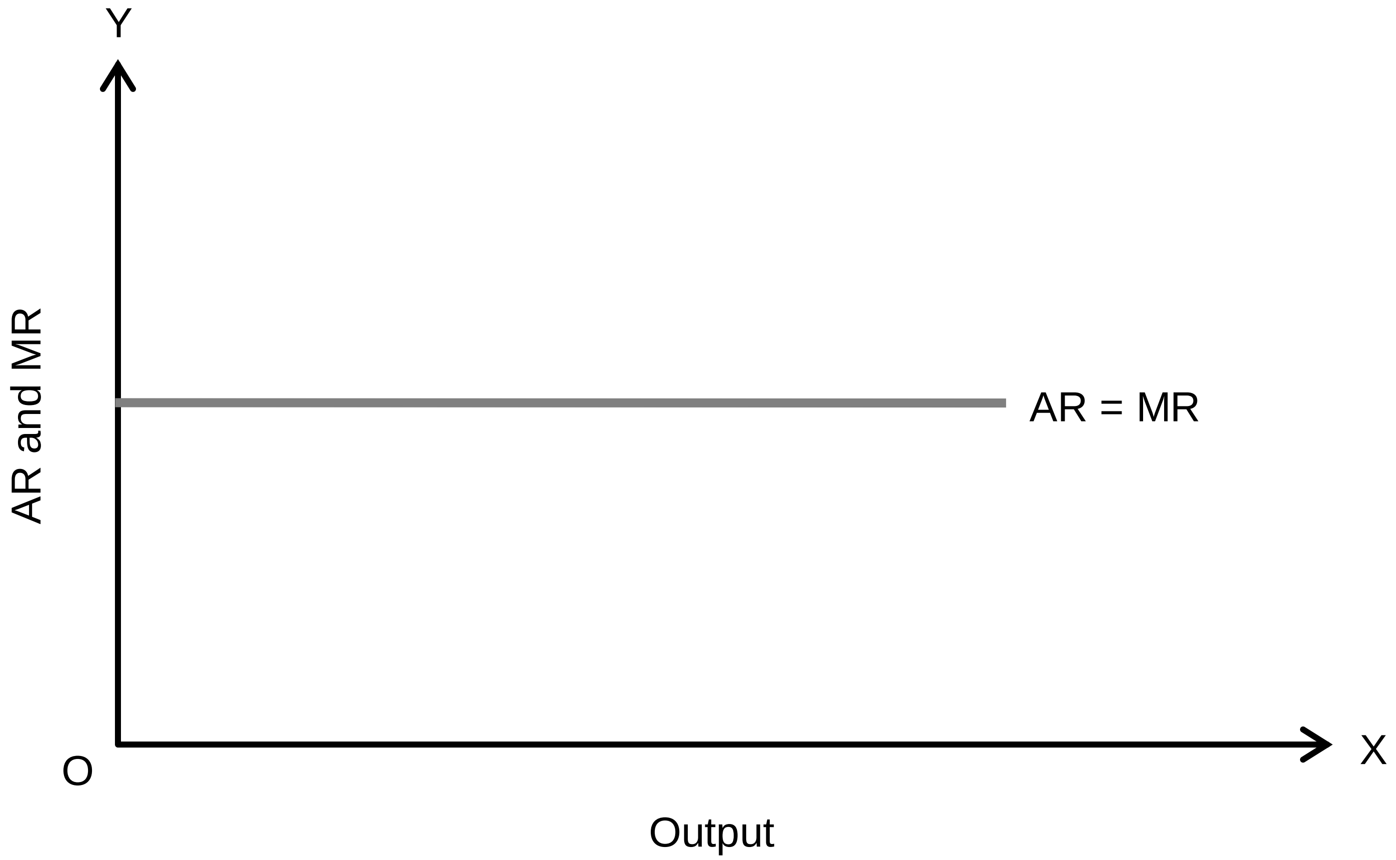
Derivation of Revenue Curves under Imperfect Competition or Monopoly Contd.

Quantity Sold (Q)	Price (P)	TR = (P × Q)	AR	MR
1	10	10	10	10
2	9	18	9	8
3	8	24	8	6
4	7	28	7	4
5	6	30	6	2
6	5	30	5	0
7	4	28	4	– 2



