Unit 2

Elasticity of Demand and Supply

Concept of Elasticity of Demand

Law of demand explains the relationship between quantity demand and price of commodity. It show the direction on which price and quantity demand change but cannot explain how much change in price leads how much change in demand? It's the job of elasticity that explains the percent change between variables.

The elasticity of demand is a measure of a degree of responsiveness of change in quantity of a product to the change in its determinants. Some major demand determinants, viz., price of the product, consumers' income, price of the substitutes and compliments, advertisement or spending made by the firms and consumers' expectations about the future prices. If the demand is more elastic, then a small change in price will cause a large change in quantity consumed. If the demand is less elastic, then it will take large changes in price to make a change in quantity consumed. The concept of elasticity of demand shows how much or to what rate the quantity demanded of a commodity will change as a result of a change in the price.

According to K.E. Boulding, "The elasticity of demand may be defined as the percentage change in the quantity demanded which would result from one percent change in its price".
According to Prof. Meyers, "Elasticity of demand is a measure of the relative change in the amount purchased in response to any change in price or a given demand curve".
According to Lipsey, "Elasticity of demand may be defined as the ratio of the percentage change in demand to the percentage change in price".
According to Mrs. John Robbins, "The elasticity of demand at any price or at any output is the proportional change to the amount purchased response to a small change in price, divided by the proportional changes of price".
In brief, the elasticity of demand is defined as the proportionate change in quantity demanded divided by the proportionate change in its determinants like price, income, etc.

Symbolically,

Elasticity of demand $Ed = \frac{Percentage\,change \in quantity\,demand}{Percentage\,Change \in determinants\,of\,demand}$

Degree/Types of Elasticity of Demand

Types of elasticity of demand depend upon the nature and extent of change in demand determinants. However, overall elasticity of demand for a commodity depends on the combined effects of changes in price of good, consumer's income and price of the substitutes and compliments goods. Therefore, elasticity of demand has been divided into three parts:

1. **Price Elasticity of Demand (E_P)**
   When the price of goods changed, its demand also changed. Price elasticity of demand measures by how much quantity demand of goods changes with a given change in the price of

it. So, the price elasticity of demand is the measure of the responsiveness of quantity demanded of a product to the change in its price, being other things constant. The term other things refers to the income of the consumer, price of related goods, etc. The price of elasticity of demand is symbolized by the letter 'Ep' and it is written as:

$$Ep = \frac{-Percentage\,change \in quantity\,demand}{percentage\,Change \in Price} = \frac{-\frac{\Delta Qd}{Qd}}{\frac{\Delta P}{P}}$$

$$¿ - ¿ \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$$

Where,

Ep = Price elasticity of demand

ΔQ = Change in quantity demand, its different between original and new demand (Qd_1-Qd)

ΔP = Change in price, its different between original and new price (P_1-P)

Qd = Initial quantity demand

Qd_1 = New quantity demand

P = Initial price

P_1 = New price

Example

Suppose, initial price per packet of a noodle is Rs.10 and quantity demanded is 100 units. If price falls to Rs.8 and quantity demanded increases to 150 units, find the price elasticity of demand.

Solution

Given,

Initial price P = Rs.10,

New price P_1 = Rs.8

Change in price P_1-P = 8 -10 = -2

Initial quantity demanded (Qd) = 100 units

New quantity demanded is (Qd_1) = 150 units

Change in quantity demand ΔQ = (Qd_1)- (Qd) =150-100 = 50 units

Using formula,

$$Ep ¿ - ¿ \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$$

$¿ - ¿ \frac{50}{-2} . \frac{10}{100}$

$= \frac{5}{2} = 2.5$

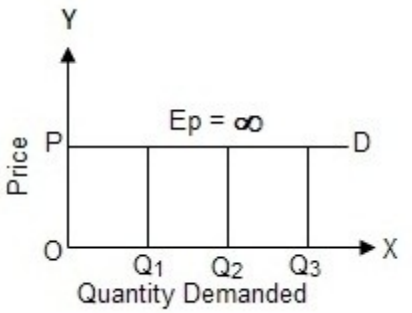
Ep =2.5 one percent decrease in price leads to 2.5 percent increase in quantity demand of commodity.

DEGREE / TYPES OF PRICE ELASTICITY OF DEMAND

Price elasticity of demand can be discussed under the following five types:

i) Perfectly Elastic Demand (Ep =∞)

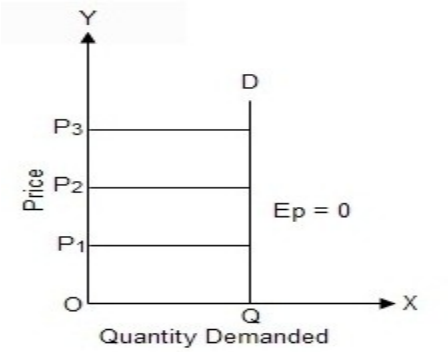
If very small changes or negligible change in the price of a good lead to an infinite change in quantity demanded that good, then the demand is known as perfectly elastic demand. In this type of demand, the value of price elasticity of demand reaches infinite. The demand curve indicates the change in price is insignificant; however the change in quantity demanded is infinite.



In the given figure, the price is measured in Y-axis and quantity demanded is measured along the X-axis. The point 'P' is the price where the consumer can buy any quantity of demand like Q_1, Q_2, Q_3 and so on. Hence, D is the perfectly elastic parallel to the x axis.

ii) Perfectly Inelastic Demand (Ep=0)

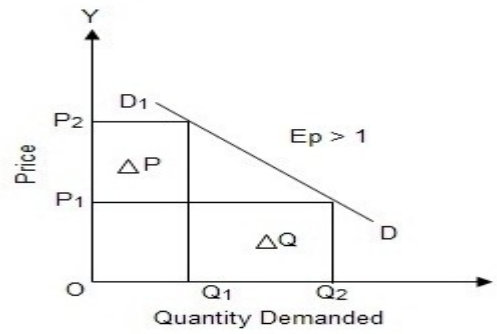
If the quantity demanded is totally irresponsive to the change in the price of a good, then the demand is known as perfectly inelastic demand. In such type of demand, whatever be the change in price, the quantity demanded remains same or unchanged. This type of elasticity is found in the case of basic necessary goods such as salt, medicine, etc. Therefore, the numerical value of elasticity becomes 0.



In the given figure, the price is measured in Y-axis and quantity demanded is measured along the X-axis. QD is the perfectly inelastic demand curve parallels to y-axis which remains constant even the price of a commodity increase from P_1 to P_2 to P_3.

iii) Relatively Elastic Demand (Ep >1)

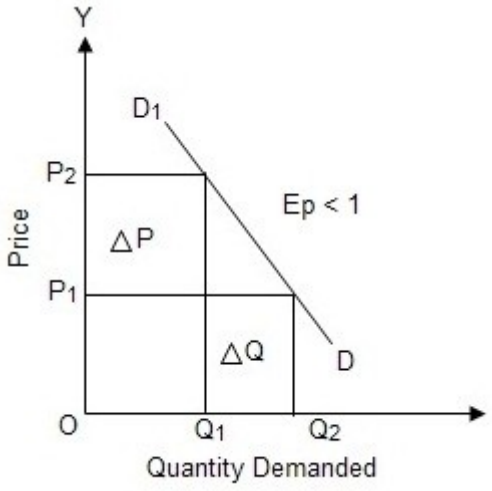
If the change in demand is greater than the change in the price of good, then the demand is known as relatively elastic demand. At that time percentage change in price leads to more than percentage change in quantity demanded. In this type of demand, the absolute value of price elasticity of demand remains greater than unity.



In the given figure, the price is measured in Y-axis and quantity demanded is measured along the X-axis. The curve is more flat which shows that demand is more elastic. The small fall in price from P_2 to P_1 effects majorly on quantity demand from Q_1 to Q_2 i.e. percentage change in demand is more than the percentage change in price.

iv) Relatively Inelastic Demand (Ep<1)

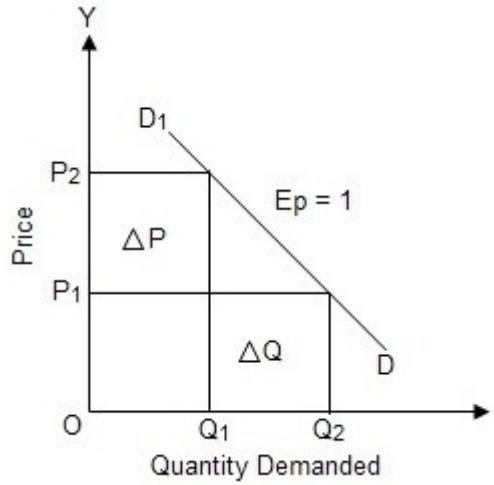
If the percentage change in demand is less than the percentage change in the price of a good, then the demand is known as relatively inelastic demand. At that time, one percentage change in price leads to less than one percentage change in quantity demand. In this type of demand, the absolute value of price elasticity of demand remains less than unity.



In the given figure, the price is measured in Y-axis and quantity demanded is measured along the X-axis. There is a huge difference in price from P_1 to P_2 but the quantity demand has no vast difference from Q_1 to Q_2. It means there is a small change in quantity demand even the price change with a huge amount. The demand curve DD_1 in the figure seems steeper.

v) Unitary Elastic Demand (Ep=1)

If the percentage change in demand is equal to the percentage change in the price of a good, then the demand is known as unitary elastic demand. In such case percentage change in price equals to the percentage change in quantity demand. At that time, the absolute value of elasticity of demand remains just equal to 1.



In the given figure, the price is measured in Y-axis and quantity demanded is measured along the X-axis. An initial point of price (P1) and quantity demanded (Q_1) is shown as related and when there is a change in price from P_1 to P_2 then it results in an equal change in quantity demand from Q_1 to Q_2. The percentage change in price and the percentage change in quantity demand is equal. DD_1 is the unitary elastic demand curve smoothly sloping downwards to the right.

Types of elasticity	Symbolic
Perfectly Elastic Demand	Ep =∞
Perfectly Inelastic Demand	Ep=0
Relatively Elastic Demand	Ep >1
Relatively Inelastic Demand	Ep<1
Unitary Elastic Demand	Ep=1

Measurement of Price Elasticity of Demand

There are three methods of measuring price elasticity of demand. They are:

- Total Outlay Method
- Point Method
- Arc Method

Total Outlay Method

Total outlay method is the major methods of measuring price elasticity of demand. In this method, price elasticity of demand is measured by comparing the total expenditure of the consumers during the changes in the price of goods.

