Question 1: Explain the concept of a production function.

Answer :

The production function of a firm depicts the relationship between the inputs used in the production process and the final output. It specifies how many units of different inputs are needed in order to produce the maximum possible output. Production function is written as:

$Qx = f(L, K)$

Where

Qx represents units of output x produced.

L represents units of labour employed.

K represents units of capital employed.

The above equation explains that Qx, units of output x are produced by employing L units of labour and K units of capital for a given technology. As the given level of technology appreciates, the output will increase with the same level of capital and labour units.

Question 2What is the total product of an input?

Answer :

Total product is defined as the sum total of output produced by a firm by employing a particular input. It is also known as the Total Physical Product and is represented

as$TP = \sum Q_x$

Where, $\sum$ represents summation of all outputs

$Q_x$represents units of output x produced by an input.

Question 3 :What is the average product of an input?

Answer :

Average product is defined as the output produced by per unit of variable factor (labour) employed. Algebraically, it is defined as the ratio of the total product by units of labour employed to produce the output, i.e.
$$AP = \frac{TP}{L}$$

Where,

TP = Total product

L = units of labour employed

Question 4 :What is the marginal product of an input?

Answer :

Marginal Product is defined as the additional output produced because of the employment of an additional unit of labour. In other words, it is the change in the total output brought by employing one additional unit of labour. Algebraically, it is expressed as the ratio of the change in the total product to the change in the units of labour employed, i.e.

$$MP_L = \frac{\Delta TP}{\Delta L} = \frac{\text{Change in Total Product}}{\text{Change in labour units}}$$

$$\text{or}, MP_L = TP_n - TP_{n-1}$$

Where,

TP_n = Total product produced by employing *n* units of labour

TP_{n-1} = Total product produced by employing (*n* - 1) units of labour

Question 5:Explain the relationship between the marginal products and the total product of an input.

Answer : According to the Law of Variable Proportion, when only one input is increased while all other inputs are kept constant, Marginal Product and Total Product behave in the following manner:

Relationship between marginal products (MP) and the total product (TP) can be represented graphically as
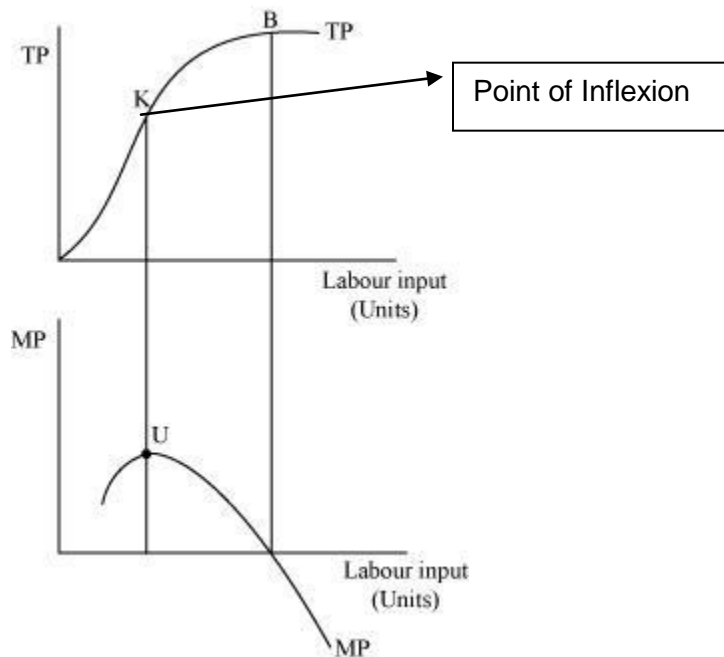
1) TP increases at an increasing rate till point K, when more and more units of labour are employed. The point K is known as the point of inflexion. At this point MP(second part of the figure) attains its maximum value at pointU.

2) After point K, TP increases but at a decreasing rate. Simultaneously, MP startsfalling after reaching its maximum level at pointU.

3) When TP curve reaches its maximum and becomes constant at point B, MP becomeszero.

4) When TP starts falling after B, MP becomesnegative.

5) MP is derived from TPby

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

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

Question 6 :Explain the concepts of the short run and the long run.

