AP MICROECONOMICS

UNIT 3

Production, Cost, and the Perfect Competition Model

22–25%
AP EXAM WEIGHTING

~11–13
CLASS PERIODS

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Remember to go to **AP Classroom** to assign students the online **Personal Progress Check** for this unit.

Whether assigned as homework or completed in class, the **Personal Progress Check** provides each student with immediate feedback related to this unit's topics and skills.

Personal Progress Check 3

Multiple-choice: ~20 questions
Free-response: 2 questions

- Short
- Short

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UNIT 3

22–25% AP EXAM WEIGHTING | **~11–13** CLASS PERIODS

Production, Cost, and the Perfect Competition Model

BIG IDEA 2
Costs, Benefits, and Marginal Analysis CBA
- How do businesses use marginal analysis to make decisions?

BIG IDEA 3
Production Choices and Behavior PRD
- What drives producers' decision making?
- How can a market be perfectly competitive?

Developing Understanding

Unit 3 focuses on firm behavior and culminates with an introduction to the perfect competition model, which will form a basis of comparison for other market structures in the next unit. This unit builds on the idea of supply, which was introduced in the previous unit, and explores in more detail what drives the decisions that firms make. Thinking like a firm may be challenging for students, who are more used to acting as consumers in their everyday lives. Drawing connections to students' own experiences and carrying out classroom simulations can help bring these concepts to life. Reminding students of the ways in which the behavior of firms is consistent with the ideas of cost-benefit analysis and marginal decision-making addressed in the first unit of the course may also be helpful in elucidating these concepts.

Building Course Skills

1.A 1.C 1.D 2.A 4.A

In this unit, students will be expected to describe the production function, the costs of production, and firms' profit-maximizing behavior. Students should be able to represent these concepts graphically and numerically. It is important to devote sufficient time to introducing new vocabulary to students and may be helpful for students to create a vocabulary notebook. Since grasping the behavior of firms is not always intuitive for students, consider beginning this unit by carrying out a factory simulation in the classroom and having students graph the data generated and interpret the outcomes of the simulation. It helps to debrief the simulation during and immediately following the activity to clarify misconceptions and deepen students' understanding of relevant concepts. Students should have additional opportunities to practice graphing, interpreting given graphs, and doing numerical problems in the context of the content covered in this unit. Proper graphing habits should continue to be reinforced throughout this unit and the entire course.

Preparing for the AP Exam

The perfect competition model is foundational to the study of market structures in this course and is frequently tested on the AP Exam. It's important to ground students in the conceptual underpinnings of perfect competition, including the concept of efficiency and production in both the short run and the long run. Students will benefit from having multiple opportunities to practice drawing and interpreting graphs that represent perfect competition; past AP Exams may be helpful in this exercise. If students are able to grasp the concepts behind perfect competition and how it's graphically represented, they will be better able to understand imperfect market structures in the next unit.

Questions on the AP Exam that cover long-run production costs are often challenging for students. It may be helpful to provide students with opportunities to practice identifying and explaining given situations to reinforce their understanding of long-run production. Keep in mind, though, that while this is a difficult topic for students, it does not comprise a significant portion of the AP Exam.

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UNIT AT A GLANCE

Enduring Understanding	Topic	Suggested Skills	Class Periods ~11–13 CLASS PERIODS
PRD-1	**3.1 The Production Function**	1.A Describe economic concepts, principles, or models.	1
PRD-1	**3.2 Short-Run Production Costs**	4.A Draw an accurately labeled graph or visual to represent an economic model or market.	1
PRD-1	**3.3 Long-Run Production Costs**	1.D Describe the similarities, differences, and limitations of economic concepts, principles, or models.	1
CBA-2	**3.4 Types of Profit**	1.C Identify an economic concept, principle, or model using quantitative data or calculations.	1
CBA-2	**3.5 Profit Maximization**	2.A Using economic concepts, principles, or models, explain how a specific economic outcome occurs or what action should be taken in order to achieve a specific economic outcome.	2
PRD-2	**3.6 Firms' Short-Run Decisions to Produce and Long-Run Decisions to Enter or Exit a Market**	2.A Using economic concepts, principles, or models, explain how a specific economic outcome occurs, or what action should be taken in order to achieve a specific economic outcome.	1
PRD-3	**3.7 Perfect Competition**	4.A Draw an accurately labeled graph or visual to represent an economic model or market.	2

Go to **AP Classroom** to assign the **Personal Progress Check** for Unit 3. Review the results in class to identify and address any student misunderstandings.

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SAMPLE INSTRUCTIONAL ACTIVITIES

The sample activities on this page are optional and are offered to provide possible ways to incorporate various instructional approaches into the classroom. Teachers do not need to use these activities or instructional approaches and are free to alter or edit them. The examples below were developed in partnership with teachers from the AP community to share ways that they approach teaching some of the topics in this unit. Please refer to the Instructional Approaches section beginning on p. 105 for more examples of activities and strategies.

Activity	Topic	Sample Activity
1	3.1	**Simulation and Debriefing** Carry out a factory simulation in which students take on the role of producers in a firm. Begin the simulation with a few fixed capital resources and no workers. Then add workers one at a time and record production data as students seek to produce additional units of a good (e.g., paper links). Connect the concepts of total product, marginal product, and average product to their results when debriefing the experience.
2	3.2	**Think-Pair-Share** Provide students with a list of formulas for short-run production costs. Include formulas that show total, average, and marginal costs. Some formulas on the list should be correct and some should be incorrect. Students should then determine which are or are not correct and explain why to a partner.
3	3.4	**Real-World Examples** The difference between accounting profit and economic profit is often difficult for students to understand, so it can be helpful to solidify students' understanding by using concrete examples. You can provide students with the salary and costs associated with a particular job and discuss whether that person makes accounting profit. Then discuss what implicit costs are and whether that person makes economic profit.

Unit Planning Notes

Use the space below to plan your approach to the unit. Consider how you want to pace your course and methods of instruction and assessment.

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1. Accounting Profit

Total revenue minus the explicit costs of production. For example, if a firm sells 100 beach balls at $2 per ball, then total revenue equals $200. If the firm spends $125 on labor, capital, and materials, then the accounting profit equals

$200 – $125 = $75.

2. Average Fixed Cost (AFC)

Fixed cost divided by the quantity of a firm's output. Decreases at decreasing rate as output rises.

3. Average Total Cost (ATC)

The sum of average fixed cost and average variable cost. Total costs incurred divided by number of units produced. Typically falls and then rises as output increases.

4. Average Variable Cost (AVC)

Variable cost divided by the quantity of a firm's output. Typically falls and then rises as output increases.

5. Average Product

The total product of a firm divided by the amount of a particular input used to produce the total product.

6. Barriers to Entry

Anything that prohibits or discourages new firms from entering into a market. Perfect competition is assumed to have no significant barriers to the entry of new firms or the exit of existing firms from the industry in the long run.

7. Commodity

A good that is identical regardless of which firm produced it.

8. Constant Returns to Scale

This exists when a firm's long-run average total cost remains constant as the firm's size increases.

9. Decreasing (Marginal) Returns

This happens when total product and marginal product both decrease as an input is added to the production process.

10. Diminishing Marginal Returns

This happens when marginal product is decreasing while total product is still increasing as an input is added to the production process.

11. Diseconomy of Scale

This exists when a firm's long-run average total cost increases as the firm's size increases. The firm becomes less productively efficient as output rises in the long run. Also known as decreasing returns to scale.

12. Economic Profit

Profits earned by a firm over and above normal profit. Areas of profit shown on economics graphs are economic profit (or loss) and encourage new firms to join industries in which they can expect to earn more than normal profit.

To calculate economic profit, you must take the accounting profit minus the opportunity cost of production. For example, assume that a firm has an accounting profit of $75. If the firm's resources could have earned an accounting profit of $70 in another industry, then the economic profit equals

$75 – $70 = $5.

13. Economy of Scale

This exists when a firm's long-run average total cost declines as the firm's size increases. The firm becomes more productively efficient as output rises in the long run. Also known as increasing returns to scale.

14. Firm

An organization that produces a good or service in order to make a profit for its owner or owners. Many people refer to a firm as a business. A fundamental assumption of economics is that firms seek to maximize profit.

15. Fixed Cost

A cost that does not change as a firm's production changes. Fixed costs are incurred prior to producing even the first unit.

16. Homogenous Products

Products that are identical or so similar that consumers can't or don't distinguish between the products made by various firms. Perfectly competitive industries are assumed to feature many firms producing goods that cannot be distinguished from one another and therefore are perfectly substitutable for one another.

17. Increasing (Marginal) Returns

This happens when both total and marginal product increase as an input is added to the production process.

18. Long Run

The production period in which all of a firm's inputs can be varied and in which firms can enter or exit various industries.

19. Long Run Average Total Cost (LRATC)

A graph which shows a firm's average total cost as it varies its size and displays economies of scale (if downward sloping) and/or diseconomies of scale.

20. Marginal Cost (MC)

The cost of producing an additional unit of output. Change in total cost divided by change in output.

21. Marginal Product

The additional output which is produced when an additional unit of input, often labor, is added to the production process.

22. Normal Profit

Amount of accounting profit that a firm would earn equal to fair market value of the resources the firm's owner uses. In particular, this includes the wages or salary that the entrepreneur could have earned working for another firm. Normal profit exists when a firm earns zero economic profit in an industry. Normal profit provides neither an incentive for firms to enter or exit the industry.

23. Perfect Competition

A market condition in which buyers and sellers have no influence over price because they are small, independent, trade in commodities, and are unable to place barriers to entry or exit from the market.

24. Price Taker

Firms in perfect competition are assumed to be price takers because they cannot control the market price for the good they sell. Due to the number of sellers of homogenous goods, each seller can sell any quantity it wants at the market price. Above this price, they would sell zero units. This means they face demand curves which are horizontal or perfectly elastic.

25. Production Function

The amount of output varies as inputs are added in production. Typically, output increases as inputs are added, but often at a decreasing rate.

26. Profit

The revenue a firm has remaining after paying all of its costs. See Economic, Normal, and Accounting Profit.

27. Short Run

The period of production time in which at least one input is constant.

28. Total Cost

The sum of fixed and variable costs. Economists include implicit costs (normal profits) as costs.

29. Total Product

All of a firm's output created by its inputs; synonym for quantity produced.

30. Variable Cost

A cost that changes with the firm's level of production.

SUGGESTED SKILL

Principles and Models

1.A

Describe economic concepts, principles, or models.

TOPIC 3.1
The Production Function

Required Course Content

ENDURING UNDERSTANDING

PRD-1

Firms' production and cost constraints over different input and output levels shape optimal decisions in the short run and long run.

LEARNING OBJECTIVE

PRD-1.A

a. Define (using graphs where appropriate) key terms and concepts relating to production and cost.

b. Explain (using graphs where appropriate) how production and cost are related in the short run and long run.

c. Calculate (using data from a graph or table as appropriate) the various measures of productivity and short-run and long-run costs.

ESSENTIAL KNOWLEDGE

PRD-1.A.1

The production function explains the relationship between inputs and outputs both in the short run and the long run.

PRD-1.A.2

Marginal product and average product change as input usage changes, and hence, total product changes.

PRD-1.A.3

Diminishing marginal returns occur as the firm employs more of one input, holding other inputs constant, to produce a product (output) in the short run.

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A. A firm, or business, is an individual or group of individuals who work together to produce goods and services for profit. Profit is the amount of money a firm gets to keep after it has paid for all of its costs or expenses.

B. Firms must decide how much of their goods or services to produce given their available land, labor, and capital. This decision begins with analysis of a firm's production function.

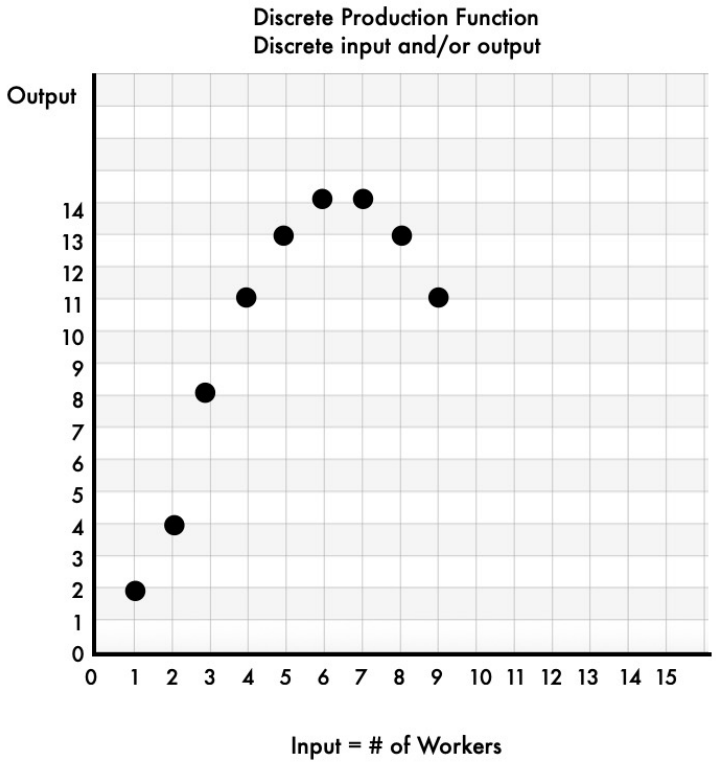
1. The production function for a firm is the amount of output, or total product, it can produce as it varies the use of an input. Usually this means labor. Typically, only one variable input will be analyzed at a time. Clearly, the amount produced results from labor, capital, and the current state of technology. However, we often assume that the quantity of capital available to the firm and the state of technology are fixed in the short run and that during this time the firm can alter the quantity it produces by increasing or decreasing the number of workers employed.

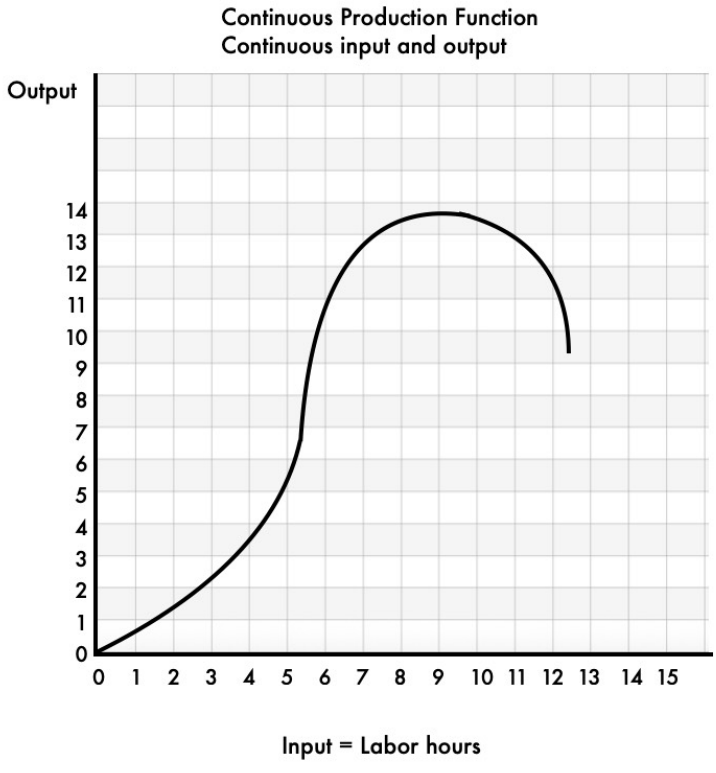
2. Initially, as a firm increases its use of labor (or of its variable input), it experiences increasing marginal returns. This means that the firm's total product is increasing at a greater rate: the contribution to total product from each additional worker (unit of input) hired is higher than for the prior worker. This added contribution from employing an additional input is called marginal product.

3. Eventually a firm reaches a point of diminishing marginal returns in which total product continues to increase as the number of inputs increases, but now at a decreasing rate: the contribution of each additional input, or marginal product, is less than the one before it, but still positive.

4. Finally, the firm may experience decreasing total returns or negative marginal returns as total product decreases and marginal product is negative.

5. Notice that initially the slope of the curve is positive and increasing as inputs increase from one to three. This range of the production function shows increasing marginal returns. As inputs increase from three through five, the slope of the production function becomes positive but decreasing, showing diminishing marginal returns. As the number of inputs increase from five to six, the slope becomes negative indicating decreasing total returns and negative marginal returns.



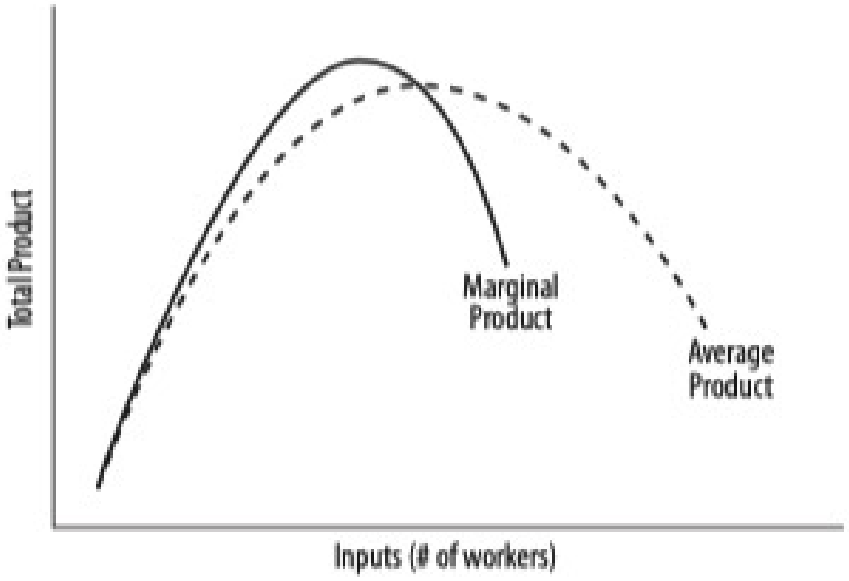


6. Average product is the total product divided by the number of inputs producing the total product.

   i. Using the marginal and average product graph shown below in Figure 5.2, study the relationship between the average product and the marginal product. Remember that marginal product is the change in total product that happens when a firm puts an additional employee or machine to work.

   ii. In the following graph, when marginal product is increasing, average product increases as well; as average product decreases, so does marginal product.

   iii. While marginal product is increasing, it is greater than average product, but when average product is decreasing, it is above marginal product.



