

III Match the following:

- | A | B |
|---------------|------------------------------|
| 1. CRS | a) $\Delta TC/\Delta C$ |
| 2. SAC | b) Long run Average cost |
| 3. LRAC | c) Short run Average cost |
| 4. $TFC+TVC=$ | d) Constant returns to scale |
| 5. SMC | e) TC |

Ans: 1 - (d); 2 - (c); 3 - (b); 4 - (e); 5 - (a)

IV Answer the following questions in a sentence or word

1. What do you mean by total product?

Ans: Total product is the relationship between a variable input and output when all other inputs are held constant.

Suppose we vary a single input and keep all other inputs constant. Then for different levels of that input, we get different levels of output. This relationship between the variable input and output, keeping all other inputs constant, is often referred to as Total Product of the variable input.

2. What is Average product?

Ans: Average Product is defined as the output per unit of variable input. We calculate it as $APL=TPL/L$.

3. Give the meaning of marginal product.

Ans: Marginal Product of an input is defined as the change in output per unit of change in the input when all other inputs are held constant. It is the additional unit of output per additional unit of variable input. It is calculated by dividing the change in output by change in input labour.

$$MPL = \Delta TPL/\Delta L.$$

4. Write the meaning of cost function of the firm.

Ans: The cost function of the firm describes the least cost of producing each level of output, given prices of factors of production and technology. It deals with the output and prices of factors of production.

5. What is total fixed cost?

Ans: The cost that a firm incurs to employ fixed factors of production (inputs) is called as Total Fixed Cost.

6. What is average fixed cost?

Ans: Average fixed cost is the cost per unit of fixed input. It is obtained by dividing the values of the Total Fixed cost by output. The formula to calculate Average Fixed cost is

$$AFC = TFC/q.$$

V Answer the following questions in four sentences.

1. What is Isoquant?

Ans: An isoquant is the set of all possible combinations of the two inputs that yield the same maximum possible level of output. Each isoquant represents a particular level of output and is labelled with that amount of output. It is just an alternative way of representing the production function.

2. Give the meaning of the concepts of short run and long run.

Ans: The concepts of short run and long run are defined as a period simply by looking at whether all the inputs can be varied or not. It is not advisable to define short run and long run in terms of days, months or years.

In the short run, at least one of the factor – labour or capital cannot be varied and therefore, remains fixed. In order to vary the output level, the firm can vary only the other factor. The factor that remains fixed is called the fixed factor and the other factor which the firm can vary is called the variable factor.

In the long run, all factors of production can be varied. A firm in order to produce different levels of output in the long run may vary both the inputs simultaneously. So, in the long there is no fixed factor.

3. Mention the types of returns to scale.

Ans: The types of returns to scale are

- (a) Constant Returns to Scale
- (b) Increasing Returns to Scale
- (c) Decreasing Returns to Scale

4. Name the short run costs.

Ans: The short run costs are: Total Fixed cost, Total Variable cost, Total Cost, Average Fixed Cost, Average Variable Cost, Average Cost and Marginal Cost.

5. What are long costs?

Ans: There are two long run costs namely, (a) Long run Average Cost (b) Long run Marginal Cost.

VI Answer the following questions in 12 sentences.

1. Explain isoquant with the help of a diagram.

Ans: An isoquant is the set of all possible combinations of the two inputs that yield the same maximum possible level of output. Each isoquant represents a particular level of output and is labelled with that amount of output. It is just an alternative way of representing the production function.

The concept of isoquant can be explained with the help of following diagram:

The above diagram generalizes the concept of isoquant. In the above diagram, labour is measured in OX axis and Capital is measured in OY axis. There are 3 isoquants for the three output levels viz., $q=q_1$, $q=q_2$ and $q=q_3$. Two input combinations (L1, K2) and (L2, K1) give us the same level of output q_1 . If we fix capital at K1 and increase labour to L3, output increases and we reach a higher isoquant $q=q_2$. When Marginal products are positive, with greater amount of one input, the same level of output can be produced

only using lesser amount of the other. Therefore, isoquants curves slope downwards from left to right (negatively sloped).

2. Explain TP, MP and AP with the example.

Ans: The TP – total product, MP- marginal product and AP – Average Product

Total Product:

Total product is the relationship between a variable input and output when all other inputs are held constant. Suppose we vary a single input and keep all other inputs constant. Then for different levels of that input, we get different levels of output. This relationship between the variable input and output, keeping all other inputs constant, is often referred to as Total Product of the variable input.

