

Chief Reader Report on Student Responses: 2017 AP[®] Microeconomics Free-Response Questions

• Number of Students Scored	87,858			
• Number of Readers	92			
• Score Distribution		Exam Score	N	%At
		5	20,614	23.5
		4	24,717	28.1
		3	15,774	18.0
		2	10,502	12.0
		1	16,251	18.5
• Global Mean	3.26			

The following comments on the 2017 free-response questions for AP[®] Microeconomics were written by Chief Reader, Pamela Schmitt of the United States Naval Academy, and Operational Question Leaders Woodrow Hughes, Walentyna Karcz, and Aaron Lowen. They give an overview of each free-response question and of how students performed on the question, including typical student errors. General comments regarding the skills and content that students frequently have the most problems with are included. Some suggestions for improving student preparation in these areas are also provided. Teachers are encouraged to attend a College Board workshop to learn strategies for improving student performance in specific areas.

Question #1**Task:** Graph and explain**Topic:** Perfect competition and Price Controls**Max. Points:** 10**Mean Score:** 5.66***What were responses expected to demonstrate in their response to this question?***

The question assessed students' understanding of the characteristics of a perfectly competitive market, how a perfectly competitive market operates, how market participants adjust to changing market conditions, how changes in one market may impact other markets, and how price controls affect a competitive market. Students were expected to draw and label graphs for both the market and the individual firm in perfect competition and, given changes in market conditions, be able to show the corresponding changes on graphs. Students were expected to analyze and explain these changes.

The question states that corn, produced in a perfectly competitive market, can be used for food or ethanol production. In part (a)(i), students were asked to draw a correctly labeled graph for both the corn market and a representative firm. Part (a)(ii) asked students to show the profit-maximizing output for a firm earning zero economic profits. This part of the question tested students' knowledge of the assumptions of a competitive market and their ability to illustrate these concepts using graphs. This task includes showing that the demand curve for the firm is a horizontal line at the price determined by the market, that the profit-maximizing output of the firm is determined by equating marginal revenue and marginal cost, and that the price must equal average total cost to show zero economic profit. This part of the question also tested students' understanding of the relationship between average and marginal costs, requiring students to show that the marginal cost (MC) curve intersects the average total cost (ATC) curve at the ATC curve's minimum point.

Part (b) states that the demand for ethanol has increased and asked students to show this change on the graphs drawn in part (a) which tested students' understanding of how profits for the firm are determined. Specifically part (b)(i) tested whether or not students recognize that an increase in the demand for ethanol will increase the demand for corn, shifting the demand curve for corn to the right, thereby increasing the equilibrium price and quantity of corn in the short run. In part (b)(ii), students were asked to show whether the firm now earns profits or losses and to show this area on the firm's graph. Students are expected to show on the graph that the higher market price shifts the firm's demand curve upward, making the firm's price greater than ATC at the new profit-maximizing quantity, creating economic profits.

Part (c) asked students to explain what would happen to the market equilibrium price and quantity of corn in the long run. This tested students' understanding of how a perfectly competitive market responds to short-run economic profits — new firms enter the market, increasing market supply, causing the market price to decrease and the market quantity to increase.

Part (d) states that soybeans and corn can be grown on the same land. Students were asked to explain what would happen to the price of soybeans in the next growing season, assuming that the price of corn has increased. This part tested students' ability to recognize substitutability in production and how the related market of soybeans would respond — the higher price for corn increases the opportunity cost of growing soybeans, farmers would substitute corn for soybeans, the supply of soybeans would decrease (leftward shift of the supply curve), and the price of soybeans would increase.