1. Define the following:
    Average Product
    Decreasing returns
    Diminishing returns
    Increasing returns
    Input
    Long-run
    Marginal Product
    Output
    Short-run
    Total Product

Complete the table below, and answer the following questions:

Units of Labor	Total Product	Marginal Product	Average Product
1	1	1	1
2	4		2
3	9	5	
4	15		3 3/4
5	19	4	
6	20		3 1/3
7	18		

9. As the units of labor increase from 1 to 4, the production function experiences
    A. Increasing returns
    B. Diminishing returns
    C. Decreasing returns

10. As the units of labor increase from 4 to 6, the production function experiences
    A. Increasing returns
    B. Diminishing returns
    C. Decreasing returns

1. Define the following:

Average Product *total product / # of inputs*
Decreasing returns *total product decreases as marginal product decreases*
Diminishing returns *total product increases as marginal product decreases*
Increasing returns *total product increases as marginal product increases*
Input *labor, capital, and raw materials firms use to produce output*
Long-run *all inputs become variable given enough time*
Marginal Product *change in total product / change in inputs*
Output *the number of units a firm produces*
Short-run *at least one input is held constant*
Total Product *see output*

Complete the table below, and answer the following questions:

Units of Labor	Total Product	Marginal Product	Average Product
1	1	1	1
2	4	3	2
3	9	5	3
4	15	6	3 3/4
5	19	4	3 4/5
6	20	1	3 1/3
7	18	-2	2 4/7

9. As the units of labor increase from 1 to 4, the production function experiences

A. Increasing returns
~~B. Diminishing returns~~
~~C. Decreasing returns~~

10. As the units of labor increase from 4 to 6, the production function experiences

~~A. Increasing returns~~
B. Diminishing returns
~~C. Decreasing returns~~

TOPIC 3.2
Short-Run Production Costs

SUGGESTED SKILL

Graphing and Visuals

4.A

Draw an accurately labeled graph or visual to represent an economic model or market.

Required Course Content

ENDURING UNDERSTANDING

PRD-1

Firms' production and cost constraints over different input and output levels shape optimal decisions in the short run and long run.

LEARNING OBJECTIVE

PRD-1.A

a. Define (using graphs where appropriate) key terms and concepts relating to production and cost.

b. Explain (using graphs where appropriate) how production and cost are related in the short run and long run.

c. Calculate (using data from a graph or table as appropriate) the various measures of productivity and short-run and long-run costs.

ESSENTIAL KNOWLEDGE

PRD-1.A.4

Fixed costs and variable costs determine the total cost.

PRD-1.A.5

Marginal cost, average (fixed, variable, and total) cost, total cost, and total variable cost change as total output changes, but total fixed cost remains constant at all output levels, including zero output.

PRD-1.A.6

Production functions with diminishing marginal returns yield an upward-sloping marginal cost curve.

PRD-1.A.7

Specialization and the division of labor reduce marginal costs for firms.

PRD-1.A.8

Cost curves can shift in response to changes in input costs and productivity.

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A. In microeconomics, the short run is any time period in which at least one of a firm's inputs (land, labor, or capital) can't be changed. Usually it's capital and that accounts for the fixed costs (FC). That is, the cost is unable to be changed in the short run. No matter how much total product a firm produces, its fixed costs stay the same.

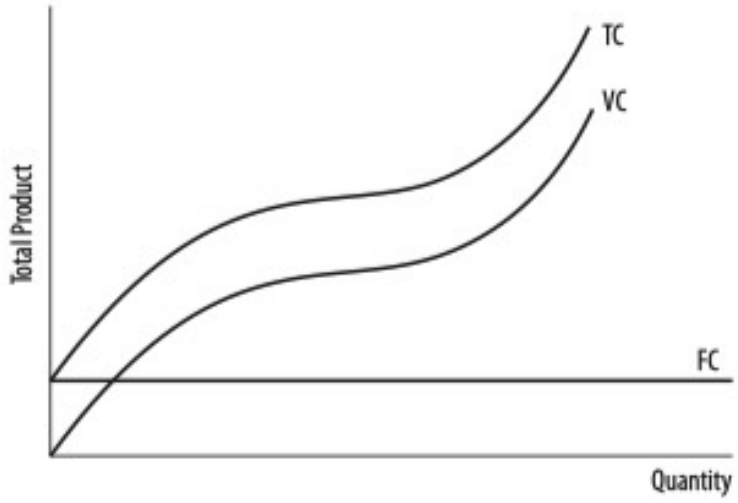
1. Fixed costs are completely independent of the firm's total product. Examples of fixed costs include: monthly rent, property taxes, salaries to managers, and payments made on loans the firm took out to purchase capital equipment.

B. Firms, or businesses, are able to change at least one input in the short run. Usually it's labor that is the variable input and accounts for (most of) the firm's variable costs (VC), or the cost which firms have some control over in the short run. Unlike fixed costs, variable costs change with a firm's total product.

1. As firms produce more, their variable costs increase. As firms produce less, their variable costs shrink, all the way down to being zero when no units are produced (this is called shutting down in the short run). Examples of variable costs include: utility bills, income taxes, wages to hourly workers, and raw materials.

C. A firm's total cost (TC) is the sum of all its fixed and variable costs, which means total cost equals fixed cost plus variable cost.

$$TC = FC + VC.$$



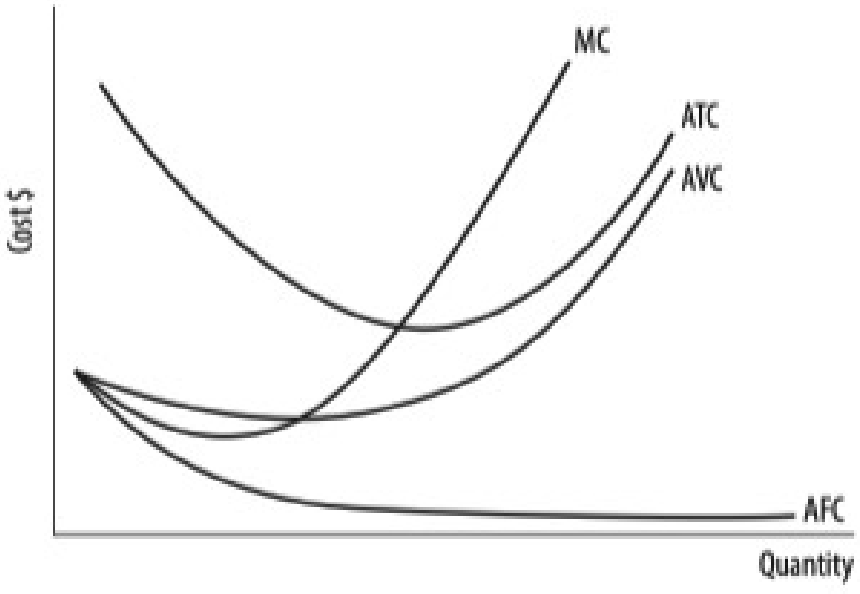
E. Marginal cost (MC) is the change in total cost that happens whenever a business produces one additional unit of output. It is also the slope of the total cost and variable cost curves at a particular quantity. The marginal product function determines the MC curve because the costs associated with employing one more unit of a variable input are spread over the number of units of output gained.

1. What causes a change in marginal cost? A change in variable cost leads to a change in marginal cost, but changes in fixed costs will not affect marginal cost. Marginal cost is extremely important in determining how to maximize profit for a firm, and so it bears a very close relationship to a firm's supply decisions.

F. Average fixed cost (AFC) is equal to a firm's fixed cost divided by FC its total product. This can be expressed as FC/Q Initially, AFC for a firm is really big, but as a firm increases its output while its fixed costs remain the same, the AFC gets closer and closer to zero, approaching, but never touching, the x axis.

G. Average variable cost (AVC) is a firm's variable cost divided by VC its total product. This can be expressed as VC/Q Initially, AVC for a firm is high, then it decreases, but eventually it increases because marginal cost is increased.

H. Average total cost (ATC) is the sum of the firm's AFC and AVC. ATC = AFC + AVC. As output increases, ATC initially decreases because of increasing returns, but eventually it increases because of diminishing marginal returns. In the graph below, also notice how ATC and AVC get closer together as the quantity increases. This happens because AFC is getting smaller and smaller as a firm increases production.



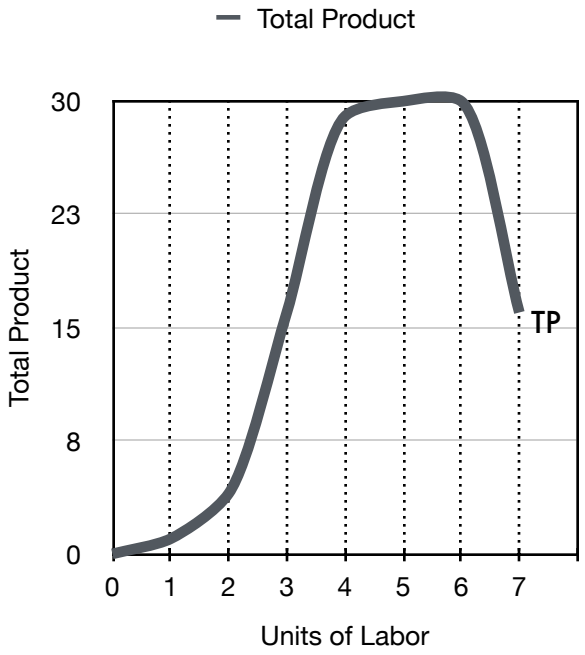
1. Define the following:
   - Average Fixed Cost
   - Average Variable Cost
   - Average Total Cost
   - Fixed Cost
   - Marginal Cost
   - Variable Cost
   - Total Cost

Assume a hypothetical firm which produces bicycles. The spreadsheet below shows their various levels of productivity and cost.

Units of Labor	Total Product	Marginal Product	Average Product	Fixed Cost = $1000	Variable Cost = $15/labor unit + $100/unit produced	Total cost	Marginal Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost
0	0	0		$1000.00	$0.00	$1000.00				
1	1	1	1	$1000.00	$115.00	$1115.00	$115.00	$1000.00	$115.00	$1115.00
2	4	3	2	$1000.00	$430.00	$1430.00	$105.00	$250.00	$107.50	$357.50
3	16	12	5	$1000.00	$1645.00	$2645.00	$101.25	$62.50	$102.81	$165.31
4	29	13	7	$1000.00	$2960.00	$3960.00	$101.15	$34.48	$102.07	$136.55
5	30	1	6	$1000.00	$3075.00	$4075.00	$115.00	$33.33	$102.50	$135.83
6	30	0	5	$1000.00	$3090.00	$4090.00	Undefined	$33.33	$103.00	$136.33
7	16	-14	2							

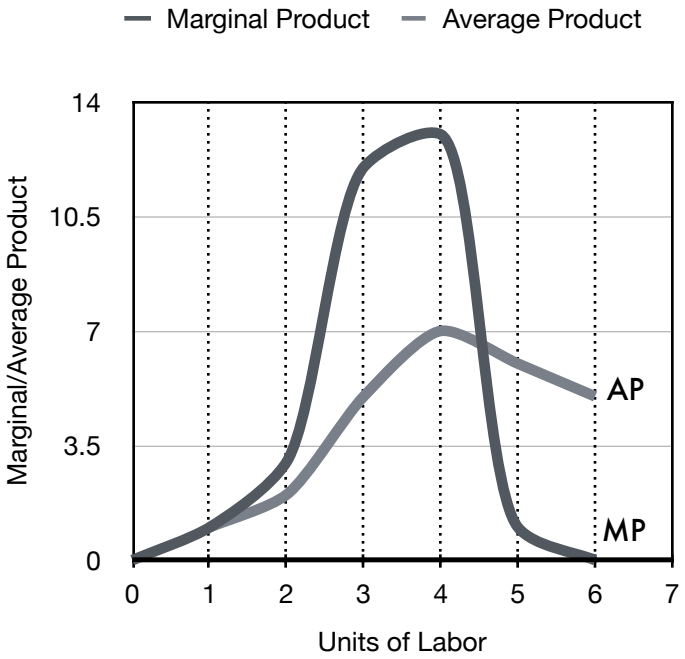
2. Referring to the spreadsheet above, the addition of which unit of labor shows diminishing returns?

3. Productive efficiency is associated with what amount of total product?

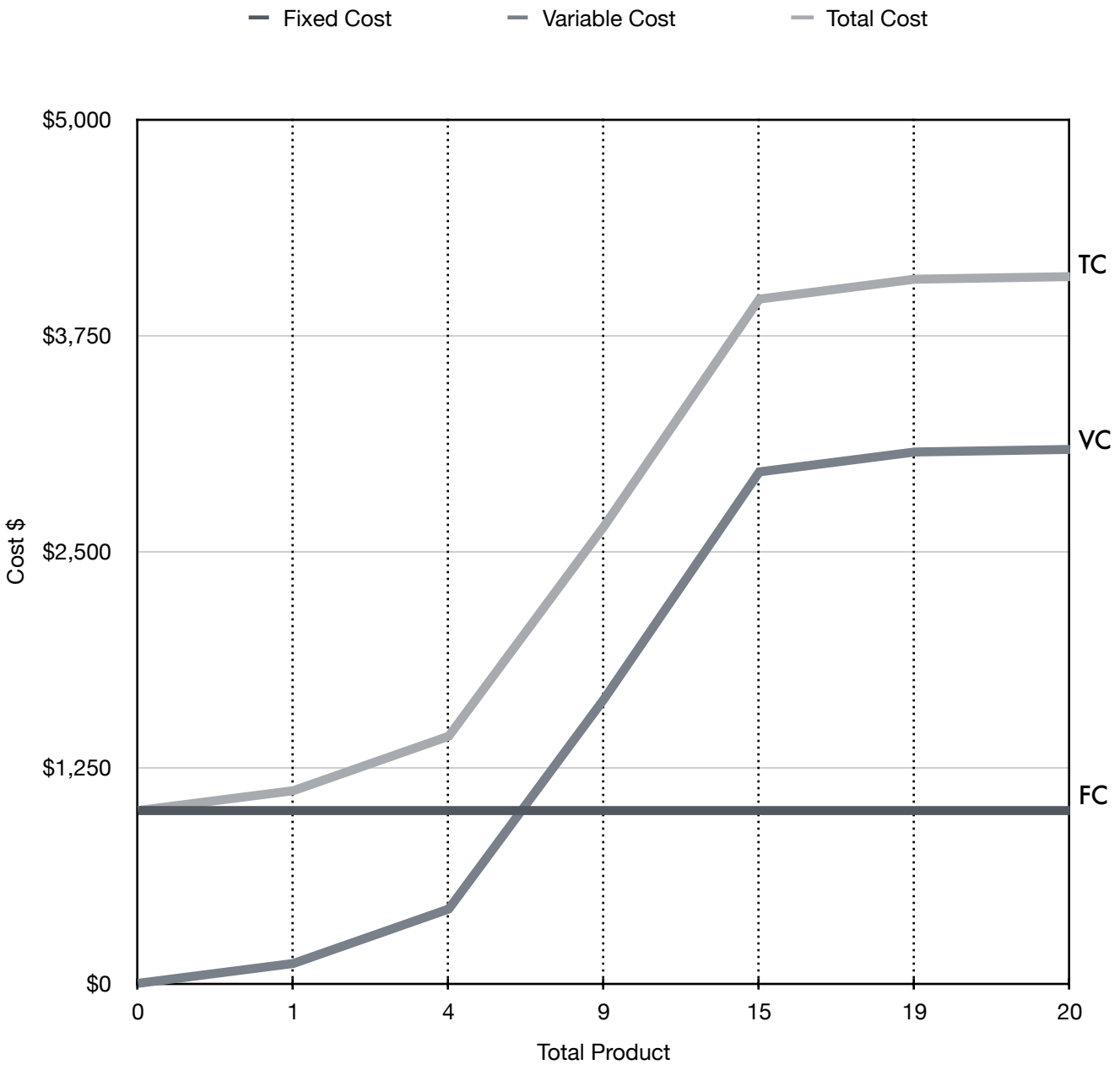


4. Referring to the production function above, between which units of labor does the firm experience increasing returns?

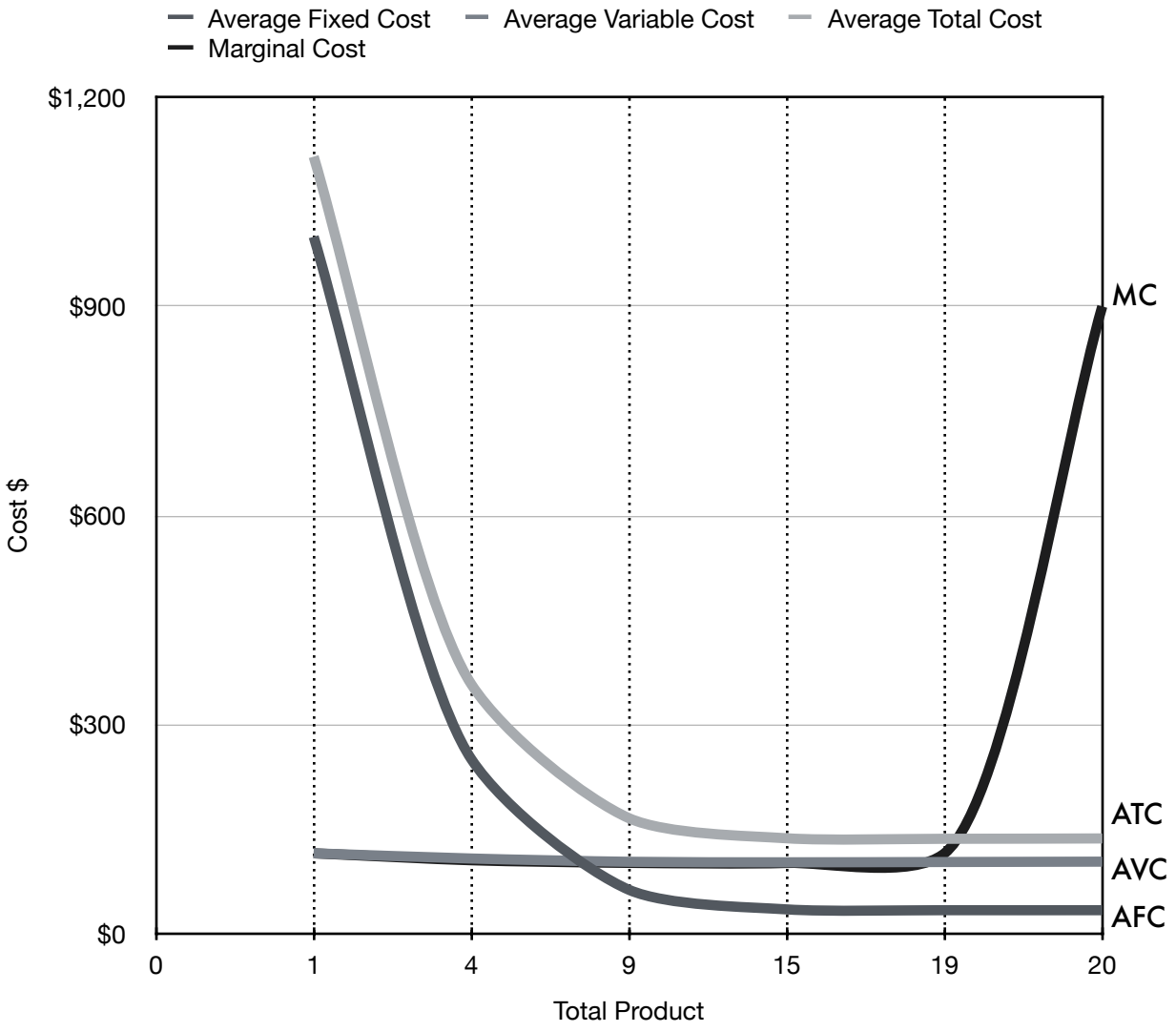
5. Referring to the production function above, the addition of which unit of labor is associated with decreasing returns?



