

Past-paper walk-through

Long-Run Production Costs ■ 3.3

eXercise

Questions in this set

- 2025 Set 2 Q1
- 2024 Set 2 Q2
- 2022 Set 2 Q3
- 2016 Q3
- 2014 Q1

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 1

2025 Set 2 ■ Q1

Deskward is a typical profit-maximizing firm that produces and sells wooden desks in a constant-cost, perfectly competitive market that is in long-run equilibrium.

(a)(i) Draw correctly labeled side-by-side graphs for the wooden desk market and for Deskward and show each of the following. The market equilibrium price and quantity, labeled P_M and Q_M , respectively.

(a)(ii) Draw correctly labeled side-by-side graphs for the wooden desk market and for Deskward and show each of the following. Deskward's profit-maximizing price and quantity, labeled P_F and Q_F , respectively.

(a)(iii) Draw correctly labeled side-by-side graphs for the wooden desk market and for Deskward and show each of the following. Deskward's average total cost curve consistent with long-run equilibrium, labeled ATC.

Question 1

2025 Set 2 ■ Q1

Deskward is a typical profit-maximizing firm that produces and sells wooden desks in a constant-cost, perfectly competitive market that is in long-run equilibrium.

(b) If the monthly rent, a fixed cost, on Deskward's factory building increases, what will happen to the firm's profit-maximizing quantity in the short run? Explain.

Question 1

2025 Set 2 ■ Q1

Deskward is a typical profit-maximizing firm that produces and sells wooden desks in a constant-cost, perfectly competitive market that is in long-run equilibrium.

(c)(i) Suppose the government is considering granting a per-unit subsidy to producers of wooden desks. On your market graph in part A, show the short-run effect of a per-unit subsidy on each of the following. The new market equilibrium price and quantity of wooden desks, labeled P^* and Q^* , respectively.

(c)(ii) Suppose the government is considering granting a per-unit subsidy to producers of wooden desks. On your market graph in part A, show the short-run effect of a per-unit subsidy on each of the following. The area representing the total cost of the subsidy to the government, shaded completely.

Question 1

2025 Set 2 ■ Q1

Deskward is a typical profit-maximizing firm that produces and sells wooden desks in a constant-cost, perfectly competitive market that is in long-run equilibrium.

(d) Instead of the per-unit subsidy, suppose the government imposes a binding price floor in the market for wooden desks. Will the price floor result in a shortage of wooden desks, a surplus of wooden desks, or neither? Explain.

Question 1

2025 Set 2 ■ Q1

Deskward is a typical profit-maximizing firm that produces and sells wooden desks in a constant-cost, perfectly competitive market that is in long-run equilibrium.

(e)(i) Deskward also produces chairs. Deskward increases its production from 500 chairs to 600 chairs, and its long-run total cost increases from \$80,000 to \$108,000. Calculate Deskward's long-run average total cost of producing 500 chairs. Show your work.

(e)(ii) As Deskward increases production from 500 chairs to 600 chairs, is Deskward experiencing economies of scale, diseconomies of scale, or the efficient scale? Explain using numbers.

Solution 1

(a)(i)

Mark scheme

- Draw a correctly labeled graph of the market for wooden desks with a downward-sloping demand (D) curve and an upward-sloping supply (S_1) curve. Label the market equilibrium price (where D and S_1 intersect) as P_M and the market equilibrium quantity as Q_M .

Solution 1

(a)(ii)

Mark scheme

- Draw Deskward's graph with the firm's horizontal demand and marginal revenue curve ($d = MR$) extended from the market equilibrium price P_M , and label the firm's price as $P_F (= P_M$, since the firm is a price taker) (1 point). Also draw a rising marginal cost (MC) curve and show the firm's profit-maximizing quantity, labeled Q_F , at the point where $MR = MC$ (1 point).

Solution 1

(a)(iii)

Mark scheme

- Show the average total cost (ATC) curve tangent to the firm's $d = MR$ curve at Q_F , and show the MC curve passing through the minimum point of the ATC curve. Tangency of ATC to price (zero economic profit) with MC crossing ATC at its minimum indicates Deskward's ATC curve is consistent with long-run competitive equilibrium.