Answer :

Short run:

In short run, a firm cannot change all the inputs, which means that the output can be increased (decreased) only by employing more (less) of the variable factor (labour). It is generally assumed that in short run a firm does not have sufficient or enough time to vary its fixed factors such as, installing a new machine, building, plant etc. Hence, the output levels vary only because of varying employment levels of the variable factor (labour, raw material etc).

Algebraically, the short run production function is expressed as

$$Q_x = f\left(L,\ \bar{K}\right)$$

Where,

Qx = units of output x produced

L = labour input

$\bar{K}$ = constant units of capital

Thus, in short run, there will be some factors of production that are fixed at predetermined levels, eg: a farmer have fixed amount of land.

Long run:

In long run, a firm can change all its inputs, which means that the output can be increased (decreased) by employing more (less) of both the inputs - variable and fixed factors. In the long run, all inputs (including capital) are variable and can be changed according to the required levels of output. The law that explains this long run concept is called *returns to scale*. The long run production function is expressed as

$Qx = f(L, K)$

Both L and K are variable and can be varied.

In other words, it is the time period where supplies can adjust itself to change in demand.

Question 7 :What is the law of diminishing marginal product?

Answer :

Law of diminishing Marginal Product

According to this law, if the units of the variable factor keeps on increasing keeping the level of the fixed factor constant, then initially the marginal product will rise but finally a point will be reached after which the marginal product of the variable factor will start falling. After this point the marginal product of any additional variable factor will be zero, and can even be negative.

For eg: It is usually possible to increase the output of a farm by adding more labour, fertilizers or water, but only upto certain extent. If it were otherwise, any farm could feed the entire world.

Question 8 :What is the law of variable proportions?

Answer :

Law of Variable Proportions

According to the law of variable proportions, if more and more units of the variable factor (labour) are combined with the same quantity of the fixed factor (capital), then initially the total product will increase but gradually after a point, the total product will start diminishing. Thus Law of variable proportions is the new name of "Law of Diminishing Returns" of classical economics. Some economists also call it as Law of Non Proportional Returns.

Question 9 :When does a production function satisfy constant returns to scale?

Answer :

Constant returns to scale will hold when a proportional increase in all the factors of production leads to an equal proportional increase in the output. For example, if both labour and capital are increased by 10% and if the output also increases by 10%, then we say that the production function exhibits constant returns to scale.

Algebraically, constant returns to scale exists when

$f(nL, nK) = n. f(L, K)$

This implies that if both labour and capital are increased by 'n' times, then the production also increases by 'n' times.

In other words, constant returns to scale occur when increasing the number of inputs lead to an equivalent increase in the output.

Question 10 :When does a production function satisfy increasing returns to scale?

Answer :

Increasing returns to scale (IRS) holds when a proportional increase in all the factors of production leads to an increase in the output by more than the proportion. In other words, when increases in inputs lead to bigger proportional increase in output, it is referred as increasing returns to scale. For example, if both the labour and the capital are increased by 'n' times, and the resultant increase in the output is more than 'n' times, then we say that the production function exhibits IRS.

Algebraically, IRS exists when

$f(nL, nK) > n. f(L, K)$

Question 11: When does a production function satisfy decreasing returns to scale?

Answer :

Decreasing returns to scale (DRS) holds when a proportional increase in all the factors of production leads to an increase in the output by less than the proportion. Or DRS mainly occur when increasing inputs lead to a proportionally smaller increase in output. For example, if both labour and capital are increased by 'n' times but the resultant increase in output is less than 'n' times, then we say that the production function exhibits DRS.

Algebraically, DRS exists when

$f(nL, nK) < n. f(L, K)$

Question 12 : Briefly explain the concept of the cost function.

Answer :

The functional relationship between the cost of production and the output is called the cost function. It is expressed as

$C = f(Qx)$

Where,

C = Cost of production

Qx = Units of output x produced / Quantity produced of x goods

In other words, the output-cost relationship for a firm is depicted by the cost function.

The cost function depicts the least cost combination of inputs associated with different output levels.

Cost function of a firm depends on two things:

- Production Function
- Price of the factors of production. Higher the output of a firm, higher would be the production cost.

Question 13 : What are the total fixed cost, total variable cost and total cost of a firm? How are they related?