Relationship between AR and MR Curves under Perfect Competition

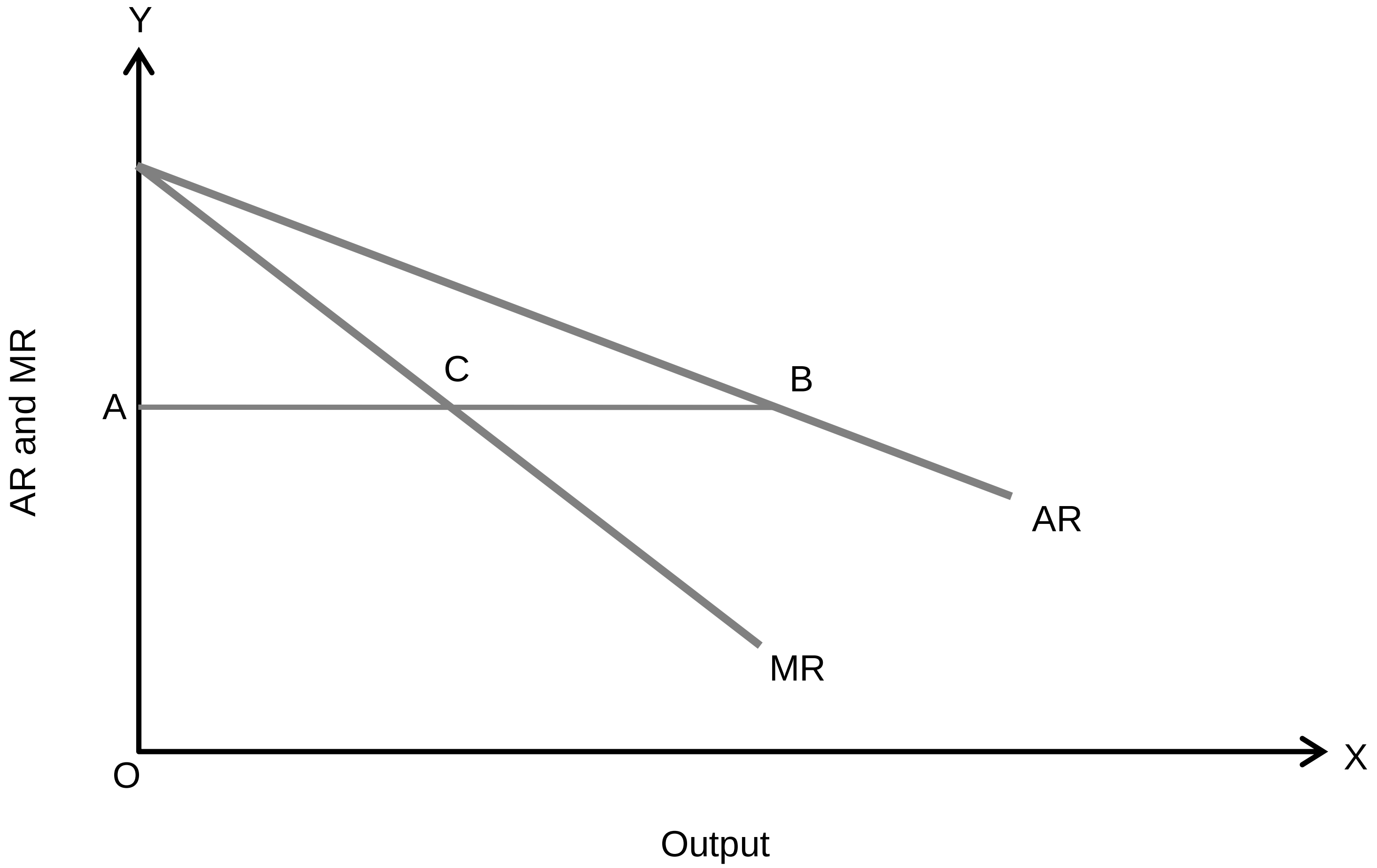
- Under perfect competition, seller cannot influence price of the product.
- He has to sell at the ruling price prevailing in the market. Thus, average revenue or price is same throughout.
- Marginal revenue curve coincides with the average revenue curve because additional units are sold at the same price as before.



Relationship between AR and MR Curves under the Imperfect Competition

1. When both AR and MR Curves are Straight Line

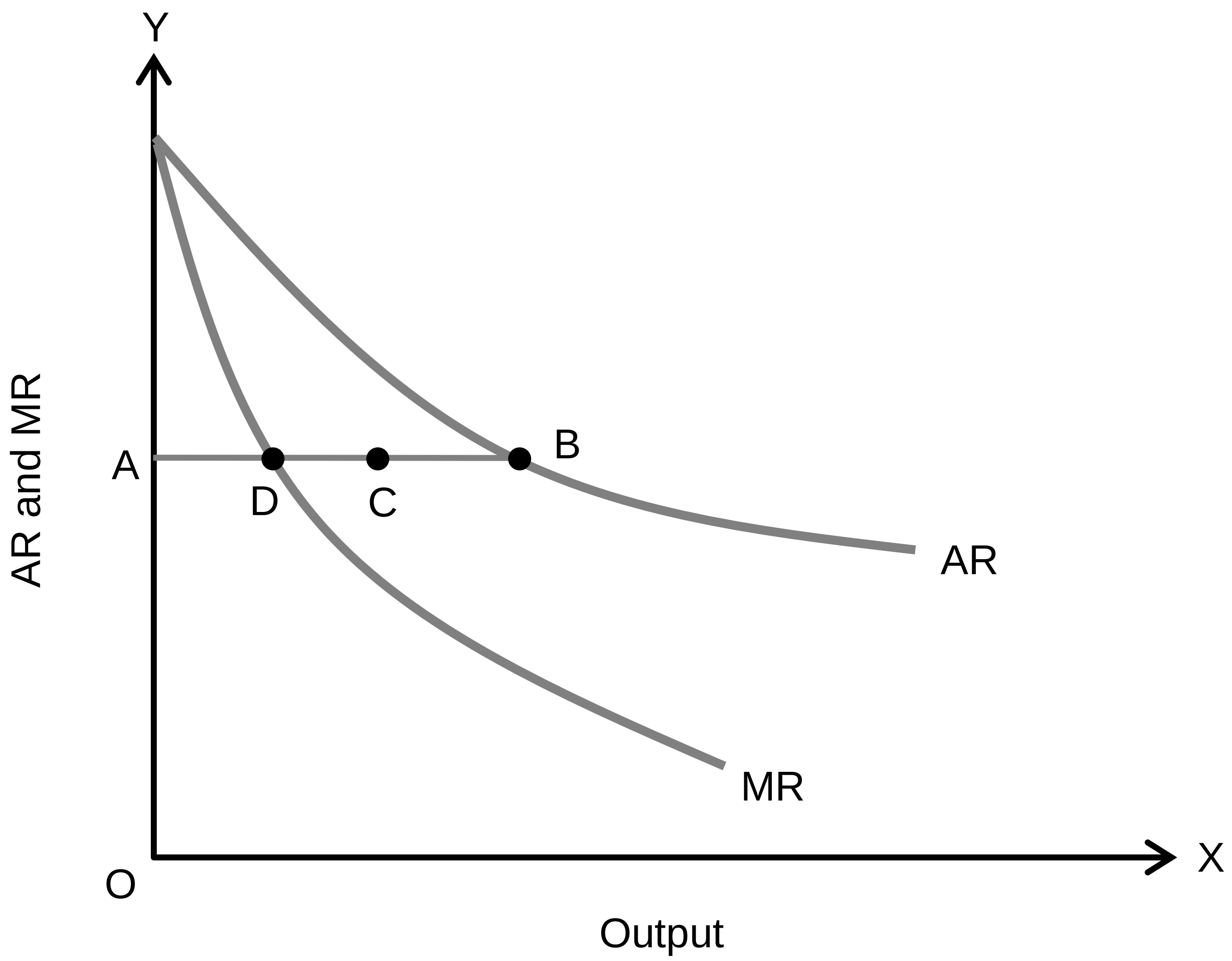
- When both AR and MR curves are downward sloping and straight lines, the MR curve cuts any perpendicular line to the Y-axis at halfway from the AR curve.