Solution 1

(b)

Mark scheme

- Deskward's profit-maximizing quantity will NOT change in the short run. An increase in a fixed cost (like rent) does not affect the firm's marginal cost or marginal revenue; since profit maximization occurs where $MR = MC$ and neither curve shifts, the profit-maximizing quantity is unchanged (only the firm's economic profit falls).

Solution 1

(c)(i)

Mark scheme

- On the market graph from part A, show the supply curve shifting right, from S_1 to S_2 (a per-unit subsidy lowers producers' effective cost of production, increasing supply). Label the new, lower market equilibrium price as P^* and the new, higher market equilibrium quantity as Q^* , at the intersection of D and S_2 .

Solution 1

(c)(ii)

Mark scheme

- Shade completely the rectangle bounded by the vertical gap between S_1 and S_2 (the per-unit subsidy) at the new equilibrium quantity Q^* — i.e., the area between S_1 and S_2 from quantity 0 to Q^* , spanning from P^* up to the price on S_1 at Q^* . This area equals the per-unit subsidy times Q^* , the total cost of the subsidy to the government.

Solution 1

(d)

Mark scheme

- The price floor will result in a surplus of wooden desks. Because the price floor is binding, it is set above the market equilibrium price; at this higher price, the quantity of wooden desks supplied is greater than the quantity demanded, creating a surplus.

Solution 1

(e)(i)

Mark scheme

- Long-run average total cost (LRATC) at 500 chairs = Total Cost / Quantity
= \$80{,}000 / 500 = \$160 per chair. Show the division as work.

Solution 1

(e)(ii)

Mark scheme

- Deskward is experiencing diseconomies of scale. As output increases from 500 to 600 chairs, LRATC increases from \$160 ($= \$80\{, \}000/500$) to \$180 ($= \$108\{, \}000/600$) per chair. Because LRATC rises as output increases, this is diseconomies of scale (economies of scale would require falling LRATC; efficient scale requires LRATC to be at its minimum).

Question 2

2024 Set 2 ■ Q2

2. The table provided shows the short-run production function for Lowen Feline, a profit-maximizing firm that produces cat food.

Number of Workers	Total Quantity of Cat Food (bags)
0	0
1	5
2	12
3	18
4	23
5	27
6	30
7	32

Question 2

8	33
9	32

Lowen Feline sells as many bags of cat food as it wants at a market price of \$10 per bag and hires as many workers as it wants at a market wage of \$18.

- (a) Lowen Feline's fixed cost is \$90. Calculate the average fixed cost if Lowen Feline hires 6 workers. Show your work.
- (b) Assume labor is the only variable input to Lowen Feline. Calculate the marginal cost if Lowen Feline increases output from 27 to 30 units. Show your work.
- (c) With the hiring of which worker do diminishing marginal returns begin? Explain using numbers.
- (d) Determine the profit-maximizing number of workers Lowen Feline will hire. Explain using marginal analysis.

Question 2

(e) In the long run, a rival company, Gato Food, increases its production from 40 to 50 units, and its total cost increases from \$600 to \$900. Over the output range of 40 to 50 units, is Gato Food experiencing economies of scale, diseconomies of scale, or constant returns to scale? Explain using numbers.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

Solution 2

(a)

Mark scheme

- Average Fixed Cost = Total Fixed Cost / Quantity of Output = $90/30 = 3$. (6 workers correspond to 30 units of output on Lowen Feline's production schedule.)

Solution 2

(b)

Mark scheme

- Marginal Cost = Change in Total Variable Cost / Change in Output = $(108 - 90) / (30 - 27) = 18/3 = 6$. (Equivalently, Marginal Cost = Change in Total Cost / Change in Output = $(198 - 180) / (30 - 27) = 18/3 = 6$.)

Solution 2

(c)

Mark scheme

- Diminishing marginal returns to labor begin with the hiring of the 3rd worker. Explanation using numbers: the marginal product of the 1st worker is 5 bags, the marginal product of the 2nd worker increases to 7 bags, and the marginal product of the 3rd worker decreases to 6 bags — since marginal product starts falling with the 3rd worker, that is where diminishing marginal returns begin.