Answer :

- **Total Fixed Cost (TFC)**

This refers to the costs incurred by a firm in order to acquire the fixed factors for production like cost of machinery, buildings, depreciation, etc. The cost which does not change with the change in output is called TFC. In short run, fixed factorscannot vary and accordingly the fixed cost remains the same through all output levels. These are also called overhead costs. In other words, fixed costs are the sum total expenditure of the purchase or hiring of fixed factors of production.

Total Variable Cost (TVC)
This refers to the costs incurred by a firm on variable inputs for production. As we increase quantities of variable inputs, accordingly the variable cost also goes up. It is also called 'Prime cost' or 'Direct cost' and includes expenses like - wages of labour, fuel expenses, etc.
The cost which changes with the change in output is called TVC.

Total Cost (TC)
The sum of total fixed cost and total variable cost is called the total cost. Total cost = Total fixed cost + Total variable cost

TC = TFC + TVC
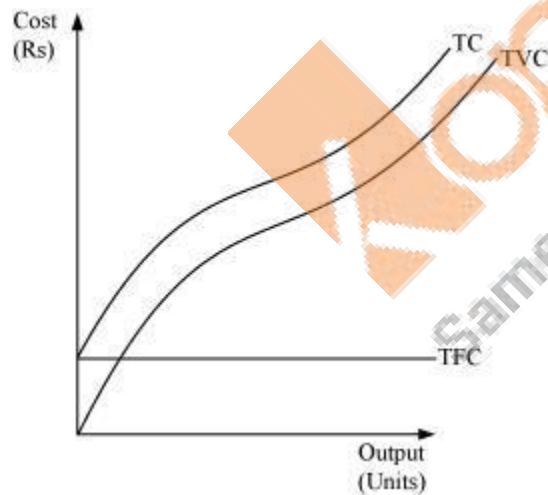
Relationship between TC, TFC, and TVC

1) TFC curve remains constant throughout all the levels of output as fixed factoris constant in shortrun.

2) TVC rises as the output is increased by employing more and more of labour units. Till point Z, TVC rises at a decreasing rate, and so the TC curve also follows the same pattern.

3) The difference between TC and TVC is equivalent toTFC.

4) After point Z, TVC rises at an increasing rate and therefore TC also rises at an increasingrate.

5) Both TVC and TFC is derived from TC i.e. TC = TVC +TFC

6) Eg: if TFC is 15, TVC is 5, and then TC will be 15+5=20.

Question 14:What are the average fixed cost, average variable cost and average cost of a firm? How are they related?

Answer :

Average Fixed Cost:

It is defined as the fixed cost per unit of output. / Production.

$$AFC = \frac{TFC}{Q}$$

Where,

TFC = Total fixed cost

Q = Quantity of output produced

Average Variable Cost:

It is defined as the variable cost per unit of output./ production

$$AVC = \frac{TVC}{Q}$$

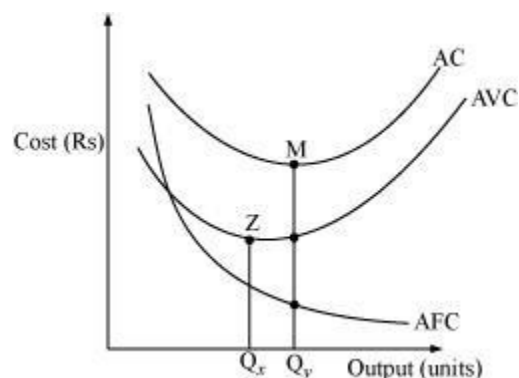Where,

TVC = Total variable cost

Q = Quantity of output produced

Average Cost:

It is defined as the total cost per unit of output/production. Average cost is derived by dividing total cost by quantity of output.

$$AC = \frac{TC}{Q}$$

AC is also defined as the sum total of average fixed cost and average variable cost. AC = AFC + AVC

Relationship between AC, AFC, AVC:

1) AVC and AFC are derived from AC as AC = AFC +AVC.

2) The plot for AFC is a rectangular hyperbola and falls continuously as the quantityof outputincreases.

3) The minimum point of AVC will always exist to the left of the minimum point ofAC; i.e., point 'Z' will always lie left to point'M'.

4) AFC being a rectangular hyperbola falls throughout; this causes the difference between AC and AVC to keep decreasing at higher output levels. However, it shouldbe noted that AVC and AC can never intersect each other. If they intersect at any point, it would imply that AC and AVC are equal at that point. However, this is not possible as AFC will never be zero because it is a rectangular hyperbola that never touches*x*-axis.