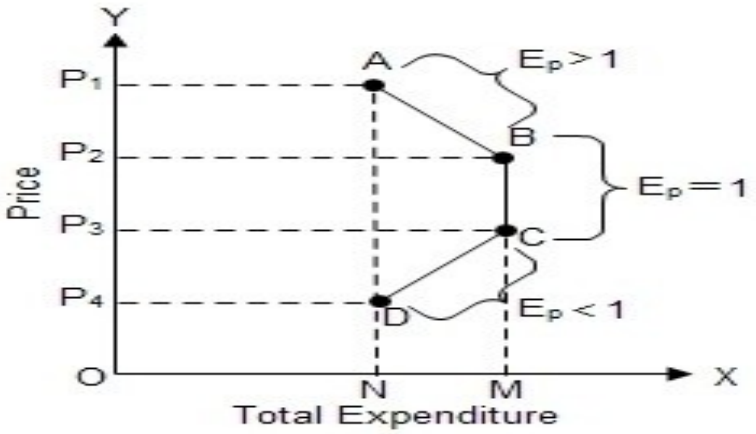
According to Alfred Marshall, "Elasticity of demand can be measured by considering the change in price and the subsequent change in the total quantity of goods purchased and the total amount of money spent on it".
Price elasticity of demand can be measured on the following three bases:-

1. **Elasticity of Demand Greater than Unitary/Relatively Elastic demand (Ep>1)**
   If the price decreases, the quantity demanded increases more than proportionately. As a result, total expenditure increases. And increase in the price causes more than proportionate decrease in the quantity demanded. is said to be greater than one. Hence, the total expenditure and price of a commodity are inversely related to each other.
2. **Elasticity of Demand Equal to Unitary (Ep=1)**
   If the total expenditure of a commodity is totally irresponsive to the change in the price of a commodity, then the price elasticity of demand is said to be equal to the unitary. In this state, whatever the price of a commodity is, total expenditure of commodity remains constant.
3. **Elasticity of Demand Less then Unitary/ Relatively inelastic Demand (Ep<1)**
   If the total expenditure of on a commodity falls with the decrease in price and vice-versa, then the price elasticity of demand is said to be less than one in this state. Hence, both total expenditure and price move in the same direction.

   The above cases are prescribed with the table below:

Price of commodity (Rs)	Quantity demanded (in kg.)	Total Expenditure (in Rs.)	Elasticity
6	1	6	Ep >1
5	2	10	
4	3	12	Ep = 1
3	4	12	
2	5	10	Ep<1
1	6	6	

In the given table, quantity demanded of a commodity is increasing serially 1, 2, 3, 4, 5 and 6 as the price of a commodity is decreasing 6, 5 4, 3, 2 and 1 respectively. In the column of total expenditure, it is rising at first and remains constant at certain then later it is decreasing. It shows all three cases based on the price elasticity of demand. These conditions are also mentioned with the help of a diagram.



In the above graph, total expenditure is measured along X-axis and price is measured along Y-axis respectively. The points A and B show the inverse relation between price and total expenditure, where the price increases and total expenditure falls and vice versa. Next point B and C seems to be parallel to price, where there is no change in total expenditure even there is a change in price. Point C and D show the positive relation between price and total expenditure. When the price increases the total expenditure also increases and when the price decreases the total expenditure also decreases.

Nature	Coefficient
If P rise TE falls or P falls leads to TE rise	Ep >1= Relatively elastic
If P rise TE rise or P falls leads to TE falls	Ep<1= Relatively inelastic
P rise or P falls TE remain same	Ep=1= Unitary elastic

Measuring Point Elasticity

Point elasticity is the measure of price elasticity at a finite point on a demand curve. Point elasticity is also known as geometrical method of estimating elasticity of demand at a particular point of the demand curve. Point elasticity is, in fact, the measure of the proportionate change in the quantity demanded in response to a very small proportionate change in the price. The concept of point elasticity is useful where change in the price and the consequent change in the quantity demanded are very small. Besides, it offers an alternative to the arc elasticity. Point elasticity may be symbolically expressed as:

$$Ep = \frac{-Percentage\ change \in quentity\ demand}{Percentage\ change \in price} = \frac{\frac{\Delta Qd}{Qd} x\,100}{\frac{\Delta P}{P} x\,100}$$

$$Ep = ¿ - \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$$

Where,

Ep = price elasticity,
ΔQd = Percentage change in the quantity demanded,
ΔP = Percentage change in the price,
Here, Ep denotes the price elasticity of demand. The numerical value of Ep is called the coefficient of price demand elasticity.
It may thus be said that price elasticity at any point on a straight line demand curve is given by

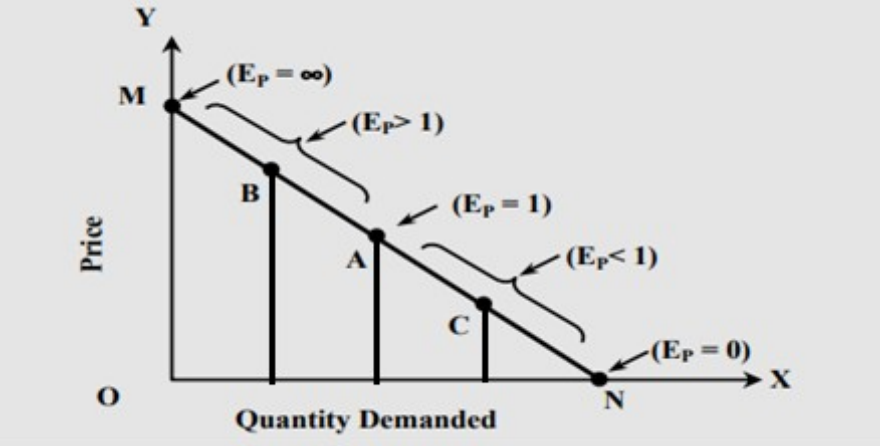
$$Ep = \frac{Lower\ Segment\ of\ demand\ curve}{Upper\ Segment\ of\ demand\ curve}$$

Given this formula, if the selected point falls at the midpoint of the demand curve, elasticity equals 1. If the point falls below the midpoint, elasticity is less than 1 and if it falls above the midpoint, elasticity is greater than1.

A general formula for measuring the price elasticity of demand is derived as follows:

$$Ep = \frac{Percentage\ change \in quentity\ demand}{percentage\ change \in price} = \frac{\frac{\Delta Qd}{Qd}}{\frac{\Delta P}{P}}$$

$$¿\ \frac{\Delta Qd / \Delta P}{P / Qd}$$



In the figure price and quantity demanded are measured along the Y and x-axes respectively. At the midpoint A lower segment is equal to upper segment so there is unitary elasticity….

1. At mid-point of the demand curve (say A), the lower segment (AN) is equal to the upper segment (AM). Hence, elasticity of demand is equal to unity. Thus, at point A, Ep = Lower segment /Upper segment = AN/ AM = 1 [∵ AN = AM]
2.At any point between A and M, say B, the lower segment (BN) is greater than the upper segment (BM). Hence, elasticity of demand is greater than unity. Thus, at point B, Ep = BN/BM> 1 [∵ BN > BM]
3. At any point between A and N, say C, the lower segment (CN) is less than the upper segment (CM). Hence, elasticity of demand is less than unity. Thus, at point C, Ep = CN/CM< 1 [∵ CN < CM]
4. At the point where the demand curve touches the vertical axis (i.e. point M), the entire length of the demand curve is the lower segment and upper segment is zero. Hence, price elasticity of demand is infinity since any number divided by zero is infinity. Thus, at point M, Ep = MN/0 = ∞
5. At the point where the demand curve touches the horizontal axis (i.e. point N), the entire length of the demand curve is the upper segment and the lower segment is zero. Hence, price elasticity of demand is zero since zero divided by any number is zero. Thus, at point N, Ep = 0/MN = 0 Thus, elasticity of demand is different at different points on the same demand curve.

Q. Calculate the point elasticity of linear demand curve of different points

Points	N	C	A	B	M
Price	0	5	10	15	20
Quantity demand	400	300	200	100	0

Solution

We have,

$$Point\ Elasticity = ¿\ \frac{Lower\ segment}{Upper\ segmen}$$

At point A, $= \frac{Lower\ segment}{Upper\ segmen} = ¿\ \frac{AN}{AM} ¿\ \frac{400-200}{200-0} ¿\ \frac{200}{200}$ = 1 [∵ AN = AM]

Hence, elasticity of demand is equal to unity

At point B, = $\frac{Lower\ segment}{Upper\ segmen} = ¿\ \frac{BN}{BM} ¿\ \frac{400-100}{100-0} ¿\ \frac{300}{100}$ = 3>1 [∵ BN > BM]

Hence, elasticity of demand is greater than unity

At point C, = $\frac{Lower\ segment}{Upper\ segmen} = ¿\ \frac{CN}{CM} ¿\ \frac{400-300}{300-0} ¿\ \frac{100}{300}$ = .33<1 [∵ CN < CM]

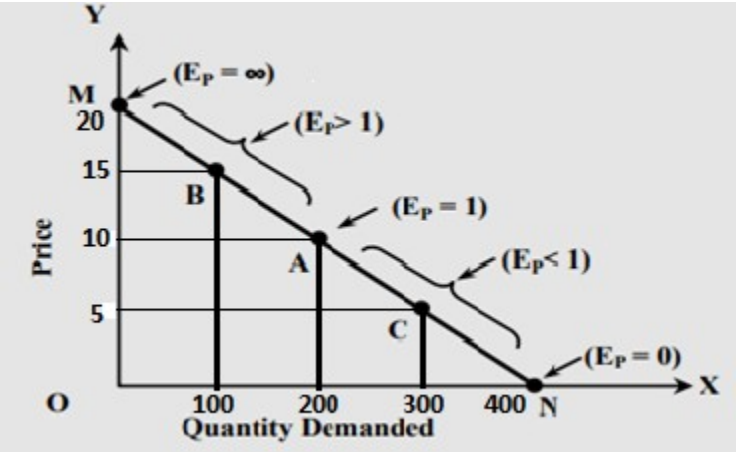
Hence, elasticity of demand is less than unity

At point M, = $\frac{Lower\ segment}{Upper\ segmen} = ¿\ \frac{MN}{M} ¿\ \frac{400-0}{0-0} ¿\ \frac{400}{0}$ = ∞

Hence, elasticity of demand is infinity

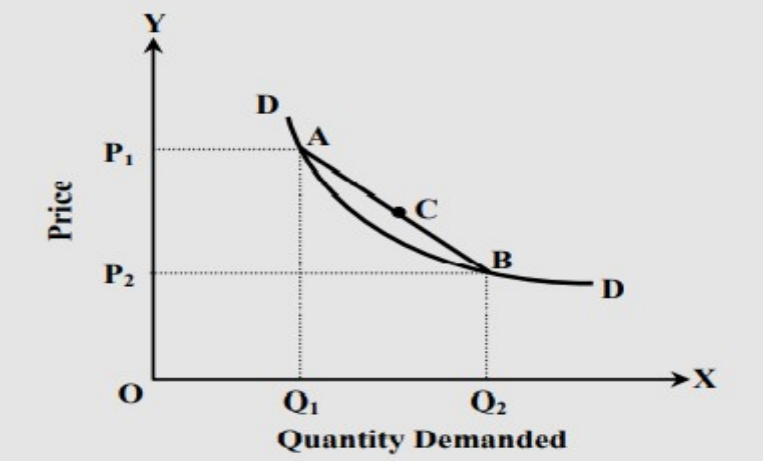
At point N, = $\frac{Lower\ segment}{Upper\ segmen} = ¿\ \frac{N}{NM} ¿\ \frac{0}{400-0} ¿\ \frac{0}{400}$ = 0

Hence, elasticity of demand is zero



Arc method

Arc method of measuring price elasticity of demand is relevant where there is substantial change in price and quantity demanded. This method measures the elasticity of demand between two points on the same demand curve. The area or stretch between two points of a demand curve is called an arc. P1+p2/2,



As shown in FIGURE... the area or stretch AB is an arc on the demand curve DD. Price elasticity of demand on this arc is measured between these points A and B. The point method of measuring elasticity at two points on a demand curve gives different values of price elasticity of demand. To avoid this discrepancy, elasticity for the arc is calculated by taking the average price and quantity demanded. That is, elasticity of demand is measured at mid-point C of the arc AB.