Solution 2

(d)

Mark scheme

- The profit-maximizing number of workers is 7. Explanation using marginal analysis: a firm hires labor up to the point where the marginal revenue product (MRP) of the last worker is at least equal to the marginal factor cost (MFC) of that worker (the wage). The MRP of the 7th worker (20) is greater than the MFC of the 7th worker (wage = 18), so hiring the 7th worker adds to profit; hiring an 8th worker would decrease profit because the MRP of the 8th worker (10) is less than the MFC of the 8th worker (wage = 18). So Lowen Feline stops hiring at 7 workers.

Solution 2

(e)

Mark scheme

- Gato Food is experiencing diseconomies of scale. Explanation using numbers: as output rises from 40 to 50 units, long-run average total cost rises from 15 *per unit* ($600 / 40 = 15$) to 18 per unit ($900 / 50 = 18$). Because long-run average total cost increases as output increases over this range, Gato Food is experiencing diseconomies of scale.

Question 3

2022 Set 2 ■ Q3

The graph provided shows the demand (D), long-run average total cost (LRATC), marginal cost (MC), and marginal revenue (MR) curves for a natural monopoly.

[Graph titled "Price, Cost

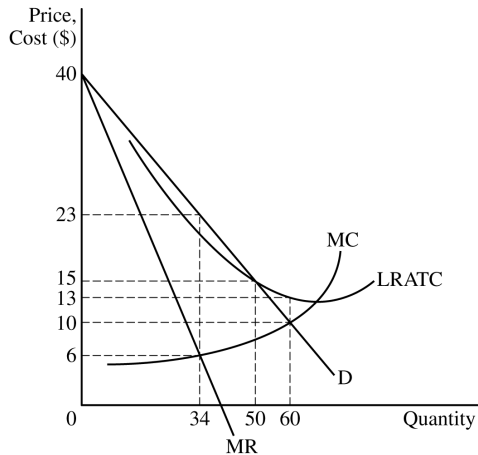
(Y)" on the Y-axis (values marked at 6, 10, 13, 15, 23, 40) and "Quantity" on the X-axis (values marked at 34, 50, 60). A downward-sloping demand curve (D) starts at (0, 40) and slopes down to the right, passing through approximately (34, 10). A steeper downward-sloping marginal revenue curve (MR) starts at (0, 40) and falls more steeply, crossing the quantity axis at 34. The long-run average total cost curve (LRATC) is U-shaped, starting high on the left, declining to a minimum of about 6 near $Q = 34$, then rising gently through about (50, 10) toward (60, 13) and beyond. The marginal cost curve (MC) is upward-sloping, starting below LRATC, crossing LRATC at its minimum point (about $Q = 34$, price \$6), and rising to intersect MR at $Q = 34$ and to intersect the

Question 3

demand curve (D) at approximately (60, 15). Dashed reference lines connect price levels 23, 15, 13, 10, 6 on the y-axis to quantities 34, 50, 60 on the x-axis, marking the curve intersections.]

- (a)** Over the output range of 0 to 60 units, is this firm experiencing economies of scale, diseconomies of scale, or constant returns to scale? Explain.
- (b)** Using numbers from the graph, identify the price and quantity produced at which the monopolist earns zero economic profit.
- (c)(i)** Assume that regulators impose a price ceiling that results in the firm producing the socially optimal quantity in the short run.
Calculate the total revenue at the price ceiling. Show your work.
- (c)(ii)** Explain why the firm requires a subsidy to continue producing in the long run.
- (c)(iii)** Calculate the lump-sum subsidy that would be required for the monopolist to produce the socially optimal quantity in the long run. Show your work.

Question 3



Solution 3

(a)

Mark scheme

- The firm is experiencing economies of scale over the range of 0 to 60 units.
Explanation: the long-run average total cost (LRATC) curve is downward sloping over that output range, meaning average cost falls as output increases.

Solution 3

(b)

Mark scheme

- Price = \$15 and quantity = 50 units — read off the graph as the price and quantity where the monopolist's demand curve intersects the LRATC curve (price = average total cost, so economic profit is zero).

