SOLUTIONS TO TEXT PROBLEMS:

Quick Quizzes

1. Farmer McDonald's opportunity cost is $300, consisting of 10 hours of lessons at $20 an hour that he could have been earning plus $100 in seeds. His accountant would not count the lost banjo-lesson money, only the seeds, worth $100. If McDonald earns $200 from selling the crops, then McDonald earns a $100 accounting profit ($200 sales minus $100 cost of seeds) but makes an economic loss of $100 ($200 sales minus $300 opportunity cost).

2. Farmer Jones's production function is shown in Figure 1 and his total-cost curve is shown in Figure 2. The production function is concave because of diminishing marginal product. As the number of bags of seeds increases, the marginal product declines, and the production function becomes flatter. The total-cost curve is convex, as the curve gets steeper as the amount of production increases. That is also a feature that arises because of diminishing marginal product, since each additional bag of seeds has lower marginal product and thus the cost of producing additional bushels of wheat goes up.

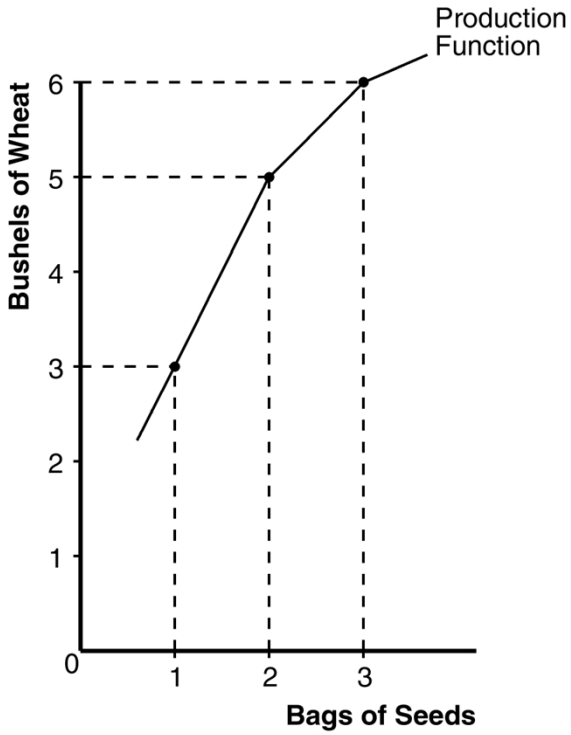

Figure 1

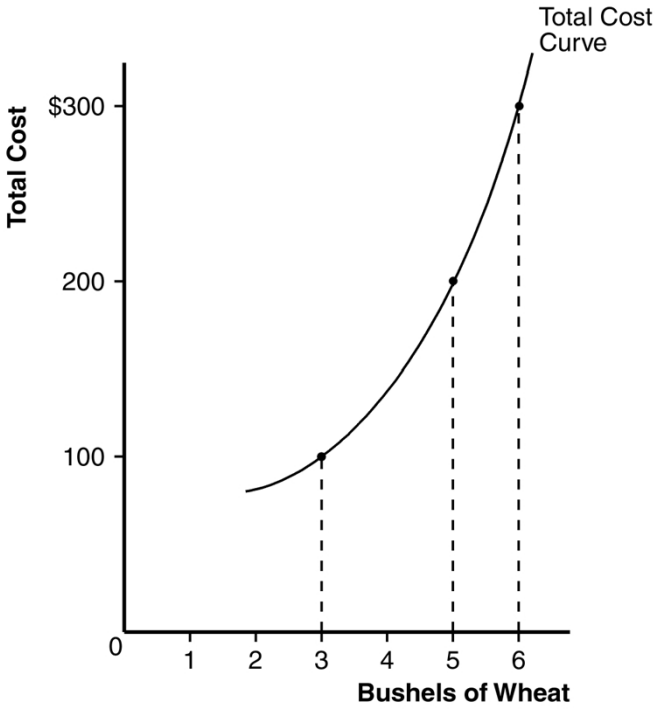

Figure 2

3. The average total cost of producing 5 cars is $250,000/5 = $50,000. Since total cost rose from $225,000 to $250,000 when output increased from 4 to 5, the marginal cost of the fifth car is $25,000.

   The marginal-cost curve and the average-total-cost curve for a typical firm are shown in Figure 3. They cross at the efficient scale because at low levels of output, marginal cost is below average total cost, so average total cost is falling. But after the two curves cross, marginal cost rises

above average total cost, and average total cost starts to rise. So the point of intersection must be the minimum of average total cost.