The formula for measuring price elasticity of demand at the middle point C of the arc on the demand curve is:

Ep = $\frac{-Percentage\,change \in quentity\,demand}{percentage\,change \in price}$

$$¿ - \frac{\frac{Change \in quantity\,demanded}{Average\,quantity\,demanded}}{\frac{Change \in Price}{Average\,Price}}$$

$$¿ - \frac{\frac{\Delta Qd}{Q1+Q2/2}}{\frac{\Delta P}{P1+P2/2}}$$

$$¿ \frac{-\Delta Qd/Q1+Q2}{\Delta P/P1+P2}$$

$$¿ - ¿ \frac{Q2-Q1}{P2-P1} . \frac{P1+P2}{Q1+Q2}$$

Where,

Q1 = Initial quantity demanded

Q2 = New quantity demanded

P1 = Initial Price

P2 = New Price

ΔQ= Change in quantity demanded

ΔP = Change in Price

Example

Q. Calculate price elasticity of demand from A to B by using Arc Method

Points	A	B
Price	20	30
Demand	100	50

Solution

By using Arc Method

Ep $¿-¿\frac{Q2-Q1}{P2-P1}.\frac{P1+P2}{Q1+Q2}$

A midway between A to B
Here P1= 20, P2= 30, Q1= 100, Q2= 50

Ep $¿-¿\frac{50-100}{30-20}.\frac{20+30}{100+50} = \frac{--50}{10}.\frac{50}{150} = \frac{5}{3}$ = 1.66>1
Hence, elasticity of demand is greater than unity

Uses/Importance of Price Elasticity of Demand

Price elasticity of demand plays an important role in the formulation of economic policies. It is regarded as a tool to analyze various economic problems. The importance or uses of price elasticity of demand are as follows:

1. **Product pricing:**
   Price elasticity of demand helps a producer to fix the price of his product. If demand for the product is inelastic, higher price can be fixed. On the other hand, if the demand is elastic, lower price is charged to maximize revenue. Thus, price increase policy is to be followed if the demand is inelastic in the market and price-decrease policy is to be followed if the demand is elastic.
2. **Price discrimination:**
   Price discrimination means practice of charging different price to the different customers in different markets for the same product. It is a special feature of the monopoly market. Low

price is charged in the market where demand is elastic and high price in the market where demand is inelastic.

3. **Nationalization of public utilities:**
   The nationalization of public utility services can also be justified with the help of elasticity of demand. Demand for public utilities such as electricity, water supply, post and telegraph, public transportation etc. is generally inelastic in nature. If the operation of such utilities is left in the hand of private individuals, they may exploit the consumers by charging high prices. Therefore, in the interest of general public, the government owns and runs such services.

4. Factor pricing:
Price elasticity of demand helps in determining price to be paid to the factors of production. If demand for a particular factor is inelastic as compared to the other factors, then it will be paid more. It is because the employers cannot readily adjust the factor of production with the change in its price.

5. International trade:
In order to fix prices of exported goods, it is important to have knowledge about the elasticity of demand for such goods. The exporting country may fix higher prices for the products with inelastic demand in the importing country. However, if demand for such goods in the importing country is elastic, then the exporting country will have to fix lower prices.

6. Formulation of taxation policy:
The concept of price elasticity of demand is important for formulating taxation policy. Government can impose higher taxes on goods with inelastic demand, whereas, lower taxes on goods with elastic demand. If the demand is inelastic, increase in tax rate will not reduce the demand much. This will bring more tax revenue to the government. On the other hand, if the demand is elastic, decrease in tax rate will increase the demand largely. Hence, there will be increase in tax revenue with the decrease in tax rate.

Determinants of Price Elasticity of Demand

1. Availability of Close Substitution Goods
Substitution goods like Pepsi and coke, tea and coffee, etc. have more elastic demand than the other goods like sugar and salt. For example, if the price of the coke rises, people will switch over Pepsi, which is a close substitute. So the demand for coke is elastic. On the other hand, sugar and salt do not have their close substitute. So, their price elasticity is less.

2. **Luxuries Goods**
   The elasticity of demand depends on nature of a commodity. Demand for luxuries goods is more elastic than other goods. Luxuries goods like a sofa, car, television, etc. can be postponed when their price rises. So, their price elasticity is more elastic.

3. **Necessities Goods**
   The consumption of necessities goods cannot be postponed like a luxuries goods. Necessities goods include clothes, foods, vegetable, medicine, etc. Such goods are less elastic as they cannot be substitute with other goods.

4. Consumers Habit

The habit of the consumer varies according to the consumer. Some of the consumers have the habit of smoking. But the rise in the price of the cigarette does not affect much the demand. The demand for habituating goods is less elastic.

1. **Range of alternative uses of commodity**

When the price of multi-use goods decreases, the consumer increases its uses. For example, the consumption of electricity can be used for several uses like cooking, heating, lighting, etc. Therefore, the price elasticity demand for elsticity is more elastic at low cost.

1. **Income Elasticity of Demand (Ey)**

Income of the consumer is the most influencing factor of demand for a good. Demand for goods responses to the change in income of the buyer. The measure of the responsiveness of quantity demands a product to change in income of the buyer, being other things constant is known as income elasticity of demand. It is always expressed in term of ratio or percentage. The value of it may be positive, negative or zero depending on the nature of goods. Income elasticity is usually symbolized by 'Ey' and written as:

Ey = $\frac{Percentage\ change \in quentity\ demand}{percentage Change \in income} = \frac{\frac{\Delta Qd}{Qd}}{\frac{\Delta Y}{Y}}$

Ey ¿ $\frac{\Delta Qd}{\Delta Y} . \frac{Y}{Qd}$

Where,

Ey = Income elasticity demand

ΔY= Change in consumer income, its different between original and new income

ΔQ= Change in quantity demand, its different between original and new demand

Q = Initial Quantity

Y = Initial Income

Example

Suppose, a consumer's income rises from Rs.100 to Rs.150 and his demand for a commodity increases from 20 units to 40 units per day. Find income elasticity of demand for the commodity.

Solution

Given,

Initial income Y = Rs.100,

New income Y_1 = Rs.150

Change in income $\Delta Y = Y_1 - Y = 150 - 100 = 50$

Initial quantity demanded (Qd) = 20 units

New quantity demanded is (Qd_1) = 40 units

Change in quantity demand $\Delta Qd = (Qd_1) - (Qd) = 40-20 = 20$ units

Using formula,

Ey ¿ $\frac{\Delta Qd}{\Delta Y} . \frac{Y}{Qd}$

$= \frac{20}{50} . \frac{100}{20} = \frac{4}{2} = 2 > 1$ Hence its positive income elasticity demand so its normal to luxurious good.

DEGREE / TYPES OF INCOME ELASTICITY OF DEMAND

There are three types of income elasticity of demand. They are as follow:

i. **Positive Income Elasticity (Ey>0)**

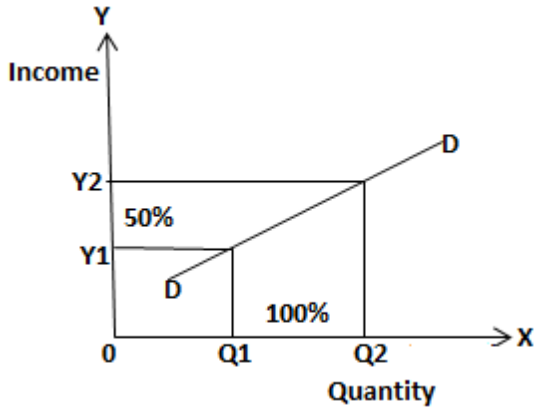
If the quantity demand for a commodity increases with the increase in consumer's income and decreases with the income of the consumer is known as positive income elasticity. Hence, there is a positive relation between income and demand. In that case, the value of elasticity remains greater than zero.

Fig: Positive income elasticity demand

In the given figure, quantity and income demanded of a commodity is measured along X-axis and Y-axis respectively. Q_1 and Y_1 are the initial quantity demand and income of the consumer respectively. As the income of the consumer increases from Y_1 to Y_2, the quantity demanded also increases Q_1 to Q_2. DD_1 is the positive income elastic demand curve sloping upward.

a. Income elasticity of demand greater than unity (EY > 1):

If the percentage change in quantity demanded for a commodity is greater than the percentage change in income of the consumer, it is said to be income elasticity of demand greater than unity. For example, if the consumer's income increases by 50 percent and the demand increases by 100 percent, it is the case of income elasticity of demand greater than unity. This type of income elasticity of demand is found in case of luxurious goods



Income elasticity of demand greater then unity
In the given figure, quantity and income demanded of a commodity is measured along X-axis and Y-axis respectively. Q and Y are the initial quantity demand and income of the consumer respectively. As the income of the consumer increases from Y to Y_1, the quantity demanded increases Q to Q_3. DD is the Income elasticity of demand greater then unity

b. Income elasticity of demand equal to unity (EY = 1):
If the percentage change in quantity demanded for a commodity is equal to the percentage change in income of the consumer, it is said to be income elasticity of demand equal to unity. For example, if the consumer's income increases by 50 percent and the demand also increases exactly by 50 percent, it is the case of income elasticity of demand equal to unity. This type of income elasticity of demand is found in case of goods of comforts

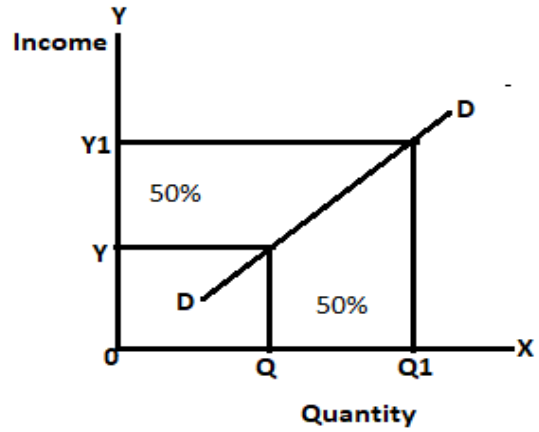


Fig: Income elasticity of demand equal to unity
In the given figure, quantity and income demanded of a commodity is measured along X-axis and Y-axis respectively. Q and Y are the initial quantity demand and income of the consumer respectively. As the income of the consumer increases from Y to Y_1, the quantity demanded also increases Q to Q_1. DD is the Income elasticity of demand equal to unity

c. Income Elasticity of demand less than unity (EY< 1):

If the percentage change in quantity demanded for a commodity is less than the percentage change in income of the consumer, it is said to be income elasticity of demand less than unity. For example, if the consumer's income increases by 50 percent and the demand increases by 30 percent, it is the case of income elasticity of demand less than unity. This type of income elasticity of demand is found in case of necessary goods.