5) AC inherits shape from AVC's shape and it is because of law of variableproportions that both the curves areU-shaped.

Question 15 :Can there be some fixed cost in the long run? If not, why?

Answer :

No, there cannot be any fixed cost in the long run. In the long run, a firm has enough time to modify factor ratio and can change the scale of production. There is no fixed factor as the firm can change quantity of all the factors of production and therefore there cannot be any fixed cost in the long-run.

Fixed costs are not permanently fixed; they will change over time, but are fixed in relation to the quantity of production for the relevant period. For example, a company may have unexpected and unpredictable expenses unrelated to production, such as warehouse costs and the like that are fixed only over the time period of the lease.

Question 16 :What does the average fixed cost curve look like? Why does it look so?

Answer :

Average fixed cost curve looks like a rectangular hyperbola. It is defined as the ratio of TFC to output. We know that TFC remains constant throughout all the output levels and as output increases, with TFC being constant, AFC decreases.

The average fixed cost curve is negatively sloped. Average fixed cost is relatively high at small quantities of output, then declines as production increases

When output level is close to zero, AFC is infinitely large and by contrast when output level is very large, AFC tends to zero but never becomes zero. AFC can never be zero because it is a rectangular hyperbola and it never intersects the *x*-axis and thereby can never be equal to zero.
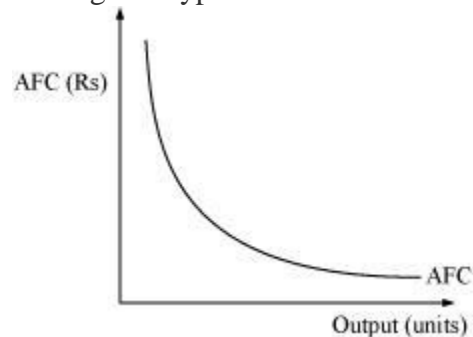
Question 17 :What do the short run marginal cost, average variable cost and short run average cost curves look like?
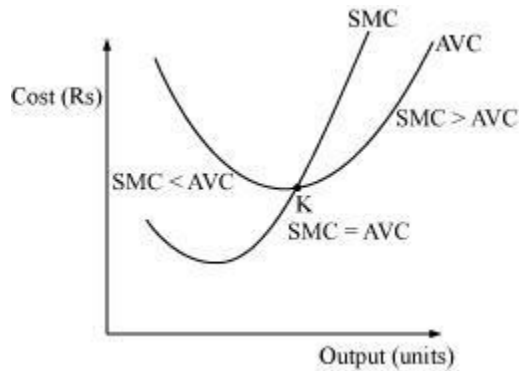
Answer :

The short run marginal cost (SMC), average variable cost (AVC) and short run average cost (SAC) curves are all U-shaped curves. The reason behind the curves being U- shaped is the law of variable proportion. In the initial stages of production in the short run, due to increasing returns to labour, all the costs (average and marginal) fall. In addition to this in the short run MP of labour also increases, which implies that more output can be produced by per additional unit of labour, leading all the costs curves to fall. Subsequently with the advent of constant returns to labour, the cost curves become constant and reach their minimum point (representing the optimum combination of capital and labour). Beyond this optimum combination, additional units of labour increase the cost, and as MP of labour starts falling, the cost curve starts rising due to decreasing returns to labour.

Question 18 :Why does the SMC curve cut the AVC curve at the minimum point of the AVC curve?

Answer :

SMC curve always intersect the AVC curve at its minimum point. This is because to the left of the minimum point of AVC, SMC is below AVC. SMC and AVC both fall but the former falls at a faster rate. At the minimum point K, AVC is equal to SMC. Beyond K, AVC and SMC both

rise but the latter rises at a faster rate than the former and also SMC lies above AVC. Therefore, the only point where SMC and AVC are equal is where SMC intersects AVC, i.e., at the minimum point of the AVCcurve.

Question 19 :At which point does the SMC curve intersect SAC curve? Give reason in support of your answer.