Relationship between AR and MR Curves under the Imperfect Competition Contd.

2. When both AR and MR Curves are Convex to the Origin

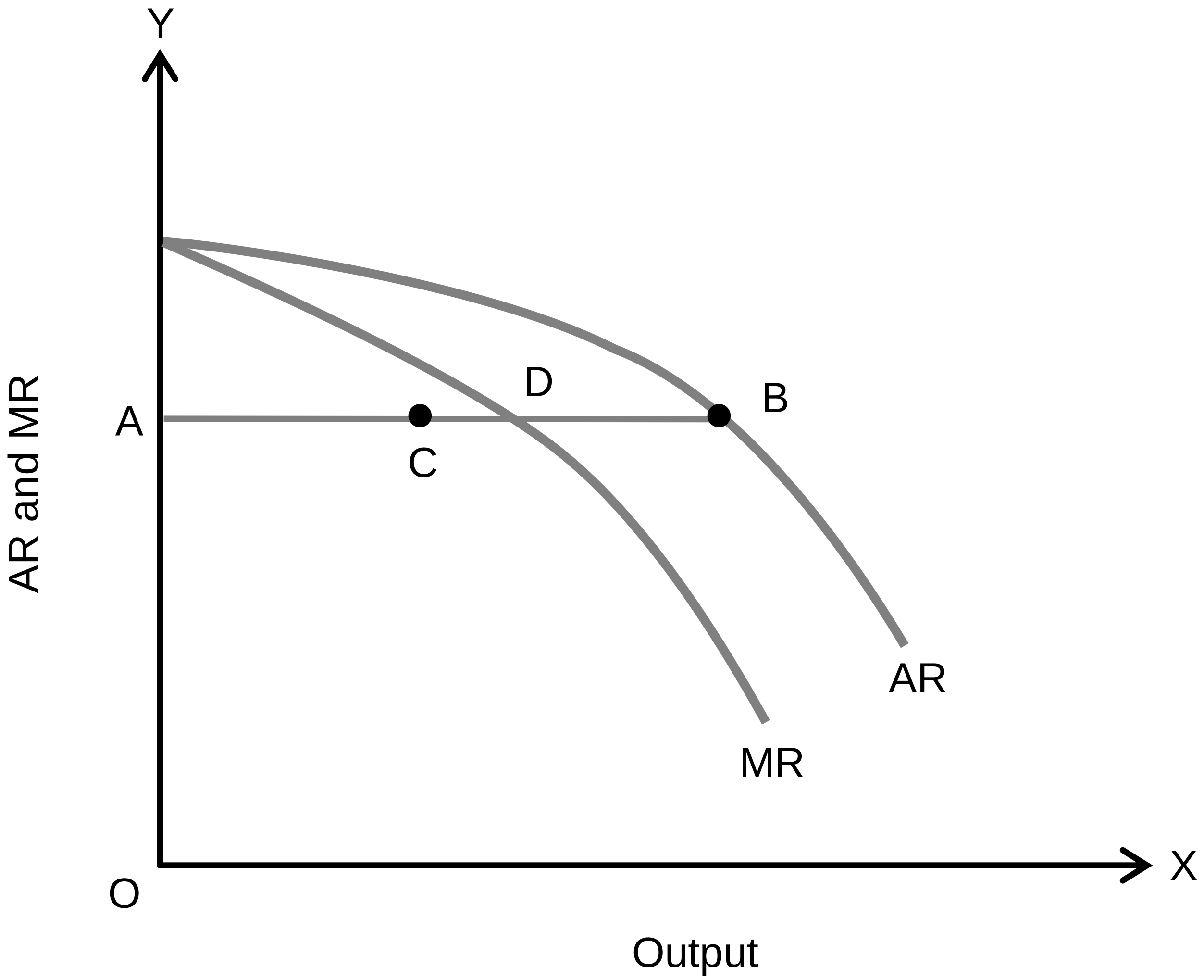
- When both AR and MR curves are convex to the origin, the MR curve cuts any perpendicular line to the Y-axis at more than half-way from the AR curve to the Y-axis.