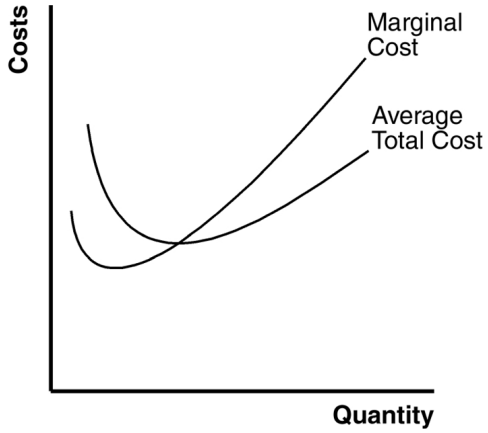

Figure 3

4. The long-run average total cost of producing 9 planes is \$9 million/9 = \$1 million. The long-run average total cost of producing 10 planes is \$9.5 million/10 = \$0.95 million. Since the long-run average total cost declines as the number of planes increases, Boeing exhibits economies of scale.

Questions for Review

1. The relationship between a firm's total revenue, profit, and total cost is profit equals total revenue minus total costs.

2. An accountant would not count the owner's opportunity cost of alternative employment as an accounting cost. An example is given in the text in which Helen runs a cookie business, but she could instead work as a computer programmer. Because she's working in her cookie factory, she gives up the opportunity to earn \$100 per hour as a computer programmer. The accountant ignores this opportunity cost because no money flow occurs. But the cost is relevant to Helen's decision to run the cookie factory.

3. Marginal product is the increase in output that arises from an additional unit of input. Diminishing marginal product means that the marginal product of an input declines as the quantity of the input increases.

4. Figure 4 shows a production function that exhibits diminishing marginal product of labor. Figure 5 shows the associated total-cost curve. The production function is concave because of diminishing marginal product, while the total-cost curve is convex for the same reason.

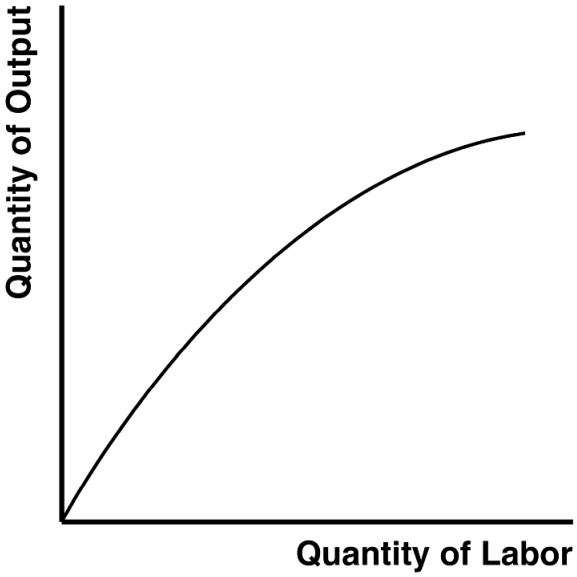

Figure 4

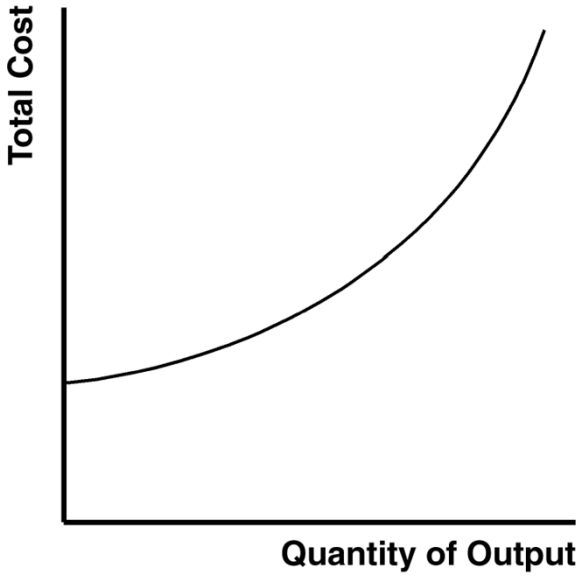

Figure 5

5. Total cost consists of the costs of all inputs needed to produce a given quantity of output. It includes fixed costs and variable costs. Average total cost is the cost of a typical unit of output and is equal to total cost divided by the quantity produced. Marginal cost is the cost of producing an additional unit of output and is equal to the change in total cost divided by the change in quantity. An additional relation between average total cost and marginal cost is that whenever marginal cost is less than average total cost, average total cost is declining; whenever marginal cost is greater than average total cost, average total cost is rising.