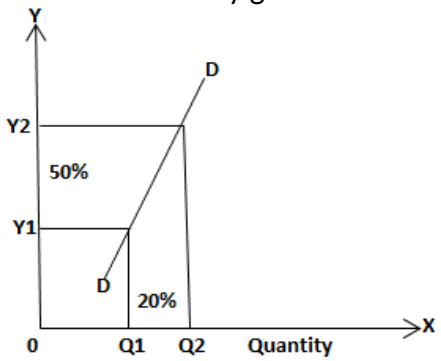


Fig: Income elasticity of demand less then unity

In the given figure, quantity and income demanded of a commodity is measured along X-axis and Y-axis respectively. Q and Y are the initial quantity demand and income of the consumer respectively. As the income of the consumer increases from Y to Y_1, the quantity demanded increases Q to Q_2. DD is the Income elasticity of demand less then unity

ii. **Zero Income Elasticity of Demand (Ey=0)**

If the quantity demand for a good is totally irresponsive to the change in income of a consumer, then the demand is known as zero income elasticity of demand. There is no relationship between change in income and demand. In that case, quantity demanded remains constant for all level of income and the value of elasticity remain zero.

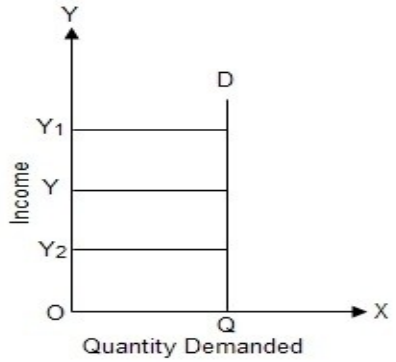


Fig: Zero income elasticity demand

In the given figure, Quantity demanded and income of the consumer is measured along X-axis and Y-axis respectively. The demand curve QD remains same for all level of income even the income decreases from OY to OY_2 or increases from OY to Oy_1.

iii) Negative Income Elasticity (Ey<0)

If the quantity demand of a commodity decreases with the increase in income of the consumer and increases with the decrease in income of the consumer is known as the negative elasticity

of demand. Hence, there is a negative relation between quantity demand and income of the consumer. In that case, the value of elasticity remains less than zero.

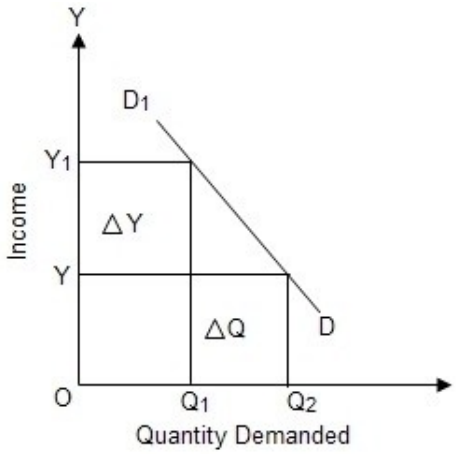


Fig: Negative income elasticity demand

In the given figure, quantity and income demanded of a commodity is measured along X-axis and Y-axis respectively. Q_1 and Y_1 are the initial quantity demand and income of the consumer. When the income of the consumer increases from Y_1 to Y_2, the quantity demanded of a commodity decreases from Q_2 to Q_1. DD_1 is the negative income elastic demand curve sloping downward.

Measurement of Income Elasticity of Demand

Income elasticity of demand can be measured by the following three methods:

Percentage method

Percentage method is also called proportionate method. This method measures price elasticity of demand by dividing the percentage change in the quantity demanded for a commodity by the percentage change in its price. According to this method, income elasticity of demand (EY) is calculated by using the following formula:

Ey = $\frac{Percentage\ change \in quentity\ demand}{percentage Change \in income} = \frac{\frac{\Delta Qd}{Qd}100}{\frac{\Delta Y}{Y}100}$

Ey ¿ $\frac{\Delta Qd}{\Delta Y} . \frac{Y}{Qd}$

Where,

Ey = Income elasticity demand

ΔY= Change in consumer income, its different between original and new income

ΔQ= Change in quantity demand, its different between original and new demand

Q = Initial Quantity

Y = Initial Income

Arc method

Arc method of measuring income elasticity of demand is relevant where there is substantial change in income and quantity demanded. This method measures the elasticity of demand between two points on the same demand curve. The area or stretch between two points of a demand curve is called an arc.

The formula for measuring income elasticity of demand at the middle point C of the arc on the demand curve is:

Ey = $\frac{Percentage\ change \in quentity\ demand}{Percentage\ change \in Income}$

$$¿ \frac{\frac{Change \in quantity\ demanded}{Average\ quantity\ demanded}}{\frac{Change \in Income}{Average\ Income}}$$

$$¿ \frac{\frac{\Delta Qd}{Q1+Q2/2}}{\frac{\Delta Y}{Y1+Y2/2}}$$

$$¿ \frac{\Delta Qd/Q1+Q2}{\Delta Y/Y1+Y2}$$

$$¿ \frac{Q2-Q1}{Y2-Y1}.\frac{Y1+Y2}{Q1+Q2}$$

Where,

Q1 = Initial quantity demanded

Q2 = New quantity demanded

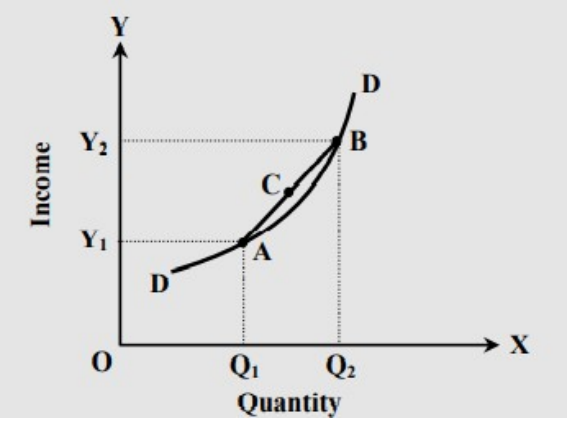
Y1 = Initial Income

Y2 = New Income

ΔQ= Change in quantity demanded

ΔP = Change in Price

The FIGURE.. Shows demand curve for normal good, which is positively sloped.



As shown in FIGURE.., the area or stretch AB is an arc on the demand curve DD. Income elasticity of demand on this arc is measured between these points A and B. The point method of measuring elasticity at two points on a demand curve gives different values of income elasticity of demand. To avoid this discrepancy, elasticity for the arc is calculated by taking the average income and quantity demanded. That is, elasticity of demand is measured at mid-point C of the arc AB.

If EY > 0 , the good is normal or superior; if EY < 0 ; the good is inferior or Giffen, Ey = 0, the good is neutral.

Example

Consider the following schedule:

Points	A	B	C	D
Income	0	500	1500	2500
Demand	10	20	30	50

a. Compute the income elasticity of demand at the movement from B to C by percentage method.

b. Compute the income elasticity of demand midway between C and D by arc method.

Solution

d. **The income elasticity of demand at the movement from B to C percentage method**

Here, Q = 20, Q1 = 30,

ΔQ = Q1- Q = 30-20 = 10

Y =Rs.500

Y1 =Rs.1500

ΔY = Y1- Y = 1500 - 500 = 1000

Using formula,

Ey $¿ \frac{\Delta Qd}{\Delta Y} . \frac{Y}{Qd}$

$¿ \frac{10}{1000} . \frac{500}{20} ¿ \frac{5}{20}$ = 0.25

Ey =0< 0.25 <1 (Positive but less than one income elasticity demand means 100 percent increase in income leads to 25 percent increase in demand such type of income elasticity found on goods like normal but necessities such as vegetables, toothpaste.)

e. The income elasticity of demand midway between C and D by arc method
Here, Q1=30, Q2 = 50, Y1 =1500 Y2 = 2500,

Ey $¿ \frac{Q2-Q1}{Y2-Y1} . \frac{Y1+Y2}{Q1+Q2}$

$¿ \frac{50-30}{2500-1500} . \frac{1500+2500}{30+50}$

= $¿ \frac{20}{1000} . \frac{4000}{80} = ¿ \frac{8}{8}$ = 1

Ey= 1=1

Uses/Importance of Income Elasticity of Demand
The concept of income elasticity of demand plays a crucial role in business decision-making. It can play a very important role in the following grounds:
1..Useful for forecasting demand:
The concept of income elasticity of demand measures the change in demand with the change in income of the consumer. It helps to forecast demand for a product looking at the change in income. Therefore, it guides the producer about how much to produce at different level of income. It also helps the firm in future planning.
2. Useful to design marketing strategy:
Income elasticity of demand helps to classify people into different classes and their demand for different types of goods such as necessary, comfort and luxury. If a firm is producing luxury goods, rich people are its prime customers. Therefore, the firm should concentrate its marketing target in the city areas.
3. Helpful for Classification of Goods:
The concept of income elasticity helps in classifying goods into luxury, inferior and necessary. Demand for luxury goods is highly income elastic whereas demand for necessary goods is income inelastic. Therefore, the concept of income elasticity helps the government in its taxation policy. It also helps the business firms in their pricing policy.
4. Determines the effect of changes in economic activity:
Income elasticity of demand helps to study the effect of changes in business activity on various industries. In the time of prosperity, as there is increase in income of the people, a firm can earn more profits if their products have high-income elasticity. On the contrary, income may fall significantly if the economy moves into depression.

Cross-Elasticity of Demand (Exy)

Cross elasticity of demand is a measure of responsiveness of demand for a product to the change in the price of related goods. In other words, the percentage change in quantity demanded of goods due to the change in the price of a related good that may me substitute goods or complementary goods, is called cross elasticity of demand. Cross elasticity of demand is symbolized by 'Exy' and written as:

Exy $= \frac{Percentage\ change \in quentity\ demand\ of\ Xgood}{percentage\ Change \in price\ of\ Y\ good}$

$$¿ \frac{\frac{\Delta Qdx}{Qdx}}{\frac{\Delta Py}{Py}}$$

Exy $¿ \frac{\Delta Qdx}{\Delta Py} . \frac{Py}{Qdx}$

Where,

Exy = Cross elasticity demand between x and y

ΔQdx = Change in quantity demand for x goods,

Its different between original and new demand.

ΔPy = Change in price of y goods,

Its different between original and new price of related goods.

Qdx = Quantity demand of x goods

Py = Price of y goods

If X and Y goods are subsititutes the result of Exy is positive, X and Y goods are complements the result of Exy is negative.