6. Refer to the graph above, what unit of labor is associated with maximum average product and marginal product?



7. Refer to the graph above, what explains the vertical distance between the total cost curve (TC) and the variable cost curve (VC)?



8. Refer to the graph above, the intersection of the marginal cost curve (MC) and the average variable cost curve (AVC) as well as (ATC) is associated with what amount of total product?

9. Refer to the graph above, why does the average total cost curve (ATC) decrease as total product initially increases?

10. Compare the marginal cost curve and the average total cost curve in the graph above with the marginal product and average product curves on the second page. What is the relationship between these graphs?

1. Define the following:

Average Fixed Cost ... *FC/Q*
Average Variable Cost ... *VC/Q*
Average Total Cost ... *TC/Q or AFC + AVC*
Fixed Cost ... *costs which remain the same regardless of how much output the firm produces*
Marginal Cost ... *Change in total cost ÷ change in total product*
Variable Cost ... *costs which change as the amount of output produced changes*
Total Cost ... *fixed cost + variable cost*

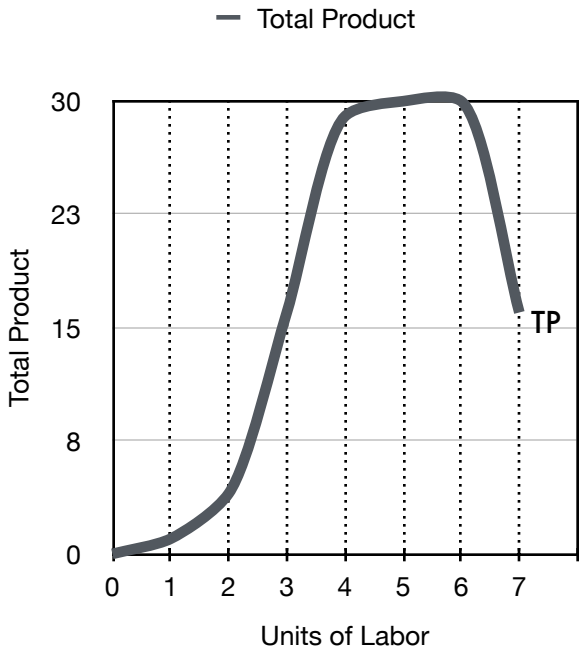
Assume a hypothetical firm which produces bicycles. The spreadsheet below shows their various levels of productivity and cost.

Units of Labor	Total Product	Marginal Product	Average Product	Fixed Cost = $1000	Variable Cost = $15/labor unit + $100/unit produced	Total cost	Marginal Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost
0	0	0		$1000.00	$0.00	$1000.00				
1	1	1	1	$1000.00	$115.00	$1115.00	$115.00	$1000.00	$115.00	$1115.00
2	4	3	2	$1000.00	$430.00	$1430.00	$105.00	$250.00	$107.50	$357.50
3	16	12	5	$1000.00	$1645.00	$2645.00	$101.25	$62.50	$102.81	$165.31
4	29	13	7	$1000.00	$2960.00	$3960.00	$101.15	$34.48	$102.07	$136.55
5	30	1	6	$1000.00	$3075.00	$4075.00	$115.00	$33.33	$102.50	$135.83
6	30	0	5	$1000.00	$3090.00	$4090.00	Undefined	$33.33	$103.00	$136.33
7	16	-14	2							

2. Referring to the spreadsheet above, the addition of which unit of labor shows diminishing returns?

3. Productive efficiency is associated with what amount of total product?

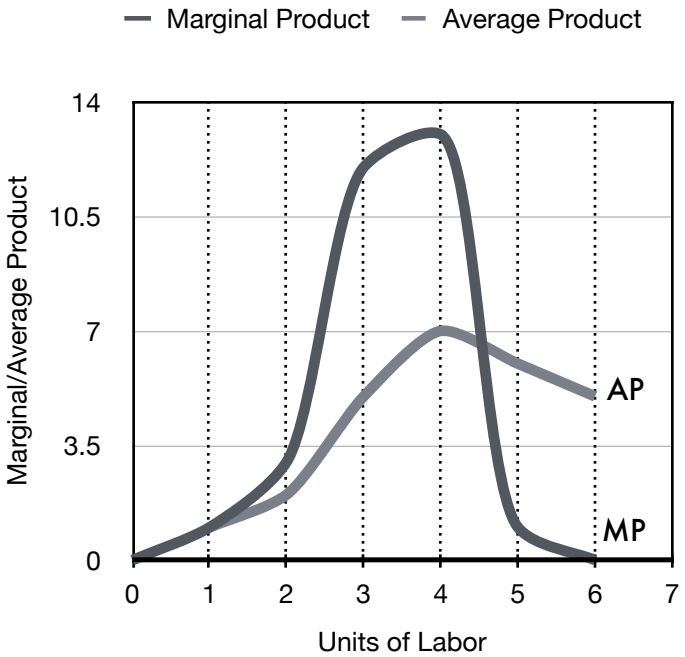
minimum ATC is achieved when total product is 30



4. Referring to the production function above, between which units of labor does the firm experience increasing returns?

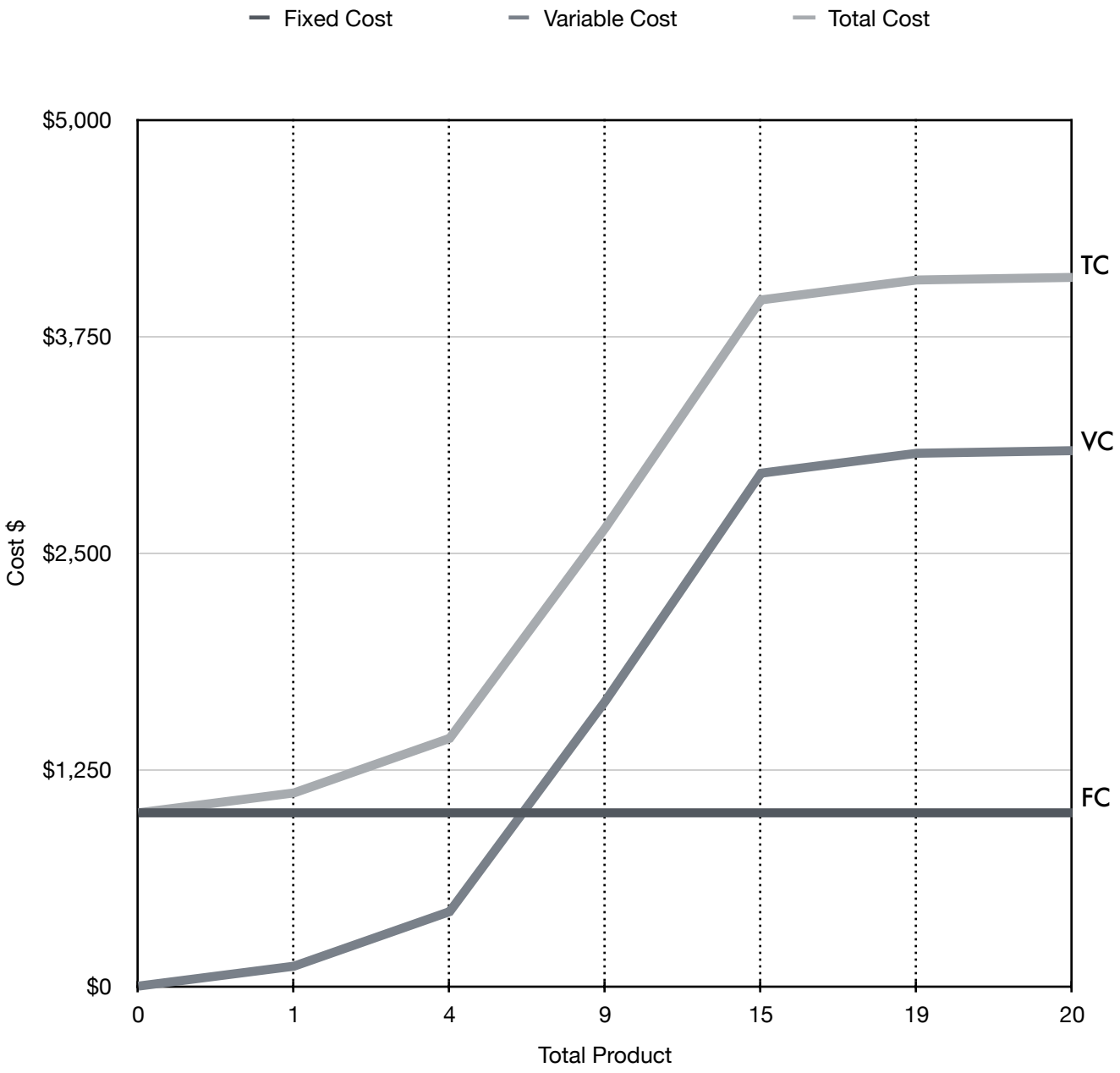
between 0 and 4

5. Referring to the production function above, the addition of which unit of labor is associated with decreasing returns?



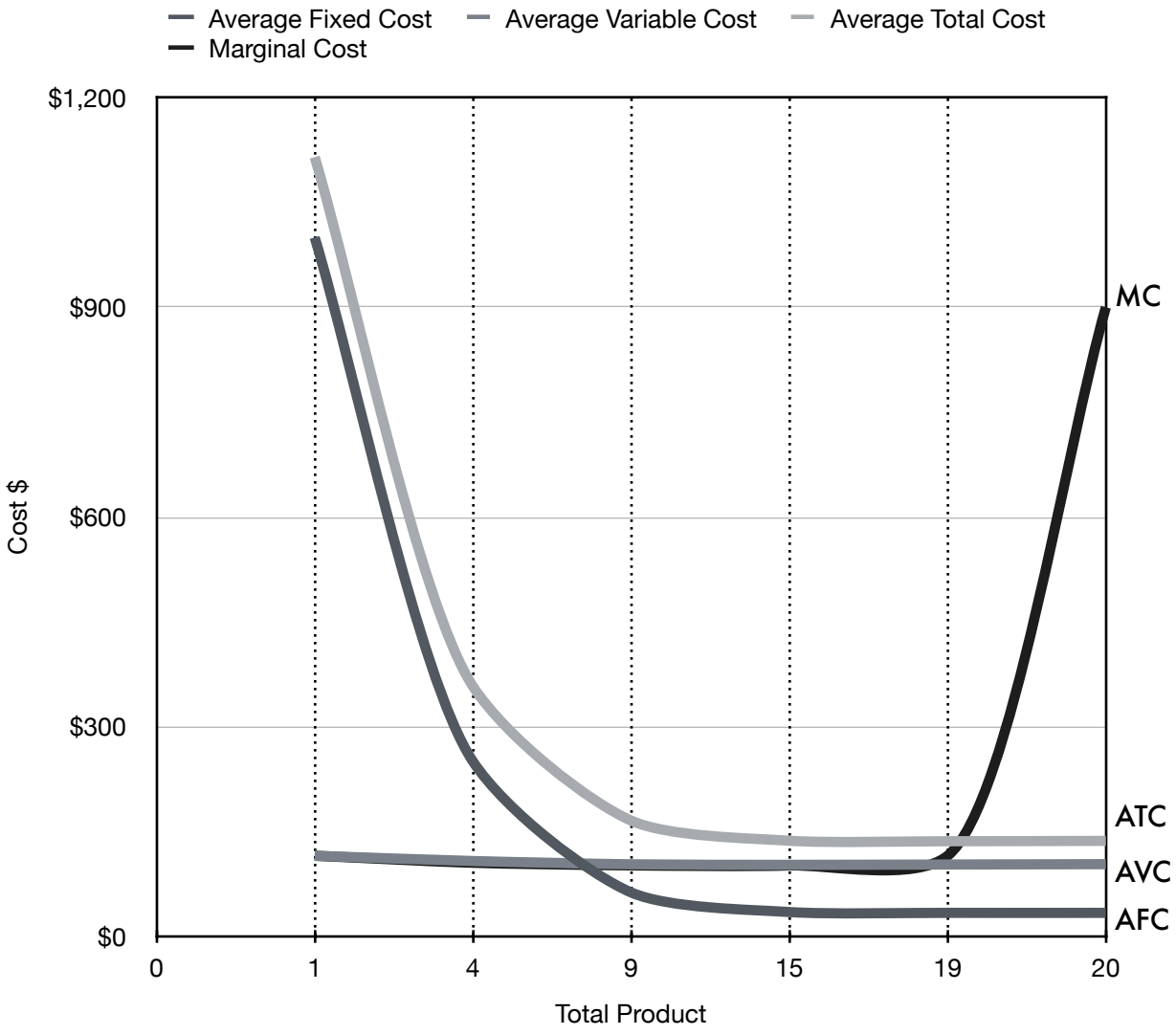
6. Refer to the graph above, what unit of labor is associated with maximum average product and marginal product?

4 units of labor



7. Refer to the graph above, what explains the vertical distance between the total cost curve (TC) and the variable cost curve (VC)?

fixed cost



8. Refer to the graph above, the intersection of the marginal cost curve (MC) and the average variable cost curve (AVC) as well as (ATC) is associated with what amount of total product?

19

9. Refer to the graph above, why does the average total cost curve (ATC) decrease as total product initially increases?

increasing returns to labor, and as output increases average fixed costs decrease

10. Compare the marginal cost curve and the average total cost curve in the graph above with the marginal product and average product curves on the second page. What is the relationship between these graphs?

increases in average and marginal product result in decreases in average and marginal costs

7. For a firm where labor is the only variable input, which of the following happens when diminishing returns set in?

(A) Average variable cost begins to increase.

(B) Average product of labor begins to decline.

(C) Total product begins to decline.

(D) Marginal cost begins to increase.

(E) Average total cost begins to increase.

(D)

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
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.

(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.

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Question 2: Short — 5 points

(a)	Calculate the average fixed cost of \$3 and show the work. $\text{Average Fixed Cost} = \frac{\text{Total Fixed Cost}}{\text{Quantity of Output}}$ $\text{Average Fixed Cost} = \frac{\$90}{30} = \$3$	**1 point**
(b)	Calculate the marginal cost as \$6 and show the work. $\text{Marginal Cost} = \frac{\text{Change in Total Variable Cost}}{\text{Change in Output}}$ $\text{Marginal Cost} = \frac{(\$108 - \$90)}{(30 - 27)} = \frac{\$18}{3} = \$6$ OR $\text{Marginal Cost} = \frac{\text{Change in Total Cost}}{\text{Change in Output}}$ $\text{Marginal Cost} = \frac{(\$198 - \$180)}{(30 - 27)} = \frac{\$18}{3} = \$6$	**1 point**
(c)	State that diminishing marginal returns to labor begin with the hiring of the 3rd worker and explain that 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.	**1 point**
(d)	State that the profit-maximizing number of workers is 7 and explain that the marginal revenue product (MRP) of the 7th worker (\$20) is greater than the marginal factor cost (MFC) of the 7th worker (wage = \$18), and that the hiring of the 8th worker would decrease profits because the MRP of the 8th worker (\$10) is less than the MFC of the 8th worker (wage = \$18).	**1 point**
(e)	State that Gato Food will experience diseconomies of scale and explain that as output increases from 40 to 50 units, long-run average total cost increases from \$15 to \$18 per unit.	**1 point**
	Total for question 2	**5 points**

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SUGGESTED SKILL

Principles and Models

1.D

Describe the similarities, differences, and limitations of economic concepts, principles, or models.

TOPIC 3.3
Long-Run Production Costs

Required Course Content

ENDURING UNDERSTANDING

PRD-1

Firms' production and cost constraints over different input and output levels shape optimal decisions in the short run and long run.

LEARNING OBJECTIVE

PRD-1.A

a. Define (using graphs where appropriate) key terms and concepts relating to production and cost.

b. Explain (using graphs where appropriate) how production and cost are related in the short run and long run.

c. Calculate (using data from a graph or table as appropriate) the various measures of productivity and short-run and long-run costs.

ESSENTIAL KNOWLEDGE

PRD-1.A.9

In the long run, firms can adjust all their inputs, and as a result, all costs become variable.

PRD-1.A.10

The relationship between inputs and outputs in the long run is described by the scale of production—increasing, decreasing, or constant returns to scale.

