Engineering Economics

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UNIT 2 MICRO ECONOMIICS ANALYSIS;

DEMAND ANALYSIS, SUPPLY analysis, theories of utility and consumers choice, cost analysis, competition and market structures, application of micro economics theories. 8 hours.

❑ **Production** means any process that transforms one commodity into another. It is an activity of transforming inputs into outputs. In other words, it means an activity by which resources (men, material, time etc.) are transformed into a different and more useful commodity or service with value added. In general, it means transforming input into an output.

❑ **Production function:** – It refers to functional relationship between inputs and outputs. In other words, it is a purely technical relation which connects factor inputs and outputs. It represents the technology of a firm of an industry, or the economy of a whole.

❑ **Factors of productions** are land, labour, capital and entrepreneur or organisation.

❑ **Factor prices** are the prices of factors of production and they are rent for land, wage for labour, interest rate for capital and profit for entrepreneurs.

❑ **Method of production (process, activity):** – It is a combination of factor inputs required for the production of one unit of output.

❑ **General mathematical form of Production function,**

- $Y= f (L, K, R, S, v, γ)$

Where, Y= output, L= labour input, K= capital, R= raw materials, S= land, v= returns to scale, γ = efficiency parameter.

Production function in traditional economy theory,
$$X = f(L, K)$$

❑ **Theory of production:** – Theory of production seeks to explain and predict the what, how and how much of production. In other words, it states the quantitative relation between inputs and outputs. In simple words, it tells how input is most likely to change in response to change in the quantity of inputs, given the technology.

❑ **Firm:** – Firm is an entity that combines inputs for the purpose of transforming them into outputs. The entrepreneur (owner and manager) decides
which commodity or commodities will be produced, and their method of production and quantity.

❑ **Industry:** – Industry is defined as a set of firms producing the same products. e.g., each shoe manufacturing company can be treated as a firm and all the companies engaged in this business will make up the shoe industry. An industry is thus an aggregate of similar firms while a firm is a single entity of production.

❑ **Input:** – Also called factors of production, include everything that goes into the process of production. e.g. land, labour, capital, time, space, water, power, fuel, managerial skills etc. However, economists classify factors of production as labour, land capital, entrepreneurs/ organization. All the inputs have a price. It means that production of commodity involves cost of production.

❑ **Output:** – Output is any good or service that comes out of production process.

❑ **Fixed input:** – A fixed input is one whose supply is inelastic in that short
run and is used in a fixed quantity in a short run. In technical sense, a fixed factor is one that remains fixed or constant for a certain level of output e.g. permanent, staff, building, plant, and machinery.

❑ **Variable inputs:** – It is defined as one whose supply in the short run is elastic. All the users of such factors can employ a larger quantity in the short run. Technically, a variable input is one that changes with the changes in the output. In the long run all inputs are variable e.g. raw material, labour, etc.

❑ **TIME DIMENSION:** – There are four time periods to study functional relationships between inputs and outputs.

1. **Very short period:** No factor is variable and production cannot be increased.

$$Q = f(\bar{L}, \bar{K})$$

Where, Q= output, L= labour and K= capital

2. **Short period:** Production can be increased only by increasing the variable factor, fixed factor remaining constant.

Q= f (L, K is constant)

3. **Long period:** Production can be increased by increasing the quantity of fixed and variable factor both. All the factors are variable in the long run.

Q= f (L, K)

4. **Very long period:** Production function can be changed and the technology of production can also be changed.

TYPES OF PRODUCTION FUNCTION

1.   **Short period or run production function:** When one factor input is variable and the others are fixed, it is called short run production function. The law which operates in the short run is called law of returns to a factor or law of variable proportion and there are three laws. They are,

    a)Law of increasing return

    b)Law of constant return

    c)Law of diminishing return

  Short run production is written as   Q= f (L, K is constant)

2. **Long period or run production function:** When all the factor inputs are variable and there is no difference between the fixed and the variable factor, it is called long run production function. The law which operates in long period is called law of returns to scale and there are three types. They are,

    a)Increasing returns to scale

    b)Constant returns to scale

    c)Diminishing returns to scale

    Long run production function is written as   Q= f (L, K)

❏ **CONCEPT OF PRODUCTION:**

1. Total product or total physical product (TP/TPP): It refers to total quantity of goods produced by a firm during a given period of time with the help of given inputs.