Example

Q. With the help of the information given below, find out the cross elasticity of demand. Ans 0.44

Price of Tea (Rs.)	Demand for Coffee (kg)
20	1800
25	2000

Solution

We know

Initial quantity demand of coffee Qdx = 1800 (kg)

New quantity demand of coffee Qdx1= 2000 (kg)

Change in quantity demand of coffee ΔQdx = 2000-1800= 200,

Initial Price tea Py = Rs.20

New price of tea Py1 = Rs 25

Change in price of tea ΔPy = 25-20 = Rs.5

Cross elasticity of demand is symbolized by 'Exy'

$$Exy = \frac{Percentage\, change \in quentity\, demand\, of\, coffee}{percentage\, Change \in price\, of\, tea}$$

$$Exy = \frac{\Delta Qdx}{\Delta Py} . \frac{Py}{Qdx}$$

=

= $\frac{200}{5} . \frac{20}{1800} = \frac{4}{9}$ = 0.44 > 0 means tea and coffee are substitutes goods

DEGREE / TYPES OF CROSS ELASTICITY OF DEMAND

There are two types of cross elasticity of demand described below:

i) Positive cross elasticity (Exy>0)

If the two goods are close substitutes to each other, then the cross elasticity of demand are said to be positive. For example, tea and coffee, when the price of a tea increases, the demand for a coffee also increases and vice versa. Hence, the increases in the price of a commodity result to the rise in a quantity demand of a substitute good.

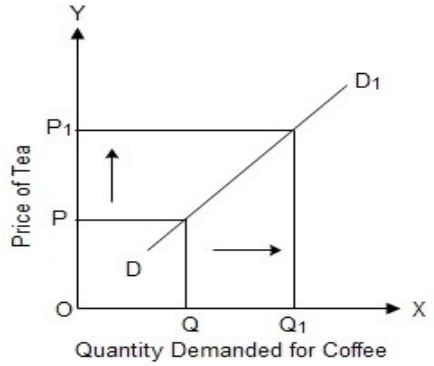


Fig: Positive cross elasticity demand

In the given figure, quantity demand of coffee is measured along X-axis and price of tea is measured along Y-axis. When the price of tea is OP, the quantity demand of coffee is OQ. When the price of tea increases from OP_1 to OP_2, the quantity demand of coffee also increases from OQ_1 to OQ_2. Hence, the DD_1 is the positive cross demand curve sloping upward to the right.

ii) Negative cross elasticity (Exy<0)

When two goods are complementary to one another, then the cross elasticity of demand is supposed to be negative. For example, pen and ink, when the price of the ink increases, the demand for pen decreases. Hence, rise in the price of commodity results to decreases in quantity demand of complementary goods.

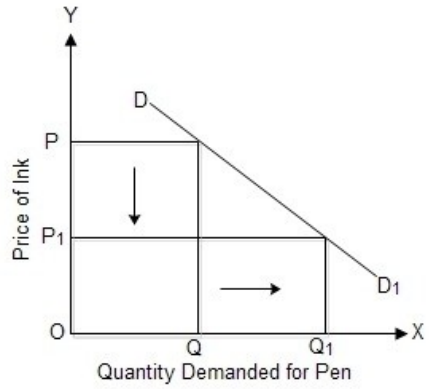


Fig: Negative cross elasticity demand

In the given figure, quantity demand of pen is measured along X-axis and price of ink is measured along Y-axis. When the price of ink is OP_1, the quantity demand of pen is OQ_1. When the price of the ink increased from OP_1 to OP_2, the quantity demand of pen decreased from $OQ_1$to OQ_2. Hence, DD_1 is the negative cross elasticity demand curve sloping downward to the right.

Measurement of Cross Elasticity of Demand

Cross elasticity of demand can be measured by the following two methods:

Percentage method

Percentage method is also called proportionate method. This method measures cross elasticity of demand by dividing the percentage change in the quantity demanded for X-commodity by the percentage change in price of Y-commodity. According to this method, cross elasticity of demand (Exy) is calculated by using the following formula:

$$Exy = \frac{Percentage\,change \in quentity\,demand\,of\ Xgood}{percentage\,Change \in price\,of\ Y\ good}$$

$$¿ \frac{\frac{\Delta Qdx}{Qdx}}{\frac{\Delta Py}{Py}}$$

$$Exy = \frac{\Delta Qdx}{\Delta Py} . \frac{Py}{Qdx}$$

Where,

Exy = Cross elasticity demand between x and y

ΔQdx = Change in quantity demand for x goods, its different between original and new demand.

ΔPy = Change in price of y goods, its different between original and new price of related goods.

Qdx = Quantity demand of x goods

Py = Price of y goods

If Exy> 0 , the goods X and Y are substitute goods; if Exy< 0, the goods X and Y are complementary goods and if Exy = 0, the goods X and Y are independent goods.

Arc method

Arc method of measuring cross elasticity of demand is relevant where there is substantial change in price of one commodity and quantity demanded for another commodity. This method measures the elasticity of demand between two points on the same demand curve. The area or stretch between two points of a demand curve is called an arc.

The formula for measuring cross elasticity of demand at the mid-point C of the arc on the demand curve is:

$$= Exy = \frac{Percentage\, change \in quentity\, demand\, X - good}{Percentage\, change \in Price\, of\, Y - good}$$

$$¿ \frac{\frac{Change \in quantity\, demanded\, of\, X\, good}{Average\, quantity\, demanded\, of\, X - good}}{\frac{Change \in Price\, of\, Y - good}{Average\, price\, of\, Y - good}}$$

$$¿ \frac{\frac{\Delta\, Qdx}{Qx\,1 + Qx\,2/2}}{\frac{\Delta\, Py}{Py\,1 + Py\,2/2}}$$

$$¿ \frac{\Delta\, Qdx/Qx\,1 + Qx\,2}{\Delta\, P\,y/P\,y\,1 + Py\,2}$$

$$¿ \frac{Qx\,2 - Qx\,1}{Py\,2 - Py\,1} . \frac{Py\,1 + Py\,2}{Qx\,1 + Qx\,2}$$

Where,

Qx1 = Initial Quantity demanded of X- good

Q2 = New quantity demanded of X-good

Py1 = Initial price of Y-good

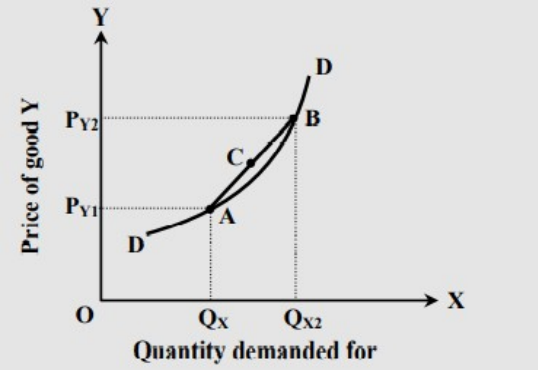
Py2 = New Price of Y-good

ΔQdx= Change in quantity demanded of X-good

ΔPy = Change in Price of Y-good

If good–X and good–Yare complementary goods, the cross demand curve will slope downward but method of measuring cross elasticity of demand by arc method will be same. If Exy> 0 , the good–X and good–Y are substitute goods; if Exy< 0, the good–X and good–Y are complementary goods and if Exy = 0, the good–X and good–Y are independent goods.

The FIGURE… shows demand curve for substitute goods, which is positively sloped.



As shown in FIGURE…, the area or stretch AB is an arc on the demand curve DD. Cross elasticity of demand on this arc is measured between these points A and B. The point method of measuring elasticity at two points on a demand curve gives different values of cross elasticity of demand. To avoid this discrepancy, elasticity for the arc is calculated by taking the average price of one commodity and quantity demanded for another commodity. That is, elasticity of demand is measured at mid-point C of the arc AB.

Example

Consider the following demand schedule

Goods	Before		After	
	Price	Quantity	Price	Quantity
Car (X)	800	2000	800	1000
Price of Petrol (Y)	100	1000	150	700

a) Compute the cross elasticity of demand by percentage method.
b) Compute the cross elasticity of supply by arc method between

Solution,

f. For cross elasticity of demand by percentage method

Qdx = 2000, Qdx1 =1000,

ΔQdx = Qdx1-Qdx = 1000-2000 = -1000
Py = 100, Py1= 150,
ΔY = Py1- Py = 150-100 = 50
Using formula,

Exy $¿ \frac{\Delta Qdx}{\Delta Py} . \frac{Py}{Qdx}$

Exy $¿ \frac{-1000}{50} . \frac{100}{2000}$

= - $\frac{10}{10}$ = -1 < 0 =Exy is negative implies car and petrol are complementary goods

g. For the cross elasticity of demand by arc method
Here
Qx1 = 2000, Qx2 =1000,
Py1 = 100, Py2= 150,

$¿ \frac{Qx2-Qx1}{Py2-Py1} . \frac{Py1+Py2}{Qx1+Qx2}$

$¿ \frac{1000-2000}{150-100} . \frac{100+150}{2000+1000}$

$¿ \frac{-1000}{50} . \frac{250}{3000}$ = $¿ \frac{-5}{3}$= -1.8 < 0
Here Exy is negative; it implies that car and petrol are complementary goods.

Uses/Importance of Cross Elasticity of Demand
Cross Elasticity of Demand is very much important and useful in business decision-making, which can be explained as follows:
1. Classification of goods:
The concept of cross elasticity of demand is very essential in classifying goods into substitutes and complementary. If the cross elasticity between two goods is positive, these goods are substitutes and if it is negative, these goods are complementary. If the goods are strong complementary, the cross elasticity will be highly negative. On the other hand, if the goods are close substitute, the cross elasticity will be highly positive.
2. Classification of market:
The market can also be classified on the basis of cross elasticity of demand. Higher the value of cross elasticity of demand between the goods, greater will be the competition in the market, and lower the value of cross elasticity, lower will be the competition in the market. If the cross elasticity is infinite, the market structure is perfectly competitive. If the cross elasticity of demand is zero, the market is monopoly.

3. Pricing policy:
In reality, many firms produce different related goods – substitutes and complementary. For example, Colgate produces both toothpaste and toothbrush. They are complementary goods. Similarly, Ice Cream Company produces ice cream of different flavor. They are substitute goods. Cross elasticity of demand helps the firms to decide whether to increase price of such related products or not.
4. Classification of industries:
On the basis of cross elasticity of demand, we can classify the different industries. The firm having high positive cross elasticity should be included in one industry. The firm having negative cross elasticity should be included in different industries.

Concepts of elasticity of Supply
The concept of elasticity of supply initially developed by classical and scientifically used but neo-classical economist Alfred Marshall. The elasticity of Supply is defined as the degree of responsiveness of supply for a commodity to the change in its determinants, such as consumers' income, price of others, technologies, future price expectations, taxes and subsidy and infrastructure development. The change in supply of a product depends on the nature and extent of change in these determinants. And, the overall elasticity of Supply for a commodity depends on the combined effects of changes in the determinants. But for the practice, we discuss in this chapter, the following kinds of elasticity.
1. Price Elasticity of Supply
2. Income Elasticity of Supply and
3. Cross Elasticity of Supply.