Solution 3

(c)(i)

Mark scheme

- Total Revenue = Price $\times$ Quantity = $\$10 \times 60 = \600 , using the price-ceiling price (\$10, the price at which the firm produces the socially optimal quantity, i.e. where $P = MC$) and the socially optimal quantity (60 units).

Solution 3

(c)(ii)

Mark scheme

- At the socially optimal quantity (60 units) under the price ceiling, the firm earns negative economic profit in the short run because price (10) is less than average total cost ($LRATC = 13$) at that quantity. Sustained losses mean the firm cannot continue producing at that price/quantity in the long run without a subsidy.

Solution 3

(c)(iii)

Mark scheme

- Lump-sum Subsidy = $(\text{LRATC} - \text{Price}) \times \text{Quantity} = (\$13 - \$10) \times 60 = \180 .

Question 3

2016 ■ Q3

Camden's Cakery is one of many dessert cafés serving a local community. Each café produces a slightly differentiated product, there are no barriers to entry or exit, and the firm is in long-run equilibrium.

(a) Draw a correctly labeled graph showing Camden's demand curve, marginal revenue curve, marginal cost curve, and long-run average total cost curve. Label Camden's profit-maximizing output Q_m and its price P_m .

[Graph to be drawn by student: monopolistically competitive firm in long-run equilibrium, showing downward-sloping demand (D) and marginal revenue (MR) curves, a marginal cost (MC) curve, and a long-run average total cost ($LRATC$) curve tangent to the demand curve; profit-maximizing output labeled Q_m and price labeled P_m at the point where $MR = MC$.]

Question 3

- (b)** On your graph in part (a), label the output at which total revenue is maximized Q_R .
- (c)** Do firms in this market experience economies of scale, diseconomies of scale, or neither in long-run equilibrium? Explain.

Solution 3

(a) Mark scheme

- A correctly labeled graph of Camden's monopolistically competitive firm in long-run equilibrium: a downward-sloping demand curve (D) with its associated marginal revenue curve (MR) lying below and steeper than D ; the marginal cost curve (MC) intersecting MR at the profit-maximizing quantity Q_m (where $MC = MR$); the profit-maximizing price P_m found by going up from Q_m to the demand curve; and the long-run average total cost curve ($LRATC$) drawn tangent to the demand curve exactly at the point above Q_m (at price P_m) — the tangency reflecting zero economic profit in long-run equilibrium. Full credit requires all four elements: (1) correctly labeled downward-sloping D with MR below it, (2) Q_m

Solution 3

shown at $MC=MR$, (3) P_m shown on D above Q_m , (4) LRATC tangent to D at Q_m .

Solution 3

(b)

Mark scheme

- QR, the output at which total revenue is maximized, is labeled at the quantity where the marginal revenue curve crosses the horizontal axis, i.e., where $MR = 0$. Because demand is downward sloping (elastic at low quantities, inelastic at high quantities) and TR is maximized where $MR=0$, QR lies to the right of Q_m (since Q_m , where $MC=MR>0$, sits on the elastic portion of demand).

Solution 3

(c)

Mark scheme

- Firms in this market experience ECONOMIES OF SCALE in long-run equilibrium, because the LRATC curve is still decreasing (downward sloping) at Q_m — equivalently, Q_m lies to the left of the minimum point of the LRATC curve.

Question 1

2014 ■ Q1

The graph below shows the demand curve (D), marginal revenue curve (MR), marginal cost curve (MC), average total cost curve (ATC), and long-run average total cost curve (LRATC) for a monopolist.

[Graph with y-axis "PRICE" showing dashed gridlines at 10, 20, 30, 35, 40, 50, 60, and x-axis "QUANTITY" showing gridlines at 0, 2, 4, 5, 6, 8, 10, 12. A downward-sloping demand curve (D) runs from (0, 60) to (12, 0). A steeper downward-sloping marginal revenue curve (MR) runs from (0, 60) to about (6, 0). A horizontal line at 20 is labeled "MC = ATC = LRATC" and extends across the graph. Dashed reference lines connect the curves to the axis values at quantities 2, 4, 5, 6, 8, 10, and prices 10, 20, 30, 35, 40, 50, \$60.]

