Chapter 4: The Theory of the Firm Under Perfect Competition

Exercises — Exercises

Q1 What are the characteristics of a perfectly competitive market?

A perfectly competitive market has these defining features: (1) a large number of buyers and sellers, each too small to influence the market; (2) a homogeneous product, so one firm's output cannot be told apart from another's; (3) free entry into and exit from the market; and (4) perfect information, so buyers and sellers know the price, quality and other relevant details. Together these make every firm a price taker.

Q2 How are the total revenue of a firm, market price, and the quantity sold by the firm related to each other?

Total revenue (TR) equals the market price (p) multiplied by the quantity the firm produces and sells (q), that is TR = p × q. For example, at a price of Rs 10 per box, selling 3 boxes gives TR = 3 × 10 = Rs 30. Since the firm is a price taker, p stays constant, so TR changes in proportion to output.

Q3 What is the 'price line'?

The price line shows the relationship between the market price and a firm's output. Because the market price is fixed at p whatever the firm produces, plotting price on the y-axis against output on the x-axis gives a horizontal straight line at height p. It is the firm's average revenue (AR) curve and also the demand curve it faces, which is perfectly elastic.

Q4 Why is the total revenue curve of a price-taking firm an upward-sloping straight line? Why does the curve pass through the origin?

For a price-taking firm, TR = p × q with p constant, which is the equation of a straight line. Revenue rises as output rises, so the line slopes upward, and its slope equals the market price p (revenue from one unit is p). When output is zero, TR = p × 0 = 0, so the curve starts at the origin and passes through it.

Q5 What is the relation between market price and average revenue of a price-taking firm?

For a price-taking firm, average revenue equals the market price. AR is total revenue per unit of output: AR = TR/q = (p × q)/q = p. So the AR curve is the horizontal price line at p.

Q6 What is the relation between market price and marginal revenue of a price-taking firm?

For a price-taking firm, marginal revenue equals the market price. When output rises from q1 to q2, MR = (pq2 – pq1)/(q2 – q1) = p. Each extra unit is sold at the market price, so total revenue rises by exactly p. Hence MR = AR = p.

Q7 What conditions must hold if a profit-maximising firm produces positive output in a competitive market?

If a profit-maximising firm produces a positive output, three conditions must hold at that output. (1) The market price equals marginal cost (p = MC). (2) Marginal cost is non-decreasing at that output, so the MC curve does not slope downwards. (3) In the short run price must be at least the average variable cost (p ≥ AVC); in the long run price must be at least the average cost (p ≥ AC).

Q8 Can there be a positive level of output that a profit-maximising firm produces in a competitive market at which market price is not equal to marginal cost? Give an explanation.

No. Profit rises as long as MR exceeds MC and falls when MR is below MC, so profit is highest where MR = MC. For a competitive firm MR equals the market price, so profit is maximised only where p = MC. At any positive output where price differs from marginal cost, the firm could raise its profit by changing output, so that output cannot be profit maximising.

Q9 Will a profit-maximising firm in a competitive market ever produce a positive level of output in the range where the marginal cost is falling? Give an explanation.

No. Suppose p = MC at an output where MC is falling. For output slightly less than this level, MC is higher than the price, so MR (= p) is below MC and cutting output slightly would raise profit. So the firm can do better by producing less than this output, and it cannot be the profit-maximising level. The firm produces only where MC is rising (non-decreasing).

Q10 Will a profit-maximising firm in a competitive market produce a positive level of output in the short run if the market price is less than the minimum of AVC? Give an explanation.

No. If price is below the minimum AVC, then at every positive output the revenue is less than the total variable cost, so the firm loses more than its fixed cost. If the firm produces nothing, TR and TVC are both zero and its loss is only the fixed cost. So it does better by producing zero. The firm therefore shuts down and produces no output in the short run.

Q11 Will a profit-maximising firm in a competitive market produce a positive level of output in the long run if the market price is less than the minimum of AC? Give an explanation.

No. If price is below the minimum long run average cost, then at any positive output total revenue ($p \times q$) is smaller than total cost ($AC \times q$), so the firm makes a loss. In the long run a firm that shuts down earns zero profit, which is better than a loss. So the firm produces nothing and exits the market.

Q12 What is the supply curve of a firm in the short run?

The short run supply curve of a firm is the rising part of the short run marginal cost (SMC) curve from and above the minimum point of the average variable cost (AVC) curve, together with zero output at all prices below the minimum AVC. It shows the output the firm supplies at each market price in the short run.