Average product

Average Product is defined as the output per unit of variable input. We calculate it as $APL = TPL/L$, where APL is the Average Product of Labour, TPL is the Total product of labour and L is the amount of labour input used.

Marginal Product

Marginal Product of an input is defined as the change in output per unit of change in the input when all other inputs are held constant. It is the additional unit of output per additional unit of variable input. It is calculated by dividing the change in output by change in input labour.

$MPL = \Delta TPL / \Delta L$.

The concepts of TP, AP and MP can be explained with the help of following table:

Labour	TP	MP _L	AP _L
0	0	-	-
1	10	10	10
2	24	14	12
3	40	16	13.33
4	50	10	12.5
5	56	6	11.2
6	57	1	9.5

The above table shows the total product of labour, Marginal product of labour and Average product of labour. The total product is also sometimes called as total return to or total physical product of the variable input labour. The third column gives us a numerical example of Marginal product of labour. The values in this column are obtained by dividing change in TP by change in Labour. The last column gives us a numerical example of average product of labour. The values in their column are obtained by dividing TP by Labour.

3. Write a brief note on returns to scale.

Ans: The returns to scale can happen only in the long run as both the factors (Labour and Capital) can be changed. One special case in the long run occurs when both factors are increased by the same proportion or factors are scaled up.

- **Constant returns to scale:** When a proportional increase in all inputs results in an increase in output by the same proportion, the production function is said display constant returns to scale.
- **Increasing returns to scale:** When proportional increase in all inputs results in an increase in output by a larger proportion, the production function is said to display increasing returns to scale.
- **Decreasing returns to scale:** When a proportional increase in all inputs results in an increase in output by a smaller proportion, the production function is said to display decreasing returns to scale.

For example, if in a production process, all inputs get doubled. As a result, if the output gets doubled, the production function exhibits constant returns to scale, if output is less than doubled, exhibits decreasing returns to scale and if is more than doubled, exhibits increasing returns to scale.

4. Explain the long run costs.

Ans: In the long run, all inputs are variable. There are no fixed costs, The total cost and the total variable cost coincide in the long run. There are two types of long run costs. They are as follows:

a) Long Run Average Cost (LRAC): The long run average cost is the cost per unit of output produced. It is obtained by dividing the Total Cost by the output produced. It can be calculated as follows:

$$LRAC = TC/q$$

Where TC is Total cost and ‘q’ is quantity of output produced.

b) Long Run Marginal Cost: The long run marginal cost is the change in total cost per unit of change in output. When output changes in discrete units, then, if we increase production from q₁₋₁ to q₁ units of output, the marginal cost of producing q₁th unit will be measured as follows:

$$LRMC = (TC \text{ at } q_1 \text{ units}) - (TC \text{ at } q_{1-1} \text{ units}) \text{ or } LRMC = TC_n - TC_{n-1}$$

5. The following table gives the TP schedule of labour. Find the corresponding Average product and marginal product schedules.

Ans: Calculation of Average Product (AP) and Marginal Product (MP). AP is obtained by dividing TPL by Labour (L) and MP is obtained from TPL with the help of formula TC_n – TC_{n-1}

TPL	L	AP	MP
0	0	0	-
1	1	1	1
35	2	17.5	34
50	3	16.66	15
40	4	10	-10
48	5	9.6	8

VII Answer the following questions in 20 sentences.

1. Explain the various short run costs.

Ans:The various short run costs are Total Cost, Total Fixed Cost, Total Variable Cost, Average Cost, Average Fixed Cost, Average Variable Cost, and Marginal Cost. The following table shows the various types of short run costs:

The TFC, TVC, TC, AFC, AVC, AC and MC is shown in table as follows:

a) Total Fixed Cost (TFC):

It refers to the total money expenses incurred on all the fixed factors in the short run. TFC remains constant at all levels of output. Therefore the total fixed cost curve is horizontal straight line to OX axis above the origin which indicates that it is never zero.

b) Total Variable Cost (TVC):

It refers to the total money expenses incurred on the variable factor inputs in the short-run. Total variable cost is the direct cost of the output because it increases along with the output & remains zero when the output is zero. So, the TVC curves starts from the origin & rises sharply in the beginning, gradually in the middle & stretch again sharply in the end the nature of this slope is in accordance with the law of variable proportion.

c) Total Cost (TC):

It is the aggregate money expenditure incurred by the firm on all the factors to produce a given quantity of output. TC varies in the same proportion as total variable cost because the total fixed cost is constant. The TC curve slope upwards from left to right, above the origin, indicating that, it includes total fixed cost and total variable cost.

d) Average Fixed Cost (AFC): It is the fixed cost per unit of output. In other words, it is average expenses incurred on a single unit of output produced. AFC and output are inverse relation i.e. AFC will be higher when the output level is less and as the output goes on increasing AFC starts reducing, when it is represented in the diagram AFC curve will have a negative slope which falls very stiffly in the beginning and later on becomes parallel to the X axis. .