(a)(i) Using the numbers given in the graph, identify each of the following for the profit-maximizing monopolist.

Question 1

The quantity produced

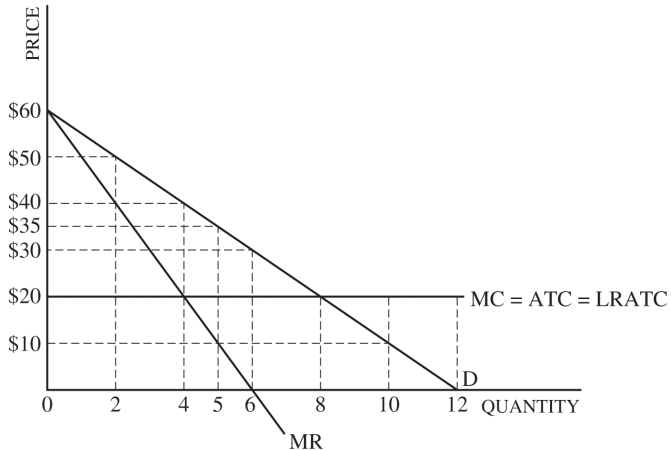
(a)(ii) Using the numbers given in the graph, identify each of the following for the profit-maximizing monopolist.

The price

(a)(iii) Using the numbers given in the graph, identify each of the following for the profit-maximizing monopolist.

The allocatively efficient quantity

Question 1



Question 1

2014 ■ Q1

The graph below shows the demand curve (D), marginal revenue curve (MR), marginal cost curve (MC), average total cost curve (ATC), and long-run average total cost curve (LRATC) for a monopolist.

[Graph with y-axis "PRICE" showing dashed gridlines at 10,20, 30,35, 40,50, 60, and x – axis "QUANTITY" showing gridlines at 0, 2, 4, 5, 6, 8, 10, 12. A downward – sloping demand curve (D) runs from (0,60) to (12, 0). A steep downward – sloping marginal revenue curve (MR) runs from (0,60) to about (6, 0). A horizontal line at 20 is labeled "MC = ATC = LRATC" and extends across the graph. Dashed reference lines connect the curves to the axis values at quantities 2, 4, 5, 6, 8, 10, and prices 10,20, 30,35, 40,50, \$60.]

(b) At the profit-maximizing quantity from part (a)(i), is the monopolist experiencing economies of scale? Explain.

Question 1

2014 ■ Q1

The graph below shows the demand curve (D), marginal revenue curve (MR), marginal cost curve (MC), average total cost curve (ATC), and long-run average total cost curve (LRATC) for a monopolist.

[Graph with y-axis "PRICE" showing dashed gridlines at 10,20, 30,35, 40,50, 60, and x – axis "QUANTITY" showing gridlines at 0, 2, 4, 5, 6, 8, 10, 12. A downward – sloping demand curve (D) runs from (0,60) to (12, 0). A steep downward – sloping marginal revenue curve (MR) runs from (0,60) to about (6, 0). A horizontal line at 20 is labeled "MC = ATC = LRATC" and extends across the graph. Dashed reference lines connect the curves to the axis values at quantities 2, 4, 5, 6, 8, 10, and prices 10,20, 30,35, 40,50, \$60.]

(c)(i) Now assume that the monopolist produces 10 units. Using the numbers given in the graph, calculate each of the following. Show your work.

Question 1

The monopolist's economic profit

(c)(ii) Now assume that the monopolist produces 10 units. Using the numbers given in the graph, calculate each of the following. Show your work.

The consumer surplus

(c)(iii) Now assume that the monopolist produces 10 units. Using the numbers given in the graph, calculate each of the following. Show your work.

The deadweight loss

Question 1

2014 ■ Q1

The graph below shows the demand curve (D), marginal revenue curve (MR), marginal cost curve (MC), average total cost curve (ATC), and long-run average total cost curve (LRATC) for a monopolist.