Part (e) states that the government imposes a price ceiling in the corn market and asked students to draw a binding price ceiling and to indicate the quantity of corn that would be purchased by consumers. This part of the question tested students' knowledge that a binding price ceiling is below the equilibrium price, and the amount purchased would be less than the equilibrium quantity because suppliers would reduce the quantity supplied.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

Most students earned the first point in part (a) with 84% correctly drawing a downward-sloping demand curve, an upward-sloping supply curve, and identifying the equilibrium price and quantity for the market. For the remainder of part (a), correct answers were less frequent. Connecting the firm’s horizontal demand curve with the market-determined price was correctly answered by approximately 62.1% of the students. Slightly more than two-thirds (67.6%) of the students identified the profit-maximizing quantity for the firm by equating marginal revenue (MR) and MC on the firm’s graph. Approximately 60% of the students earned the final point in part (a) by identifying on the graph the long-run zero economic profit condition for the firm ($P = MC = \text{minimum ATC}$).

In part (b)(i), students were asked to show how the corn market would change assuming the demand for ethanol increased. Over three-fourths (77.7%) of the students correctly shifted the market demand curve to the right and labeled the new, higher equilibrium price and quantity. In part (b) (ii), approximately 21.6% of the students were able to show that the representative firm would earn an economic profit in the short run as a result of the increase in the demand for corn.

In part (c), students were asked to explain what would happen in the corn market in the long run. To earn this point, students needed to explain by using the following sequence of events (1) the existence of economic profits would attract new firms to enter the market, which would (2) increase the market supply or shift the market supply to the right, which would (3) decrease the market price of corn and (4) increases the equilibrium quantity in the market. Only approximately one-fifth (21.6%) of the students answered this question correctly. Many students missed this point because they were not able to make all four connections.

Part (d) states that soybeans are produced in a competitive market and that farmers can grow either corn or soybeans on the same land. Students were asked to explain what would happen to the price of soybeans in the next planting season. To earn this point, students needed to explain that (1) farmers would switch from soybean to corn production which (2) would decrease the supply of soybeans which (3) would increase the price of soybeans. Over a quarter (26.5%) of students answered this part correctly. Many students missed this point because they shifted demand curve and did not recognize that the impact was on the supply curve because the goods are substitutes in production.

Part (e)(i) asked students to draw a graph of the corn market and show the impact of imposing a binding price ceiling in the corn market, and part (e)(ii) asked students to show on the graph the quantity purchased by consumers. More than three-fourths (75.6%) of the students answered part (e)(i) correctly. Nearly two-thirds (63.8%) answered part (e)(ii) correctly.

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

<i>Common Misconceptions/Knowledge Gaps</i>	<i>Responses that Demonstrate Understanding</i>
<p>Part (a)</p> <ul style="list-style-type: none"> Not making a distinction between the market and the firm graphs (either with subscripts or market/firm titles). 	<ul style="list-style-type: none"> Drawing the market graph on the left labeled price on the vertical axis, quantity on the horizontal axis, downward sloping demand curve, and upward sloping supply curve. Drawing the firm’s graph on the right with axes labeled same as market and a horizontal demand curve labeled $d=P=MR=AR$.

<ul style="list-style-type: none"> • Not connecting the market price and the firm's horizontal demand curve. • Missing or incorrect labels on the firm's demand curve. • Improper relationship between MC and ATC. 	<ul style="list-style-type: none"> • Showing an explicit connection from the market price to the firm's demand curve, such as a dashed line. • Labeling the firm's demand with $d = P = MR = AR$. • MC must intersect ATC at the minimum point on the ATC curve.
<p>Part (b)</p> <ul style="list-style-type: none"> • Unable to illustrate the firm's profit on a graph; often shading to the minimum of the ATC or not using the new profit maximizing quantity. 	<ul style="list-style-type: none"> • The firm's profit is delineated by four points: 1) price on vertical axis; 2) the new quantity where $MR=MC$ at the new price labeled on vertical axis; 3) ATC for the quantity where $MR=MC$; 4) ATC on vertical axis.
<p>Part (c)</p> <ul style="list-style-type: none"> • Omitting steps in the long run adjustment response to economic profits being earned. 	<ul style="list-style-type: none"> • Increased demand increases economic profits for firms, attracts entry, increases market supply, decreases market price and increases market quantity.
<p>Part (d)</p> <ul style="list-style-type: none"> • Confusing substitution in production with substitution in consumption. • Shifting the demand curve instead of the supply curve; not being consistent with the information given. 	<ul style="list-style-type: none"> • When the price of corn rises, the opportunity cost of producing soybeans rises. This will cause producers to switch from soybeans to corn. • When firms switch production from soybeans to corn, this decreases the supply of soybeans, increasing the price.
<p>Part (e)</p> <ul style="list-style-type: none"> • Drawing a price ceiling at or above the equilibrium price. • Indicating the quantity purchased either at the unregulated market's equilibrium quantity or on the demand curve at the binding price ceiling. 	<ul style="list-style-type: none"> • A binding price ceiling would be a horizontal line below the equilibrium price. • The quantity purchased would be at the intersection of the binding price ceiling and the supply curve. At the price ceiling, producers would reduce their quantity supplied, and consumers would be able to purchase only this limited amount.

