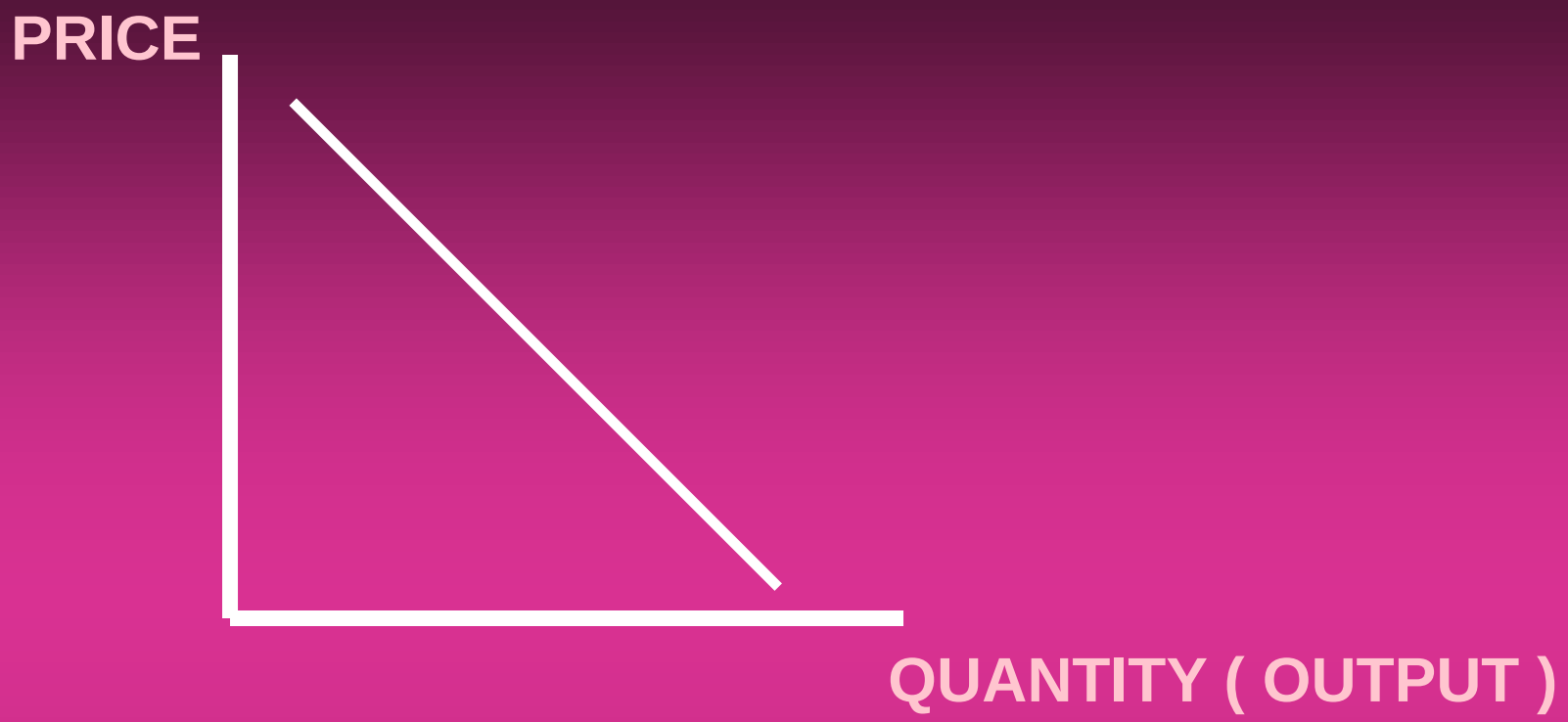
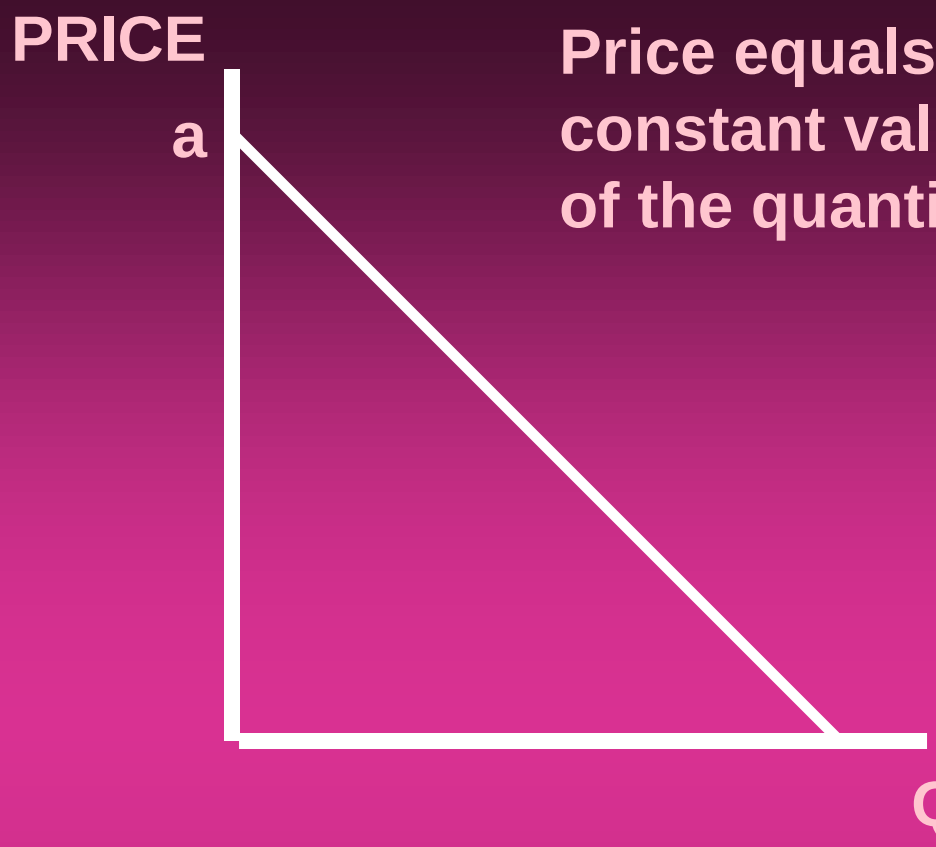
UTILITY AND DEMAND