Answer :

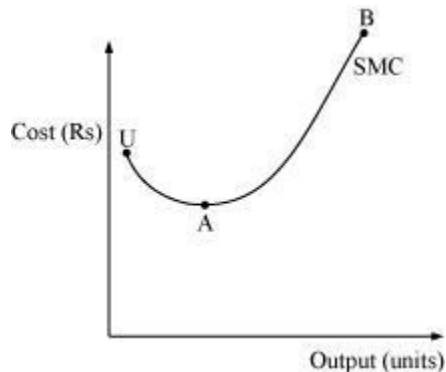SMC curve intersects SAC curve at its minimum point. This is because as long as SAC is falling, SMC remains below SAC and when SAC starts rising, SMC remains above SAC. SMC intersects SAC at its minimum point P, where SMC = SAC.
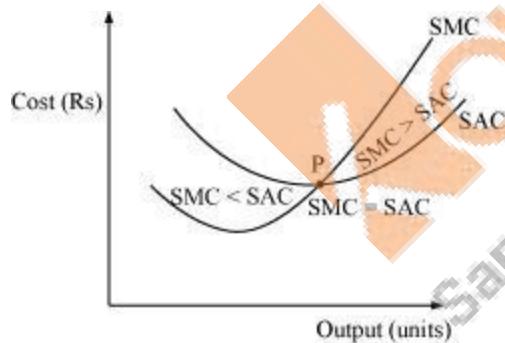
Question 20 :Why is the short run marginal cost curve 'U'-shaped?

Answer :

The SMC curve is a U-shaped curve due to the law of variable proportions or law of

diminishing returns. In order to understand the reason behind the U-shape of SMC, let us divide the SMC curve (UAB) into three different parts according to the law of variable proportions:

i. UA part corresponds to increasing returns tofactor.

ii. Minimum point A corresponds to constant returns tofactor.

iii. AB part corresponds to decreasing returns tofactor.

In the initial production stages, the falling part of SMC (UA) is due to application of increasing returns to factor. Then the SMC stops falling and reaches its minimum point 'A' due to the existence of constant returns to a factor.

After the minimum point A, SMC starts rising (i.e. 'AB' part of SMC) due to the onset of decreasing returns of variable factor. This trend of SMC curve (initially falling, then becoming constant at its minimum point and then rising) makes it look like the English alphabet - 'U'.
In other words, Due to operation of law of variable proportion, MP first rises, reaches its maximum point and then decline. Since increasing returns means diminishing costs and diminishing returns implies increasing cost, therefore, MC first falls because of increasing returns, reaches its minimum and then rises due to operation of diminishing returns. As a result MC curve becomes U-shaped.

Question 21 :What do the long run marginal cost and the average cost curves look like?

Answer :
The long run marginal cost (LMC) and long run average cost (LAC) are U shaped curves. The reason behind them being U-shaped is due to the law of returns to scale. It is argued that a firm generally experiences IRS during the initial period of production followed by CRS, and lastly by DRS. Consequently, both LAC and LMC are U-shaped curves. Due to IRS, as the output increases, LAC falls due to economies of scale. Then falling LAC experiences CRS at Q1 level of output which is also called the optimum capacity. Beyond Q1 level of output, the firm experiences diseconomies of scale and if the firm continues to produce beyond Q1 level, the cost of production will rise.
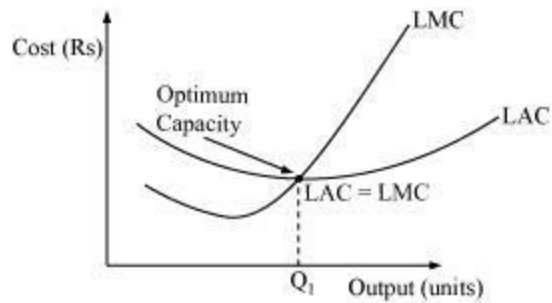
Question 22 : The following table gives the total product schedule of labour. Find the corresponding average product and marginal product schedules of labour.

L	TP$_L$ (units)
0	0
1	15
2	35
3	50
4	40
5	48

L	TP$_L$(units)	$AP = \dfrac{TP}{L}$	$MP = TP_n - TP_{n-1}$
0	0	0	--
1	15	15.00	15
2	35	17.50	20
3	50	16.67	15
4	40	10.00	- 10
5	48	9.60	- 8

Answer :

Question 23 : The following table gives the average product schedule of labour. Find the total product and marginal product schedules. It is given that the total product is zero at zero level of labour employment.