- **TP= Σ Marginal Product**
- Or TP = (Average product) x (Quantity of variable input)

2. Average product (AP): It is defined as output per unit of variable input.

- **AP= TP ÷ Q**

3. Marginal Product (MP): It is a change in total product or output per unit of change in the variable input, while keeping the input fixed.

MP= dTP ÷ dQ

❏ **MODERN APPROACH: LAW OF VARIABLE PROPORTION or Law of returns to a factor:**

The law of variable proportions states that the marginal product of a factor input initially rises with its employment level but after reaching a certain level of employment it starts falling. And there are three stages of production according to modern approach and they are

1. **Stage 1 or Increasing returns:** TP increases at increasing rate and MP rises due to better coordination between factors. **Law of increasing returns to a factor state that** with an increase in employment of one input, other factors held constant, if MP increases or TP increases at increasing rate then it is law of increasing returns applying to production process. Stage 1 happens during increasing returns to a factor. Stage 1 ends when AP becomes maximum and then stage 2 begins. The reason are **i.** better utilization of fixed resources, **ii.** efficient utilization of variable factor and **iii.** better co-ordination between fixed and variable factor.

2. **Diminishing returns:** TP increases at diminishing rate and MP begins to falls positively due to poor coordination between factors. Under this, the second stage ends at P = 0. This law states that with an increase in the employment of one input, other factors held constant, MP begins to fall in the following ways

i. MP falls positively, TP increases at diminishing rate.

ii. MP = 0, TP becomes maximum.

The reasons for it are **i.** over utilization of fixed factor, **ii.** imperfect substitutes of factors and **iii.** poor coordination of fixed and variable factor.

3. **Negative returns:** TP decreases and MP becomes negative due to poor coordination between factors. Under this, third stage starts when MP falls negavtively. The reasons for it are **i.** over utilization of fixed factor, **ii.** imperfect substitutes of factors and **iii.** poor coordination of fixed and variable factor.

Table: Law of variable proportion

Units of Labour	TP	MP	AP	Stages
1	2	2	2	Stage 1 Ends when AP is maximum.
2	5	3	2.5	
3	9	4	3	
4	12	3	3	
5	14	2	2.8	Stage 2 ends when MP =0 or TP=maximum
6	15	1	2.5	
7	15	0	2.1	
8	14	-1	1.7	Stage 3: MP falls negatively
9	12	-2	1.3	
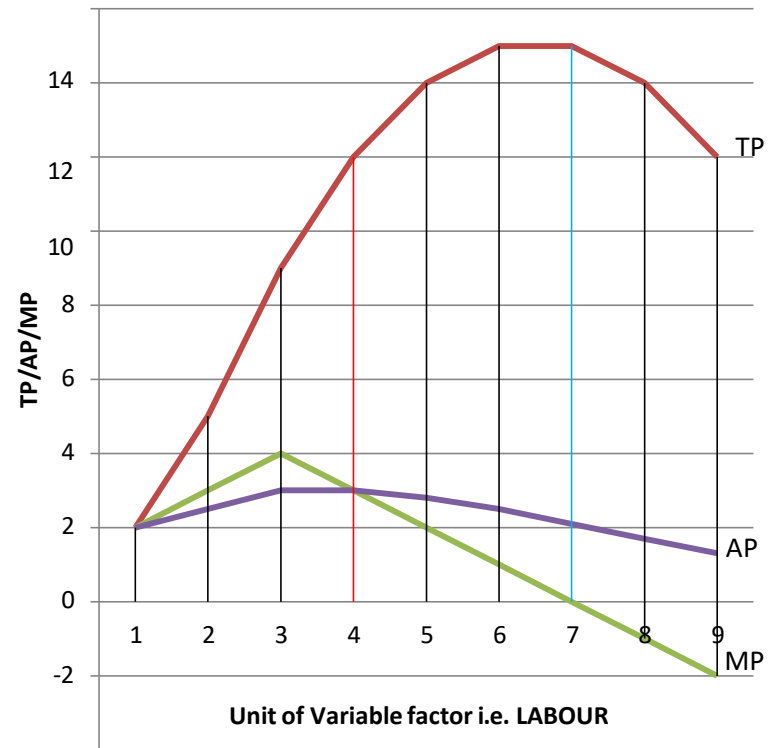
❑ **LAW OF RETURNS TO SCALE:** in the long run, all factors are variable. A firm changes its scale (size) of production by changing quantity of fixed and variable factors in same proportion. Returns to scale refers to the rate by which output changes if all inputs are changed by the same proportion. The laws under returns to scale are