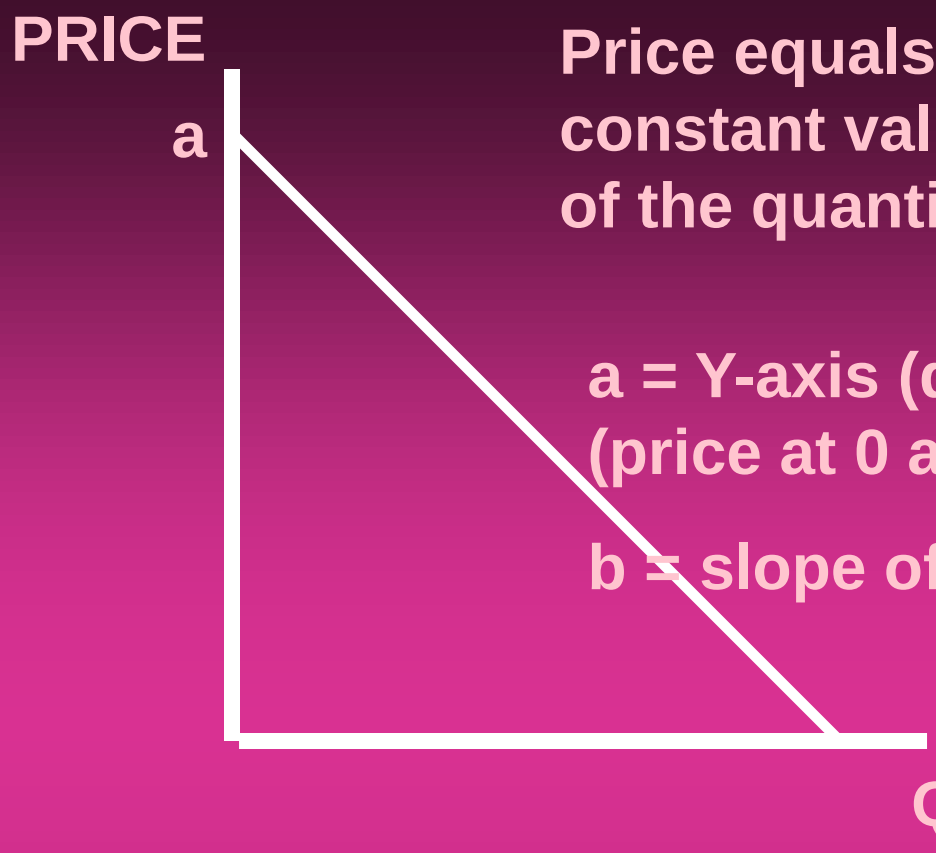
- Utility is a measure of the value which consumers of a product or service place on that product or service;
- Demand is a reflection of this measure of value, and is represented by price per quantity of output;


PRICE
QUANTITY (OUTPUT)



Price equals some constant value minus some multiple of the quantity demanded:

$$p = a - b D$$



Price equals some constant value minus some multiple of the quantity demanded:

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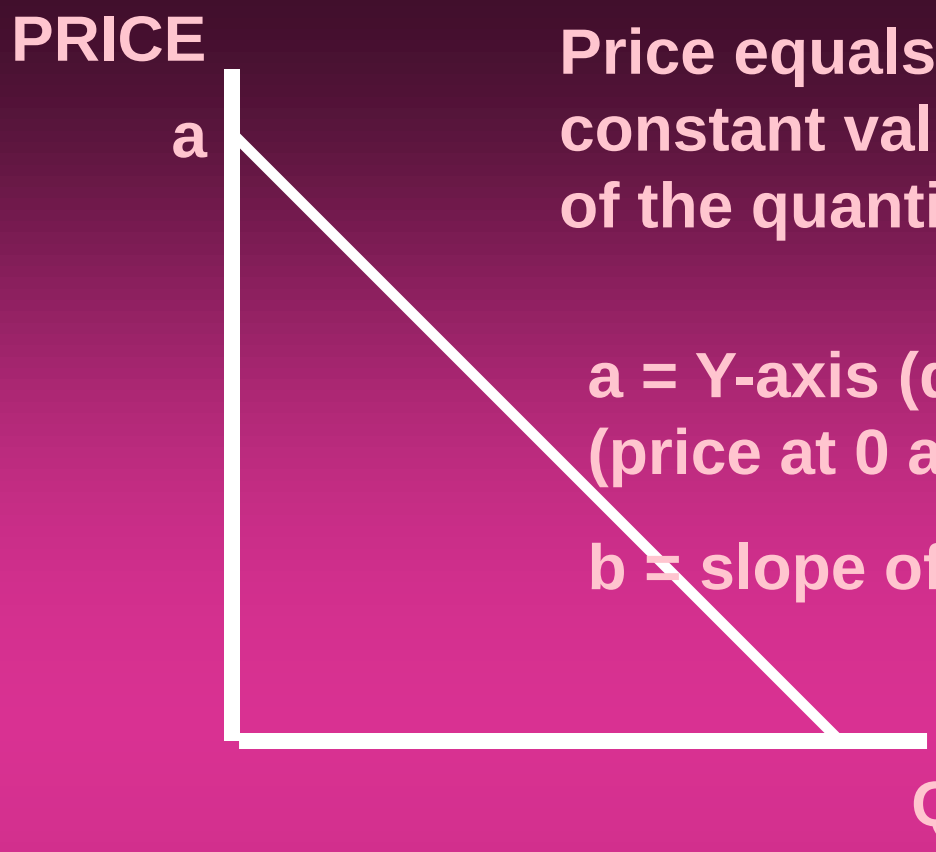

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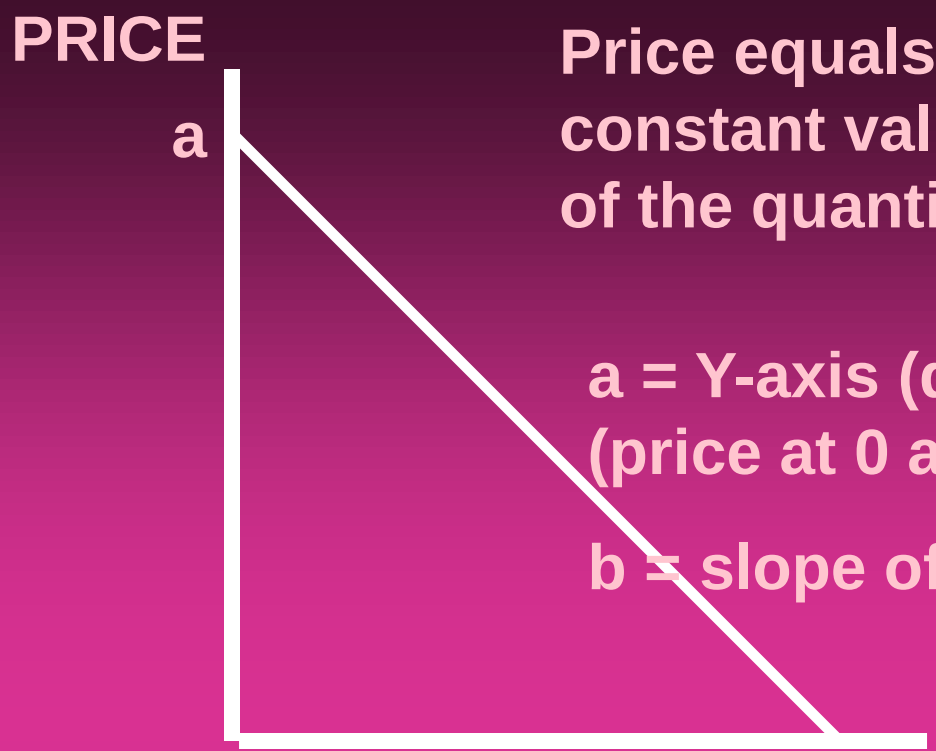
$$D = (a - p) / b$$