Price Elasticity of Supply
Definition and Measurement
Price elasticity of supply is the measure of responsiveness of the quantity supplied of a good to the change in its market price. The coefficient of price elasticity of supply (Esp) is the measure of percentage change in the quantity supplied of a good due to a given percentage change in its price. The formula of supply elasticity is given as

Esp = $\frac{Percentage\ change \in quantity\ Supply}{percentage\ Change \in Price} = \frac{\Delta Qs/Qs}{\Delta P/P}$

Esp ¿ $\frac{\Delta Qs}{\Delta P} x \frac{P}{Qs}$

Where,
Esp = Coefficient of price elasticity of supply. It is independent of units.
Qs = Initial quantity supplied.
ΔQs = Change in quantity supplied.
P = Initial price of the good.
ΔP = Change in price.

The positive sign indicates that price and quantity supplied of a good are positively related, i.e., greater units of the good will be placed in the market only at higher prices and vice-versa. Given the formula, price elasticity of supply can be easily measured.

Example
When the price of four-star hotel rooms rose from $160 to 180, supply rose from 3200 to 3600 rooms per week. Calculate the elasticity of supply. (Ans = 1)

Solution
Initial quantity supplied Qs = 3200
New quantity supplied Qs1= 3600
Change in quantity supplied ΔQs = 3600-3200 = 400
Initial price of the room P = $ 160
New price of the room P1 = $ 180
Change in price ΔP =180-160 = 20.
The formula of supply elasticity is

Esp = $\frac{Percentage\ change \in quantity\ Supply}{percentage\ Change \in Price}$

Esp ¿ $\frac{\Delta Qs}{\Delta P} X \frac{P}{Qs}$

= $\frac{400}{20} X \frac{160}{3200} = \frac{4}{4}$ = 1 Unitary Elastic Supply (Esp = 1).

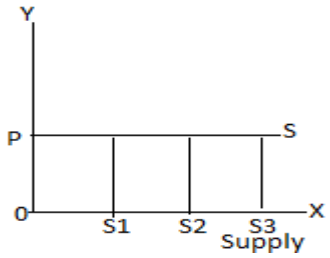
Determinants of Elasticity of Supply
The important factors affecting price elasticity of supply are,
1 Time Factors: time is important determinant of supply. Longer the time period, more the time is available to adjust the supply more elastic the supply curve.
2. Nature of the Good: Inelastic supply in case of perishable goods (e.g. milk, bread, etc.) because its supply can be neither be increased nor be decreased within a short period case of durable goods.
3. Production Capacity: If unlimited production capacity exists (i.e., production can be increased easily), then there is elastic supply. If limited production capacity exists, then there is inelastic supply.
4. Production Methods and Techniques: If an industry uses complicated methods and techniques of production, supply of the commodity produced by that industry will be relatively inelastic. On the contrary, if an industry uses simple methods and techniques of production, supply of the commodity produced by that industry will be relatively elastic.
5. Stage of Laws of Return: If the law of diminishing return is applied on the production of a commodity, elasticity of supply for such a commodity will be inelastic. On the contrary, if the law of increasing return is applied on the production of a commodity, supply of such a commodity will be elastic.

6. Future Price Expectation: If the producers expect that the price will rise in future, then they will supply less quantity in the market presently. Thus, supply will become inelastic. If the producers expect that the price will fall in the future, supply will be more elastic.
7. Number of Products being produced by an Industry: If an industry is producing many products, supply is elastic as the producers can switch over to the production of other goods and vice versa.

Degree/ types of elasticity of Supply

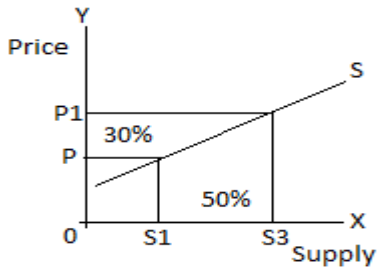
There are five degrees or types of elasticity of supply.

1. Perfectly Elastic Supply (Esp = ∞). Supply of commodity is said to be perfectly elastic when its supply expands (rises) or contracts (falls) to any extent without any change in the price. The coefficient of Esp = ∞ (infinity). It is shown graphically in Figure…. Perfectly Elastic Supply Curve



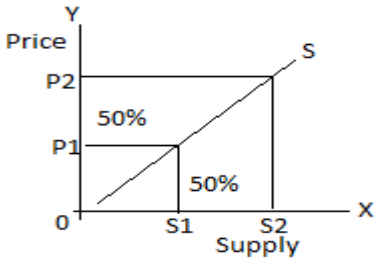
The perfectly elastic supply curve is S which is a
horizontal line. It shows that at a price of of per unit, any quantity of the commodity can be supplied.

2. Elastic Supply (Esp >1). When percentage change in supply is more than the percentage change in price, supply is said to be elastic or more than unitary elastic. In this case, the value of the Esp is more than one. It is shown in Fig. 5. Elastic Supply Curve

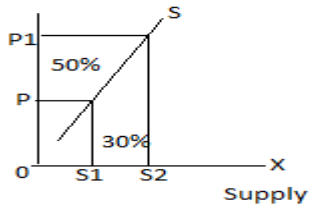


The elastic supply curve is SS which is upward sloping originating from the y-axis.

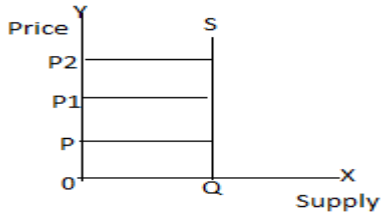
2. Unitary Elastic Supply (Esp = 1). Supply of a commodity is said to be unitary elastic if percentage change in supply equals the percentage change in price. In this case, the coefficient of Esp is equal to one. It is shown in Figure 5. Unitary Elastic Supply Curve



The unitary elastic supply curve is OC which is a straight positively sloping line from the origin.
4. Inelastic Supply (Esp < 1). When percentage change in quantity supplied is less than percentage change in price, supply is said to be inelastic or less than unitary elastic. This is shown in Fig. 5. .Inelastic Supply Curve



The inelastic supply curve is SS which is upward sloping originating from the x-axis.
5. Perfectly Inelastic Supply (Esp = 0). When supply of a commodity does not change irrespective of any change in its price, it is called perfectly inelastic supply. In this case, Es = 0. Its graphically in Figure 5....



.5..Perfectly Inelastic Supply Curve
The supply curve, SS is a vertical line showing that quantity supplied is fixed at OS3 units irrespective of the price

Measurement of Elasticity of Supply
The elasticity of supply is measured on the basis of slope and nature of supply curve. There are three methods of measuring elasticity of supply, which are as follows:

Percentage method
Percentage method is also called proportionate method. This method measures price elasticity of supply by dividing the percentage change in the quantity supplied for a commodity by the percentage change in its price. According to this method, price elasticity of supply (ES) is calculated by using the following formula:

Esp = $\frac{Percentage\ change \in quantity\ Supply}{percentage\ Change \in Price} = \frac{\Delta Qs / Qs}{\Delta P / P}$

Esp ¿ $\frac{\Delta Qs}{\Delta P} X \frac{P}{Qs}$

Where,
Qs = Initial quantity supplied P = Initial Price
ΔQs = Change in quantity supplied ΔP = Change in price

Arc method

Arc method of measuring price elasticity of supply is relevant where there is substantial change in price and quantity supplied. This method measures the elasticity of supply between two points on the same supply curve. The area or stretch between two points of a supply curve is called an arc.

The formula for measuring price elasticity of supply at the middle point C of the arc on the supply curve is:

Esp = $\frac{Percentage\ change \in quentity\ Supply}{percentage\ change \in Price}$

$$¿ \frac{\frac{Change \in quantity\ Supply}{Average\ quantity\ Supply} x\ 100}{\frac{Change \in Price}{Average\ Price} x\ 100}$$

$$¿ \frac{\frac{\Delta Qs}{Q1+Q2/2}}{\frac{\Delta P}{P1+P2/2}}$$

$$¿ \frac{\Delta Qs/Q1+Q2}{\Delta P/P1+P2}$$

$$¿ \frac{Q2-Q1}{P2-P1} X \frac{P1+P2}{Q1+Q2}$$

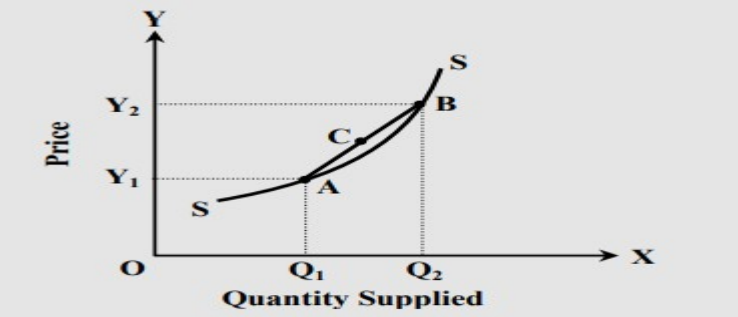
Where,

Q1 = Initial quantity supplied

Q2 = New quantity supplied

P1 = Initial Price

P2 = New Price



As shown in FIGURE.., the area or stretch AB is an arc on the supply curve SS. Price elasticity of supply on this arc is measured between these points A and B. The point method of measuring

elasticity at two points on a supply curve gives different values of price elasticity of supply. To avoid this discrepancy, elasticity for the arc is calculated by taking the average price and quantity supplied. That is, elasticity of supply is measured at mid-point C of the arc AB.

Relationship between Price Elasticity of Demand and Revenue

The concept of Price Elasticity of Demand is very useful in estimating the revenue of firm. Here we study the two different concept of revenue and price elasticity of demand.