Relationship between AR and MR Curves under the Imperfect Competition Contd.

3. When both AR and MR Curves are Concave to the Origin

- When both AR and MR curves are concave to the origin, the MR curve cuts any perpendicular line to the Y-axis at less than half-way form the AR curve.



Relationship between Price Elasticity of Demand and Marginal Revenue

Marginal revenue is the addition in total revenue as a results of increase in sales by one additional unit. Then,

$$MR = \frac{dTR}{dQ} = \frac{d(P \times Q)}{dQ} \quad (\because TR = P \times Q)$$

where

MR = Marginal revenue

TR = Total revenue, which is the product of price and quantity sold

P = Price

Q = Quantity sold

Relationship between Price Elasticity of Demand and Marginal Revenue Contd.

Differentiating $TR = P \times Q$ with respect to Q, we get

$$MR = P \cdot \frac{dQ}{dQ} + Q \cdot \frac{dP}{dQ}$$

$$\text{or,} \quad MR = P \cdot 1 + Q \cdot \frac{dP}{dQ}$$

$$\text{or,} \quad MR = P + Q \cdot \frac{dP}{dQ}$$

Taking P common, we get

$$\mathbf{MR = P\left(1 + \frac{Q}{P} \cdot \frac{dP}{dQ}\right) \quad \ldots (i)}$$

In the above equation $\frac{dP}{dQ} \cdot \frac{Q}{P}$ is the reciprocal of coefficient of price elasticity of demand. It means that

$$\mathbf{\frac{dP}{dQ} \cdot \frac{Q}{P} = \frac{-1}{E_P}}$$

Relationship between Price Elasticity of Demand and Marginal Revenue Contd.

By substituting $\left(\frac{-1}{E_P}\right)$ in the above equation (I), we get

$$\mathbf{MR = P\left(1 - \frac{1}{E_P}\right)}$$

$$\textbf{or,}\quad \mathbf{MR = P\left(\frac{E_P - 1}{E_P}\right)} \qquad \textbf{... (ii)}$$

The above equation (ii) gives the relationship between price elasticity of demand and marginal revenue. Given the relationship between marginal revenue (MR) and price elasticity of demand E_P, we can draw following conclusions:

i. When $E_P = 1$, $MR = 0$. It means that total revenue remains constant for both rise and fall in price.

ii. If $E_P > 1$, $MR > 0$. It means that increase in price results decrease in total revenue and vice-versa.

iii. If $E_P < 1$, $MR < 0$. It means that increase in price results increase in total revenue and vice-versa.

Relation between Price Elasticity of Demand and Average Revenue

We know that price is same as average revenue in all market conditions. Therefore, substituting P = AR in the above equation, (ii) we get