PRD-1.A.11

The long-run average total cost is characterized by economies of scale, diseconomies of scale, or constant returns to scale (efficient scale).

PRD-1.A.12

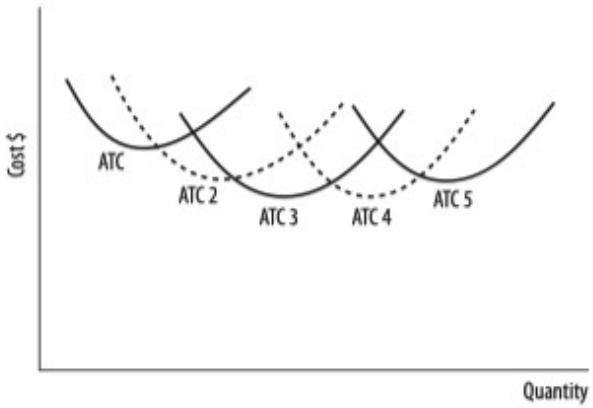
The minimum efficient scale plays a role in determining the concentration of firms in a market and the market structure.

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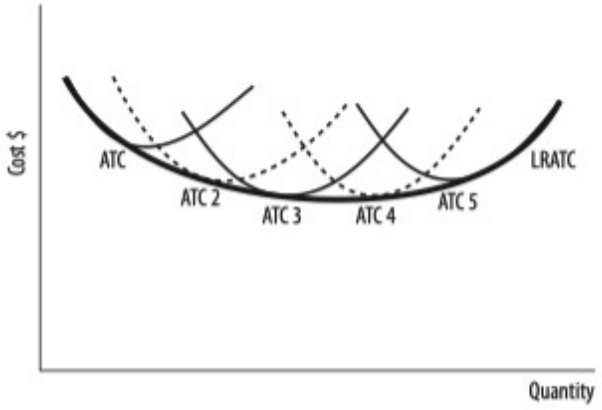
A. The long run happens when firms can change all of their inputs. All costs are variable in the long run. Unlike the short run in which a firm may only be able to hire more workers in response to demand for its product, in the long run, a firm can increase not only the number of workers, but also the number of machines, the size of its factory, and even the way it does business.

B. In the series of graphs below, you can see many different short run ATC (average total cost) curves that could exist as a firm grows in size. At first, the SRATC curves get lower as the firm gets bigger, then it levels out. Finally, the SRATC curves get higher as the firm gets even bigger. What you are seeing are different economies of scale. Combining the minimum points of all of the ATC curves that could exist gives us the long run average total cost curve (LRATC).

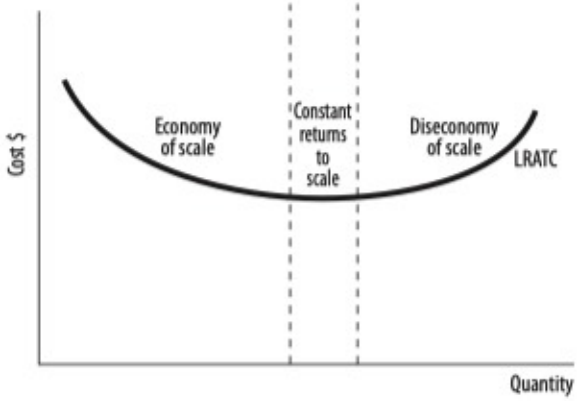
A



B



C



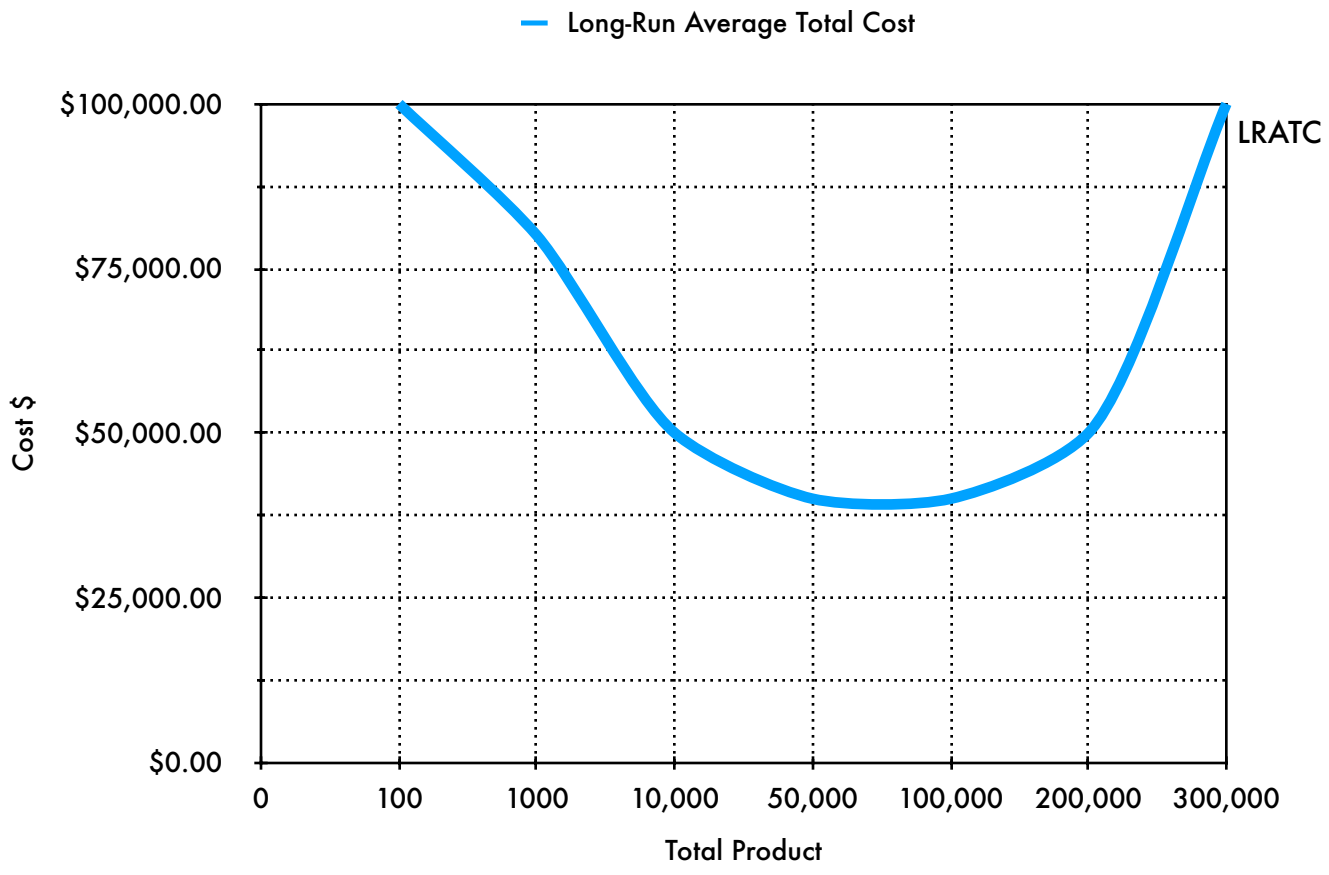
1. The region of the LRATC left of both dashed lines in graph C illustrates economy of scale. Economies of scale means that increasing the size of the firm results in lower average total cost, which is productively efficient. This happens because as firms become larger, the marginal product of labor increases.

2. The region to the right of both dashed lines in graph C shows a diseconomy of scale. Diseconomies of scale happen when firms become too big and they stop being productively efficient as their average total cost increases.

3. Constant returns to scale can be seen between the dashed lines in graph C. In this case, the constant returns to scale occur as the firm's average total cost ranges from ATC 3 to ATC 4 in graph A. Notice that the minimum of ATC 3 and ATC 4 in graph A are the same. Constant returns to scale may occur if increasing a firm's size neither decreases nor increases its average total cost.

1. Define the following:
   - constant returns to scale
   - decreasing returns to scale
   - diseconomies of scale
   - economies of scale
   - increasing returns to scale
   - long-run average total cost
   - minimum efficient scale

2. What is the difference between the short-run and the long-run for a firm?



3. Refer to the graph above. As total product increases from 100 to 50,000, the firm experiences which scale of production?

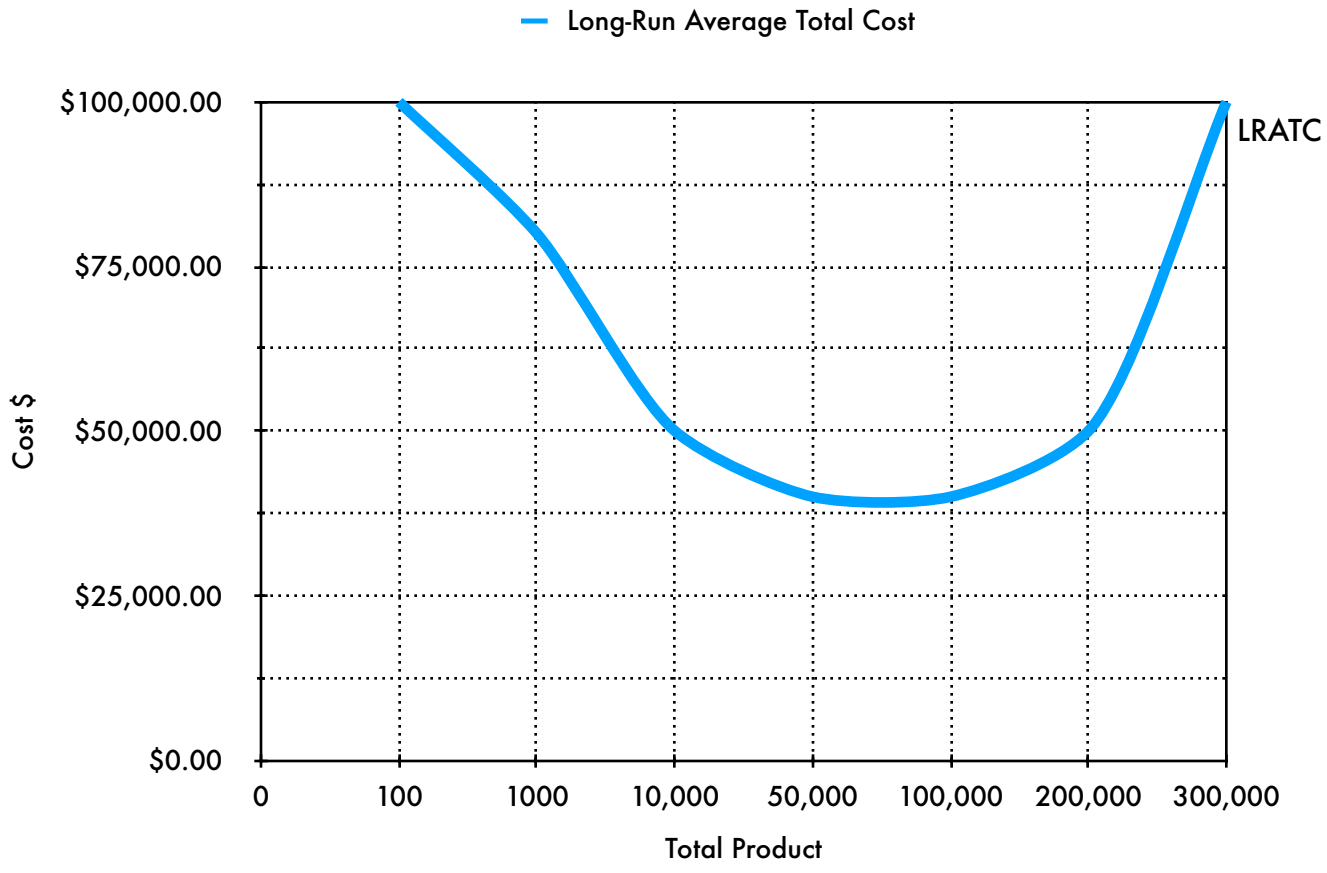
4. Refer to the graph above, total product in excess of what value is associated with diseconomies of scale?

5. Increasing production from 50,000 units to 100,000 units has what effect on the firm's LRATC?

1. Define the following:

constant returns to scale ... *increases in firm's size neither increases or decreases ATC*
decreasing returns to scale ... *increases in firm's size increases ATC*
diseconomies of scale ... *if firms grow too large they become productively inefficient*
economies of scale ... *increases in firm size resulting in productive efficiency*
increasing returns to scale ... *increases in firm's size decreases ATC*
ong-run average total cost ... *ATC when all inputs are variable*
minimum efficient scale ... *the firm size which results in lowest ATC*

2. What is the difference between the short-run and the long-run for a firm?



3. Refer to the graph above. As total product increases from 100 to 50,000, the firm experiences which scale of production? *Increasing returns to scale and/or economies of scale*

4. Refer to the graph above, total product in excess of what value is associated with diseconomies of scale? *100,000*

5. Increasing production from 50,000 units to 100,000 units has what effect on the firm's LRATC?

none

8. Which of the following indicates the presence of economies of scale as the quantity of output increases?

   (A) Short-run average variable cost decreases.

   (B) Long-run average total cost decreases.

   (C) Marginal cost decreases.

   (D) Average fixed cost decreases.

   (E) Marginal cost exceeds average total cost.

(B)

TOPIC 3.4
Types of Profit

SUGGESTED SKILL

Principles and Models

1.C

Identify an economic concept, principle, or model using quantitative data or calculations.

Required Course Content

ENDURING UNDERSTANDING

CBA-2

To determine the optimal level at which to pursue an activity whose total benefits exceed total cost, rational economic agents compare marginal benefits and marginal costs.

LEARNING OBJECTIVE

CBA-2.C

a. Define the different types of profit.
b. Explain how firms respond to profit opportunities.
c. Calculate a firm's profit or loss.

ESSENTIAL KNOWLEDGE

CBA-2.C.1

Firms respond to economic profit (loss) rather than accounting profit.

CBA-2.C.2

Accounting profit fails to account for implicit costs (such as cost of financial capital, compensation for risk, or an entrepreneur's time), which, if fully compensated, result in normal profit.

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A. A profit happens whenever a firm makes more money (revenue) from producing and selling a good or service than it spends in producing and selling the same good or service.

B. An accounting profit exists when the amount of revenue is greater than the explicit or clearly seen costs of production. Recall that explicit costs are money payments made to others for use of factors of production not owned by the business owner.

C. An economic profit exists when the amount of revenue is greater than both the explicit costs and implicit costs (opportunity costs) of production.

D. In economics, a firm is making a normal profit when its economic profit is zero.

1. A firm earning a normal profit is making just enough profit to keep the entrepreneur from leaving the industry and entering another industry, but not enough so that new firms are tempted to rush to join the industry.

E. Economic profits are important because their presence is a signal for other firms to enter into the market and compete with existing firms.

1. If firms in an industry are earning a normal profit, then no incentive exists for the firms to exit and for other firms to enter.

2. If a firm is earning less than a normal profit (taking an economic loss), then the firm should leave the industry.

3. Keep in mind (when looking at economics graphs) that areas of profit represent economic profits or losses. When it looks on a graph as though the firm is breaking even, it is making exactly a normal profit and there will be no tendency for the industry to grow or shrink.

1. Define the following:
   accounting profit
   economic profit
   explicit costs
   implicit costs
   normal profit

Refer to the following information when responding to 2 & 3:

A firm earning total revenue of $10 million faces the following costs:

Rent = $1 million
Utilities = $500,000
Physical capital = $2 million
Wages and Salaries to employees = $2 million
Raw Materials = $1 million
Administrative Expenses = $250,000
Advertising/Marketing = $250,000

In addition, the firm's owner can earn a wage of $1 million by becoming the CEO of another firm in a different industry. Also, the firm's physical capital could earn $2 million if it were deployed in another industry.

2. Calculate the firm's accounting profit and economic profit.

3. Is the firm earning a normal profit? Why or why not

4. The presence of economic profit in one industry has what effect on firms in other industries.

5. Explain how the presence of economic losses for some firms in an industry influences their behavior.

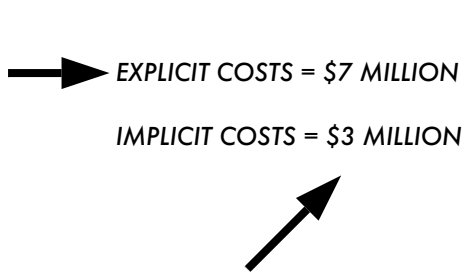
1. Define the following:

accounting profit ... *total revenue - explicit costs*
economic profit ... *total revenue - explicit costs - implicit costs*
explicit costs ... *costs associated with a direct expenditure by firms*
implicit costs ... *opportunity costs associated with operating in one industry rather than another*
normal profit ...*zero economic profit*

Refer to the following information when responding to 2 & 3:

A firm earning total revenue of $10 million faces the following costs:

Rent = $1 million
Utilities = $500,000
Physical capital = $2 million
Wages and Salaries to employees = $2 million
Raw Materials = $1 million
Administrative Expenses = $250,000
Advertising/Marketing = $250,000



In addition, the firm's owner can earn a wage of $1 million by becoming the CEO of another firm in a different industry. Also, the firm's physical capital could earn $2 million if it were deployed in another industry.

2. Calculate the firm's accounting profit and economic profit.

ACCOUNTING PROFIT = $10 MILLION - $7 MILLION = $3 MILLION
ECONOMIC PROFIT = $10 MILLION - $7 MILLION - $3 MILLION = $0

3. Is the firm earning a normal profit? Why or why not

NORMAL PROFIT BECAUSE ECONOMIC PROFIT IS 0

4. The presence of economic profit in one industry has what effect on firms in other industries.

ECONOMIC PROFIT PROVIDES AN INCENTIVE FOR FIRMS TO REALLOCATE RESOURCES FROM

5. Explain how the presence of economic losses for some firms in an industry influences their behavior.

THE PRESENCE OF ECONOMIC LOSSES MAKES LESS EFFICIENT FIRMS LEAVE AN INDUSTRY

SUGGESTED SKILL

Interpretation

2.A

Using economic concepts, principles, or models, explain how a specific economic outcome occurs, or what action should be taken in order to achieve a specific economic outcome.