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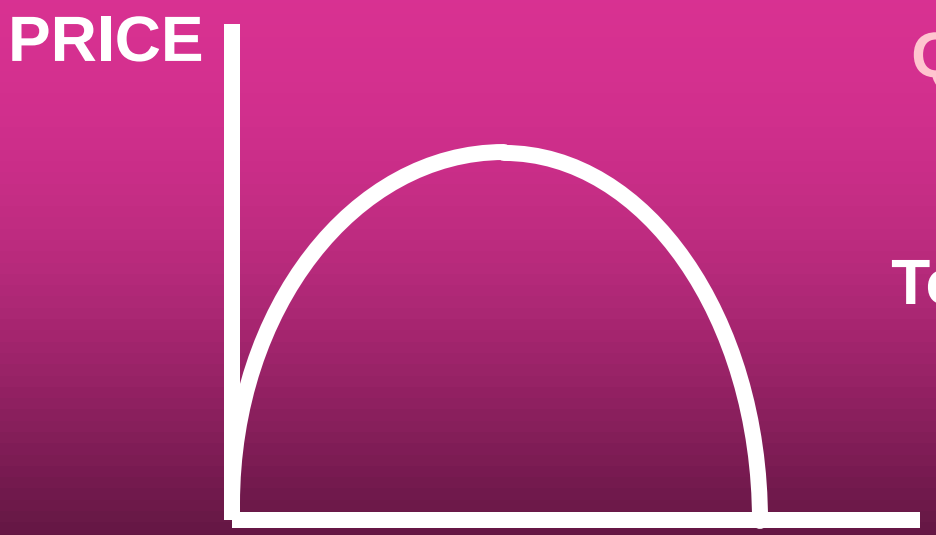
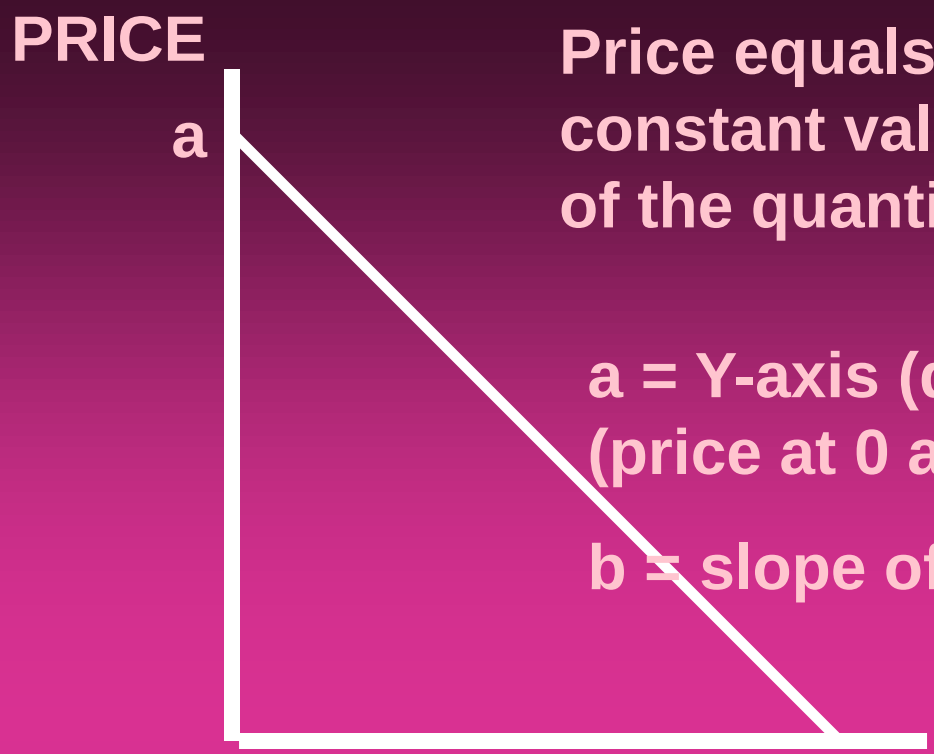


Total Revenue = p x D

= (a – bD) x D

QUANTITY (OUTPUT)