1. Relationship between price elasticity of demand, marginal revenue and total revenue
   We know that
   Total Revenue = Price x Quantity
   Or, TR = P x Q
   Differentiating TR w.r.to output Q, and applying product rule

   MR=$\frac{d\,TR}{d\,Q}$ = $\frac{d\left(PxQ\right)}{d\,Q}$

   = P . $\frac{d\,Q}{d\,Q}$ + Q . $\frac{dP}{d\,Q}$ ……

   Multiplying and dividing the last term by P and rearranging the term

   = P + Q . $\frac{dP}{d\,Q}x\frac{dP}{d\,P}$

   = P (1 + $\frac{dP}{d\,Q}x\frac{dQ}{d\,P}¿$

   By definition price elasticity is- $\frac{dQ}{d\,P}x\frac{P}{Q}$

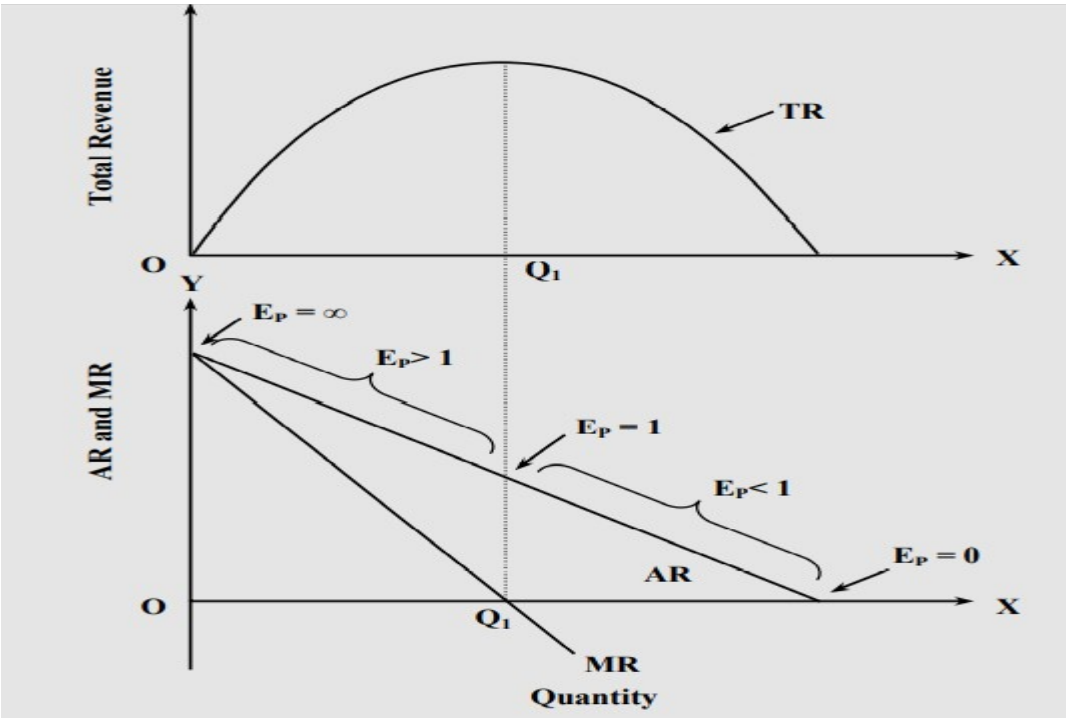
   We know in the above term $\frac{dP}{d\,Q}x\frac{dQ}{d\,P}$ is reciprocal of elasticity

   is 1/$\frac{dQ}{d\,P}x\frac{P}{Q}$ = $\frac{-1}{Ep}$

   so MR = P (1- $\frac{1}{Ep}¿$

   Where,
   MR = Marginal Revenue, TR = Total Revenue, P = Price, EP = Price elasticity of demand

   Form the above final equation following conclusion can be drawn.
   1. If price elasticity is unitary Ep = 1, MR = 0; it means TR remains constant with any change in price.
   2. If price elasticity is elastic Ep> 1, MR > 0; it means TR increases when price decreases and a increase in price leads to TR decreases.
   3. If price elasticity is inelastic Ep< 1, MR < 0; it means TR increases when price increases and vice – versa.



In the figure , the quantity sold is measured along the X-axis and revenue along the Y-axis. TR is the total revenue curve. It is inversely Ushaped. is shown in the upper panel of the figure . AR and MR curves are shown in the lower panel of the figure. The above curve represents the curve of the imperfect market. Following relation can be summed up between the three revenue curves:

1. When TR is increasing at decreasing rate MR is falling but is positive and the AR or demand curve will have price elasticity greater than 1.
2. When TR reaches its maximum MR reaches zero at output Q1 and elasticity of demand is equal to 1.
3. When TR starts falling, MR becomes negative in value and the elasticity of demand is less than unity.

2. **Relationship between price electricity of demand and average revenue**

Since

MR = P (1- $\frac{1}{Ep}$ ¿

P = AR in market we replace P by AR in the equation

MR = AR (1- $\frac{1}{Ep}$ ¿

MR = AR ($\frac{Ep-1}{Ep}$ ¿

Or, AR = MR ($\frac{Ep}{Ep-1}$ ¿

or, MR. Ep= AR. Ep – AR

or, MR . Ep – AR Ep. = – AR

or, Ep (MR – AR) = (– AR)

Ep = - ($\frac{-AR}{MR-AR}$ ¿

Ep = ($\frac{AR}{AR-MR}$ ¿

Example

Consider the following demand function and supply function
Q_d = 100-5Px, Q_s =10+10Px
Find the equilibrium price and quantity
Solution
Demand function = Q_d = 100-5Px
Supply function = Q_s =10+10Px
Equilibrium condition Q_d = Q_s
100-5Px =10+10Px
100-10 = 10Px +5Px
90= 15Px
Px = $\frac{90}{15}$ = 6
Putting the value of Px in demand and supply function
Q_d = 100-5Px
= 100-5(6)
= 100-30
Q_d = 70
Q_s =10+10Px
= 10+10(6)
= 10+60
Q_s =70

Example
The demand function of a commodity is given by Q = 500 − 20P. Price of the commodity is Rs.10 per unit. Compute the price elasticity of demand. If the objective is to increase total revenue, should the price be increased or decreased? Why?

Given, Q = 500 − 20P … (i)
Then, ΔQ/ΔP = d(500 − 20P)/dP
= − 20
At P = Rs.10
Q = 500 − 20P
Q = 500 − 20 × 10
= 400 units
We know that,

Price elasticity of demand Ep ¿ $-¿ \frac{\Delta Qd}{\Delta P}.\frac{P}{Qd}$

Now, putting the above values in the formula, we get

Ep ¿ $-(-20).\frac{10}{400}$

EP = = 0.5

Since, EP = 0.5 < 1 relatively inelastic

Now, as the value of EP is less than 1,

It is beneficial to rise price of the commodity to increase total revenue.

It can be explained by the help of the following example.

Initially, when price was Rs.10, Q = 500 – 20P

Q = 500 – 20 × 10= 300 units

Total revenue (TR) = P × Q = 10 × 300= Rs.3000

If price falls from Rs.10 to Rs.9, then Q = 500 – 20 × 9 = 320 units

Total revenue (TR) = P × Q = 9 × 320 = Rs.2880

Hence, total revenue decrease from Rs.3000 to Rs.2880 when there is fall in price of the commodity from Rs.10 to Rs.9

Example

Consider the following demand schedule:

Points	A	B	C	D
Price (Rs)	40	56	72	80
Demand	96	80	64	48

a. Compute the price elasticity of demand at the movement from B to C by percentage method.

b. Compute the price elasticity of demand between C and D by arc method.

Solution

a. Price elasticity of demand at the movement from B to C by percentage method.

Initial price P = 56

New price P_1 = 72

Change in price ΔP = (P_1-P) = 72 - 56 = - 16

Initial quantity demand Qd = 80

New quantity demand Qd_1 = 64

Change in quantity demand ΔQ = (Qd_1-Qd)= 64 - 80 = -16

$Ep=-¿ \frac{\Delta Qd}{\Delta P}.\frac{P}{Qd}$

$¿-¿ \frac{-16}{-16}.\frac{56}{80}$ =

¿ $\frac{-56}{80}$ = -0.7 < 1 relatively Inelastic

b. Price elasticity of demand between C and D by arc method

Initial Price P = 72

New Price P1 = 80

Initial quantity demanded Qd= 64

New quantity demanded Qd1 = 48

$$Ep = -¿ \frac{Qd1 - Qd}{P1 - P} . \frac{P + P1}{Qd1 + Qd}$$

$$¿ - ¿ \frac{48 - 64}{80 - 72} . \frac{72 + 80}{48 + 64}$$

$$¿ - ¿ \frac{-16}{8} . \frac{152}{112}$$ = 2.71 >1 Elastic

Example

DDC has introduced four types of product as a join product since 2019. The figure of the total product in 2019 and 2020 are given below:

Product types	2019 (Price)	2019 (Q) Demanded	2020 (Price)	2020 (Q) Demanded
Milk	12	20,000	10	30,000
Ghee	10	30,000	8	40,000
Curd	10	40,000	12	35,000
Paneer	12	32,000	16	30,000

a) Compute the price elasticity on demand for different product.
b) Suppose you are appointed as a loan manager In December,2022. The board of director has directed you to revised price in order to increase revenue in 2022. How do you revise price of each product to meet this target?

Solution

c. Price elasticity using percentage method

Price elasticity of milk

Initial price P = 12

New price P_1 = 10

Change in price ΔP = (P_1-P) = 10-12 = -2

Initial quantity demand Qd = 20,000

New quantity demand Qd_1 = 30,000

Change in quantity demand ΔQ = (Qd_1-Qd)= 30,000-20,000 = 10,000

$$Ep = -¿ \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$$

$$¿ - ¿ \frac{10,000}{-2} . \frac{12}{20,000} =$$

$$¿ \frac{12}{4} = 3 > 1 \text{ relatively elastic}$$

Price elasticity of Ghee
Initial price P = 10

New price P_1 = 8

Change in price ΔP = (P_1-P) = 8-10 = -2

Initial quantity demand Qd = 30,000

New quantity demand Qd_1 = 40,000

Change in quantity demand ΔQ = (Qd_1-Qd)= 40,000-30,000 = 10,000

$$Ep = -¿ \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$$

$$¿ - ¿ \frac{10,000}{-2} . \frac{10}{30,000} =$$

$$¿ \frac{10}{6} = 1.66 > 1 \text{ Elastic}$$

Price elasticity of Curd
Initial price P = 10

New price P_1 = 12

Change in price ΔP = (P_1-P) = 12-10 = 2

Initial quantity demand Qd = 40,000

New quantity demand Qd_1 = 35,000

Change in quantity demand ΔQ = (Qd_1-Qd)= 35,000 -40,000 = -10,000

$$Ep = -¿ \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$$

$¿ -¿ \frac{-10,000}{2} . \frac{10}{40,000}$ =

$¿ \frac{10}{8}$ = 1.25 > 1 Elastic

Price elasticity of Paneer
Initial price P = 12

New price P_1 = 16

Change in price ΔP = (P_1-P) = 16-12 = 4

Initial quantity demand Qd = 32,000

New quantity demand Qd_1 = 30,000

Change in quantity demand ΔQ = (Qd_1-Qd)= 30,000 -32,000 = -2,000

$Ep = -¿ \frac{\Delta Qd}{\Delta P} . \frac{P}{Qd}$

$¿ -¿ \frac{-2,000}{4} . \frac{12}{32,000}$

$¿ \frac{3}{16}$ = 0.18 < 1 Inelastic

d. To increase the revenue, price of milk, ghee, and curd should reduce because price elasticity are elastic demand and price of paneer should further increase because price elasticity paneer is inelastic.

Example
Consider the following supply schedule:

Points	A	B	C	D
Price	0	10	15	25
Supply	10	20	30	60

a. Compute the price elasticity of supply at the movement from B to C by percentage method.
b. Compute the price elasticity of supply by arc method between B and D by are method.

Solution

ii. Price elasticity of supply at the movement from B to C by percentage method.