Based on your experience at the AP[®] Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

The model of perfect competition is a very important concept in microeconomics and frequently appears on the exam. While most students (84%) correctly drew the market graph, understanding and drawing the graph for the representative firm in long-run equilibrium need more attention. Emphasizing that firms are price-takers should help make the linkage between the market equilibrium price and the firm's horizontal demand curve. To demonstrate this graphically, having a dashed line from the market equilibrium price to the firm's horizontal demand would improve student performance. Another point of emphasis is the graphing of the MC and ATC curves for the firm such that the MC curve intersects the ATC curve at the ATC curve's minimum point. Additionally, emphasizing that zero economic profits occur when price equals ATC for a perfectly competitive firm also means that ($P=MC=\min ATC$).

Most students (77.7%) correctly illustrated the increase in market demand, but showing how the increased market demand impacted the firm proved more difficult. Many students stated or showed on the graph that profits were being earned, but only a small proportion (21.2%) of students correctly shaded the area representing the firm's profits. When the market demand increased, the price for the firm increased, resulting in a different intersection for MR and MC at a higher level of output. The higher output also moves the firm up and to the right along the ATC curve. To calculate the profits of the firm, teachers should emphasize that the price must be greater than the ATC at the quantity being produced, and the quantity produced is determined by the intersection of MR and MC. Teachers should have students practice drawing graphs that are large and easy to read. When graphs are small, important points on the graph may become blurred or too close to each other, making it appear that there is no difference between these locations, possibly resulting in students losing points on the exam.

Parts (c) and (d) illustrate how markets respond to a change in conditions and how markets are interrelated. Part (c) illustrates a long-run adjustment to economic profits in a competitive market. A small percentage of students (21.6%) were able to explain this process correctly. Emphasis should be placed on stating a step-by-step process that returns the market and firm to long-run equilibrium. That process includes: (1) new firms are attracted to the industry when existing firms earn positive economic profits, (2) increasing market supply or shifting market supply curve to the right (3) decreasing the equilibrium price and (4) increasing the equilibrium market quantity. This process of entry of firms continues until economic profits fall to zero and the long-run equilibrium is achieved. Part (d) examines how the higher price for corn impacts the soybean market. While it is true that corn and soybeans may be considered substitute goods on the demand side of the market (and many responses indicated this relationship), the question points to the supply side of the market by stating that farmers can grow either corn or soybeans on the same land. Here teachers can emphasize that students need to understand producers may and will change what they produce based on the opportunity cost of their current production. If farmers can get a higher price for corn than they can for soybeans, and the land is equally suitable for either, then the opportunity cost of producing soybeans has increased. If the opportunity cost increases, then producers have an incentive to switch to the higher priced commodity. When this switch occurs, the supply of soybeans would decrease causing the price of soybeans to rise.

