The purpose of this set of (mostly) short answers is to provide a way for students to check on their work. Our answers here leave out a lot of intermediate steps; we hope this will encourage students to work out the intermediate steps for themselves. We also have a set of longer and more detailed answers, which is available to instructors.

1We thank EeCheng Ong and Amy Serrano for their superb help in working out these solutions.
Chapter 2 Solutions

1.(a) For this consumer, $6 \succ 0$. Show that $0 \sim 6$ if the transitivity assumption holds.

1.(b) Show that $x \succ y$, $y \succ z$, and $z \succ x$.

2.(a) The indifference curve corresponding to $u = 1$ passes through the points $(0.5, 2)$, $(1, 1)$, and $(2, 0.5)$. The indifference curve corresponding to $u = 2$ passes through the points $(0.5, 4)$, $(1, 2)$, $(2, 1)$, and $(4, 0.5)$.

2.(b) The $MRS$ equals 1 along the ray from the origin $x_2 = x_1$, and it equals 2 along the ray from the origin $x_2 = 2x_1$.

3.(a) The indifference curves are downward-sloping parallel lines with a slope of $-1$ and the arrow pointing northeast.

3.(b) The indifference curves are upward-sloping with the arrow pointing northwest.

3.(c) The indifference curves are vertical with the arrow pointing to the right.

3.(d) The indifference curves are downward-sloping and convex with the arrow pointing north-east.

4.(a) The indifference curves are horizontal; the consumer is neutral about $x_1$ and likes $x_2$.

4.(b) The indifference curves are downward-sloping parallel lines with a slope of $-1$; the consumer considers $x_1$ and $x_2$ to be perfect substitutes.

4.(c) The indifference curves are L-shaped, with kinks along the ray from the origin $x_2 = \frac{1}{2}x_1$; the consumer considers $x_1$ and $x_2$ to be perfect complements.

4.(d) The indifference curves are upward-sloping and convex (shaped like the right side of a U); the consumer likes $x_2$, but dislikes $x_1$, i.e., good 1 is a bad for the consumer.
5.(a) $MU_1 = 6x_1x_2^4$.

5.(b) $MU_2 = 12x_1^2x_2^3$.

5.(c) $MRS = \frac{x_2}{2x_1}$.

5.(d) $MRS = 1$.

5.(e) $MRS = \frac{1}{8}$. The MRS has diminished because Donald has moved down his indifference curve. As he spends more time fishing and less time in his hammock, he is increasingly reluctant to give up hammock time for an extra hour of fishing.

5.(f) He is just as happy this week as he was last week.

6.(a) The $MRS$ is the amount of money I am willing to give up in exchange for working an extra hour. My $MRS$ is negative, meaning that someone would have to pay money to me in order to have me work more.

6.(b) Since work is a bad, the $MRS$ should be negative. The $MRS$ is negative because the indifference curves are upward-sloping, and the $MRS$ is $(-1)$ times the slope.

6.(c) The $MRS$ is decreasing (increasing in absolute value) as the hours of work increase. The indifference curves are upward sloping and convex. As I work more and more hours, I would require ever higher rates of pay in order to be willing to work an additional hour.
Chapter 3 Solutions

1. (a) The new budget line is \(2p_1x_1 + \frac{1}{2}p_2x_2 = M\), and its slope is four times the slope of the original budget line.

1. (b) The new budget line is \(2p_1x_1 + p_2x_2 = 3M\), and its slope is twice the slope of the original.

2. (a) \(3x_1 + 2x_2 = 900\). Horizontal intercept at 300 and vertical intercept at 450.

2. (b) \((x_1^*, x_2^*) = (100, 300)\).

3. (a) \(M = 60\) and \(p_b = 1\).

3. (b) He will consume 0 apples and 60 bananas.

4. (a) The \(x_1\) intercept is 27, the \(x_2\) intercept is 12, and the kink is at \((20, 2)\).

4. (b) Peter’s indifference curves are linear, with slopes of \(-\frac{1}{3}\). His optimal consumption bundle is \((0, 12)\).