The Average Fixed Cost is obtained by dividing Total Fixed Cost by Output. $AFC = TFC / \text{Output}$.

e) Average Variable Cost (AVC):

It is a variable cost for per unit of output. It can be calculated by dividing total variable cost by the total units of output. When this cost is graphically represented, we get a 'U' shaped AVC, which shows that the cost will be less as the number of units produced increase, this is because as the number of variable inputs are added in a fixed plant the efficiency will increase and vice versa.

$$AVC = TVC / \text{Output} \text{ or } AVC = AC - AFC$$

f) Average Cost (AC): It is the cost per unit of output produced. It is obtained by dividing total cost by the total output produced i.e. $AC = TC / Q$ or it is also obtained by adding AFC & AVC. If the AC is graphical represented we get U shaped curve because of the operation of law of variable proportions. The short run AC curve is also called as 'Plant Curves' because it indicates the optimum utilization of a given plant (Industry) capacity.

g) Marginal Cost (MC): It is an additional cost incurred to produce an additional output. In other words it is the net additions to the total cost when one more unit of output is produced.

$$MC = TC_n - TC_{n-1}$$

(Where TC_n = Total Cost of 'n' selected unit of output and TC_{n-1} is Total cost of previous output)

2. Explain the shapes of long run cost curves.

Ans: In the long run, all inputs are variable. There are no fixed costs, The total cost and the total variable cost coincide in the long run. There are two types of long run costs. They are as follows:

c) Long Run Average Cost (LRAC): The long run average cost is the cost per unit of output produced. It is obtained by dividing the Total Cost by the output produced. It can be calculated as follows:

$$LRAC = TC/q$$

Where TC is Total cost and 'q' is quantity of output produced.

In a typical firm the Increasing Returns to scale is observed at the initial level of production. This is then followed by the Constant Returns to Scale and then by the Diminishing Returns to Scale. Accordingly, the LRAC curve is 'U' shaped curve. Its downward sloping part corresponds to Increasing Returns to Scale and upward rising part corresponds to Decreasing Returns to scale. At the minimum point of the LRAC curve, Constant returns to scale is observed.

d) Long Run Marginal Cost: The long run marginal cost is the change in total cost per unit of change in output. When output changes in discrete units, then, if we increase production from q_{1-1} to q_1 units of output, the marginal cost of producing q_1 th unit will be measured as follows:

$$LRMC = (TC \text{ at } q_1 \text{ units}) - (TC \text{ at } q_{1-1} \text{ units}) \text{ or } LRMC = TC_n - TC_{n-1}$$

For the first unit of output, both LRMC and LRAC are the same. Then, as output increases, LRAC initially falls, and then, after a certain point, it rises. As long as average cost is falling, marginal cost must be less than the average cost. When the average cost is rising, marginal cost must be greater than the average cost. LRMC curve is there a 'U' shaped curve. It cuts the LRAC curve from below at the minimum point of LRAC. The following diagram shows the shapes of the long run marginal and the long run average cost curves for a typical firm.

In the above diagram, LRAC reaches its minimum at q_1 . To the left of q_1 , LRAC is falling and LRMC is less than the LRAC curve. To the right of q_1 , LRAC is rising and LRMC is higher than LRAC.

3. Explain the shapes of TP, MP and AP curves.

Ans: Total Product (TP):

Total product is the relationship between a variable input and output when all other inputs are held constant. Suppose we vary a single input and keep all other inputs constant. Then for different levels of that input, we get different levels of output. This relationship between the variable input and output, keeping all other inputs constant, is often referred to as Total Product of the variable input.

The total product curve in the input-output plane is a positively sloped curve as follows:

The above diagram shows the total product curve for labour. When all other inputs are held constant, it shows the different output levels obtainable from different units of labour.

Labour is measured in OX axis and output is measured in OY axis. With L units of labour, the firm can at most produce q1 units of output.

Average product (AP) and Marginal Product (MP):

Average Product is defined as the output per unit of variable input. We calculate it as $APL = TPL/L$, where APL is the Average Product of Labour, TPL is the Total product of labour and L is the amount of labour input used.