In part (e), most students (75.6%) correctly drew the price ceiling below the equilibrium. Teachers should continue to emphasize that binding ceilings mean the price cannot rise above the ceiling to the equilibrium. Fewer students recognized that when a price ceiling is in effect, firms would produce less than the equilibrium quantity. Teachers should emphasize that consumers can purchase only the amount of output available in the market. The demand curve shows the various price and quantity combinations consumers are willing and able to buy, but with a binding price ceiling, consumers are not able to buy as much as they would like at the binding price ceiling because suppliers have reduced their production.

Question #2**Task:** Interpret data from a table and calculate**Topic:** Production and Costs**Max. Points:** 5**Mean Score:** 1.91***What were responses expected to demonstrate in their response to this question?***

The question assessed students' ability to apply the concept of returns to scale for a given input–output table based on the variation of the inputs (labor and capital) in the long run and short run under the assumption of perfectly competitive input markets. Students also needed to demonstrate knowledge of how to calculate marginal product, how to determine where diminishing marginal returns set in, how to calculate average total costs, and how to determine the number of workers a firm should hire to maximize profit, using the marginal product of labor, the wage rate, and the product price.

The question provided a production data table that shows the output produced using varying levels of labor and capital. In part (a), students were expected to use the data in the table to recognize that the firm operates with increasing returns to scale. Using 1 unit of labor and 1 unit of capital results in producing 10 units of output. When the inputs are doubled, 2 units of labor and 2 units of capital results in producing 50 units of output. Therefore, when both inputs are doubled, output more than doubles so the firm operates with increasing returns to scale.

In part (b)(i), using data in a table, students were expected to calculate the marginal product of labor by applying the formula $\frac{\Delta TP}{\Delta L}$. In part (b)(ii), students were asked to recognize that the firm experiences diminishing marginal returns and explain that this is because the marginal product of the additional worker hired is less than the marginal product of the previously hired worker. Part (b)(iii) required students to calculate the average total cost using the formula $\frac{TC}{Q} = ATC$ or $AVC + AFC = ATC$. Finally, in part (b)(iv), students were asked to identify the lowest price at which the additional unit of labor would be hired. This required the student to understand that (1) the marginal revenue product of labor must be equal to the marginal resource (factor) cost; (2) that the marginal resource (factor) cost is equal to the wage; (3) that the marginal revenue product of labor is equal to the marginal revenue times the marginal product; and (4) that the marginal revenue is equal to the product price when markets are perfectly competitive. This results in finding the lowest product price that the firm will charge in order to hire the third worker: $P = \frac{W}{MP}$.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

Most students were not able to answer part (a) correctly; 0.64% of students understood that both inputs needed to be increased to determine if the firm operates with returns to scale. Using the data in the table, if both inputs are doubled (from 1 to 2 units), the output more than doubles (from 10 to 50 units). Students asserted that the firm operates with increasing returns to scale, but varied only the amount of labor to explain the answer.

A majority of students (66.16%) answered part (b)(i) correctly and calculated the marginal product of labor for the third worker using the formula ($\frac{\Delta TP}{\Delta L}$) and the data from the table: $\frac{75-50}{3-2} = 25$.

The students also performed well on part (b)(ii). Again, a majority of students (67%) recognized that the firm experiences diminishing marginal returns with the addition of the third unit of labor, and were able to provide an explanation that the marginal product of the third unit of labor (25 units) is less than the marginal product of the second unit of labor (30 units).

The students did not perform well on part (b)(iii). Only 30% of students were able to correctly calculate the average total cost (ATC). Many students did not know the formula for ATC ($ATC = \frac{TC}{Q}$) or they were unable to use the information (the rental rate of capital, \$75 per unit, and the wage rate, \$200 per unit) from the table (the firm currently has two units of capital and is using three units of labor, which results in 75 units of output) to complete the average total cost calculation:

$$TC = wL + rK = \$200 * 3 + \$75 * 2 = \$750; ATC = \frac{TC}{Q} = \frac{750}{75}$$