$$MR = AR\left(\frac{E_P - 1}{E_P}\right)$$

or, $$AR = MR\left(\frac{E_P}{E_P - 1}\right)$$

$$AR \cdot E_P - AR = MR \cdot E_P$$

or, $$MR \cdot E_P = AR \cdot E_P - AR$$

or, $$MR \cdot E_P - E_P \cdot AR = -AR$$

or, $$E_P\ (MR - AR) = (-AR)$$

or, $$E_P = \frac{(-AR)}{MR - AR}$$

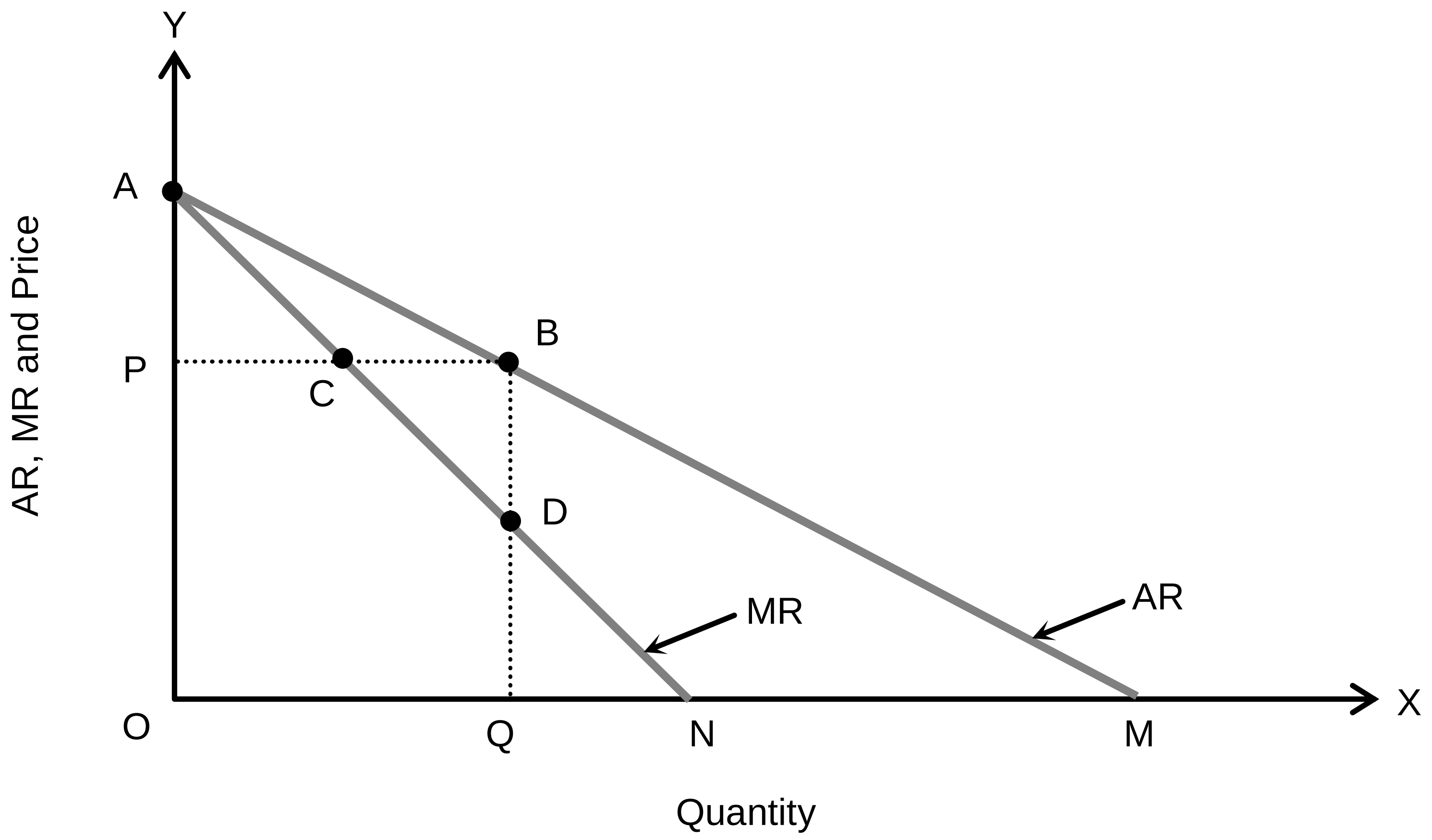
or, $$E_P = \frac{-AR}{-(AR - MR)}$$

$$\therefore \quad \mathbf{E_P = \left(\frac{AR}{AR - MR}\right)} \qquad \ldots\text{(iii)}$$

Relation between Price Elasticity of Demand and Average Revenue Contd.

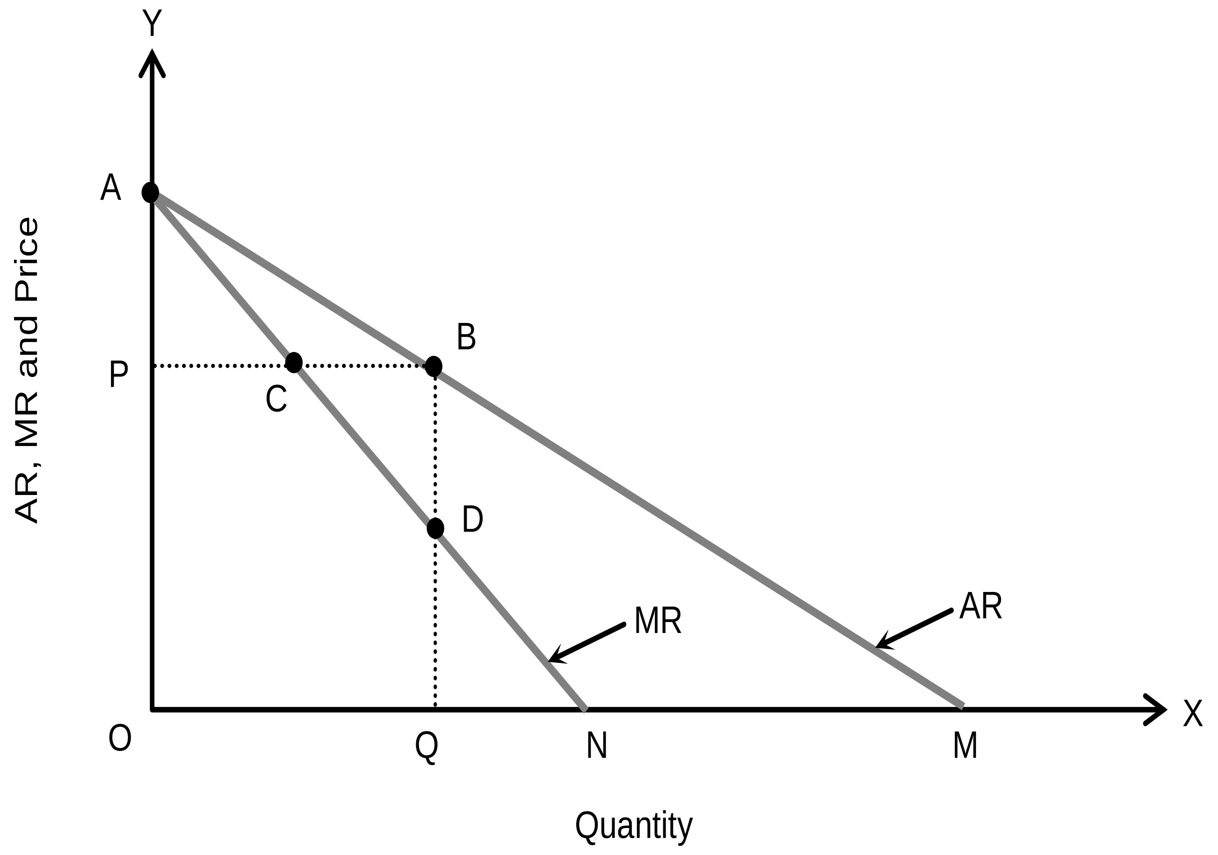
Alternatives Method (Graphical/ Geometrical Proof)

- The above equation (iii) gives the relationship between AR and MR and between AR and E_P.