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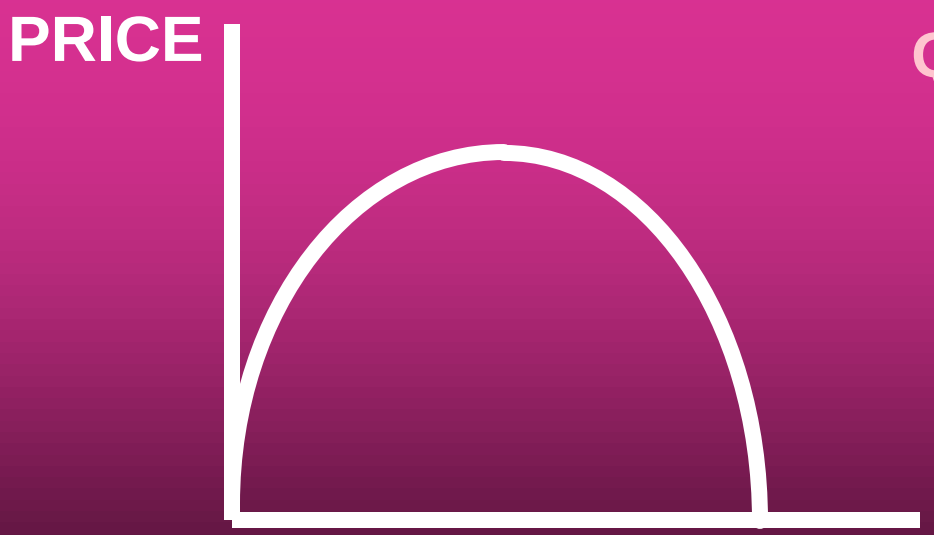
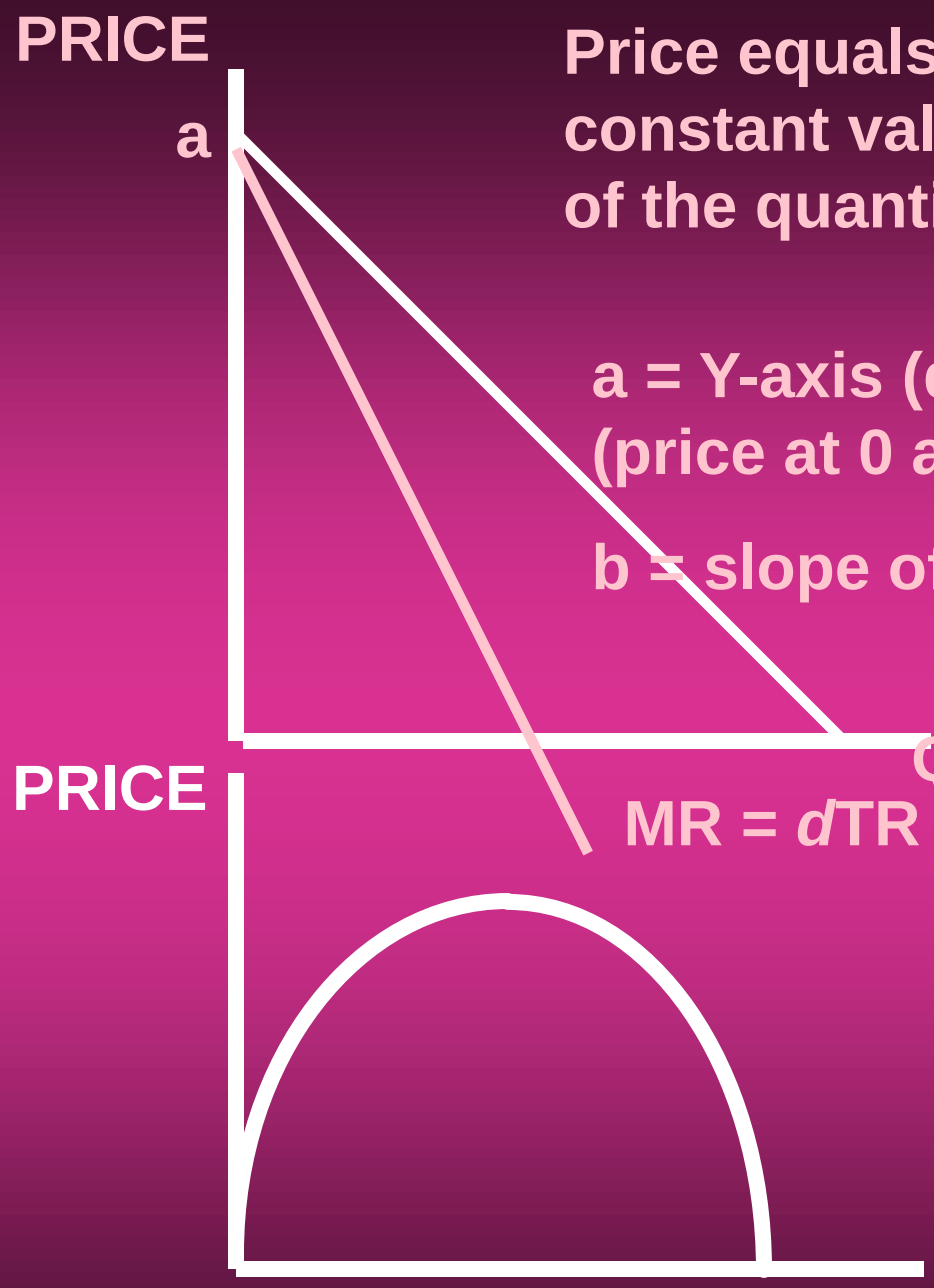


Total Revenue = p x D

$= (a - bD) \times D$

$= aD - bD^2$

QUANTITY (OUTPUT)



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$$MR = dTR / dD = a - 2bD = 0$$