AVAILABLE RESOURCE

- Classroom Resources > **Mastering Economic Thinking Skills—*Marginal Thinking: Key Concepts and Questions***

TOPIC 3.5
Profit Maximization

Required Course Content

ENDURING UNDERSTANDING

CBA-2

To determine the optimal level at which to pursue an activity whose total benefits exceed total cost, rational economic agents compare marginal benefits and marginal costs.

LEARNING OBJECTIVE

CBA-2.D

a. Define (using graphs or data as appropriate) the profit-maximizing rule.

b. Explain (using a graph or data as appropriate) the profit-maximizing level of production.

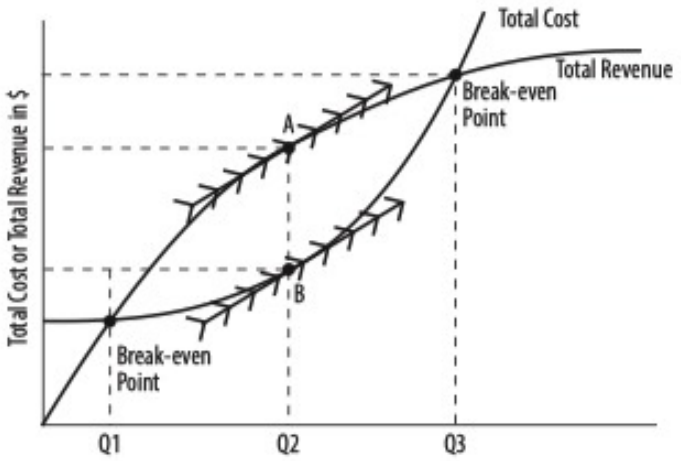
ESSENTIAL KNOWLEDGE

CBA-2.D.1

Firms are assumed to produce output to maximize their profits by comparing marginal revenue and marginal cost.

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A. Firms make the biggest (maximum) profits when the amount of revenue they earn from producing an additional unit of output (marginal revenue) equals the cost of producing the additional unit of output (marginal cost). To see why that is, look at the graph below, which compares the total revenue of a firm with its total cost.



1. As a firm produces more and more output, it experiences various levels of profit and loss. In the graph above, when the firm produces quantity Q1, both its total revenue and total cost are equal. This means that the firm is earning zero economic profit (exactly normal profit), or is breaking even.

2. As the firm increases output from Q1 to Q2, notice what happens to the slope of the total revenue curve and the total cost curve. Initially, the rate of change in total revenue (marginal revenue) is greater than the rate of change in total cost (marginal cost), so the TR curve rises faster than the TC curve.

   i. When the firm reaches an output of quantity Q2, the rate at which total revenue is changing (marginal revenue) is equal to the rate at which total cost is changing (marginal cost). This is seen as points A and B. The arrowed lines represent the slopes of each curve at these points. The slope of the line going through point A is the same thing as the firm's marginal revenue. The slope of the line going through point B is the same thing as the firm's marginal cost. When marginal revenue equals marginal cost, total revenue is at its greatest relative to total cost. The vertical distance between TR and TC (from point A down to point B) is the maximum profit that the firm can possibly earn in the short run.

   ii. If the firm were to increase its output from Q2 toward Q3, the profit would shrink as the marginal revenue diminishes and the marginal cost increases. Note that TC is rising more rapidly than TR in this section of the graph.

   iii. The vertical distance between TR and TC is shrinking as the firm's profits, while still positive, decline. At Q3, the firm reaches its second break-even point where its total revenue and total cost are equal.

   iv. Beyond Q3, the firm's total cost is greater than the firm's total revenue. The vertical distance (TR – TC) is actually negative and the firm is taking an economic loss.

B. A firm maximizes profits when marginal revenue (MR) equals marginal cost (MC). This is true for every firm regardless of whether it's a small lemonade stand or a large multinational corporation.

1. Profit maximization happens when MR = MC no matter the market structure.

2. For some firms, it may be the case that they can't make a profit or manage to break even at any quantity. In those cases, the firm would be expected to try to minimize its losses.

3. The phrase profit maximization should be interpreted to cover these situations as well. The firm's task is the same because it is still trying to maximize profit (TR – TC) even if the unfortunate reality for it is that the maximum value is a negative profit.

1. Define the following:
profit maximizing rule

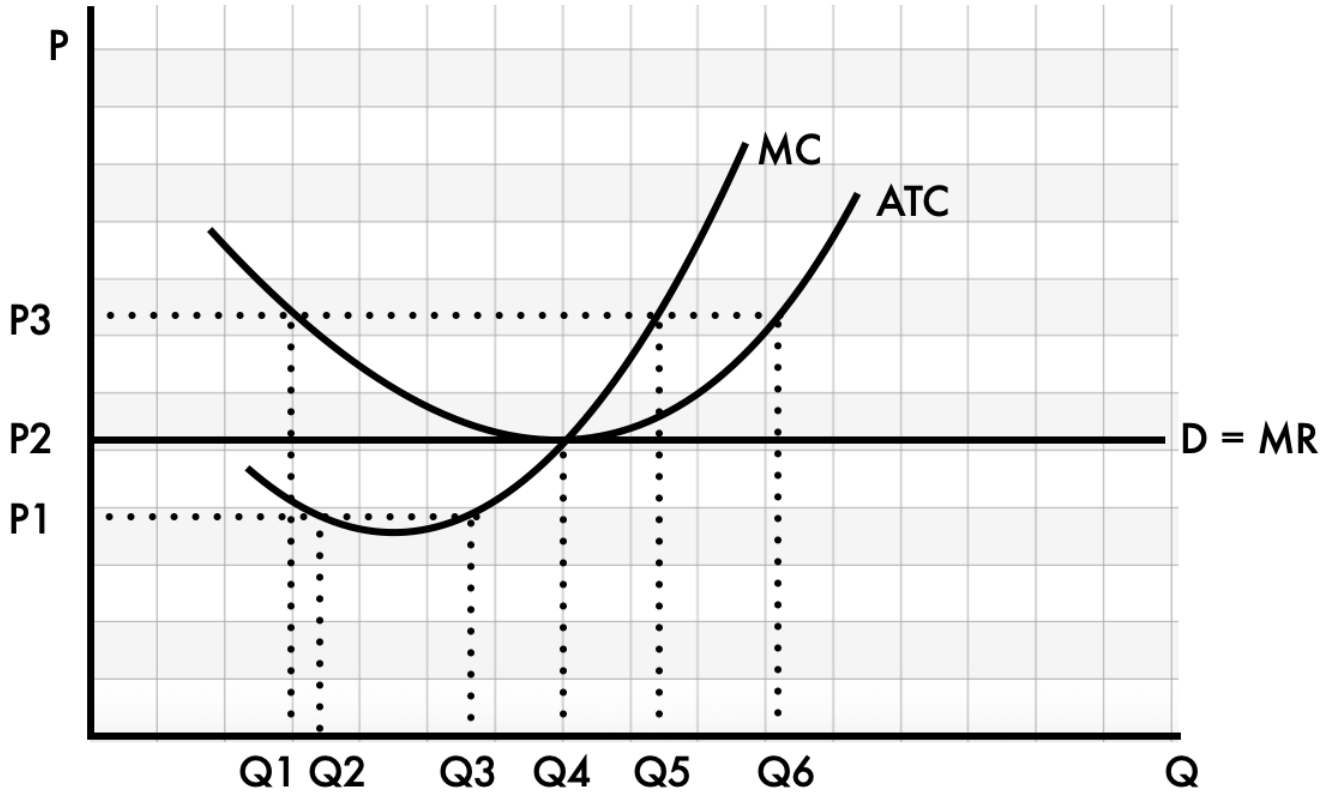
Refer to the following table showing a firm's marginal revenue and marginal cost to answer questions 2 & 3

Total Product	Marginal Revenue	Marginal Cost
1	$10	$6
2	$9	$7
3	$8	$8
4	$7	$9
5	$6	$10

2. If the firm decides to only produces 1 unit of output, explain why it should consider increasing its output?

3. What level of output should this firm produce to maximize its profit?

Refer to the following graph for a firm to answer questions 4 and 5



4. What is the profit maximizing price and quantity for the firm?

5. At the profit-maximizing level of production, explain why this firm does not earn an economic profit?

1. Define the following:
profit maximizing rule

ALL FIRMS MAXIMIZE PROFIT BY PRODUCING OUTPUT WHERE

MARGINAL REVENUE = MARGINAL COST

MR = MC

Refer to the following table showing a firm's marginal revenue and marginal cost to answer questions 2 & 3

Total Product	Marginal Revenue	Marginal Cost
1	$10	$6
2	$9	$7
3	$8	$8
4	$7	$9
5	$6	$10

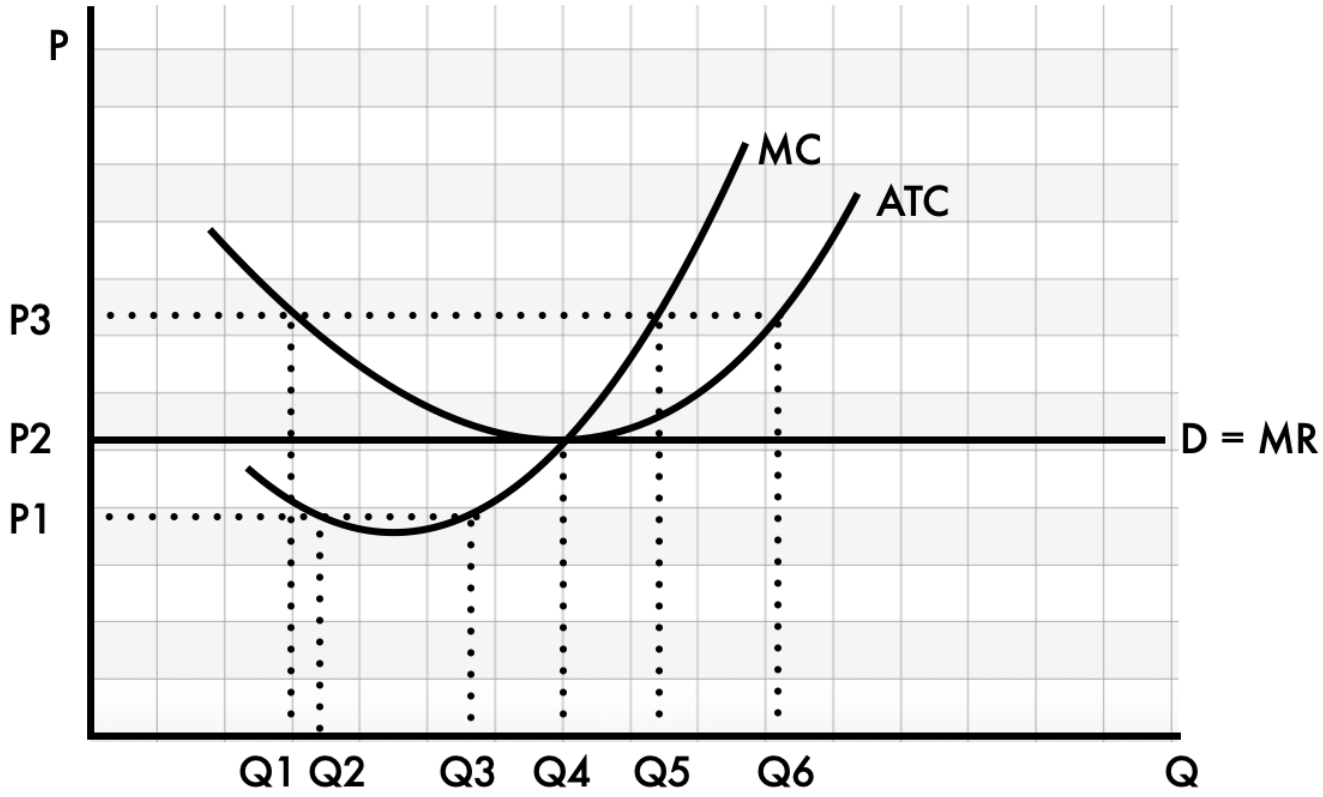
2. If the firm decides to only produces 1 unit of output, explain why it should consider increasing its output?

MR > MC, MEANS THE FIRM CAN INCREASE PROFIT BY INCREASING OUTPUT

3. What level of output should this firm produce to maximize its profit?

WHERE MR=MC AT A TOTAL PRODUCT OF 8

Refer to the following graph for a firm to answer questions 4 and 5



4. What is the profit maximizing price and quantity for the firm?

MR = MC at P2, Q4

5. At the profit-maximizing level of production, explain why this firm does not earn an economic profit?

P2 = ATC, so total revenue = total cost

TOPIC 3.6
Firms' Short-Run Decisions to Produce and Long-Run Decisions to Enter or Exit a Market

Required Course Content

ENDURING UNDERSTANDING

PRD-2

Firms' short-run decisions to produce output, and long-run decisions to enter or exit a market, are based on profitability.

LEARNING OBJECTIVE

PRD-2.A

Explain (using graphs or data where appropriate) firms' short-run decisions to produce positive output levels, or long-run decisions to enter or exit a market in response to profit-making opportunities.

ESSENTIAL KNOWLEDGE

PRD-2.A.1

In the short run, firms decide to operate (i.e., produce positive output) or shut down (i.e., produce zero output) by comparing total revenue to total variable cost or price to average variable cost (AVC).

PRD-2.A.2

In the absence of barriers to entry or exit, in the long run (i.e., once factors that are fixed in the short run become variable), firms enter a market in which there are profit-making opportunities and exit a market when they anticipate economic losses.

SUGGESTED SKILL

Interpretation

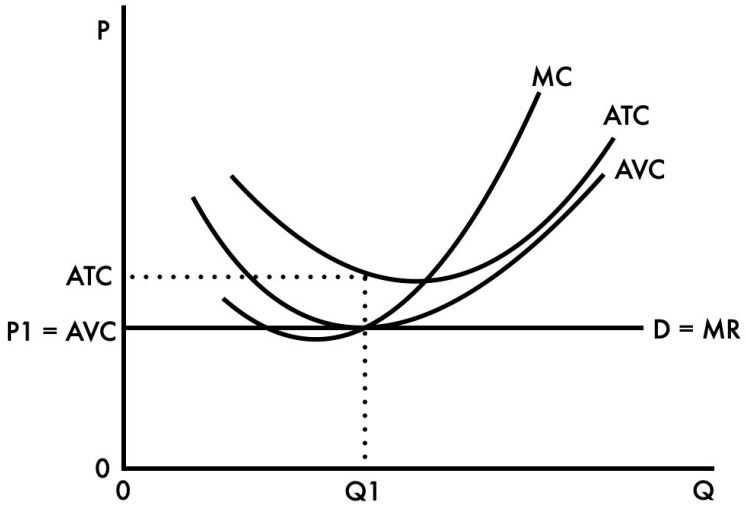
2.A

Using economic concepts, principles, or models, explain how a specific economic outcome occurs, or what action should be taken in order to achieve a specific economic outcome.

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1. Will a firm produce if it is taking an economic loss? It depends. If the firm can at least cover its variable costs, it will remain in business. However, if a firm is unable to earn enough to at least cover its variable costs, then the firm will shut down. In the long run, firms may not just shut down, but exit the industry entirely.

2. In the graph below, a decrease in market demand resulted in a firm facing a lower price, lower marginal revenue, and less demand.



i. In the short run, the firm earns an economic loss equal to [(ATC - P1) X Q1]. Should it shut down? No, as long as the price is equal to or greater than AVC, then the firm should continue to operate in the short run.

ii. Why should a firm operate if it's taking a loss? When a firm is operating above AVC, then it is at least covering its variable costs and maybe even some of its fixed costs. If the firm shuts down, then its loss will be greater (ATC X Q1) than if it were to continue.

iii. When should a firm shut down? Above, a firm is operating at a price equal to its average variable cost (P1 = AVC). In review, a firm operating below ATC and above AVC should continue to produce in the short run. Below point AVC, the firm should shut down.

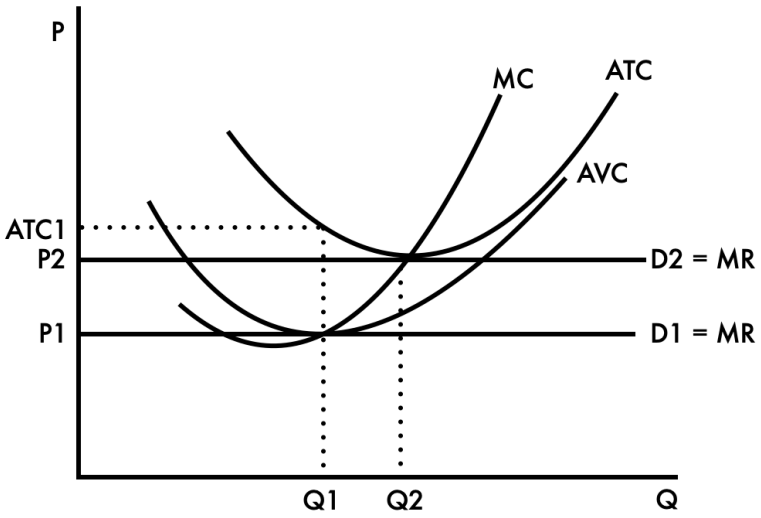
*Note that the firm's marginal cost curve from AVC up is also the firm's supply curve.

Use the table to below to determine whether each of these firms should produce or shut-down

Firm	Total Revenue	Variable Cost	Total Cost
A	$500	$400	$600
B	$750	$750	$1,000
C	$1,000	$1,200	$2,000
D	$2,500	$1,600	$2,200

1. Which firm(s) should shut down immediately?
2. Which firm(s) should continue to produce in the short-run?
3. Which firm is operating at the shut-down point?
4. Which firm is earning an economic profit?