L	AP_L
1	2
2	3
3	4
4	4.25
5	4
6	3.5

Answer :

L	AP_L	$TP_L = AP \times L$	$MP = TP_n - TP_{n-1}$
1	2	$2 \times 1 = 2$	2
2	3	$3 \times 2 = 6$	6 - 2 = 4
3	4	$4 \times 3 = 12$	12 - 6 = 6
4	4.25	$4.25 \times 4 = 17$	17 - 12 = 5
5	4	$4 \times 5 = 20$	20 - 17 = 3
6	3.5	$3.5 \times 6 = 21$	21 - 20 = 1

Question 24 : The following table gives the marginal product schedule of labour. It is also given that total product of labour is zero at zero level of employment. Calculate the total and average product schedules of labour.

L	MP$_L$
1	3
2	5
3	7
4	5
5	3
6	1

Answer :

L	MP_L	$TP_n = TP_{n-1} + MP_n$	$AP_L = \dfrac{TP_L}{L}$
1	3	3	$\dfrac{3}{1} = 3$
2	5	$3 + 5 = 8$	$\dfrac{8}{2} = 4$
3	7	$8 + 7 = 15$	$\dfrac{15}{3} = 5$
4	5	$15 + 5 = 20$	$\dfrac{20}{4} = 5$
5	3	$20 + 3 = 23$	$\dfrac{23}{5} = 4.6$
6	1	$23 + 1 = 24$	$\dfrac{24}{6} = 4$

Question 25 : The following table shows the total cost schedule of a firm. What is the total fixed cost schedule of this firm?Calculate the TVC, AFC, AVC, SAC and SMC schedules of the firm.

L	TP_L
0	10
1	30
2	45
3	55
4	70
5	90
6	120

Answer :

Q (units)	TC (Rs)	$TFC = TC - TVC$ $10 = 10 - 0$ (Rs)	$TVC = TC - TFC$ (Rs)	$AFC = \dfrac{TFC}{Q}$ (Rs)	$AVC = \dfrac{TVC}{Q}$ (Rs)	$SAC = AFC + AVC$ (Rs)	$SMC = TC_n - TC_{n-1}$ (Rs)
0	10	10	10 - 10 = 0	-	-	-	-
1	30	10	30 - 10 = 20	$\dfrac{10}{1} = 10$	$\dfrac{20}{1} = 20$	20 + 10 = 30	30 - 10 = 20
2	45	10	45 - 10 = 35	$\dfrac{10}{2} = 5$	$\dfrac{35}{2} = 17.5$	17.5 + 5 = 22.5	45 - 30 = 15
3	55	10	55 - 10 = 45	$\dfrac{10}{3} = 3.33$	$\dfrac{45}{3} = 15$	15 + 3.33 = 18.33	55 - 45 = 10
4	70	10	70 - 10 = 60	$\dfrac{10}{4} = 2.5$	$\dfrac{60}{4} = 15$	15 + 2.5 = 17.5	70 - 55 = 15
5	90	10	90 - 10 = 80	$\dfrac{10}{5} = 2$	$\dfrac{80}{5} = 16$	16 + 2 = 18	90 - 70 = 20
6	120	10	120 - 10 = 110	$\dfrac{10}{6} = 1.66$	$\dfrac{110}{6} = 18.33$	18.33 + 1.66 = 19.99	120 - 90 = 30

Question 26 : The following table gives the total cost schedule of a firm. It is also given that the average fixed cost at four units of output is Rs 5/-. Find the TVC, TFC, AVC, AFC, SAC and SMC schedules of the firm for the corresponding values of output.

L	TP_L
1	50
2	65
3	75
4	95
5	130
6	185

Answer :