Finally, in part (b)(iv), many students were not able to recognize that if the third worker would be hired, the amount of revenue that worker brings in (the marginal revenue product of labor) must be greater than or equal to what that worker costs the firm (the marginal resource cost or the wage). Only 23.6% of students answered this question correctly. Many students were not able to calculate the marginal revenue product of labor, which is the marginal revenue times the marginal product of labor, or that the marginal revenue is equal to the product price in the perfectly competitive market ($P * MP = \text{wage}$). Others did not calculate the marginal product for the third unit of labor ($75 - 50 = 25$), or find the correct wage from the question (wage = \$200). And many were not able to rearrange the formula to solve for the price $P = \frac{\$200}{25} = \8

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

<i>Common Misconceptions/Knowledge Gaps</i>	<i>Responses that Demonstrate Understanding</i>
<p>Part (a)</p> <ul style="list-style-type: none"> The firm will operate with decreasing or constant returns to scale. The firm will operate with increasing returns to scale since hiring the extra unit of capital (from 1 to 2) increases output (from 10 to 20). The firm will operate with increasing returns to scale since hiring the extra unit of labor (from 1 to 2) increases output by more than double (from 10 to 25, which is increasing marginal returns that happens in the short run). The firm operates with increasing returns to scale because the average total cost decreases from \$27.5 to \$19. <ul style="list-style-type: none"> That is, $(\frac{200+75}{10}) = \\$27.50$ to $(\frac{400+75}{25}) = \\$19$. 	<ul style="list-style-type: none"> The firm operates with increasing returns to scale because doubling labor <u>and</u> capital more than doubles the output. The output increases from 10 to 50 units when both labor and capital are doubled. The firm will operate with increasing returns to scale because when the inputs are doubled the average total cost decreases from \$27.50 to \$11. <ul style="list-style-type: none"> That is, $(\frac{200+75}{10}) = \\$27.50$ to $(\frac{400+150}{50}) = \\11

<p>Part (b)(i)</p> <ul style="list-style-type: none"> • $MP = 25$ • $MP = \frac{38-15}{3-2} = 13$ • $MP = \frac{75}{3} = 25$ 	<ul style="list-style-type: none"> • $MP = \frac{75-25}{3-2} = 25$
<p>Part (b)(ii)</p> <ul style="list-style-type: none"> • Yes, the firm experienced diminishing marginal returns because with the addition of the third worker the total cost of production goes up. • Yes, the outputs increased by a smaller amount. • Yes, because the marginal product decreased from 15 to 13. 	<ul style="list-style-type: none"> • Yes, because the marginal product of the third unit of labor (25 unit) is less than the marginal product of the second unit of labor (30 units)
<p>Part (b)(iii)</p> <ul style="list-style-type: none"> • $(75 * 2) + (200 * 3) = \\750 • $3 * 200 = \\$600$ • $\frac{750}{3} = \\$250$ 	<ul style="list-style-type: none"> • $\frac{75*2}{75} + \frac{200*3}{75} = \\10 or $\frac{750}{75} = \\$10$
<p>Part (b)(iv)</p> <ul style="list-style-type: none"> • \$10 	<ul style="list-style-type: none"> • \$8 or $\frac{200}{25} = \\$8$

Based on your experience at the AP[®] Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

Part (a) of the question was challenging for students. Students' answers showed insufficient knowledge of the resource market and its connection with the product market. It would be beneficial for students to master the concepts of average and marginal product, as well as the law of diminishing marginal returns within the context of the short run production function. A discussion of long-run costs and the examination of economies and diseconomies of scale, as well as return to scale, needs to be emphasized in class. Economies and diseconomies of scale depict what happens to the LRATC when output changes, while returns to scale depicts what happens to output when both inputs change proportionally. Teachers must emphasize that the concept of returns to scale is a long-run relationship between inputs and outputs. In the case of this question, the firm would be operating with increasing returns to scale if both inputs, capital and labor, were doubled and it led to more than double output.

The students should practice working with data tables; many students could not distinguish between the two separate capital columns. It is a good idea to go over the definition of the terms such as “show your work”, “explain using numbers”, and “calculate” before the exam so students know exactly what they need to do on the exam.