Relation between Price Elasticity of Demand and Average Revenue Contd.

- In figure, X–axis represents quantity and Y–axis represents average revenue, marginal revenue and price. The downward sloping curve AM represents average revenue curve (AR) and AN represents marginal revenue curve (MR).
- Lets us suppose, that price is given at PO (= QB). According to point elasticity of demand, price elasticity of demand at point B is the lower segment of the demand curve (AR curve) divided by upper segment of the demand curve (AR curve).



Relation between Price Elasticity of Demand and Average Revenue Contd.

$$E_P \text{ at } B = \frac{\text{Lower segment}}{\text{Upper segment}}$$

$$= \frac{BM}{AB} \qquad \ldots \text{(i)}$$

Since Δ APC and Δ QBM are equiangular,

$$E_P \text{ at } B = \frac{BM}{AB} = \frac{BQ}{AP} \qquad \ldots \text{(ii)}$$

Again, in congruent triangles, APC and DBC,

$$AP = BD \qquad \ldots \text{(iii)}$$

From equation (i), (ii) and (iii), we get

$$E_P \text{ at } B = \frac{BM}{AB} = \frac{BQ}{AP} = \frac{BQ}{BD} \qquad [\because AP = BD]$$

$$= \frac{BQ}{(BQ - DQ)} \qquad [\because BD = BQ - BD]$$

$$E_P \text{ at } B = \left(\frac{AR}{AR - MR}\right) \qquad [\because BQ = AR \text{ and } DQ = MR]$$

Hence, by graphical or geometrical method also we can establish the relationship between E_P, AR and MR.

Relationship between Price Elasticity of Demand and Total Revenue

Since the total revenue (TR), marginal revenue (MR) and price elasticity of demand (E_P) are interrelated, the relationship between TR and E_P can be traced through the relationship between MR and E_P. Given the relationship between MR and E_P in the equation, MR = P, the relationship between TR and E_P can be summed up as follows:

i. If $E_P = 1$, MR = 0; TR does not change with change in price.

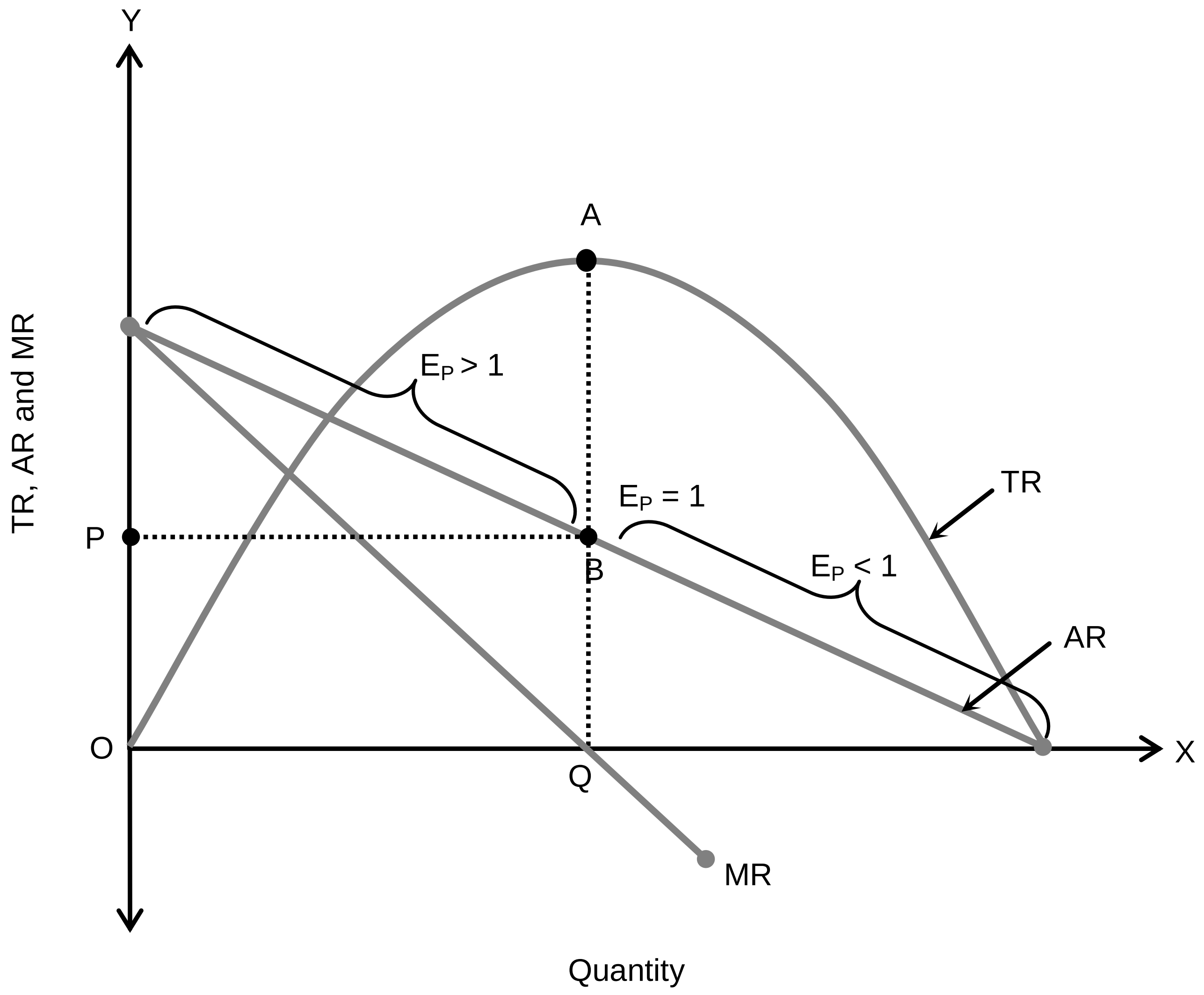
ii. If $E_P < 1$, MR < 0; TR decreases with decrease in price and increase with increase in price.