Total Revenue = p x D

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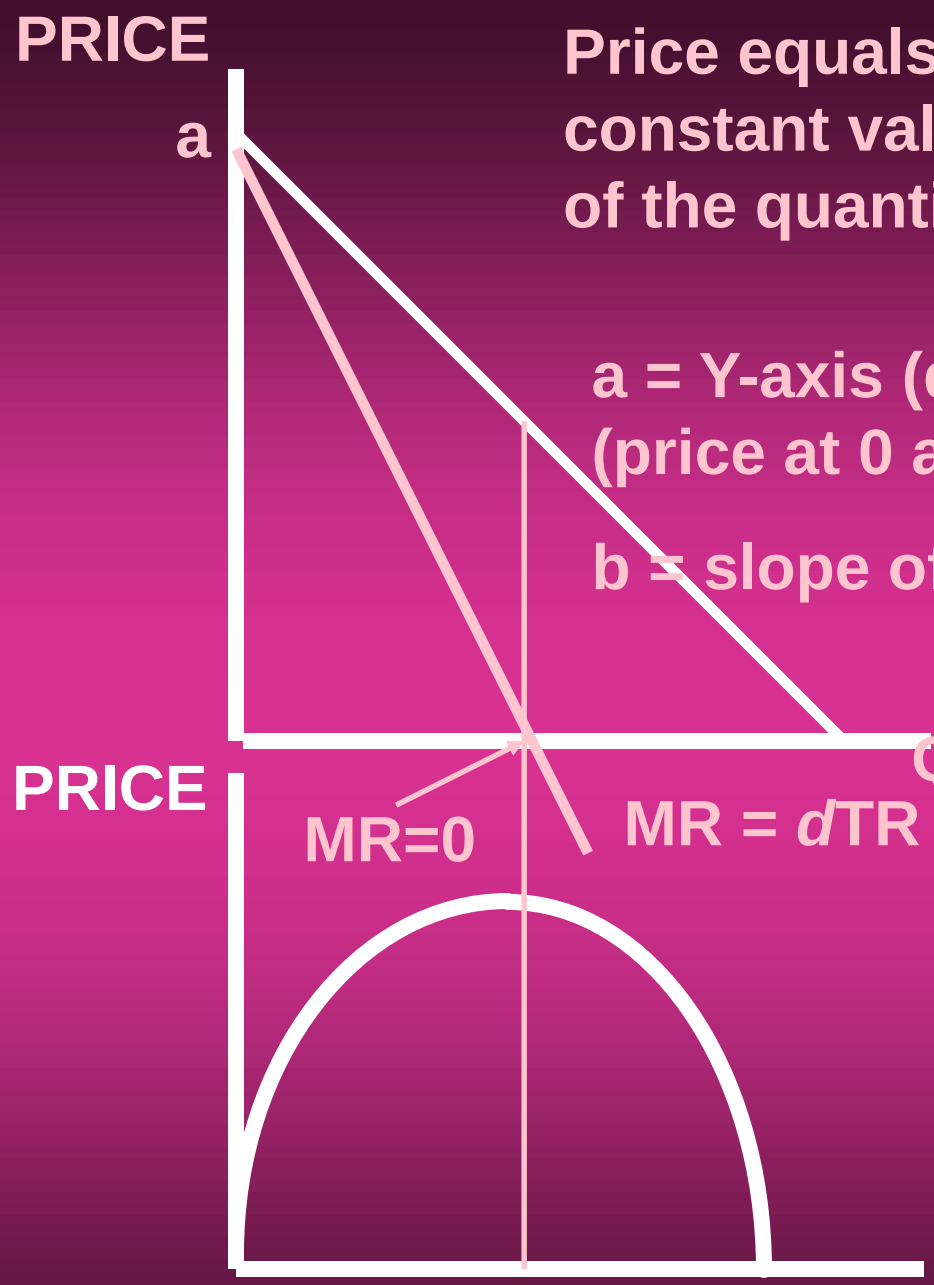

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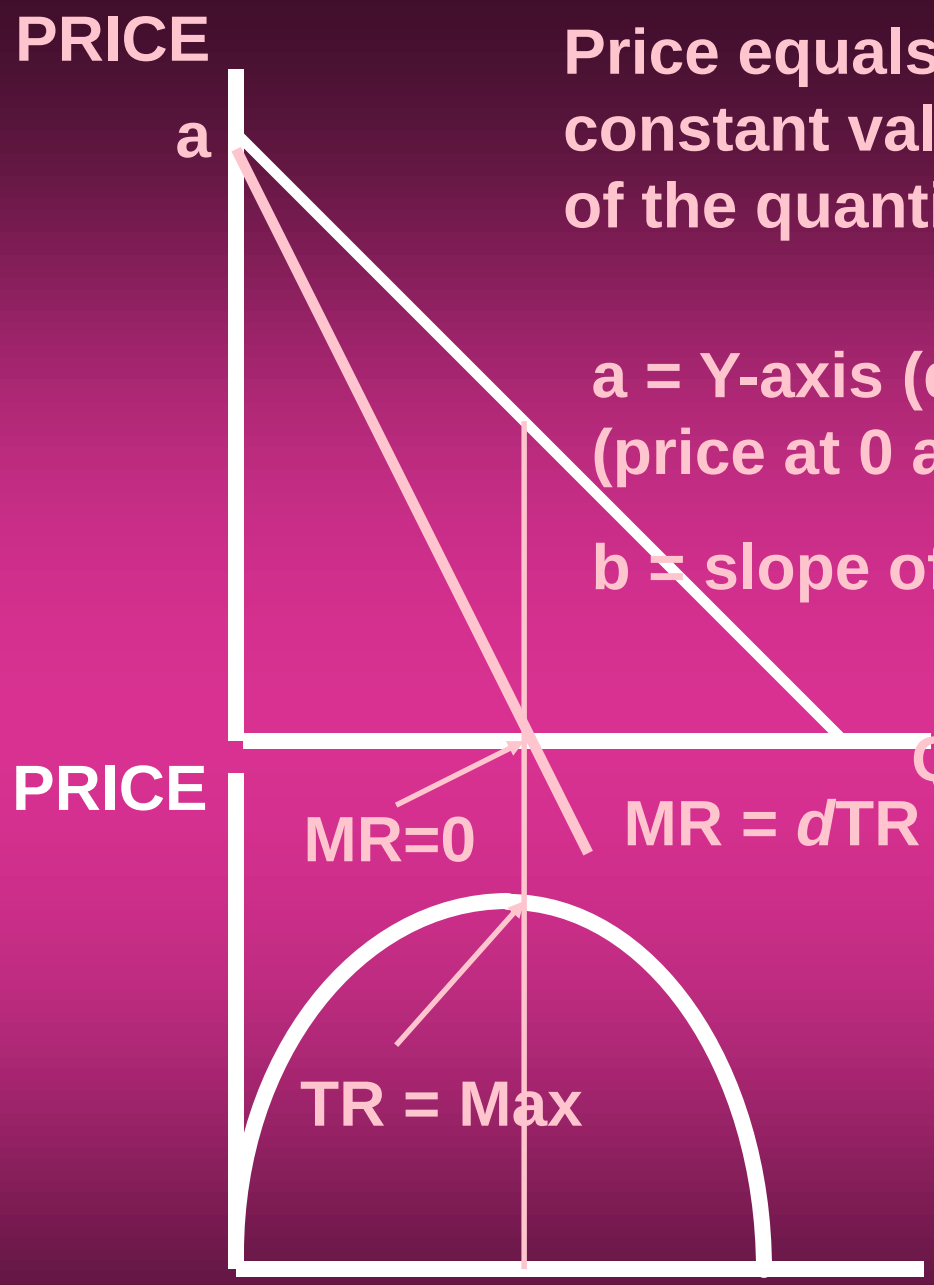