6. Figure 6 shows the marginal-cost curve and the average-total-cost curve for a typical firm. It has three main features: (1) marginal cost is rising; (2) average total cost is U-shaped; and (3) whenever marginal cost is less than average total cost, average total cost is declining; whenever marginal cost is greater than average total cost, average total cost is rising. Marginal cost is rising for output greater than a certain quantity because in the short run the firm must hire additional labor to produce more output without being able to buy additional equipment. The average total cost curve is U-shaped because the firm initially is able to spread out fixed costs over additional units, but as quantity increases, it costs more to increase quantity further because some important input is limited. Marginal cost and average total cost have the relationship they do because marginal cost pulls average total cost in the same direction. The marginal cost and average total cost curves intersect at the minimum of average total cost; that quantity is the efficient scale.

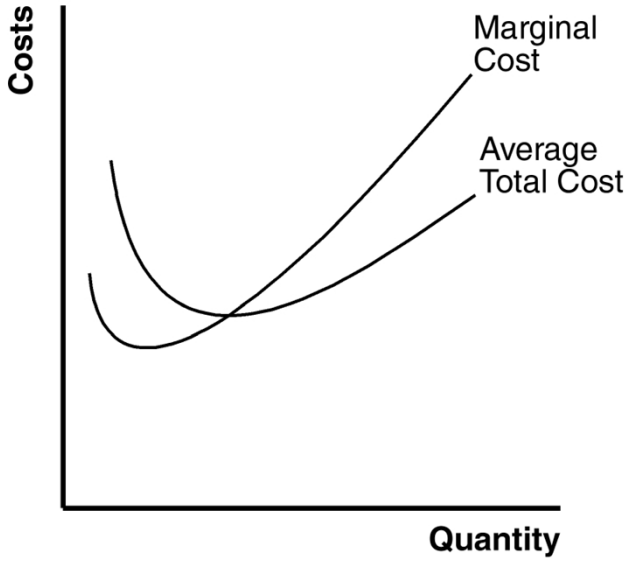

Figure 6

7. In the long run, a firm can adjust the factors of production that are fixed in the short run; for example, it can increase the size of its factory. As a result, the long-run average-total-cost curve has a much flatter U-shape than the short-run average-total-cost curve. In addition, the long-run curve lies along the lower envelope of the short-run curves.

8. Economies of scale exist when long-run average total cost falls as the quantity of output increases, which occurs because of specialization among workers. Diseconomies of scale exist when long-run average total cost rises as the quantity of output increases, which occurs because of coordination problems inherent in a large organization.

Problems and Applications

1. a. opportunity cost; b. average total cost; c. fixed cost; d. variable cost; e. total cost; f. marginal cost.

2. a. The opportunity cost of something is what must be forgone to acquire it.

   b. The opportunity cost of running the hardware store is $550,000, consisting of $500,000 to rent the store and buy the stock and a $50,000 opportunity cost, since your aunt would quit her job as an accountant to run the store. Since the total opportunity cost of $550,000 exceeds revenue of $510,000, your aunt should not open the store, as her profit would be negative—she would lose money.

3. a. Since you would have to pay for room and board whether you went to college or not, that portion of your college payment is not an opportunity cost.

   b. The explicit opportunity cost is the cost of tuition and books.

   c. An implicit opportunity cost is the cost of your time. You could work at a job for pay rather than attend college. The wages you give up represent an opportunity cost of attending college.

4. a. The following table shows the marginal product of each hour spent fishing:

Hours	Fish	Fixed Cost	Variable Cost	Total Cost	Marginal Product
0	0	$10	$0	$10	---
1	10	10	5	15	10
2	18	10	10	20	8
3	24	10	15	25	6
4	28	10	20	30	4
5	30	10	25	25	2

b. Figure 7 graphs the fisherman's production function. The production function becomes flatter as the number of hours spent fishing increases, illustrating diminishing marginal product.