P= 10, P1 = 15, ΔP = P1-P = 15-10 = 5
Qs = 20, Qs_1 = 30, ΔQs= Qs_1- Qs = 30-20 = 10

Esp $¿ \frac{\Delta Qs}{\Delta P} x \frac{P}{Qs}$

$= \frac{10}{5} x \frac{10}{20}$ = 1 Unitary Elastic Supply

2. **Price elasticity of supply by arc method between B and D by are method.**

Here,

P= 10, P1 = 25, ΔP = P1-P = 25-10 =15

Qs = 20, Qs_1 = 60, ΔQs= Qs_1- Qs = 60-20 = 40

$$Esp = \frac{\Delta Qs}{\Delta P} x \frac{P}{Qs}$$

$= \frac{40}{15} x \frac{10}{20} = \frac{4}{3}$ = 1.33

Eps =1.33 > 1 more than unitary elastic.

MCQ

Candidates are required to answer the questions in their own words as far as practicable

Attempt all the questions:

Circle (◯) the correct answer:

1. Which one of the following is not a determinant of demand?
A. Taste or preference
B. Income
C. Expenditures
D. Consumer expectations
E. Population

2. When demand increases, what happens to a demand curve?
A. It shifts left.
B. It shifts right.
C. No movement occurs.
D. The quantity does not change.
E. It becomes positively sloped.

3. What would happen to the demand curve for cars if the price of gasoline tripled?
A. It would shift to the right because of income.
B. It would shift to the right because of population.
C. It would shift to the left because of price of the complementary good.
D. It would shift to the left because of the price of the substitute.
E. Both A and D are correct.

4. Which one of the following is not a determinant of supply?
A. Income
B. Input costs
C. Number of suppliers
D. Supplier expectations
E. Government

5. The law of supply states that:
A. As prices rise, so does demand.
B. As prices rise, supply falls.
C. Supply increases as demand increases.
D. As prices rise, quantity supplied rises.
E. Prices have nothing to do with supply.

6. On a supply curve, prices and quantity are:
A. Inversely related
B. Not related
C. Not shown
D. Positively related
E. Independent variables

7. Where is the price floor located?
A. Above the equilibrium
B. Below the equilibrium
C. Below the market price
D. At the equilibrium price
E. None of the above

8. When the supply curve shifts right and the demand curve stays constant, what happens?
A. Prices rise and quantity falls.
B. Prices fall and quantity rises.
C. Prices are indeterminate.
D. Quantity is indeterminate.
E. Both price and quantity are indeterminate.

9. The area above the equilibrium price is also known as:
A. A surplus
B. A shortage
C. Scarcity
D. Price ceilings
E. Market price

10. If price increased by 5 percent and quantity supplied increased by 7 percent:
A. Supply is elastic.
B. Demand is elastic.
C. Supply is inelastic.
D. Demand is inelastic.
E. Supply is unitary.

11. When income and consumption have a positive relationship, which of the following is true?
A. The good is inferior.
B. The good is normal.
C. The good is complementary.
D. The good is a substitute.
E. None of the above.

12. When cross-elasticity of demand is positive, what are the goods in question?
A. Substitutes
B. Rivals
C. Inferior
D. Negative
E. Complement

13. In measuring the price-elasticity……
    A. Price is a dependent variable and quantity is an independent variable
    B. Price is the independent variable and quantity is a dependent variable.
    C. Price and quantity both are independent variables.
    D. Price and quantity both are dependent variables.
14. The demand for salt is likely to have a low price elasticity because ……
    A. Involves only a small proportion of consumers expenditure.
    B. It is single-use good.
    C. Has no close substitutes.
    D. Can readily be foregone.
15. The elasticity of demand at the mid point of a straignt line demand curve is…
    A. 0
    B. 1
    C. 1.5
    D. 2

16. The expenditure on a good remains constant with the change in its price in case of…
    A. Perfect elasticity
    B. Perfect inelasticity
    C. Unit elasticity
    D. Zero elasticity
17. Income- elasticity of demand will be zero when a change in income brings….
    A. A less than proportionate change in quantity demanded
    B. A more than proportionate change in quantity demanded
    C. The same proportionate change in demand
    D. No change in demand
18. Cross elasticity of complementary goods is……
    A. Negative
    B. Zero
    C. High
    D. Infinite
19. In case of luxury goods, income elasticity is…

A. Greater than one
B. Equal to one
C. Less than one but more than zero
D. None of these

20. Elasticity of demand is equal to unity while marginal revenue is
A. Positive
B. Zero
C. Negative
D. Indeterminate

21. A demand curve which takes the form of a horizontal line parallel to the quantity axis illustrates elasticity which is…
A. Zero
B. Infinite
C. >1
D. <1

22. Income elasticity of demand will be zero when a given change in income brings about…
A. A less than proportionate change in quantity demanded
B. A more than proportionate change in quantity demanded
C. The same proportionate change in quantity demanded
D. No change in demand

23. The price elasticity of demand is affected by…
A. Availability of close substitutes
B. Price level
C. Amount of labor used
D. Productivity of factors of production

24. If quantity demanded falls from 200 to 150 as price rises from 5 to 10, demand is …
A. Elastic
B. Unitarily elastic
C. Relatively Inelastic
D. Perfectly elastic

25. In case the two substitutes goods, the crosselasticity will be…
A. Positive
B. Unitary
C. Negative
D. Infinite

26. In case the two complementary goods, the crosselasticity will be…
A. Positive
B. Unitary

C. Negative
D. Infinite

27. If cross elasticity is zero, it means the two commodities are…
    A. Close substitutes
    B. Good complements
    C. Completely unrelated
    D. None of these
28. A high value of cross elasticity indicates that the two commodities are…
    B. Very good substitutes
    C. Poor substitutes
    D. Good complements
    E. Poor complements
29. The vertical demand curve for a commodity shows that its demand is……
    A. Highly elastic
    B. Perfectly inelastic
    C. Fairly elastic
    D. Moderately elastic
30. If more is demanded at the same price or the same quantity is demanded at a higher price, this is known as
    A. Increase in quantity demanded
    B. Decrease in quantity demand
    C. Increase in demand
    D. Decrease in demand

Answer key

1 C	**2 B**	**3 C**	**4 A**	**5 D**	**6 D**	**7 A**	**8 B**	**9 A**	**10 A**
11 B	**12 A**	**13 B**	**14 C**	**15 B**	**16 C**	**17 D**	**18 A**	**19 A**	**20 B**
21 B	**22 D**	**23 B**	**24 C**	**25 A**	**26 C**	**27 C**	**28 A**	**29 B**	**30 A**

Descriptive Answer Questions

1. Define price elasticity of demand. Explain its types.
2. Explain the uses of price elastic of demand.
3. What is price elasticity of demand? How is it measured by point method?
4. What is income elasticity of demand? Explain its types.
5. Define cross elasticity of demand. Explain its type.
6. Explain the uses of income elasticity in business decision-making.
7. Explain the importance of cross elasticity of demand to a business firm.

8. Define price elasticity of supply. Explain its types.
9. Explain the different methods of measuring price elasticity of demand.
10. What is price elasticity of demand? Explain its determinants.
11. Explain the uses of price, income and cross elasticity of demand.
12. What is meant by price elasticity of supply? Explain its determinants.

Numerical

1. Consider the following demand schedule

Price Rs/Kg	100	80	60	40	20	
Qd	100	200	300	400	500	

a. What is the price elasticity of demand when price fall from 80 to 60?
b. What is the price elasticity demand when price rise from 60 to 80?
Ans a. 2, b. 1

2. Suppose a demand function is represented by Q= 100 – 10P.
a. What is the price elasticity of demand at the point where the price is Rs.4?
b. What is the price elasticity at the point where the price is Rs.5?
c. What is the arc elasticity between these two points?
Ans.:a) EP = 0.67, b) 1 and C) 0.82

3. Suppose that demand schedule for orange is given in Gorkha district

Price (Rs/Kg)	Quantity demand Kg when income 10,000	Quantity demand Kg when income 10,000
8	80	100
10	64	90
12	48	60
14	32	40
16	16	30

a. Calculate the price elasticity of demand when the price orange increase to Rs.14 from 8 when the income is 10,000
b. Calculate the income elasticity of demand as the income increase from 10,000 to 15,000 when the price orange is 12
Ans Ep = - 0.8, Ey = 0.5

4. Price of a chocolate falls from Rs.5 to Rs.4 per unit. This leads to an increase in its demand from 10 units to 20 units a day. Comment on its elasticity of demand.
Ans.: EP = 5, Elastic Demand

5. Consider the following demand schedule:

Points	A	B	C	D
Price (Rs)	40	56	72	80
Demand	96	80	64	48

c. Compute the price elasticity of demand at the movement from B to C by percentage method.
d. Compute the price elasticity of demand between C and D by arc method.
e. Compute the price elasticity of demand between D to B
Ans a) -0.7, b) 2.71, c) 0.7

6. A consumer spends Rs.40 on a good at a price of Rs.1 per unit and Rs.60 at a price of Rs.2 per unit. What is the price elasticity of demand? What kind of good is it? What shape will its demand curve take?
   Ans.: (a) 0.25, necessity, steeper
7. Compute the income elasticity of demand as the income increase to Rs150 from 100 as a result quantity demand also increase to 30 kg from 25 kg
   Ans Ey=0.4

Points	A	B	C	D
Income (Rs)	4000	6000	8000	10000
Demand	50	100	120	140

f. Compute the income elasticity of demand at the midway between B to D and D to B.
g. Compute the income elasticity of demand movement between B to D and D to B.
h. Compute the income elasticity of demand at point B and D.
   Ans a) 2/3,and 2/3 b) 0.6,and 0.7 c) 1 and 0.5

8. Consider the following table and find out cross elasticity of case: Interpret the result

Particular	Orginal	New
Price of Pepsi	Rs.20	25
Demand for Coke (Bottle/ per week)	1,200	1,400

9. With the help of the information given below, find out the cross elasticity of demand.

Price of Tea (Rs.)	Demand for Coffee
20	1800
25	2000

10. Ans 0.44
11. Calculate elasticity of supply by arc method when price increases from Rs.10 to Rs.20 and quantity supplied increases from 40 units to 80 units.
12. Calculate the price elasticity of supply at price Rs. 10 with given supply function QS = 10+ 5P.
    Ans 0.83
13. Suppose, initial price per packet of a noodle is Rs.10 and quantity supplied is 100 units. If price rises to Rs.12 and quantity supplied increases to 140 units, find the price elasticity of supply.
    Ans 2

14. Suppose a supply function is represented by Q = 20 + 2P. Calculate price elasticity of supply when price per unit is Rs.10.
    Ans.: ES = 0.7
15. Consider the following supply schedule:

Points	A	B	C	D
Price	0	5	10	15
Supply	10	20	30	40

a. Compute the price elasticity of supply at the movement from B to C by percentage method.

b. Compute the price elasticity of supply by arc method between C and D by are method. Ans.: (a) ES = 0.5 (b) ES = 0.71

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