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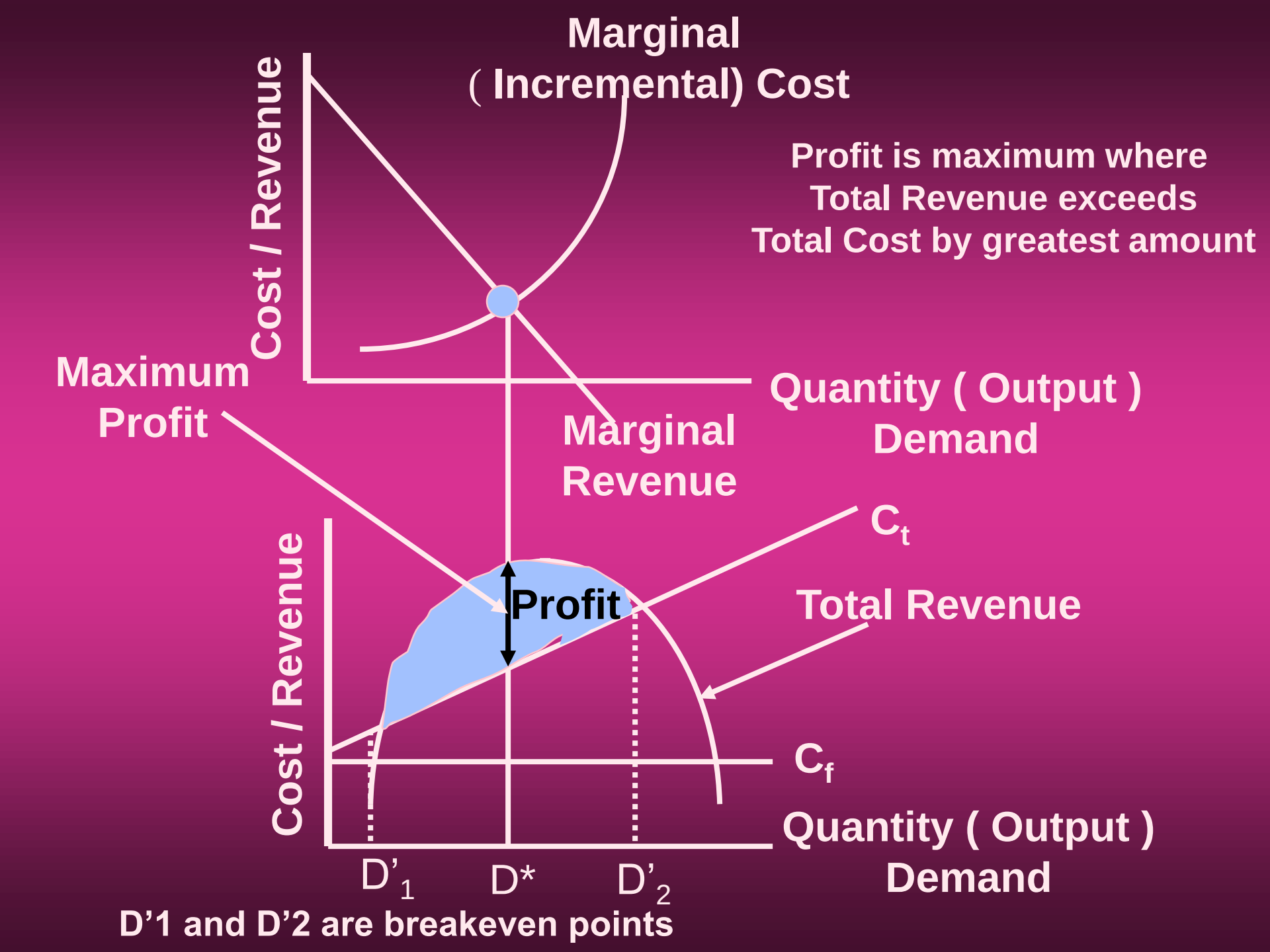
Marginal
(Incremental) Cost
Cost / Revenue
Profit is maximum where
Total Revenue exceeds
Total Cost by greatest amount
Maximum
Profit
Quantity (Output)
Demand
Marginal
Revenue
C_t
Profit
Total Revenue
Cost / Revenue
C_f
Quantity (Output)
Demand
D'1
D*
D'2
D'1 and D'2 are breakeven points