iii. If $E_P > 1$, MR > 0; TR decreases with increase in price and increases with decrease in price.

The relationship between TR and E_P can be shown graphically in figure.

Relationship between Price Elasticity of Demand and Total Revenue Contd.

- In figure, X-axis represents quantity of output sold and Y-axis represents total revenue, average revenue and marginal revenue.
- The inversely U-shaped curve represents total revenue curve (TR) in the imperfect competition.
- Before output OQ, TR is increasing but at the diminishing rate.
- At output OQ, it is maximum and after output OQ, it is declining.
- The downward sloping curves MR and AR represent marginal and average revenue curves respectively.
- The point B is the mid-point of the demand curve or AR curve. Therefore, at that point E_P is 1. It is clear that when TR is maximum or MR = 0, E_P is equal to unity.



Relationship between Price Elasticity of Demand and Total Revenue Contd.

On the other hand, when TR is increasing, $E_P > 1$ and when TR is declining, $E_P < 1$.

S.No.	Coefficient of elasticity of demand	Change in price	Change in total revenue
1.	$E_P = 1$ (Unity Elastic Demand)	Increase Decrease	No Change No Change
2.	$E_P < 1$ (Inelastic Demand)	Increase Decrease	Increase Decrease
3.	$E_P > 1$ (Elastic Demand)	Increase Decrease	Decrease Increase
4.	$E_P = 0$ (Perfectly Inelastic)	Increase Decrease	Increase Decrease
5.	$E_P = \infty$	Increase	Decrease

Numerical Examples 1

Suppose that price of good X is Rs. 100 and price of good Y is Rs. 200 and budget or money income of the consumer is Rs. 10,000 all of which s/he spends on both goods X and Y.

SOLUTION

Given

Q = 10 units

TC = Rs. 250

TFC = Rs. 100

We know that

TVC = TC – TFC = 250-100 = Rs. 150

$$AVC = \frac{TVC}{Q} = \frac{150}{10} = Rs.\ 15$$

Hence, AVC = Rs. 15

Numerical Examples 2

Suppose a firm produces an output of 10 units where the firms' SAC = LAC = SMC = Rs. 25. What is the LMC at this level of output?

SOLUTION

Since, SAC = LAC = SMC =LMC, LMC is also Rs. 25.

Numerical Examples 3

Complete the following table.

Quantity	TFC	TVC	TC
0	120	0	
1	-	60	
2	-	80	
3	-	90	
4	-	105	
5	-	140	
6	-	210	

SOLUTION

We know that TFC remains constant and TC is the sum of TVC and TFC.

Quantity	TFC	TVC	TC
0	120	0	120
1	120	60	180
2	120	80	200
3	120	90	210
4	120	105	225
5	120	140	260
6	120	210	330

Numerical Examples 4

Find out marginal revenue when average revenue is Rs. 60 and price elasticity of demand is 3.

SOLUTION

Given

Average revenue (AR) = Rs. 60

Price elasticity of demand (E_P) = 3

We know that

$$MR = AR\left(\frac{E_P - 1}{E_P}\right) = 60\left(\frac{3 - 1}{3}\right) = 60 \times \frac{2}{3} = 40$$

Hence, MR = Rs. 40

Numerical Examples 5

Complete the following table and explain the relationship between AC and MC.

Output (Q)	TFC	TVC	TC	AFC	AVC	AC	MC
0	200	0					
1	-	50					
2	-	90					
3	-	120					
4	-	140					
5	-	175					
6	-	230					
7	-	310					
8	-	400					

SOLUTION

Output (Q)	TFC	TVC	TC	AFC	AVC	AC	MC
0	200	0	200	-	-	0	-
1	200	50	250	200	50	250	50
2	200	90	290	100	45	145	40
3	200	120	320	66.6	40	106.6	30
4	200	140	340	50	35	85	20
5	200	175	375	40	35	75	35
6	200	230	430	33.3	38.3	71.6	55
7	200	310	510	28.5	44.2	72.7	80
8	200	400	600	25	50	75	90

SOLUTION

The relationship between AC and MC can be pointed as follows:

i. At the beginning both AC and MC are declining.

ii. When MC is decreasing, it declines faster than AC.

iii. MC is minimum at fifth unit of output and AC is minimum at sixth unit of output.

iv. AC = MC at sixth unit of output and at this output AC is minimum.

v. Beyond minimum point of AC, MC > AC.