1. **Increasing returns to scale (IRS):** when all puts are increased by a same percentage, the output increases more than proportionately then increasing returns to scale is applicable in the production process. It is due to the application of economies of scale. **Economies of scale refers** to benefits enjoyed by the firm on expanding its scale of production. It is of two types

     a. **Internal Economies of scale** are economies which arise from the actions of an individual firm. e.g. technical economies, labour economies, marketing economies, financial economies, risk bearing economies, transport and storage economies and managerial economies.

     b. **External economies of scale** refer to the advantages of an industry as whole e.g. economies of information, economies of concentration, economies of government action, economies of marketing etc.

2. **Constant returns to scale (CRS):** if all inputs are increased by a same proportion, constant returns to scale hold when output increases exactly by the proportion in which inputs are increased. It is due to the counterbalancing between economies of scale and diseconomies of scale.

3. **Decreasing/ diminishing returns to scale (DRS):** when all inputs are increased by a same percentage, the output increases less than proportionately then diminishing returns to scale operates in the process of production. it is due to the application of diseconomies of scale. **Diseconomies of scale** refers to losses which accrue to the firms in the industry due to expansion of their scale of production beyond optimum capacity. It is of two types:

1. **Internal diseconomies of scale** are those factors which raise the cost of production of a firm as the firm expands. These occur because of managerial constraints. e.g. inefficient management due to lack of coordination, lack of availability of skilled inputs, inefficient investment, etc; labour diseconomies; technical difficulties.

2. **External diseconomies of scale** refer to the disadvantages faced by the industry as a whole. Examples are scarcity of raw materials, wage differentials and concentration problems.

Units of Labor	Units of Capital	% increase in labour and capital	Total Product	% increase in Total Product	Returns to scale
1	2	–	10	–	
2	4	100%	30	200%	
3	6	50%	60	100%	Increasing
4	8	33%	80	33%	
5	10	25%	100	25%	Constant
6	12	20%	110	10%	
7	14	16%	120	9%	
8	16	14%	125	4%	Decreasing

○(1) Increasing Returns to Scale
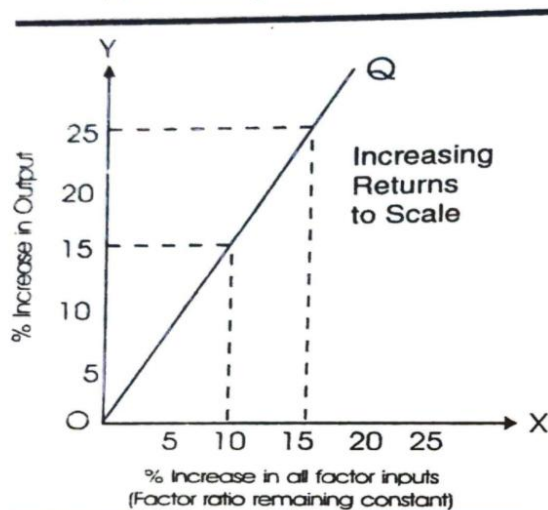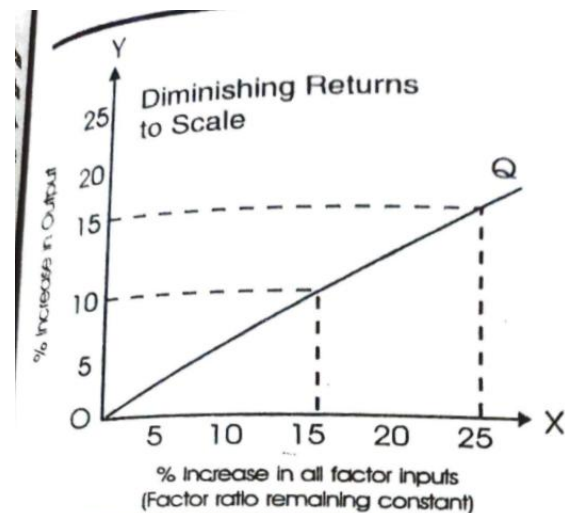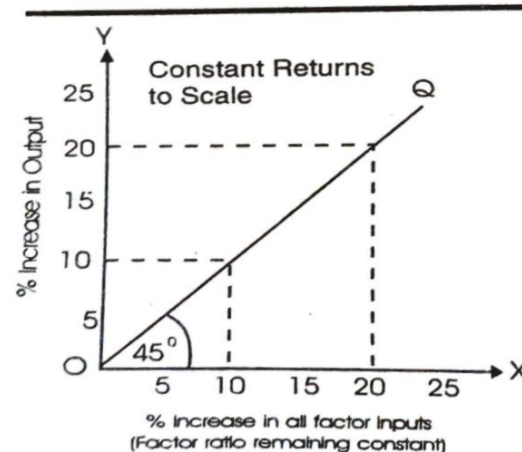
○(2) Constant Returns to Scale