PROFIT MAXIMIZATION D*

- Occurs where total revenue exceeds total cost by the greatest amount;
- Occurs where marginal cost = marginal revenue;
- Occurs where $dTR/dD = dC_t/dD$;
- $D^* = [a - C_v] / 2b$

BREAKEVEN POINT
D'_1 and D'_2

- Occurs where TR = C_t
- $(aD - D^2) / b = C_f + (C_v) D$
- $- D^2 / b + [(a / b) - C_v] D - C_f$
- Using the quadratic formula: $D' =$

$$\frac{- [(a / b) - C_v] \pm \{ [(a / b) - C_v]^2 - (4 / b) (- C_f) \}^{1/2}}{2 / b}$$

COST-DRIVEN DESIGN OPTIMIZATION

Must maintain a life-cycle design perspective

Ensures engineers consider:

- Initial investment costs
- Operation and maintenance expenses
- Other annual expenses in later years
- Environmental and social consequences over design life

DESIGN FOR THE ENVIRONMENT (DFE)

This green-engineering approach has the following goals:

- Prevention of waste
- Improved materials selection
- Reuse and recycling of resources

COST-DRIVEN DESIGN OPTIMIZATION PROBLEM TASKS

1. Determine optimal value for certain alternative's design variable
2. Select the best alternative, each with its own unique value for the design variable

COST-DRIVEN DESIGN OPTIMIZATION PROBLEM COST TYPES

1. Fixed cost(s)
2. Cost(s) that vary *directly* with the design variable
3. Cost(s) that vary *indirectly* with the design variable

Simplified Format of Cost Model With One Design Variable

$$\text{Cost} = aX + (b \,/\, X) + k$$

a is a parameter that represents directly varying cost(s)

b is a parameter that represents indirectly varying cost(s)

k is a parameter that represents the faced cost(s)

X represents the design variable in question

(In a particular problem, the parameters *a,b* and *k* may actually represent the sum of a group of costs in that category, and the design variable may be raised to some power for either directly or indirectly varying costs.)

GENERAL APPROACH FOR OPTIMIZING A DESIGN WITH RESPECT TO COST

1. Identify primary cost-driving design variable
2. Write an expression for the cost model in terms of the design variable
3. Set first derivative of cost model with respect to continuous design variable equal to 0. (For discrete design variables, compute cost model for each discrete value over selected range).
4. Solve equation in step 3 for optimum value of continuous design variables
5. For continuous design variables, use the second derivative of the cost model with respect to the design variable to determine whether optimum corresponds to global maximum or minimum.

PRESENT ECONOMY STUDIES

When alternatives for accomplishing a task are compared for one year or less (I.e., influence of time on money is irrelevant)

Rules for Selecting Preferred Alternative

Rule 1 – When revenues and other economic benefits are present and vary among alternatives, choose alternative that maximizes overall profitability based on the number of defect-free units of output

Rule 2 – When revenues and economic benefits are not present or are constant among alternatives, consider only costs and select alternative that minimizes total cost per defect-free output

PRESENT ECONOMY STUDIES

Total Cost in Material Selection

In many cases, selection of among materials cannot be based solely on costs of materials. Frequently, change in materials affect design, processing, and shipping costs.

Alternative Machine Speeds

Machines can frequently be operated at different speeds, resulting in different rates of product output. However, this usually results in different frequencies of machine downtime. Such situations lead to present economy studies to determine preferred operating speed.

PRESENT ECONOMY STUDIES

Make Versus Purchase (Outsourcing) Studies

A company may choose to produce an item in house, rather than purchase from a supplier at a price lower than production costs if:

1. direct, indirect or overhead costs are incurred regardless of whether the item is purchased from an outside supplier, and
2. The incremental cost of producing the item in the short run is less than the supplier's price

The relevant short-run costs of the make versus purchase decisions are the incremental costs incurred and the opportunity costs of resources

PRESENT ECONOMY STUDIES

Make Versus Purchase (Outsourcing) Studies

- Opportunity costs may become significant when in-house manufacture of an item causes other production opportunities to be foregone (E.G., insufficient capacity)
- In the long run, capital investments in additional manufacturing plant and capacity are often feasible alternatives to outsourcing.