Numerical Examples 5

Total cost function of a producer is given by $TC = 1000 + 10Q - 0.9Q^2 + 0.004Q^3$. Find TFC, TVC, TC, AFC, AVC and MC to produce 5 units of output.

SOLUTION

Given

$TC = 1000 + 10Q - 0.9Q^2 + 0.004Q^3$

Total fixed cost (TFC) is the total cost at zero level of output and it remains the same whatever be the level of output. It remains the same regard less of change in output.

When Q = 0, TC = 1000. Hence, at Q = 5, TFC = 1000

When Q = 5, $AFC = \frac{TFC}{Q} = \frac{1000}{5} = 200$

We know that TC = TFC + TVC

TVC = TC – TFC

$TVC = 1000 + 10Q - 0.9Q^2 + 0.004Q^3 - 1000$

$TVC = 10Q - 0.9Q^2 + 0.004Q^3$

At, $Q = 5$

$TVC = 10 \times 5 - 0.9\,(5)^2 + 0.004(5)^3 = 50 - 22.5 + 0.5 = 28$

Now, $TC = TFC + TVC = 1000 + 28 = 1028$

Now,

$$AVC = \frac{TVC}{Q} = \frac{28}{5} = 5.6$$

$$MC = \frac{dTC}{dQ} = \frac{d}{dQ}(1{,}000 + 10Q - 0.9Q^2 + 0.004Q^3)$$

$$= \frac{d(1000)}{dQ} + 10\,\frac{dQ}{dQ} - 0.9\left(\frac{dQ^2}{dQ}\right) + 0.004\left(\frac{dQ^3}{dQ}\right)$$

$$= 0 + 10 \times 1 - 2 \times 0.9 \times Q + 3 \times 0.004 \times Q^2$$

$$= 10 - 1.8\,Q + 0.012Q^2$$

Putting $Q = 5$,

$$MC = 10 - 1.8(5) + 0.012 \times 5^2$$

$$= 10 - 9 + 0.3$$

$$= \text{Rs. } 1.3$$

Part C: Profit Analysis

Profit

- Profit is defined as the excess of total revenue over the cost of production.
- In other words, profit is the reward for the entrepreneur for his or her efforts, skill, risks and innovations.
- Profit is the residual income of an entrepreneur left after payments to the other inputs, i.e. rent to the land, wages to labour and interest to the capital.
- The definition of profit is quite different for the economists than for accountants.
- Accountants are concerned with business profit whereas economists are concerned with economic profit.

Business Profit and Economic Profit

Business Profit

Business profit is defined as the excess of total revenue over the explicit cost or accounting cost. It is also known as the accounting profit or gross profit. In the business sense, business profit is the excess of total revenue over the total cost of production.

Business Profit (Accounting Profit) = Total Revenue – Explicit Cost

= Total Revenue – Accounting Cost

Economic profit

Economic profit is defined as the excess of total revenue over the economic cost. Economic cost is the sum of implicit cost and explicit cost.

Economic Profit = Business Profit – Implicit Cost

Economic profit is also calculated deducting economic cost from total revenue. Thus,

Economic Profit = Total Revenue – Economic Cost

= Total Revenue – (Implicit Cost + Explicit Cost)

= Total Revenue – Implicit Cost – Explicit Cost

Numerical Example

Tejaswini, a fashion designer, working as a manager of a Boutique for Rs. 120,000 per year wants to start her own business by investing her own money of Rs. 400,000 on which she could earn 10 percent interest if deposited in a bank. Her estimated revenue during the first year of operation is Rs. 300,000 and costs are - salaries to employee Rs. 90,000; supplies Rs. 30,000; rent Rs. 20,000 and utilities Rs. 2,000.

a. Calculate is the business profit.

b. Calculate is the economic profit.

c. If she seeks your advice on whether to stay in the business or not what will be your advice and why?

SOLUTION

a. Business profit (Accounting profit) = TR – Total explicit costs

= TR – (Salaries to employee + Supplies + Rent + Utilities)

= 300,000 – (90,000 + 30,000 + 20,000 + 2,000)

= 300,000 – 142,000

= Rs. 158,000

Alternatively,

Particulars	Amount (Rs.)	Amount (Rs.)
Revenue		300,000
Less: Explicit costs		
Salaries to employees	90,000	
Supplies	30,000	
Rent	20,000	
Utilities	2,000	142,000
Business Profit/ Accounting Profit		158,000

b. Economic profit = Business profit – Implicit costs

= Business profit – (Salary of previous job + Interest of her own money invested)

= 158,000 – (120,000 + 10% of 400,000)

= 158,000 – (120,000 + 40,000)

= – Rs. 2,000 (Loss)

Alternatively,

Particulars	Amount (Rs.)	Amount (Rs.)
Business profit/ Accounting profit		158,000
Less: Implicit costs Salary of previous job Interest on Rs. 400,000 @ 10%	120,000 40,000	160,000
Economic profit		(2,000) or –2,000

c. Here, she has loss of Rs. 2,000 because economic profit is negative economic profit is lower than total revenue. Therefore, I advice her not to start new business. If economic profit was positive, I would suggest to start new business.