Use the graph below to answer questions 5 - 13



5. A firm facing D2 = MR, has an average total cost equal to...

6. A firm facing D2 = MR has total cost equal to...

7. A firm facing D2 = MR has total revenue equal to....

8. A firm facing D2 = MR has economic profit equal to...

9. A firm facing D1 = MR, has total cost equal to...

10. A firm facing D1 = MR, has total revenue equal to...

11. A firm facing D1 = MR, has an economic profit/loss equal to....

12. A firm operating at a price less than P1 should
    a. Continue to produce in the short run
    b. Continue to produce in the long run
    c. Shut down immediately

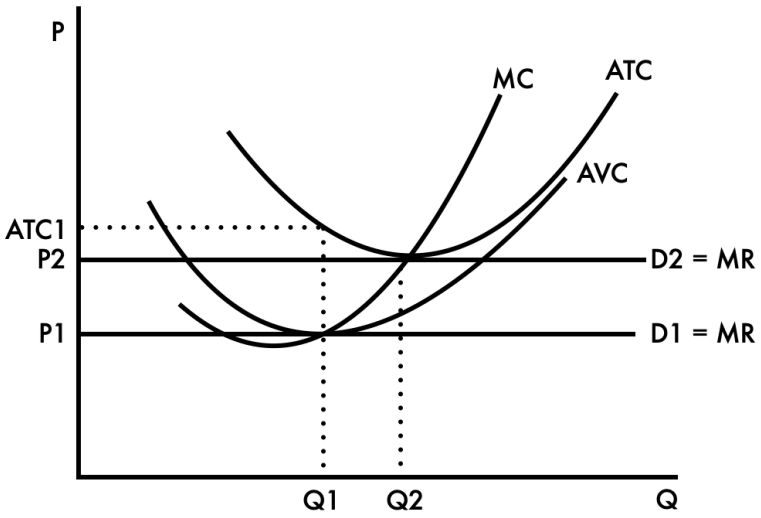
13. Why is a firm facing D1 = MR at P1 better off producing in the short run rather than shutting down?

Use the table to below to determine whether each of these firms should produce or shut-down

Firm	Total Revenue	Variable Cost	Total Cost
A	$500	$400	$600
B	$750	$750	$1,000
C	$1,000	$1,200	$2,000
D	$2,500	$1,600	$2,200

1. Which firm(s) should shut down immediately? Firm C
2. Which firm(s) should continue to produce in the short-run? Firms A, B, and D
3. Which firm is operating at the shut-down point? Firm B
4. Which firm is earning an economic profit? Firm D

Use the graph below to answer questions 5 - 13



5. A firm facing D2 = MR, has an average total cost equal to... P2

6. A firm facing D2 = MR has total cost equal to... P2 X Q2

7. A firm facing D2 = MR has total revenue equal to.... P2 X Q2

8. A firm facing D2 = MR has economic profit equal to... Zero

9. A firm facing D1 = MR, has total cost equal to... ATC1 X Q1

10. A firm facing D1 = MR, has total revenue equal to... P1 X Q1

11. A firm facing D1 = MR, has an economic profit/loss equal to.... Loss = (ATC1 - P1) X Q1

12. A firm operating at a price less than P1 should
    a. Continue to produce in the short run
    b. Continue to produce in the long run
    c. Shut down immediately

    C

13. Why is a firm facing D1 = MR at P1 better off producing in the short run rather than shutting down?

Loss of [(ATC1 - P1) X Q1] < Loss of (ATC1 X Q1)

SUGGESTED SKILL

Graphing and Visuals

4.A

Draw an accurately labeled graph or visual to represent an economic model or market.

AVAILABLE RESOURCE

- Classroom Resources > Markets—Product and Factor Markets

TOPIC 3.7
Perfect Competition

Required Course Content

ENDURING UNDERSTANDING

PRD-3

Even with a common goal of profit-maximization, market structure constrains and influences prices, output, and efficiency.

LEARNING OBJECTIVE

PRD-3.A

a. Define (using graphs as appropriate) the characteristics of perfectly competitive markets and efficiency.

b. Explain (using graphs where appropriate) equilibrium and firm decision making in perfectly competitive markets and how prices in perfectly competitive markets lead to efficient outcomes.

c. Calculate (using data from a graph or table as appropriate) economic profit (loss) in perfectly competitive markets.

ESSENTIAL KNOWLEDGE

PRD-3.A.1

A perfectly competitive market is efficient. Firms in perfectly competitive markets face no barriers to entry and have no market power.

PRD-3.A.2

In perfectly competitive markets, prices communicate to consumers and producers the magnitude of others' marginal costs of production and marginal benefits of consumption and provide incentives to act on that information (i.e., price equals marginal cost in an efficient market).

PRD-3.A.3

In perfectly competitive markets, firms can sell all their outputs at a constant price determined by the market.

PRD-3.A.4

At a competitive market equilibrium, firms are price takers and select output to maximize profit by producing the level of output where the marginal cost equals marginal revenue (at the price).

continued on next page

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LEARNING OBJECTIVE

PRD-3.A

a. Define (using graphs as appropriate) the characteristics of perfectly competitive markets and efficiency.

b. Explain (using graphs where appropriate) equilibrium and firm decision making in perfectly competitive markets and how prices in perfectly competitive markets lead to efficient outcomes.

c. Calculate (using data from a graph or table as appropriate) economic profit (loss) in perfectly competitive markets.

ESSENTIAL KNOWLEDGE

PRD-3.A.5

At a competitive market equilibrium, the price of a product equals both the private marginal benefit received by the last unit consumed and the private marginal cost incurred to produce the last unit, thus achieving allocative efficiency.

PRD-3.A.6

In a short-run competitive equilibrium, price can either be above or below its long-run competitive level resulting in profits or losses, motivating entry or exit of firms and moving prices and quantities toward long-run equilibrium.

PRD-3.A.7

In a long-run perfectly competitive equilibrium, productive efficiency implies all operating firms produce at efficient scale, price equals marginal cost and minimum average total cost, and firms earn zero economic profit.

PRD-3.A.8

Firms may be in a constant cost, increasing cost, or decreasing cost industry. Long-run prices depend on the portion of the long-run cost curves on which firms operate.

PRD-3.A.9

A perfectly competitive market in long-run equilibrium is allocatively and productively efficient.

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A. Perfect competition exists when both buyers and sellers are price-takers. That means neither has any influence over the price of a product.

B. Conditions for perfect competition

1. There are so many sellers that no single seller's contribution to the industry's output is significant. Sellers can sell any quantity they want at a market price that is determined outside their control. This is what it means to be a price taker, and it means that from the firm's perspective, demand is a perfectly elastic horizontal line.

2. Producers all offer an identical product or commodity. In perfect competition, consumers don't care from which seller they buy the product because all of the producers are offering the exact same thing.

   i. Homogenous and undifferentiated are terms frequently used to describe this same idea. For example, most people don't care which farmer produced the wheat or corn they eat. Because the goods are identical, there is no non-price competition between firms claiming to have better products than each other.

3. Producers are able to enter into and exit from the market freely. This means that they don't face any barriers to entry. Based on your understanding of economic profit, you'd probably guess if entrepreneurs could expect to make positive economic profits in an industry, that new firms would be joining that industry over time.

   i. The opposite happens when firms in a sector are taking losses—some go under in the long run. Whether there are barriers to entry in an industry dictates whether firms will be able to make economic profits in the long run. In this case, since there are no barriers to market entry and exit, firms can be expected to break even or make exactly a normal profit in the long run.

C. Graphing Perfect Competition

1. The graph below shows a market for an industry (left) and an individual firm (right) in a long-run equilibrium.

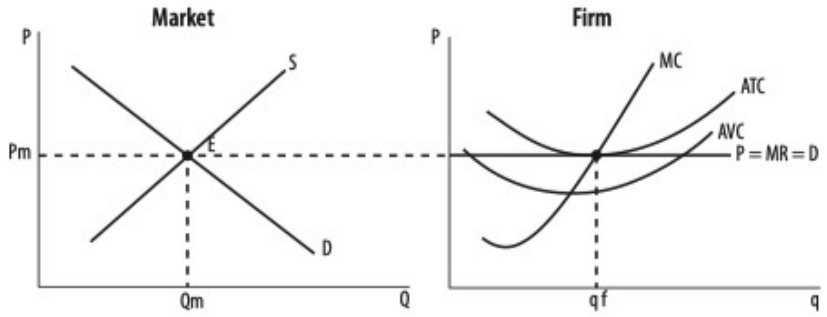
   i. The price determined in the market (Pm) becomes the demand curve and the marginal revenue curve the firm faces.

   ii. The firm uses the profit maximization rule (MR = MC) to determine its profit maximizing output of (q f).

   iii. In this case, a long-run equilibrium is shown because the firm is only earning a normal profit (zero economic profit).

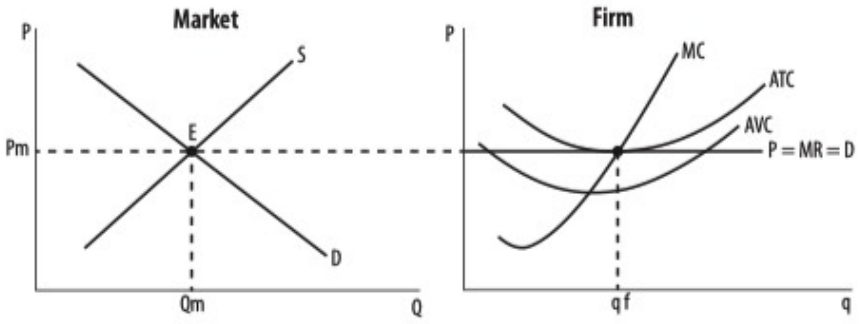
   iv. The firm is productively efficient because it is producing at the lowest average total cost (ATC).

   v. The firm is allocatively efficient because it is producing at the point where the marginal cost equals the market price.

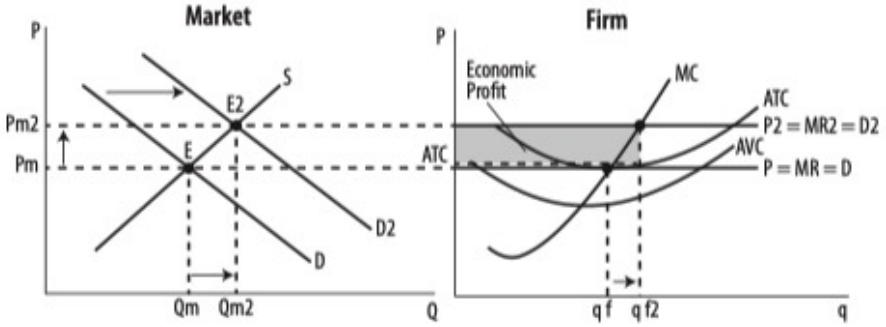


A. Changes in the market supply or demand for a product will cause the firm to either earn economic profits or encounter economic losses.

Assume a perfectly competitive firm in a long run equilibrium where price equals marginal revenue equals marginal cost equals average total cost. In this case, the firm produces quantity qf and is earning zero economic profit. The firm is allocatively efficient because the price equals marginal cost, and it is productively efficient because it is producing qf at minimum average total cost.



1. The side-by-side graphs below show how an increase in market demand affects the firm in the short run.



i. In the market graph on the left, the increase in demand from D to D2 tugs the market into a new equilibrium, E2. There has been an increase in the market price from Pm to Pm2 and an increase in quantity from Qm to Qm2.

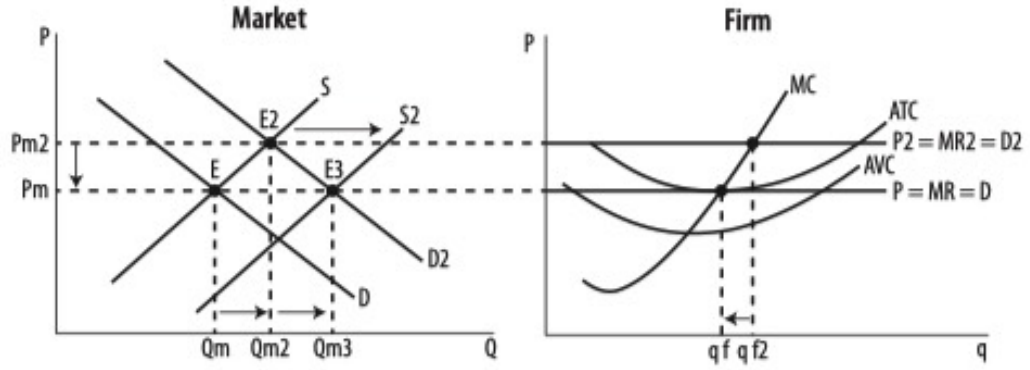
ii. The new equilibrium-market price (Pm2) becomes the price the firm takes and as a result is also the firm's marginal revenue (MR2) and new demand curve (D2).

iii. The firm produces at the point where MR2 = MC to maximize profits. This results in the firm increasing production from q f to q f2. At that quantity, the firm earns economic profits (shaded area) in the short run because the price is greater than the firm's average total cost (ATC). Note carefully where the profit box is. It will always have a height of price minus average total cost (P – ATC) and always have a width of the quantity the firm produces (the q for which MC = MR).

iv. Although the firm is allocatively efficient (P2 = MC at the quantity the firm makes – q2), it is not productively

2. In the long run, the presence of economic profits in the industry gives other entrepreneurs an incentive to enter into the industry and compete with the firms already there. The side-by-side graphs below show how the market and firm adjust to the long run.

i. In the market graph, the entrance of the new firms (one of the determinants of supply) is seen as the increase in the supply curve from S to S2. This results in a new equilibrium (E3). At E3, the price returns to the previous market price of Pm while the quantity produced increases from Qm2 to Qm because of the additional firms adding to the already existing output.

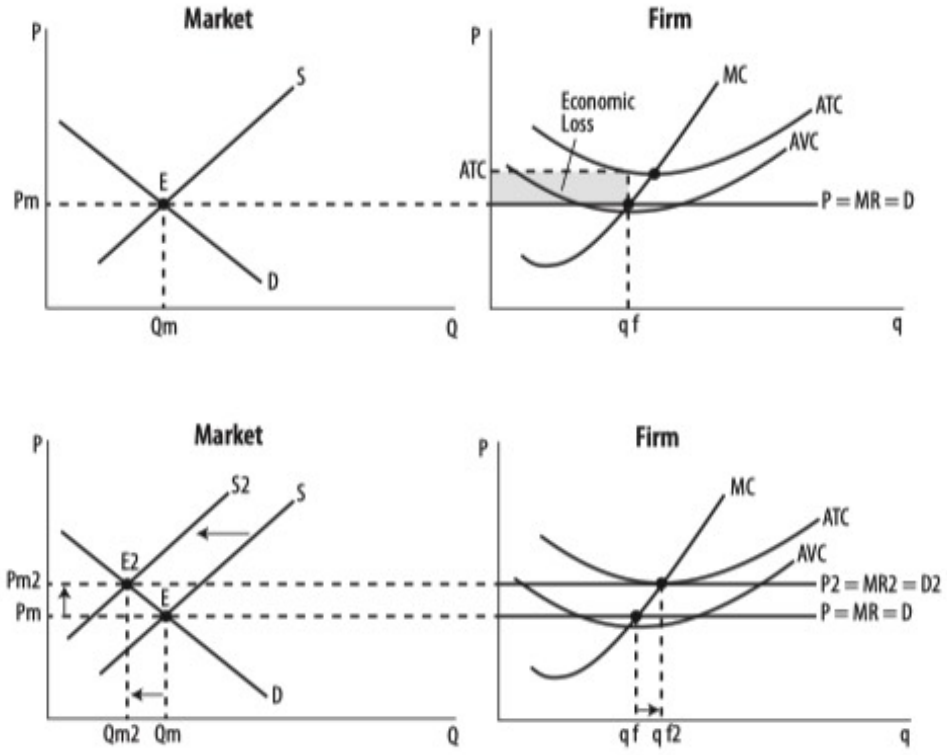


ii. The firm sees its economic profits disappear as the market price and therefore the firm's demand and marginal revenue return to their original level.

iii. As always, the firm maximizes profits by producing where MR = MC and so returns to producing quantity qf. Note that each firm produces a smaller quantity after this long-run adjustment but that the market quantity increases due to the increased number of firms.

iv. Note that as before when in long-run equilibrium, the firm is allocatively and productively efficient once again.

6. How does the presence of economic losses affect firms in the long run? The graphs below illustrate the long-run response to losses in an industry as some firms exit.



7. As some firms exit the industry because of economic losses, the market supply decreases. This results in a higher market price (Pm2) but lower market quantity (Qm2).

8. The higher market price means an increase in the firm's marginal revenue and demand. This results in a return to the long-run equilibrium in which the firm earns a normal profit and is both allocatively efficient (P = MC) and productively efficient (q at ATC minimum).

B. Costs in the Long Run

1. In the long run, perfectly competitive firms face different average total costs depending on the industry they compete in.

   i. Constant costs across an industry occur when the number of firms in the industry has no effect on each individual firm's average total cost. Whether the firm is new or has been around awhile it has no effect on each firm's average total cost. For example, farmers face the same average total cost regardless of the time they have spent in the industry.

   ii. Increasing costs across an industry happens when the entrance of new firms drives up the cost of inputs used by the entire industry. For example, as more hotels are built along a popular beach, newer firms face ever-increasing costs as scarce beachfront property becomes increasingly expensive.

   iii. Decreasing costs across an industry happens when the entrance of new firms drives down the cost of inputs used by the entire industry. As tablet computers become more popular, the firms that supply the glass and lightweight components to the tablet industry expand and experience economies of scale, which reduces the cost of inputs for the tablet industry as a whole.

1. Define the following:
    allocative efficiency
    barriers to entry
    constant cost industry
    decreasing cost industry
    increasing cost industry
    market power
    price-taker
    productive efficiency

2. Draw a side-by-side graph of the perfectly competitive market for green beans and the perfectly competitive firm Billy's Green Beans in a long run equilibrium.

3. Assume green beans and peas are substitute goods. Using the side–by–side graphs you drew in question 2, show the effect of an increase in the price of peas on the market for green beans and Billy's Green Beans.