Emphasis on equations, such as $ATC = \frac{TC}{Q}$, is also important, especially in the context of working with tables from which the students must calculate the TC.

Question #3**Task:** Identify and explain **Topic:** Market Failure**Max. Points:** 7**Mean Score:** 3.24***What were responses expected to demonstrate in their response to this question?***

The question assessed students' ability to use information on a given graph to identify the profit-maximizing quantity and price for a monopolist, identify why a negative externality exists, identify the socially optimal quantity with a negative externality, identify the size of the marginal external cost (which would be equal to the size of the per-unit tax), identify the quantity produced if a per-unit tax equal to the marginal external cost was imposed, and indicate what happens to the deadweight loss prior to and after the per-unit tax.

The question is based on a given graph, which illustrates a monopolist whose production of a good generates a negative externality. The graph consists of the marginal private cost (MPC), marginal social cost (MSC), marginal social benefit (MSB) and marginal revenue (MR) curves for the firm. Typically market failures are taught in isolation, separating the inefficiency of monopoly power, underproduction, from the inefficiency of a negative externality, overproduction. The graph shows that the profit-maximizing quantity for the monopolist where $MR = MPC$ is equal to Q_3 and that the socially optimal quantity where $MSC = MSB$ is equal to Q_3 . Therefore, in the given graph, the inefficiency of market power, underproduction, is completely offset by the inefficiency of the negative externality, overproduction, which leads to no deadweight loss prior to government intervention. The resulting per-unit tax, which is required to correct for a negative externality in a perfectly competitive market, leads to an increase in deadweight loss in the context of the monopoly market.

In part (a), students were required to recognize that: (1) a monopolist's profit-maximizing quantity occurs where the marginal private cost equals the marginal revenue and (2) the profit-maximizing monopolist charges a price equal to the maximum price consumers are willing to pay for that quantity. In part (b), students were asked to use information from the graph to verify that the firm's production created a negative externality. Part (c) tested whether students understood that the socially optimal quantity occurs where marginal social cost equals marginal social benefit. In part (d), students were asked to: (1) identify the dollar value of a per-unit tax that aligns marginal private costs with marginal social costs and (2) determine the firm's profit-maximizing quantity given the per-unit tax. Finally, part (e) tested whether students understood that monopoly power may offset a negative externality and that a per-unit tax may create or increase deadweight loss rather than eliminate it.

How well did the responses address the course content related to this question? How well did the responses integrate the skills required on this question?

In part (a), most students were able to identify the monopolist's profit-maximizing quantity (68.2%) and the profit-maximizing price derived from the demand curve that corresponded to the profit-maximizing quantity (82.7%). In part (b), over half of the students were able to describe the information from the graph that indicated there was a negative externality (53.6%). Similarly, in part (c), over half of the students were able to identify the socially optimal quantity (58.6%). In part (d)(i), about one-third of the students (32.0%) were able to identify the dollar value of the tax as the value of the marginal external cost, which was equal to the vertical distance between the marginal social cost and marginal private cost curves. In part (d)(ii), over a third of students were able to identify the monopolist's profit-maximizing quantity given the per-unit tax (38.3%). Few students were able to conclude, in part (e), that the per-unit tax increased deadweight loss in a market with a monopolist whose underproduction already corrected for the negative externality (5.6%).

What common student misconceptions or gaps in knowledge were seen in the responses to this question?