[Graph with y-axis "PRICE" showing dashed gridlines at 10, 20, 30, 35, 40, 50, 60, and x-axis "QUANTITY" showing gridlines at 0, 2, 4, 5, 6, 8, 10, 12. A downward-sloping demand curve (D) runs from (0, 60) to (12, 0). A steeper downward-sloping marginal revenue curve (MR) runs from (0, 60) to about (6, 0). A horizontal line at 20 is labeled "MC = ATC = LRATC" and extends across the graph. Dashed reference lines connect the curves to the axis values at quantities 2, 4, 5, 6, 8, 10, and prices 10, 20, 30, 35, 40, 50, \$60.]

(d) At what quantity is demand unit elastic?

Question 1

2014 ■ Q1

The graph below shows the demand curve (D), marginal revenue curve (MR), marginal cost curve (MC), average total cost curve (ATC), and long-run average total cost curve (LRATC) for a monopolist.

[Graph with y-axis "PRICE" showing dashed gridlines at 10,20, 30,35, 40,50, 60, and x – axis "QUANTITY" showing gridlines at 0, 2, 4, 5, 6, 8, 10, 12. A downward – sloping demand curve (D) runs from (0,60) to (12, 0). A steep downward – sloping marginal revenue curve (MR) runs from (0,60) to about (6, 0). A horizontal line at 20 is labeled "MC = ATC = LRATC" and extends across the graph. Dashed reference lines connect the curves to the axis values at quantities 2, 4, 5, 6, 8, 10, and prices 10,20, 30,35, 40,50, \$60.]

(e)(i) Suppose the monopolist perfectly price discriminates and chooses the quantity that maximizes profit. Determine the dollar value of each of the following.

Question 1

The monopolist's profit

(e)(ii) Suppose the monopolist perfectly price discriminates and chooses the quantity that maximizes profit. Determine the dollar value of each of the following.

The consumer surplus

Solution 1

(a)(i)

Mark scheme

- The profit-maximizing quantity is $Q = 4$, found where $MR = MC$ (\$20) on the graph.

(a)(ii)

Mark scheme

- The profit-maximizing price is $P = \$40$, read off the demand curve (D) at $Q = 4$.

Solution 1

(a)(iii)

Mark scheme

- The allocatively efficient quantity is $Q = 8$, where price equals marginal cost (the demand curve intersects $MC = ATC = LRATC = \$20$).

Solution 1

(b)

Mark scheme

- No, the monopolist is not experiencing economies of scale. LRATC is not downward sloping as output increases — it is constant (flat) at \$20 ($MC = ATC = LRATC$), so average cost does not fall as output rises.

Solution 1

(c)(i)

Mark scheme

- Economic profit = $(P - ATC) \times Q = (10 - 20) \times 10 = -100$, *i.e. a loss of 100*. (Price at $Q = 10$ is read off demand as 10; $ATC = 20$.) Other correct calculations showing this work are acceptable.

(c)(ii)

Mark scheme

- Consumer surplus = $\frac{1}{2} \times (\text{choke price} - \text{price}) \times Q = \frac{1}{2} \times (\$60 - \$10) \times 10 = \250 . Other correct calculations are acceptable.

Solution 1

(c)(iii)

Mark scheme

- Deadweight loss = $\frac{1}{2} \times (MC - P) \times (Q - Q_{\text{efficient}}) = \frac{1}{2} \times (\$20 - \$10) \times (10 - 8) = \10 — from overproducing 2 units (10 vs. the allocatively efficient 8) where MC exceeds price. Other correct calculations are acceptable.

Solution 1

(d)

Mark scheme

- Demand is unit elastic at $Q = 6$, the quantity where marginal revenue equals zero (equivalently, where total revenue is maximized).

Solution 1

(e)(i)

Mark scheme

- A perfectly price-discriminating monopolist produces where $D = MC$, i.e., $Q = 8$ (same as the allocatively efficient quantity), and captures the full area between demand and MC as profit: Profit = $\frac{1}{2} \times (\$60 - \$20) \times 8 = \$160$.

Solution 1

(e)(ii)

Mark scheme

- Consumer surplus = \$0. A perfectly price-discriminating monopolist charges every consumer exactly their maximum willingness to pay, so it captures the entire consumer surplus as profit, leaving none for consumers.