4. Based on your responses to question 3, indicate the changes in the following
    a. Market quantity of green beans
    b. Market price of green beans
    c. Quantity of green beans produced by Billy's Green Beans
    d. Economic profit for Billy's Green Beans.
    e. Billy's Green Beans' average total cost

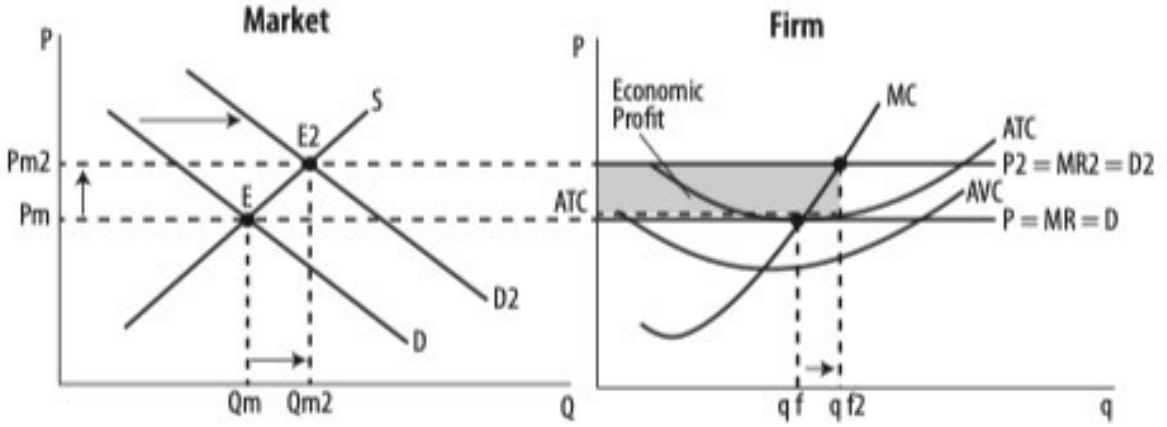
5. Explain how the perfectly competitive market for green beans will adjust in the long run to the changes you identified in 4.

6. In the long-run, will Billy's Green Beans earn economic profits? Explain.

1. Define the following:

allocative efficiency	*P = MC*
barriers to entry	*Factors which prevent entry or exit from an industry*
constant cost industry	*As number of firms increase in an industry costs do not change*
decreasing cost industry	*As number of firms increase in an industry costs decrease*
increasing cost industry	*As number of firms increase in an industry costs increase*
market power	*The ability of some firms to exert limited control over the market price*
price-taker	*Perfectly competitive firms take the market price and have no control*
productive efficiency	*Producing at minimum ATC*

2. Draw a side-by-side graph of the perfectly competitive market for green beans and the perfectly competitive firm Billy's Green Beans in a long run equilibrium.



3. Assume green beans and peas are substitute goods. Using the side–by–side graphs you drew in question 2, show the effect of an increase in the price of peas on the market for green beans and Billy's Green Beans.

4. Based on your responses to question 3, indicate the changes in the following
   a. Market quantity of green beans *Increase*
   b. Market price of green beans *Increase*
   c. Quantity of green beans produced by Billy's Green Beans *Increase*
   d. Economic profit for Billy's Green Beans. *Increase*
   e. Billy's Green Beans' average total cost *Increase*

5. Explain how the perfectly competitive market for green beans will adjust in the long run to the changes you identified in 4.

In the long-run, the presence of economic profit in the industry attracts new firms which

6. In the long-run, will Billy's Green Beans earn economic profits? Explain.

No, the presence of more firms in the industry increases the supply, reducing the market price

9. For a perfectly competitive firm, assume the price equals a rising marginal cost at 200 units of output. At this output, average total cost is $8 and average variable cost is $5. If the price is $4, by how much can this firm reduce its losses by shutting down?
   (A) $800
   (B) $600
   (C) $400
   (D) $200
   (E) $100

10. Which of the following is true for a perfectly competitive firm?
   (A) The firm is a price taker.
   (B) The firm chooses its profit-maximizing quantity by equating price to average total cost.
   (C) The firm faces a downward-sloping demand curve for its product.
   (D) The firm's short-run supply curve is the same as its average variable cost curve above the minimum of the marginal cost curve.
   (E) The firm can expect to earn positive economic profit in long-run equilibrium.

9. (D), 10. (A)

Section II: Free-Response

The following are examples of the kinds of free-response questions found on the exam. Note that on the actual AP Exam, there will be one long free-response question worth 10 points and two short free-response questions, each worth 5 points.

1. On the island of Gratin, potatoes are produced in a perfectly competitive constant cost industry. The market for potatoes is currently in long-run equilibrium at the market price of $5 per sack.
   (a) Draw correctly labeled side-by-side graphs for the potato market and for farmer Lamo and show each of the following.
      (i) The market equilibrium quantity and price, labeled Q_M and $5, respectively
      (ii) The quantity produced and the price for farmer Lamo, labeled Q_L and $5, respectively
   (b) Believing that the incomes of potato farmers are unfairly low, the government of Gratin imposes a binding price floor at $7 per sack. The government will purchase any surpluses of potatoes. On your graph in part (a), show each of the following.
      (i) The market quantity of potatoes that would be supplied at the price floor, labeled Q_F
      (ii) The profit farmer Lamo earns, shaded completely
   (c) If the absolute value of the price elasticity of demand is 0.92, would consumer spending on potatoes increase, decrease, or stay the same as a result of the price floor? Explain.
   (d) How would the price floor affect the demand for labor by potato farmers?
   (e) Potatoes, corn, and rice are all produced on the island of Gratin in perfectly competitive markets.
      (i) Assume corn is a substitute in production (an alternate output) for potatoes. How would setting the price floor on potatoes affect the equilibrium price and quantity of corn?
      (ii) As a result of an increase in the price of rice, the demand for potatoes increased. Are rice and potatoes substitutes or complements in consumption?

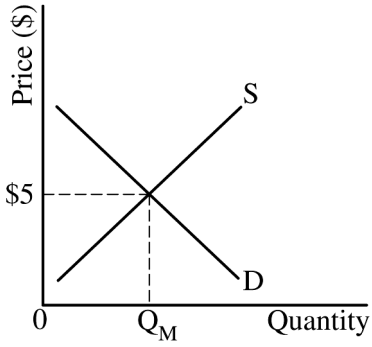
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Scoring Guidelines for Question 1: Long — 10 points

Learning Objectives: MKT-3.B | MKT-3.D | MKT-3.E | POL-4.A | PRD-3.A | PRD-4.B

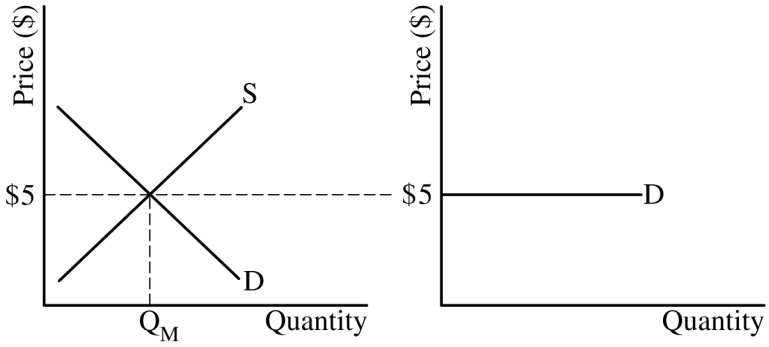
(a) Draw a correctly labeled graph of the potato market that shows the market equilibrium quantity and price labeled Q_M and \$5, respectively. **1 point** 4.A

Task type: Create graphs or visual representations



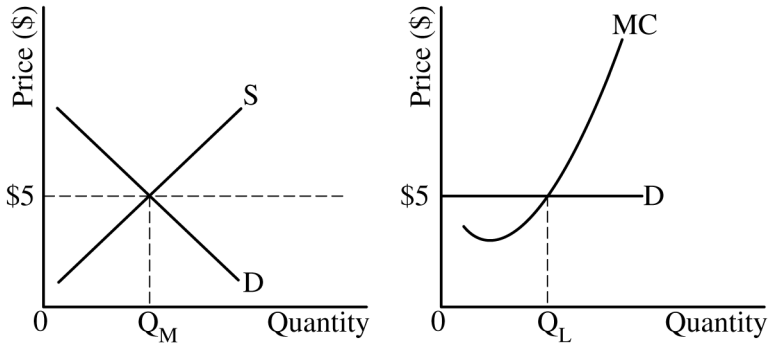
Draw a correctly labeled graph for farmer Lamo next to the graph of the potato market that shows a horizontal demand curve for Lamo coming from the market equilibrium price of \$5. **1 point** 4.A

Task type: Create graphs or visual representations



Show the profit-maximizing quantity Q_L, where P = MC. **1 point** 4.B

Task type: Create graphs or visual representations



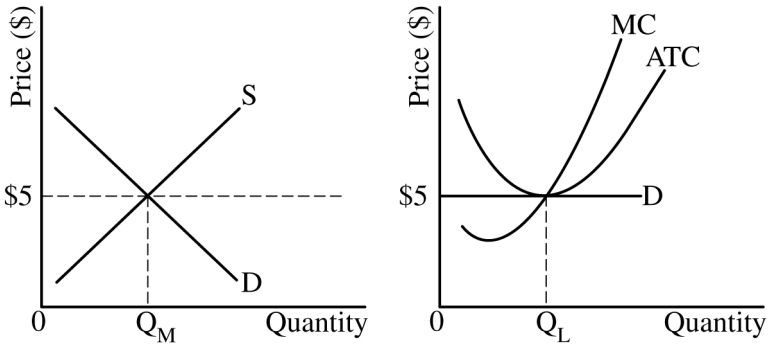
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Show the ATC curve tangent to Lamo's demand curve at Q_L.

1 point

4.B

Task type: Create graphs or visual representations



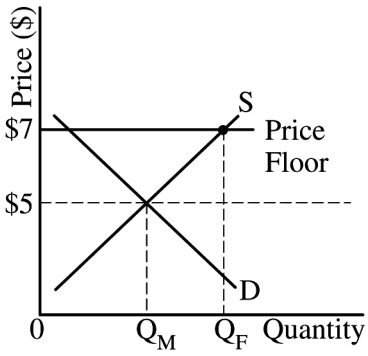
Total for part (a) **4 points**

(b) **(i)** On the graph from part (a), show the market quantity of potatoes that would be supplied at the price floor, labeled Q_F.

1 point

4.C

Task type: Create graphs or visual representations

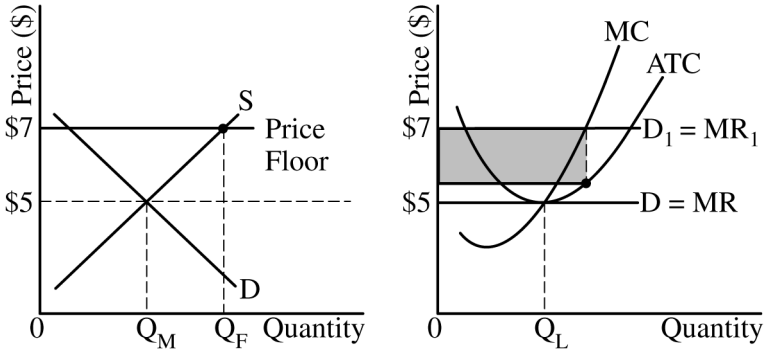


(ii) On the graph from part (a), show the profit farmer Lamo earns with the price floor, shaded completely.

1 point

4.C

Task type: Create graphs or visual representations



Total for part (b) **2 points**

(c) State that consumer spending on potatoes will increase and explain that because the demand for potatoes is inelastic, the price increase will result in an increase in total spending. (It is also acceptable to explain that because demand is inelastic, the percentage increase in price outweighs the percentage decrease in the quantity demanded of potatoes, resulting in an increase in total spending on potatoes.)

1 point

3.C

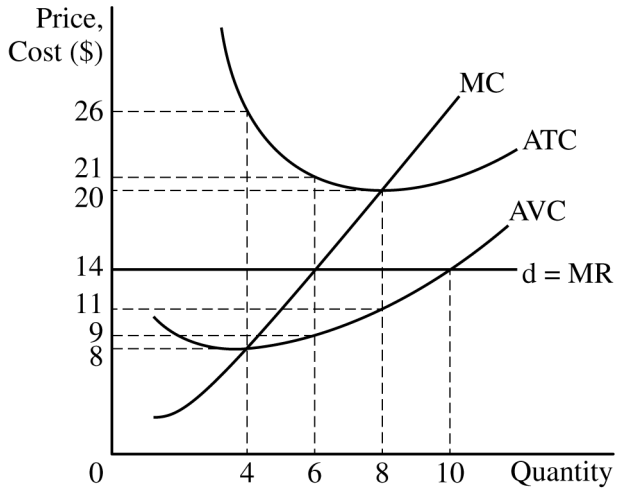
Task type: Explain

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(d)	State that the demand for labor will increase and/or the demand curve will shift to the right. *Task type: Make an assertion*	**1 point** 3.B
(e)	**(i)** State that the equilibrium price of corn will increase and the equilibrium quantity of corn will decrease. *Task type: Make an assertion*	**1 point** 3.B
	(ii) State that potatoes and rice are substitutes in consumption. *Task type: Make an assertion*	**1 point** 2.A
	Total for part (e)	**2 points**
	Total for question 1	**10 points**

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3. The graph provided shows the demand (d), marginal revenue (MR), average total cost (ATC), average variable cost (AVC), and marginal cost (MC) curves for Hansel Hangout, a typical profit-maximizing firm in a perfectly competitive market producing Good X.



(a) Calculate Hansel Hangout's total fixed cost. Show your work.

(b) Identify the price and Hansel Hangout's profit-maximizing quantity of Good X.

(c) Calculate Hansel Hangout's economic profit at the quantity identified in part (b). Show your work.

(d) As the market for Good X adjusts to the long-run equilibrium, what will happen to the price of Good X? Explain.

(e) Assume the cross-price elasticity of demand between Good X and Good C is positive. Given the change in the long-run price of Good X in part (d), will the quantity demanded of Good C increase, decrease, or remain the same? Explain.

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.

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Question 3: Short — 5 points

(a)	Calculate the total fixed cost as \$72 and show your work. $\text{Total Fixed Cost} = (\text{Average Total Cost} - \text{Average Variable Cost}) \times \text{Quantity}$ $\text{Total Fixed Cost} = (\$26 - \$8) \times 4 = (\$18 \times 4) = \$72$ OR $\text{Total Fixed Cost} = (\$21 - \$9) \times 6 = (\$12 \times 6) = \$72$ OR $\text{Total Fixed Cost} = (\$20 - \$11) \times 8 = (\$9 \times 8) = \$72$	**1 point**
(b)	Identify the price as \$14 and the profit-maximizing quantity as 6 units.	**1 point**
(c)	Calculate Hansel Hangout's economic profit at the profit-maximizing quantity as $-\$42$ and show your work. $\text{Economic Profit} = (\text{Price} - \text{Average Total Cost}) \times \text{Quantity}$ $= (\$14 - \$21) \times 6 \text{ units} = (-\$7 \times 6) = -\$42$ OR $\text{Economic Profit} = \text{Total Revenue} - \text{Total Cost}$ $= (\$14 \times 6) - (\$21 \times 6) = \$84 - \$126 = -\$42$	**1 point**
(d)	State that the market price of Good X will increase in the long run and explain that some firms will exit the market due to the negative economic profits, causing the market supply curve to shift to the left, increasing the market equilibrium price.	**1 point**
(e)	State that the quantity demanded of Good C will increase and explain that a positive cross-price elasticity of demand indicates that the two goods are substitutes in consumption, and an increase in the price of Good X will increase the demand for Good C, causing an increase in the quantity demanded of Good C.	**1 point**
	Total for question 3	**5 points**

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1. Soja Farm is a typical profit-maximizing firm that produces and sells soybeans in a constant-cost, perfectly competitive market that is in long-run equilibrium. The market equilibrium price of soybeans is $14 per bushel.

   (a) Draw correctly labeled side-by-side graphs for the soybean market and for Soja Farm, and show each of the following.

   (i) The market equilibrium price and quantity, labeled $14 and Q_M, respectively
   (ii) Soja Farm's profit-maximizing price and quantity, labeled P_F and Q_F, respectively
   (iii) Soja Farm's average total cost curve consistent with a long-run equilibrium, labeled ATC

   (b) If Soja Farm is the only firm in the market that chooses to increase its price of soybeans to $15 per bushel, will Soja Farm's total revenue increase by $1, remain the same, or decrease to $0 ? Explain.

   (c) Soybeans are used as an input in the production of tofu. Tofu now becomes a more popular food option among consumers. On your graphs in part (a), show the short-run effect of the increased popularity of tofu on each of the following.

   (i) The new market equilibrium price and quantity of soybeans, labeled P_2 and Q_2, respectively
   (ii) Soja Farm's new profit-maximizing quantity, labeled Q*

   (d) Given the increase in popularity of tofu in part (c), what will happen to the number of firms in the soybean market in the long run? Explain.

   (e) Suppose a 25% increase in the market price of quinoa causes a 5% decrease in the quantity demanded of quinoa and a 10% increase in the quantity demanded for tofu.

   (i) Is the demand for quinoa elastic, inelastic, or unit elastic? Explain using numbers.
   (ii) Calculate the cross-price elasticity of demand between quinoa and tofu. Show your work.