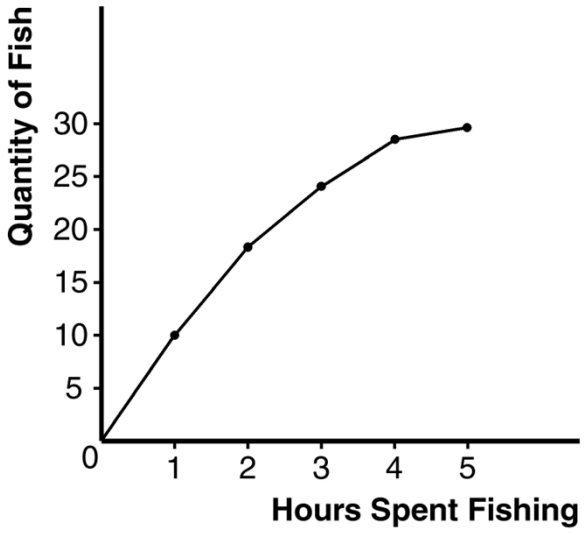

Figure 7

c. The table shows the fixed cost, variable cost, and total cost of fishing. Figure 8 shows the fisherman's total-cost curve. It slopes up because catching additional fish takes additional time. The curve is convex because there are diminishing returns to fishing time—each additional hour spent fishing yields fewer additional fish.

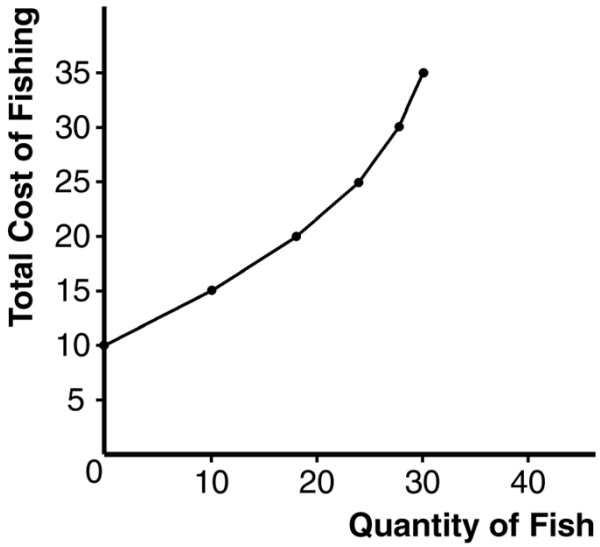

Figure 8

5. Here is the table of costs:

Workers	Output	Marginal Product	Total Cost	Average Total Cost	Marginal Cost
0	0	---	$200	---	---
1	20	20	300	$15.00	$5.00
2	50	30	400	8.00	3.33
3	90	40	500	5.56	2.50
4	120	30	600	5.00	3.33
5	140	20	700	5.00	5.00
6	150	10	800	5.33	10.00
7	155	5	900	5.81	20.00

a. See table for marginal product. Marginal product rises at first, then declines because of diminishing marginal product.

b. See table for total cost.

c. See table for average total cost. Average total cost is U-shaped. When quantity is low, average total cost declines as quantity rises; when quantity is high, average total cost rises as quantity rises.

d. See table for marginal cost. Marginal cost is also U-shaped, but rises steeply as output increases. This is due to diminishing marginal product.

e. When marginal product is rising, marginal cost is falling, and vice versa.

f. When marginal cost is less than average total cost, average total cost is falling; the cost of the last unit produced pulls the average down. When marginal cost is greater than average total cost, average total cost is rising; the cost of the last unit produced pushes the average up.

6. Fixed costs include the cost of owning or renting a car to deliver the bagels and the cost of

advertising; they are fixed costs because they do not vary with output. Variable costs include the cost of the bagels and gas for the car, since those costs will increase as output increases.

7. a. The fixed cost is $300, since fixed cost equals total cost minus variable cost.

b.

Quantity	Total Cost	Variable Cost	Marginal Cost (using total cost)	Marginal Cost (using variable cost)
0	$300	$0	---	---
1	350	50	$50	$50
2	390	90	40	40
3	420	120	30	30
4	450	150	30	30
5	490	190	40	40
6	540	240	50	50

Marginal cost equals the change in total cost or the change in variable cost. That is because total cost equals variable cost plus fixed cost and fixed cost does not change as the quantity changes. So as quantity increases, the increase in total cost equals the increase in variable cost and both are equal to marginal cost.

8. a. The fixed cost of setting up the lemonade stand is $200. The variable cost per cup is 50 cents.