Q13 What is the supply curve of a firm in the long run?

The long run supply curve of a firm is the rising part of the long run marginal cost (LRMC) curve from and above the minimum point of the long run average cost (LRAC) curve, together with zero output at all prices below the minimum LRAC. It shows the output the firm supplies at each market price in the long run.

Q14 How does technological progress affect the supply curve of a firm?

Technological progress lets the firm produce the same output with fewer inputs, which lowers its marginal cost at every output level. The MC curve shifts to the right (downwards). Since the supply curve is a segment of the MC curve, the firm's supply curve shifts to the right: at any given market price the firm supplies more output.

Q15 How does the imposition of a unit tax affect the supply curve of a firm?

A unit tax is a tax per unit of output sold. It raises both the long run average cost and the long run marginal cost of the firm by the amount of the tax (Rs t) at every output level. The supply curve, which is based on these curves, shifts to the left (upwards by t). At any given market price the firm now supplies less output.

Q16 How does an increase in the price of an input affect the supply curve of a firm?

A rise in the price of an input, such as the wage rate, raises the cost of production. The firm's average cost and usually its marginal cost rise at every output level, so the MC curve shifts to the left (upwards). The supply curve, being a part of the MC curve, shifts to the left: at any given price the firm supplies fewer units.

Q17 How does an increase in the number of firms in a market affect the market supply curve?

The market supply curve is the horizontal sum of the supply curves of the firms in the market. If the number of firms increases, more supply is added at every price, so the market supply curve shifts to the right. If the number of firms decreases, the market supply curve shifts to the left.

Q18 What does the price elasticity of supply mean? How do we measure it?

Price elasticity of supply measures how responsive the quantity supplied is to a change in the price of the good. It is measured as the percentage change in quantity supplied divided by the percentage change in price: $eS = (\Delta Q/Q \times 100) \div (\Delta P/P \times 100) = (\Delta Q/\Delta P) \times (P/Q)$. It is independent of units. It is zero for a vertical supply curve and positive for an upward-sloping one.

Q19 Compute the total revenue, marginal revenue and average revenue schedules for quantity sold 0 to 6. Market price of each unit of the good is Rs 10.

SOLUTION

TR = p × q with p = Rs 10; MR = change in TR ÷ change in quantity; AR = TR ÷ q.

Quantity	TR (Rs)	MR (Rs)	AR (Rs)
0	0	-	-
1	10	10	10
2	20	10	10
3	30	10	10
4	40	10	10
5	50	10	10
6	60	10	10

Result: TR = 0, 10, 20, 30, 40, 50, 60 (Rs); MR = Rs 10 and AR = Rs 10 at every output (both equal the market price).

Q20 The table shows the total revenue and total cost schedules of a competitive firm (quantity 0 to 7; TR = 0, 5, 10, 15, 20, 25, 30, 35; TC = 5, 7, 10, 12, 15, 23, 33, 40). Calculate the profit at each output level. Determine also the market price of the good.

SOLUTION

Profit = TR – TC.

Market price = TR ÷ quantity = 5 ÷ 1 = Rs 5 (also 10 ÷ 2 = 5, 35 ÷ 7 = 5).

Quantity	TR (Rs)	TC (Rs)	Profit (Rs)
0	0	5	–5
1	5	7	–2
2	10	10	0
3	15	12	3
4	20	15	5
5	25	23	2
6	30	33	–3
7	35	40	–5

Result: Profit = Rs –5, –2, 0, 3, 5, 2, –3, –5 for output 0 to 7; market price = Rs 5 per unit.

Q21 The table shows the total cost schedule of a competitive firm (output 0 to 10; TC = 5, 15, 22, 27, 31, 38, 49, 63, 81, 101, 123). The price of the good is Rs 10. Calculate the profit at each output level. Find the profit-maximising level of output.

SOLUTION

TR = 10 × q; Profit = TR – TC.

Output	TR (Rs)	TC (Rs)	Profit (Rs)
0	0	5	–5
1	10	15	–5
2	20	22	–2
3	30	27	3
4	40	31	9
5	50	38	12
6	60	49	11
7	70	63	7
8	80	81	–1
9	90	101	–11
10	100	123	–23

Check with MC: MC of the 5th unit = 38 – 31 = Rs 7 (below price Rs 10, so raise output); MC of

the 6th unit = 49 – 38 = Rs 11 (above price, so do not produce it).
Result: Profit is highest at Rs 12, so the profit-maximising output is 5 units.