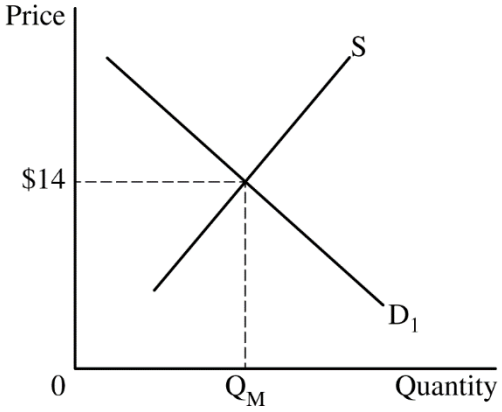
Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

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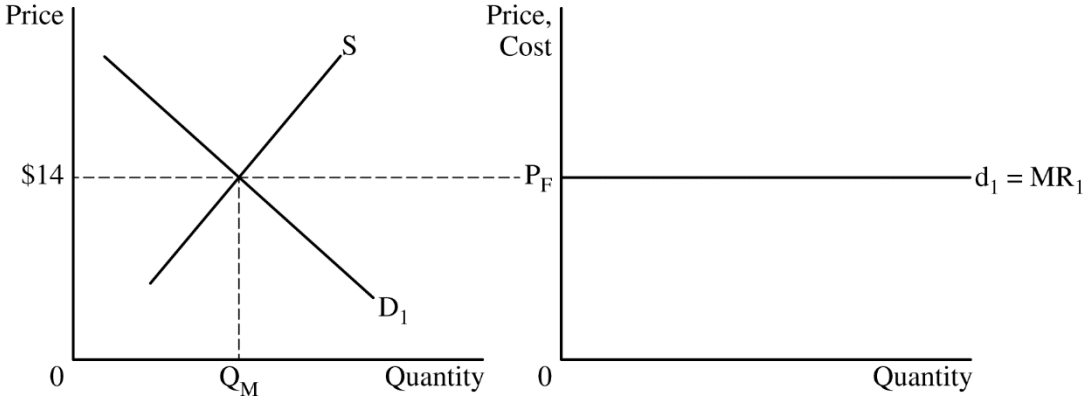
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Question 1: Long — 10 points

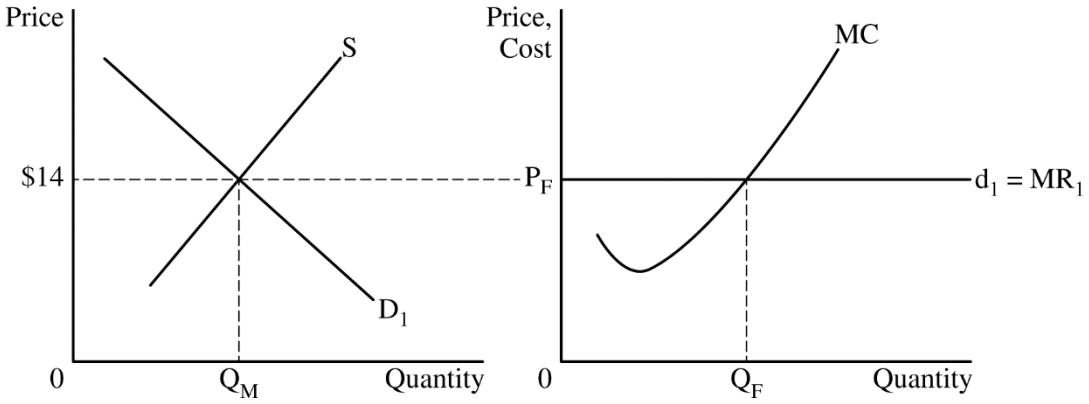
(a) Draw a correctly labeled graph of the market for soybeans with a downward-sloping demand (D_1) curve and an upward-sloping supply (S) curve and label the market equilibrium price as \$14 and the market equilibrium quantity as Q_M. **1 point**



For the second point, draw a correctly labeled graph of Soja Farm and show the firm's horizontal demand and marginal revenue (d_1=MR_1) curve extended from the market equilibrium price and label the firm's price as P_F. **1 point**

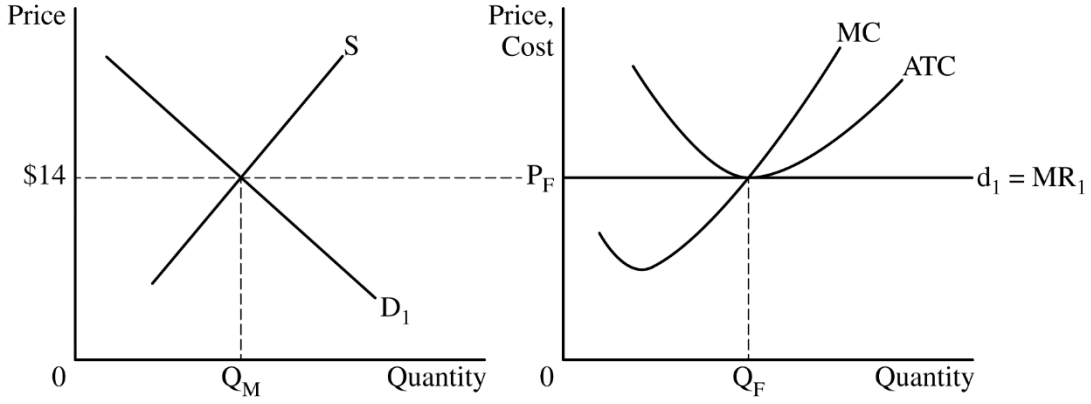


For the third point, the firm's graph must show a rising marginal cost (MC) curve, and show the profit-maximizing quantity, labeled Q_F where MR = MC. **1 point**



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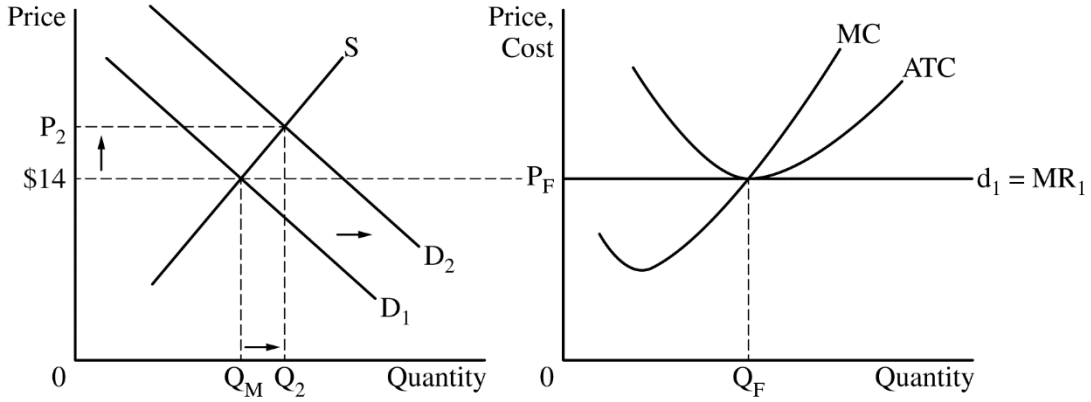
For the fourth point, the firm's graph must show the average total cost (ATC) curve tangent to the firm's demand curve at Q_F and show the MC curve passing through the minimum point of the ATC curve. **1 point**



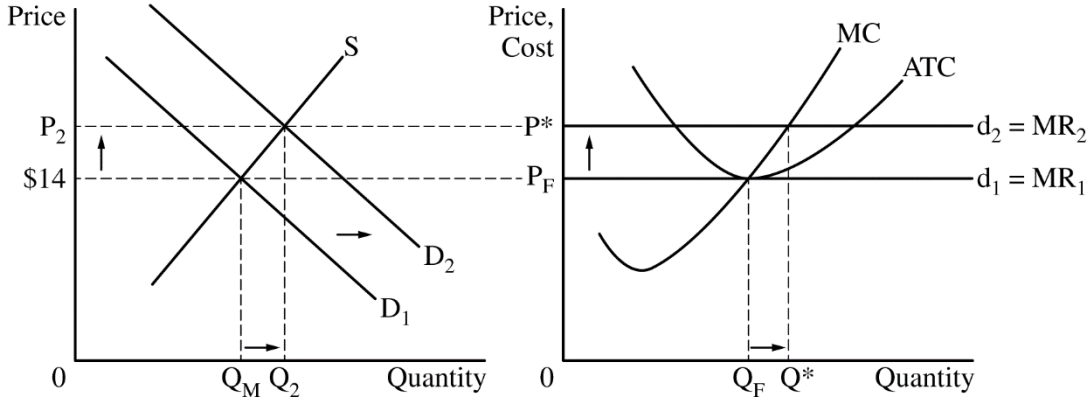
Total for part (a) **4 points**

(b) State that Soja Farm's total revenues would decrease to $0 and explain that all consumers of soybeans would buy soybeans from other sellers who charge the market price of $14. **1 point**

(c) (i) The market graph from part (a) must show a rightward shift of the market demand curve and the new equilibrium price labeled P_2 and the new equilibrium quantity labeled Q_2. **1 point**



(ii) The firm's graph from part (a) must show an upward shift in the firm's marginal revenue (demand) curve at P_2 and the new profit-maximizing quantity for Soja Farms, labeled Q*. **1 point**



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	Total for part (c)	**2 points**
(d)	State that the number of firms will increase in the long run and explain that the positive economic profits earned by soybean producers will encourage new firms to enter the market.	**1 point**
(e) (i)	State that demand for quinoa is inelastic and explain with **ONE** of the following. • The absolute value of the price elasticity of demand for quinoa is 0.2. • The 5% decrease in the quantity demanded of quinoa is less than the 25% increase in the price of quinoa.	**1 point**
(ii)	Calculate the cross-price elasticity of demand as 0.4 and show your work. $\text{Cross Price Elasticity of Demand} = \frac{\%\ \text{Change in } Q_D \text{ of Tofu}}{\%\ \text{Change in Price of Quinoa}} = \frac{10\%}{25\%} = 0.4$	**1 point**
	Total for part (e)	**2 points**
	Total for question 1	**10 points**

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1. Sugar is produced in a perfectly competitive market using inputs from perfectly competitive factor markets. Frank Sugar Co. is a representative firm in the sugar market.

   (a) Assume Frank Sugar Co. is earning zero economic profit. Draw correctly labeled side-by-side graphs for the sugar market and Frank Sugar Co. and show each of the following.

   (i) The market equilibrium price and quantity, labeled P_M and Q_M, respectively
   (ii) The profit-maximizing price and quantity for Frank Sugar Co., labeled P_F and Q_F, respectively

   (b) Assume the demand for sugar increases and sugar is produced in a constant-cost industry.

   (i) On your graph in part (a), show the short-run effect of the increased demand for sugar on the market price, labeled P_2, and the quantity sold by Frank Sugar Co., labeled Q_N.
   (ii) Compared to the equilibrium identified in part (a)(ii), what will happen to the short-run profit earned by Frank Sugar Co. as a result of the increased demand for sugar?
   (iii) When the market adjusts to long-run equilibrium, how will the market price of sugar in the long run compare to P_2 ? Explain.

~~(c) Instead, assume sugar consumption has a negative impact on public health over time and the negative impact of sugar on health is underestimated by consumers. Draw a correctly labeled graph of the market, with the marginal social benefit (MSB), marginal private benefit (MPB), marginal social cost (MSC), and marginal private cost (MPC) curves, and show each of the following.~~

~~(i) The market equilibrium quantity, labeled Q_M~~
~~(ii) The socially optimal quantity, labeled Q_S~~

~~(d) Assume the government decides to intervene in the market to affect consumers' incentives and to address the negative impact of sugar consumption on public health. Which of the following policies would best achieve that objective in the short run: a lump-sum tax, a per-unit tax, a lump-sum subsidy, or a per-unit subsidy? Explain.~~

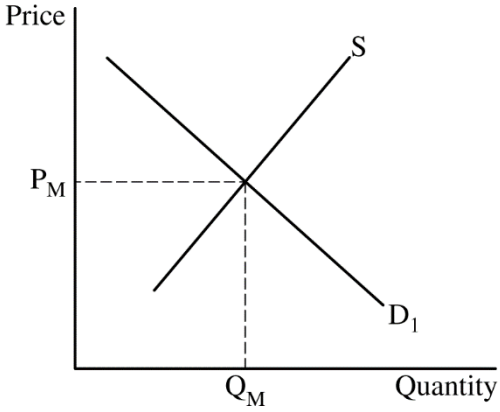
Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

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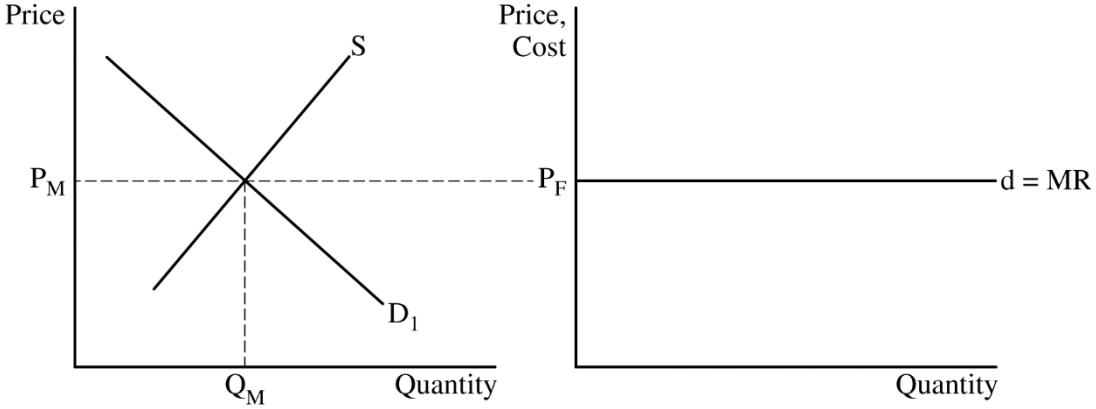
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Question 1: Long — 10 points

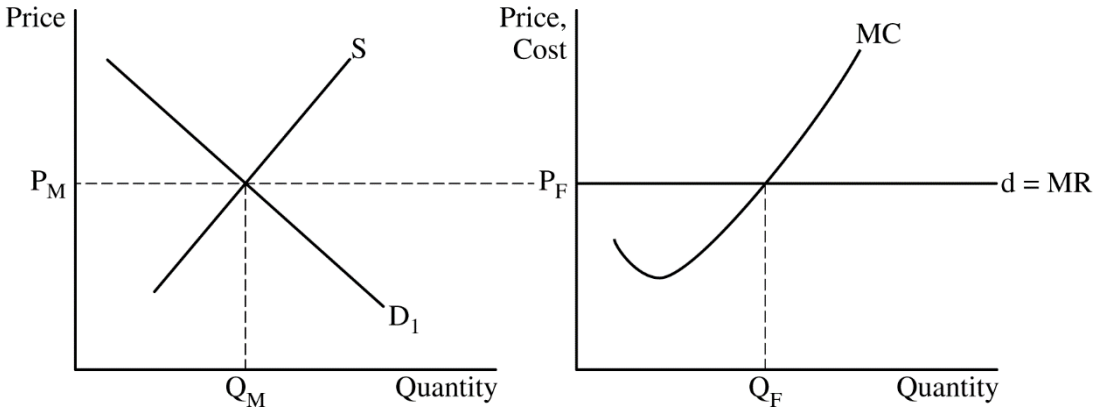
(a) Draw a correctly labeled graph of the market for sugar and show the equilibrium price and quantity, labeled P_M and Q_M, respectively. **1 point**



For the second point, the graph must show a horizontal demand curve (d = MR) for Frank Sugar Co. and label the firm's profit-maximizing price P_F at P_M. **1 point**

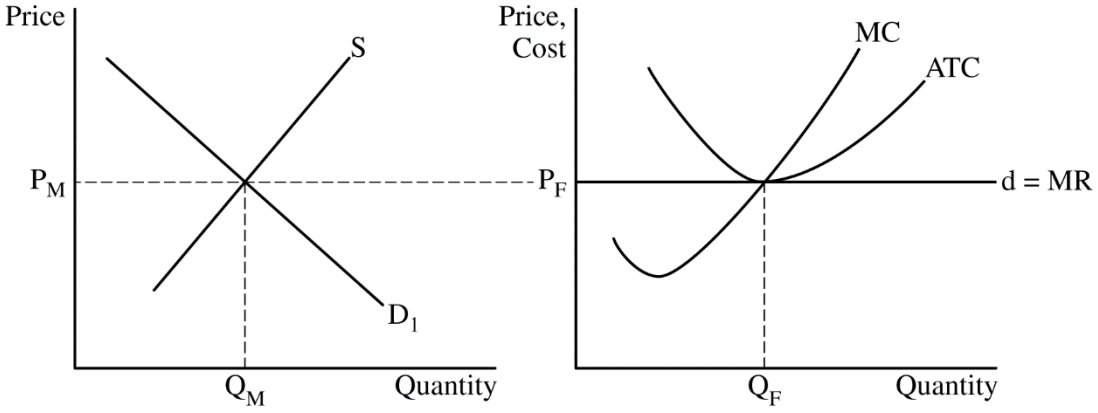


For the third point, the firm's graph must show the marginal cost (MC) curve and show the profit-maximizing quantity, labeled Q_F where MR = MC. **1 point**



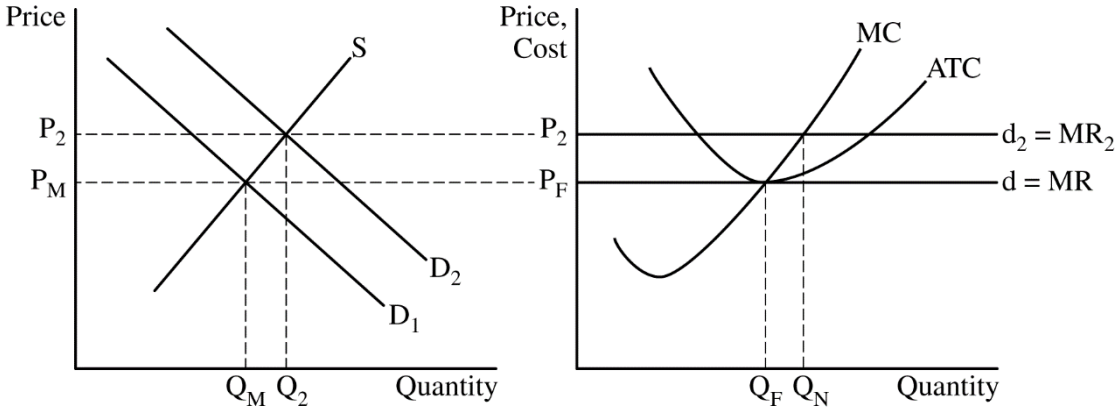
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For the fourth point, the firm's graph must show the average total cost (ATC) curve tangent to the firm's demand curve at Q_F and show the MC curve passing through the minimum point of the ATC curve. **1 point**



Total for part (a) 4 points

(b) On your market graph from part (a), show a rightward shift in the market demand curve with a higher market price, labeled P_2, and show an upward shift in the firm's demand curve with a greater quantity sold by Frank Sugar Co., labeled Q_N. **1 point**



State that the profit earned by Frank Sugar Co. will increase in the short run. **1 point**

State that the market price in long-run equilibrium will be lower than P_2 and explain that new firms will enter the market, which increases the market supply, lowering the market price back to P_M where firms earn zero economic profit in the long run. **1 point**

Total for part (b) 3 points

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