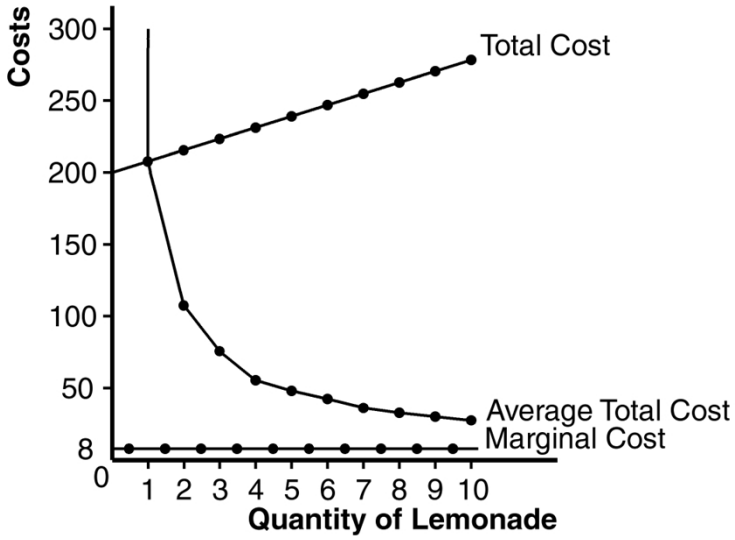

Figure 9

b. The following table shows total cost, average total cost, and marginal cost. These are plotted in Figure 9.

Quantity	Total Cost	Average Total Cost	Marginal Cost
0	$200	---	---
1	208	$208	$8
2	216	108	8
3	224	74.7	8
4	232	58	8
5	240	48	8
6	248	41.3	8
7	256	36.6	8
8	264	33	8
9	272	30.2	8
10	280	28	8

9. The following table illustrates average fixed cost (*AFC*), average variable cost (*AVC*), and average total cost (*ATC*) for each quantity. The efficient scale is 4 houses per month, since that minimizes average total cost.

Quantity	Variable Cost	Fixed Cost	Total Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost
0	$0	$200	$200	---	---	---
1	10	200	210	$200	$10	$210
2	20	200	220	100	10	110
3	40	200	240	66.7	13.3	80
4	80	200	280	50	20	70
5	160	200	360	40	32	72
6	320	200	520	33.3	53.3	86.7
7	640	200	840	28.6	91.4	120

10 a. The following table shows average variable cost (*AVC*), average total cost (*ATC*), and marginal cost (*MC*) for each quantity.

Quantity	Variable Cost	Total Cost	Average Variable Cost	Average Total Cost	Marginal Cost
0	$0	$30	---	---	---
1	10	40	$10	$40	$10
2	25	55	12.5	27.5	15
3	45	75	15	25	20
4	70	100	17.5	25	25
5	100	130	20	26	30
6	135	165	22.5	27.5	35

b. Figure 10 graphs the three curves. The marginal cost curve is below the average total cost curve when output is less than 4, as average total cost is declining. The marginal cost curve is above the average total cost curve when output is above 4, as average total cost is rising. The marginal cost curve lies above the average variable cost curve.

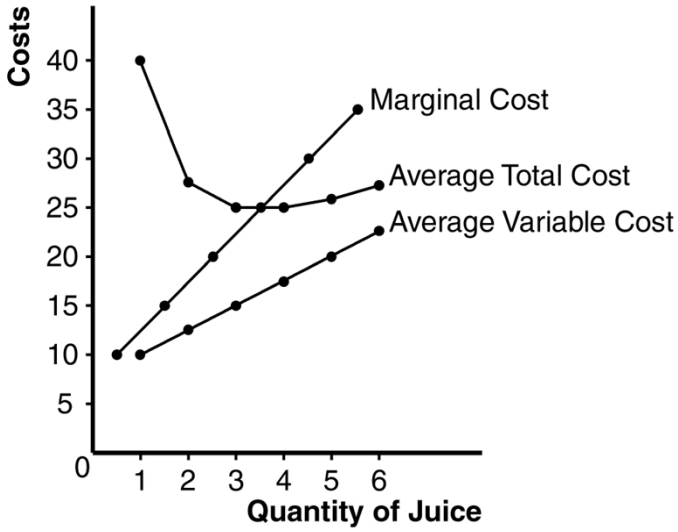

Figure 10

11. The following table shows quantity (*Q*), total cost (*TC*), and average total cost (*ATC*) for the three firms:

	Firm A		Firm B		Firm C	
Quantity	***TC***	***ATC***	***TC***	***ATC***	***TC***	***ATC***
1	60	60	11	11	21	21
2	70	35	24	12	34	17
3	80	26.7	39	13	49	16.3
4	90	22.5	56	14	66	16.5
5	100	20	75	15	85	17
6	110	18.3	96	16	106	17.7
7	120	17.1	119	17	129	18.4

Firm A has economies of scale since average total cost declines as output increases. Firm B has diseconomies of scale since average total cost rises as output rises. Firm C has economies of scale for output from 1 to 3, then diseconomies of scale for greater levels of output.