<i>Common Misconceptions/Knowledge Gaps</i>	<i>Responses that Demonstrate Understanding</i>
<p>Part (a)(i)</p> <ul style="list-style-type: none"> • A monopolist's profit-maximizing quantity is that level where marginal private cost is equal to demand, Q_5 • A monopolist's profit-maximizing quantity is that level where marginal revenue is equal to zero, Q_4 	<ul style="list-style-type: none"> • A monopolist's profit-maximizing quantity occurs where marginal private cost is equal to marginal revenue, Q_3
<p>Part (a)(ii)</p> <ul style="list-style-type: none"> • A monopolist's profit-maximizing price is given by the marginal cost or marginal revenue at the profit-maximizing quantity, P_1 	<ul style="list-style-type: none"> • A monopolist's profit-maximizing price is derived from the demand curve at the profit-maximizing quantity, P_4
<p>Part (b)</p> <ul style="list-style-type: none"> • A negative externality occurs where the marginal cost of production is greater than marginal revenue 	<ul style="list-style-type: none"> • Negative externalities occur where the (marginal) social cost is greater than the firm's (marginal) private cost of production at every quantity
<p>Part (c)</p> <ul style="list-style-type: none"> • The socially optimal quantity occurs where marginal private cost is equal to marginal social benefit (demand) despite the presence of a negative externality, Q_5 	<ul style="list-style-type: none"> • The socially optimal quantity occurs where marginal social cost is equal to marginal social benefit (demand), Q_3
<ul style="list-style-type: none"> • The marginal social cost curve is the marginal private cost curve "shifted" by the marginal external cost 	<ul style="list-style-type: none"> • The marginal social cost (MSC) curve and the marginal private cost (MPC) curve are separate curves. The MSC curve is not the MPC shifted to the right; the difference between these two lines is the marginal external cost (MEC) to third parties. When the MEC is equal to zero, so there are no external costs, the $MSC = MPC$.

<p>Part (d)(i)</p> <ul style="list-style-type: none"> • The dollar value of a per-unit tax that corrects for a negative externality is equal to the difference in prices where marginal social cost equals demand and where marginal private cost equals demand, $P_4 - P_2$ • The dollar value of a per-unit tax (interpreted as tax revenue) is equal to the per-unit tax times the pre-tax quantity, $(P_4 - P_1) \times Q_3$ 	<ul style="list-style-type: none"> • The dollar value of a per-unit tax that corrects for a negative externality is equal to the difference between marginal social cost and marginal private cost at a given quantity, $P_4 - P_1$ • The dollar value of a per-unit tax (interpreted as tax revenue) is equal to the per-unit tax times the quantity produced given the tax, $(P_4 - P_1) \times Q_2$
<p>Part (d)(ii)</p> <ul style="list-style-type: none"> • A monopolist's profit-maximizing quantity given a per-unit tax occurs where marginal private cost equals marginal revenue, Q_3 	<ul style="list-style-type: none"> • A monopolist's profit-maximizing quantity given a per-unit tax occurs where marginal private cost plus the per-unit tax equals marginal revenue, Q_2
<p>Part (e)</p> <ul style="list-style-type: none"> • Per-unit taxes levied on a monopolist increase deadweight loss because profit-maximizing monopolists always choose to underproduce • Per-unit taxes always increase deadweight loss • Per-unit taxes always decrease deadweight loss when there is a negative externality 	<ul style="list-style-type: none"> • A monopolist's underproduction may be socially optimal if their production corrects for a negative externality

Based on your experience at the AP[®] Reading with student responses, what advice would you offer to teachers to help them improve the student performance on the exam?

One common student error was misinterpreting the marginal social cost curve as a shift of the marginal private cost curve. This indicates students may not understand that the vertical distance between the marginal social cost curve and the marginal private cost curve represents the marginal external cost at any given quantity. Teachers may be able to help students by emphasizing that the curves represent different concepts.

A second common student error was stating that marginal social cost was less than marginal private cost. Teachers may help students by clarifying that a greater vertical distance indicates a higher cost at a given quantity when interpreting cost curves.

Finally, few students were able to analyze the per-unit tax in a way that accounted for both market failures. Many responses analyzed the tax using just one of the two market failures, concluding that the per-unit tax either reduced deadweight loss because taxes correct for negative externalities, or increased deadweight loss because monopolists always produce less than the socially optimal quantity. Teachers may be able to help students by demonstrating the implication of a per-unit tax imposed on a monopoly with a negative externality.