Marginal Product of an input is defined as the change in output per unit of change in the input when all other inputs are held constant. It is the additional unit of output per additional unit of variable input. It is calculated by dividing the change in output by change in input labour.

$$MPL = \Delta TPL / \Delta L.$$

According to the law of variable proportions, the marginal product of an input initially rises and then after a certain level of employment, it starts falling. The MP curve therefore, looks like an inverse ‘U’ shaped curve.

For the first unit of the variable input, one can easily check that the MP and the AP are same. As the amount of input is increased, the MP rises. AP being the average of marginal products also rises, but rises less than MP. Then after a point, the MP starts falling. However, as long as the value of MP remains higher than the value of the AP, the AP continues to rise. Once MP has fallen sufficiently, its value becomes less than the AP and the AP also starts falling. So AP curve is also inverse ‘U’ shaped.

This can be diagrammatically represented as follows:

In the above diagram, MPL is marginal product of labour, APL is the average product labour. As long as the AP increases, it must be the case that MP is greater than AP. Otherwise, AP cannot rise. Similarly, when AP falls, MP has to be less than AP. It follows that MP curve cuts AP curve from above at its maximum. In the diagram, AP is maximum at L. To the left of L, AP is rising and MP is greater than AP. To the right of L, AP is falling and MP is less than AP.

4. A firm's SMC schedule is shown in the following table. TFC is Rs.100. find TVC, TC, AVC and SAC schedules of the firm

Q	0	1	2	3	4	5	6
SMC	-	500	300	200	300	500	800

Ans:

Q	SMC	TFC	TVC	TC	AVC	SAC
0	-	100	0	100	0	0
1	500	100	500	600	500	600
2	300	100	800	900	400	450
3	200	100	1000	1100	333.33	366.66
4	300	100	1300	1400	325	350
5	500	100	1800	1900	360	380
6	800	100	2600	2700	433.33	450

Note: TFC is given. TVC is obtained by adding SMC for each unit of output like 500 as it is taken, then $500+300=800$; $800+200(\text{SMC})=1000$ and so on. TC is $\text{TFC}+\text{TVC}$, AVC is TVC divided by Q; and SAC is TC divided by Q.

5. Explain the law of variable proportions with the help of a diagram.

Ans: The law of variable proportions say that the Marginal product of a factor input initially rises with the employment level. But after reaching a certain level of employment, it starts falling.

The law of variable proportions can be explained with the help of the following table and diagram.

Labour	TP	MPL	APL
0	0	-	-
1	10	10	10
2	24	14	12
3	40	16	13.33
4	50	10	12.5
5	56	6	11.2
6	57	1	9.5

The above table shows the total product of labour, Marginal product of labour and Average product of labour. The total product is also sometimes called as total return to or total physical product of the variable input labour. The third column gives us a numerical example of Marginal product of labour. The values in this column are obtained by dividing change in TP by change in Labour. The last column gives us a numerical example of average product of labour. The values in their column are obtained by dividing TP by Labour.

If we plot the above table in graph, placing labor on X axis and output on Y axis, we get the curves shown in the diagram below:

The TP increases as labour input increases. But the rate at which it increases is not constant. An increase in labour from 1 to 2 increases TP by 10 units. An increase in labour from 2 to 3 increases TP by 12 units. The rate at which TP increases is shown by the MP. The MP first increases (till 3 units of labour) and then begins to fall. This tendency of the MP to first increase and then fall is called the law of variable proportions.

The law of variable proportions is also known as law of diminishing marginal product. It occurs because of change in factor proportions. Factor proportions represent the ratio in which the two inputs are combined to produce output. As we hold one factor fixed and keep the other increasing, the factor proportions change. Initially, as we increase the amount of the variable input, the factor proportions become more and more suitable for the production and marginal product increases. But after a certain level of employment, the production process becomes too crowded with the variable input.

In the above diagram, TP is Total Product curve which is increasing in different proportions due the change in labour input. The AP and MP curves are increasing in the beginning and decreasing later. But the change in MP is greater than AP.

Factor 1	TP	MP1	AP1
0	0	0	0
1	10	-	10
2	24	-	12
3	40	16	13.33
4	-	10	-
5	-	6	11.2
6	57	1	9.5

VIII Assignment and project oriented questions.

1. Find the missing products of the following table.

Ans:

Factor 1	TP	MP1	AP1
0	0	0	0
1	10	<u>10</u>	10
2	24	<u>14</u>	12
3	40	16	13.33
4	<u>50</u>	10	<u>12.5</u>
5	<u>56</u>	6	11.2
6	57	1	9.5