Figure 5

❑ **THE TRADITIONAL THEORY OF COST-OUTPUT RELATIONS:** The traditional theory of cost analysis cost behaviour in response to change in production. Cost behaviour is analysed under (i) short-run conditions, and (ii) long run conditions. In the short run, therefore, cost-output relationship depends on the returns to the variable factor. In the long run, cost output relationship depends on the returns to scale.

❑ **SHORT-RUN COST-OUTPUT RELATIONS:** In the process of production in the short run can be classified as (i) fixed factors, and (i) variable factors. Fixed factors include land, plant, building, machinery and equipments, etc. Variable factors include such inputs as direct labour, raw material, fuel etc. The total cost incur on the fixed inputs are called fixed cost and total cost incurred on variable inputs is called variable cost. **Thus, the total short-run cost (STC) consists of (i) total fixed cost (TFC), and (ii) total variable cost (TVC).** That this,

- Cost or C= f (Output or Q)
- STC or TC = TFC + TVC
- Table: TFC, TVC, TC, AC, AFC, AVC and MC

Q	TFC	TVC	TC=TFC+TVC	AC=TC ÷Q	AFC= TFC÷Q	AVC=TVC÷Q	MC=dTC÷dQ
0	20	0	20	-	-	-	-
1	20	10	30	30	20	10	10
2	20	18	38	19	10	9	8
3	20	24	44	14.6	6.6	8	6
4	20	28	48	12	5	12	4
5	20	32	52	10.4	4	10.4	4
6	20	38	58	9.5	3.3	9.5	6
7	20	46	66	9.5	2.9	9.5	8
8	20	58	78	9.8	2.5	9.8	10
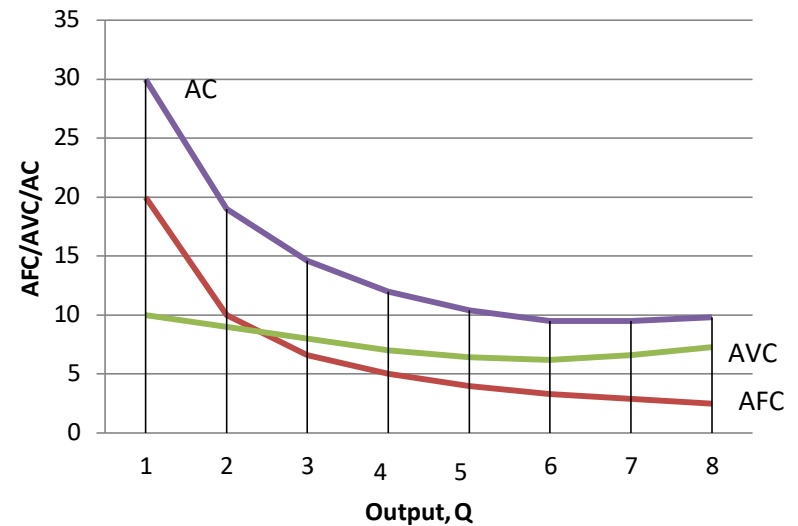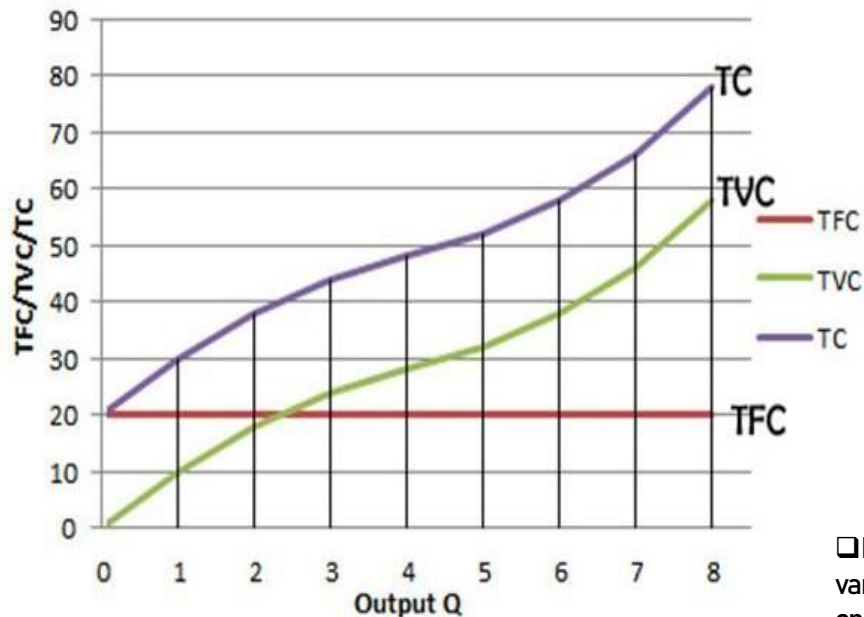
In the above diagram, AVC curve is 'U' shape because of application of law of variable proportion. As output increases, the AVC begins to fall due to the operation of law of increasing returns to a factor. Then AVC reaches its minimum point. Then AVC starts increasing due to law of diminishing returns to a factor.