Q (units)	TC (Rs)	TFC = Rs 20 (Rs)	TVC = TC - TFC (Rs)	$AVC = \dfrac{TVC}{Q}$ (Rs)	$AFC = \dfrac{TFC}{Q}$ (Rs)	SAC = AFC + AVC (Rs)	SMC = TCn - TCn - 1 (Rs)
1	50	20	50 - 20 = 30	$\dfrac{30}{1} = 30$	$\dfrac{20}{1} = 20$	20 + 30 = 50	50 - 20 = 30
2	65	20	65 - 20 = 45	$\dfrac{45}{2} = 22.5$	$\dfrac{20}{2} = 10$	10 + 22.5 = 32.5	65 - 50 = 15
3	75	20	75 - 20 = 55	$\dfrac{55}{3} = 27.5$	$\dfrac{20}{3} = 6.66$	6.66 + 27.5 = 34.16	75 - 65 = 10
4	95	20	95 - 20 = 75	$\dfrac{75}{4} = 18.75$	$\dfrac{20}{4} = 5$	5 + 18.75 = 23.75	95 - 75 = 20
5	130	20	130 - 20 = 110	$\dfrac{110}{5} = 22$	$\dfrac{20}{5} = 4$	4 + 22 = 26	130 - 95 = 35
6	185	20	185 - 20 = 165	$\dfrac{165}{6} = 27.5$	$\dfrac{20}{6} = 3.33$	3.33 + 27.5 = 30.83	185 - 130 = 55

Question 27 : A firm's SMC schedule is shown in the following table. The total fixed cost of the firm is Rs 100/-. Find the TVC, TC, AVC and SAC schedules of the firm.

L	TP_L
0	-
1	500
2	300
3	200
4	300
5	500
6	800

Answer :

Q (units)	SMC/TP_L (Rs)	$TFC = $ Rs 100 (Rs)	$TVC_n = SMC_n + TVC_{n-1}$ (Rs)	$TC = TVC + TFC$ (Rs)	$AVC = \dfrac{TVC}{Q}$ (Rs)	$SAC = \dfrac{TC}{Q}$ (Rs)
0	-	100	-	100	-	-
1	500	100	500	500 + 100 = 600	$\dfrac{500}{1} = 500$	$\dfrac{600}{1} = 600$
2	300	100	300 + 500 = 800	800 + 100 = 900	$\dfrac{800}{2} = 400$	$\dfrac{900}{2} = 450$
3	200	100	200 + 800 = 100	1000 + 100 = 1100	$\dfrac{1000}{3} = 333.33$	$\dfrac{1100}{3} = 366.67$
4	300	100	300 + 1000 = 1300	1300 + 100 = 1400	$\dfrac{1300}{4} = 325$	$\dfrac{1400}{4} = 350$
5	500	100	500 + 1300 = 1800	1800 + 100 = 1900	$\dfrac{1800}{5} = 360$	$\dfrac{1900}{5} = 380$
6	800	100	800 + 1800 = 2600	2600 + 100 = 2700	$\dfrac{2600}{6} = 433.33$	$\dfrac{2700}{6} = 450$

Question 28 : Let the production function of a firm be

$$Q = 5L^{\frac{1}{2}} K^{\frac{1}{2}}$$

Find out the maximum possible output that the firm can produce with 100 units of *L* and 100 units of *K*.

Answer :

$$Q = 5L^{\frac{1}{2}} K^{\frac{1}{2}}$$ ----- Equation (1)

L = 100 units of labour
K = 100 units of capital
Putting these values in equation (1)

$$Q = 5(100)^{\frac{1}{2}} (100)^{\frac{1}{2}}$$
$$= 5(10)(10)$$
$$= 500 \text{ units}$$

Thus, the maximum possible output that the firm can produce is 500 units.

Question 29 : Let the production function of a firm be $Q = 2L^2 K^2$.

Find out the maximum possible output that the firm can produce with 5 units of *L* and 2 units of *K*. What is the maximum possible output that the firm can produce with zero unit of *L* and 10 units of *K*?

Answer :

a) $Q = 2L^2 K^2$ ---------- (1)

$L = 5$ units of labour

$K = 2$ units of capital

Putting these values in equation (1)

$Q = 2\,(5)^2(2)^2$

$= 2\,(25)\,(4)$

$Q = 200$ units

b) If $L = 0$ units and $K = 100$ units

Putting these values in equation (1) Q

$= 2\,(0)^2\,(100)^2$

$Q = 0$ units

Question 30 :Find out the maximum possible output for a firm with zero unit of L and 10 units of K when its production function is Q = 5L = 2K.

Answer :

$Q = 5L + 2K$ (1)   equation (1)

If $L = 0$ and $K = 10$, then putting these values in equation (1)

$Q = 5\,(0) + 2\,(10)$

$= 20$ units of maximum output