Q22 Consider a market with two firms. The SS1 column gives the supply schedule of firm 1 and the SS2 column that of firm 2. Compute the market supply schedule. (Price Rs 0 to 6; SS1 = 0, 0, 0, 1, 2, 3, 4 units; SS2 = 0, 0, 0, 1, 2, 3, 4 units.)

SOLUTION

Market supply at each price = SS1 + SS2.

Price (Rs)	SS1	SS2	Market supply
0	0	0	0
1	0	0	0
2	0	0	0
3	1	1	2
4	2	2	4
5	3	3	6
6	4	4	8

Result: Market supply = 0, 0, 0, 2, 4, 6, 8 units at prices Rs 0 to 6.

Q23 Consider a market with two firms. SS1 and SS2 give the supply schedules of firm 1 and firm 2. Compute the market supply schedule. (Price Rs 0 to 8; SS1 = 0, 0, 0, 1, 2, 3, 4, 5, 6 kg; SS2 = 0, 0, 0, 0, 0.5, 1, 1.5, 2, 2.5 kg.)

SOLUTION

Market supply at each price = SS1 + SS2.

Price (Rs)	SS1 (kg)	SS2 (kg)	Market supply (kg)
0	0	0	0
1	0	0	0
2	0	0	0
3	1	0	1
4	2	0.5	2.5
5	3	1	4
6	4	1.5	5.5

Price (Rs)	SS1 (kg)	SS2 (kg)	Market supply (kg)
7	5	2	7
8	6	2.5	8.5

Result: Market supply = 0, 0, 0, 1, 2.5, 4, 5.5, 7, 8.5 kg at prices Rs 0 to 8.

Q24 There are three identical firms in a market. The table shows the supply schedule of firm 1 (price Rs 0 to 8; SS1 = 0, 0, 2, 4, 6, 8, 10, 12, 14 units). Compute the market supply schedule.

SOLUTION

The firms are identical, so each supplies the same as firm 1; market supply = 3 × SS1.

Price (Rs)	SS1	Market supply (3 × SS1)
0	0	0
1	0	0
2	2	6
3	4	12
4	6	18
5	8	24
6	10	30
7	12	36
8	14	42

Result: Market supply = 0, 0, 6, 12, 18, 24, 30, 36, 42 units at prices Rs 0 to 8.

Q25 A firm earns a revenue of Rs 50 when the market price of a good is Rs 10. The market price increases to Rs 15 and the firm now earns a revenue of Rs 150. What is the price elasticity of the firm's supply curve?

SOLUTION

Initial quantity Q1 = TR ÷ P = 50 ÷ 10 = 5 units.
New quantity Q2 = 150 ÷ 15 = 10 units.
Percentage change in quantity = (10 – 5) ÷ 5 × 100 = 100%.
Percentage change in price = (15 – 10) ÷ 10 × 100 = 50%.
eS = 100 ÷ 50 = 2.
Result: Price elasticity of supply = 2 (supply is elastic).

Q26 The market price of a good changes from Rs 5 to Rs 20. As a result, the quantity supplied by a firm increases by 15 units. The price elasticity of the firm's supply curve is 0.5. Find the initial and final output levels of the firm.

SOLUTION

Percentage change in price = (20 – 5) ÷ 5 × 100 = 300%.
eS = % change in quantity ÷ % change in price, so % change in quantity = 0.5 × 300 = 150%.
Let the initial output be Q1. Then ΔQ ÷ Q1 × 100 = 150, so 15 ÷ Q1 = 1.5, giving Q1 = 10 units.
Final output Q2 = 10 + 15 = 25 units.
Check: (25 – 10) ÷ 10 × 100 = 150%, and 150 ÷ 300 = 0.5.
Result: Initial output = 10 units; final output = 25 units.

Q27 At the market price of Rs 10, a firm supplies 4 units of output. The market price increases to Rs 30. The price elasticity of the firm's supply is 1.25. What quantity will the firm supply at the new price?

SOLUTION

Percentage change in price = (30 – 10) ÷ 10 × 100 = 200%.
% change in quantity = eS × % change in price = 1.25 × 200 = 250%.
Change in quantity = 250% of 4 = 10 units.
New quantity = 4 + 10 = 14 units.
Check: (14 – 4) ÷ 4 × 100 = 250%, and 250 ÷ 200 = 1.25.
Result: The firm will supply 14 units at the new price.