❑ RELATIONSHIP AMONG TC, TFC AND TVC:

(a) Total cost can never be zero, even when the level of output is zero, because fixed cost is positive and constant at zero level of output.

(b) As the level of output increases, total cost also increases due to increase in variable costs.

(c) TC and TVC curves are parallel to each other, but can never meet at any level of output, because the difference between these two is of TFC which is always positive and constant.

(d) TFC is constant and hence a horizontal straight line parallel to X-axis while TC and TVC curves are inverse 'S'-shared curves.

❑ **AVERAGE COST (AC) OR AVERAGE TOTAL COST (ATC):** Average cost is per unit cost of producing the commodity. AC is the total cost divided by output. It is sum of AFC and AVC.

$$AC = AVC + AFC$$
$$Or\ AC = TC \div Q$$

AC comprises of two types of costs in the short period:
1. Average Fixed Cost (AFC)
2. Average Variable Cost (AVC)

❑ **Average Fixed Cost:** It is unit per fixed cost of producing the commodity. Or It refers to the ratio of total fixed cost to total output.

$$AFC = TFC \div Q$$

As output increases, AFC goes on falling and forms a downward sloping curve but never touches X–axis as fixed cost can never be zero.

❑ **Average Variable Cost:** It is per unit variable cost of producing the commodity.

- $AVC = TVC \div Q$

    Or It refers to the ratio of total variable cost to total output.

❑ **WHAT CAUSES 'U' SHAPE OF AC OR ATC CURVE (short run)?** Due to the following points,
(i) AC is the sum total of AFC and AVC
(ii) Law of variable proportion:
- (a) Initially AC falls due to the application of law of increasing returns to a factor that is due to better utilisation of the fixed and variable factors.
- (b) AC reaches its minimum points i.e., point of optimum capacity of the firm or lowest per unit cost of production.
- (c) AC begins to rise due to law of diminishing returns. This happens due to over utilisation of the fixed factor and imperfect substitution of the variable factors.

❑ <u>MARGINAL COST</u>: It is a change in total cost by producing one more unit of output.

❑ <u>RELATION BETWEEN AC(ATC) AND MC:</u>

i.   When AC falls, MC curve is below AC curves because MC is less than AC.

ii.   When AC is minimum and constant then MC curve cuts AC curve or MC=AC.

iii. When AC is rising, MC curve is above AC curve because MC is more than AC.

•   **<u>Note: MC curve cuts AC and AVC curve at their lowest point.</u>**

❑ **<u>Producer's Equilibrium in Perfect Competition:</u>** A producer is aid to be in equilibrium when he produces the level of output at which his profits are maximum. It can be explained by using the following approaches:

1. By using isoquant and isocost approach: The producer is in equilibrium when the isoquant is tangent to the isocost and the isoquant is convex to the origin .i.e.,

   Condition i: Slope of Isoquant = Slope of Isocost

   Condition ii: Isoquant is convex to the origin

2. By using Total Revenue TR and Total Cost TC Approach: Producer aims to produce that level of output at which he can earn maximum profits.

Condition i: Difference between TR and TC is maximum

Condition ii: Profits fall, when one more unit of output is produced

3. By using Marginal Revenue MR and Marginal Cost MC approach:

Condition i: MC = MR

Condition ii: MC cuts MR curve from below.

- ❑ <u>**CONCEPT OF REVENUE:**</u> **Revenue** refers to the money receipts of a firm from selling its output. The demand curve of the consumers for a commodity is the average revenue curve of the firm because the price paid by the consumers is the revenue of the firm.
- ❑ **Total revenue TR:** TR is amount a firm receives by selling a given quantity of output. Mathematically, TR = number of unit sold × price of the good sold
- ❑ **Average Revenue AR:** AR is the per unit revenue received from the sale of the commodity as

  AR = TR÷Q where Q = Quantity sold

Or AR is the income received from the sale of given quantity of output. It is also called price.

- ❑ **Marginal Revenue MR:** MR is the addition to the total revenue from sale of an additional unit of a commodity. MR = ΔTR ÷ ΔQ

table: TR,AR, MR and Price under Perfectly competitive market

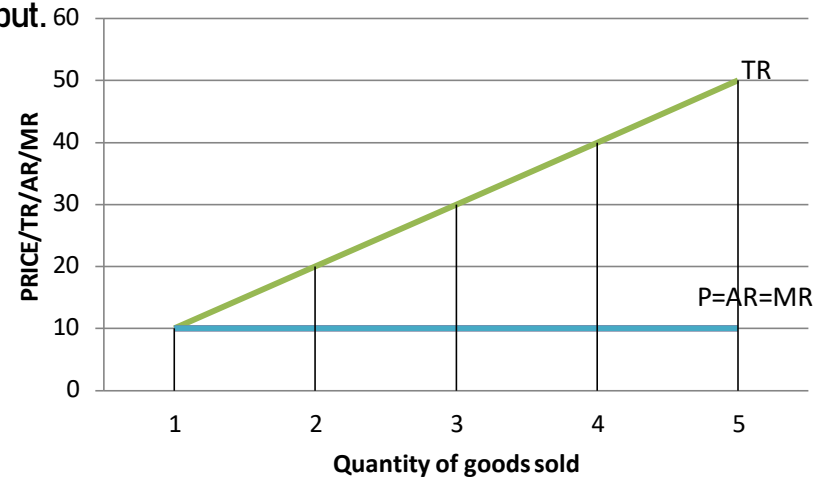| Quantity of goods sold Q	Price,P	TR= Q.P	AR= TR÷Q	MR= ΔTR ÷ ΔQ
1	10	1×10= 10	10÷1= 10	10÷1= 10
2	10	2×10=20	20÷2= 10	10÷1= 10
3	10	3×10=30	30÷3= 10	10÷1= 10
4	10	4×10=40	40÷4= 10	10÷1= 10
5	10	5×10=50	50÷5= 10	10÷1= 10

Note: In a perfectly competitive market, price of product is determined by the industry. A firm has no control over the price that is why Price= AR= MR

❑ **RELATIONSHIP AMONG TR, AR and MR in perfect competition (when price remains constant)**

1. MR curve is a horizontal straight line parallel to X axis, it is due to price of the commodity remains the same. Therefore, TR increases at the same rate when MR is constant.

2. TR curve is a positively slope straight line forming an angle of 45 at the origin.

3. TR curve passes through the origin as TR is 0 level of output.

4. AR and MR curves coincide.

❑ **TR, MR AND AR IN MONOPOLY AND MONOPOLISTIC COMPETITION (IN IMPERFECT MARKET)**

Quantity of goods sold Q	AR= TR÷Q And AR= Price,P	TR= Q.P	MR= ΔTR ÷ ΔQ
1	10	10	10
2	9	18	8
3	8	24	6
4	7	28	4
5	6	30	2
6	5	30	0
7	4	28	-2
8	3	24	-4

❏ RELATIONSHIP AMONG TR, AR and MR in monopoly OR in monopolistic competition:

1. When MR is falling positively TR increases at the diminishing rate.
2. When MR is 0, TR is maximum and constant.
3. When MR becomes negative, TR decreases.
4. AR falls when MR<AR.
5. MR curve is steeper than the AR curve.
6. Fall in MR is double than that in AR.
7. When MR is 0 and become negative AR always remain positive.
8. MR curve remains below AR curve because MR is limited to one unit, whereas AR is derived by all the units.