4. (c) The \(x_1\) intercept is 11, the \(x_2\) intercept is 4, and the kink is at \((4, 2)\).

4. (d) Paul’s indifference curves are L-shaped, with kinks at \((2, 3)\), \((4, 6)\), etc. His optimal consumption bundle is \((2, 3)\).

5. (a) \(c_1 + \left(\frac{1+\pi}{1+i}\right)c_2 = M\), or \(c_1 + c_2 = 50\).

5. (b) \((c_1^*, c_2^*) = (25, 25)\).

5. (c) \((c_1^*, c_2^*) = (25, 22.73)\).
6.(a) The budget line is \( c_1 + \left( \frac{1.05}{1.10} \right) c_2 = 190.91 \). The \( c_1 \)-intercept is 190.91, and the \( c_2 \)-intercept is 200. The slope is \(-\frac{1.10}{1.05} = -1.048\), reflecting the relative price of current consumption. The zero savings point is \((100, 95.24)\), the consumption plan he can afford if he spends exactly his income in each period.

6.(b) \((c_1^*, c_2^*) = (127.27, 66.67)\); Sylvester is a borrower. His optimal choice is a point of tangency between his indifference curve and the budget line, to the southeast of the zero-savings point.

6.(c) The budget line pivots counterclockwise through the zero savings point, and now has a slope of \(-1\). The intercepts are 195.24 at both axes. The new consumption bundle is \((c_1^*, c_2^*) = (130.16, 65.08)\).

6.(d) Sylvester is better off than before.
Chapter 4 Solutions

1.(a) Use the budget constraint and tangency condition to solve for \( x_1(p_1, p_2, M) \).

1.(b) Good 1 is normal and ordinary. Goods 1 and 2 are neither substitutes nor complements.

2.(a) Show that the original consumption bundle is \((5, 5)\), and the new consumption bundle is \((2, 5)\).

2.(b) Show that the Hicks substitution effect bundle is \( \left( \sqrt{10}, \frac{5\sqrt{10}}{2} \right) \).

3. With the Giffen good on the horizontal axis, the Hicks substitution effect bundle is to the southeast of the original bundle, and the final bundle is to the northwest of the original bundle. See Solutions-graphs file.

4.(a) \((x^*, y^*) = (8, 8)\).

4.(b) \((x^*, y^*) = \left( \frac{200}{33}, \frac{200}{33} \right) \). He will pay \( \frac{16}{33} \) in taxes.

4.(c) The demand functions are \( x = y = \frac{M}{p_x + p_y} \). The goods are normal, ordinary, and complements of one another.

5.(a) \((x^*, y^*) = (1, 1)\).

5.(b) \((x^*, y^*) = (0.5, 1)\).

5.(c) His parents would have to increase his allowance by \( 2\sqrt{2} - 2 \), which is approximately $0.83.

5.(d) All the answers are the same because \( v \) is an order-preserving transformation of \( u \). That is, both consumers have identical preferences.

6.(a) The x-intercept is 8, and the y-intercept is 5. The budget line is horizontal between \((0, 5)\) and \((3, 5)\), and is downward-sloping with a slope of \(-1\) beyond \((3, 5)\).

6.(b) \((x^*, y^*) = (5.5, 2.5)\).
Chapter 5 Solutions

1. Use the budget constraint and tangency condition to solve for $L^*$. Note that this problem assumes that $T = 24$.

2. The budget line is downward-sloping between $\left(0, \frac{wT + M}{p}\right)$ and $\left(T, \frac{M}{p}\right)$ and vertical at $T$. The optimal bundle is $\left( T, \frac{M}{p} \right)$. See Solutions-Graphs file.

3. (a) The budget line has a kink at the zero-savings point. The slope is steeper to the right of the zero savings point, and flatter to its left.

3. (b) The budget line has a kink at the zero-savings point. This time the slope is flatter to the right of the zero-savings point, and steeper to its left. An indifference curve has two tangency points with the budget line, each one at either side of the zero-savings point.

4. (a) The budget line is $c_1 + c_2 = 195.24$. Both the intercepts are 195.24. The slope is $-1$. The zero-savings point is $(100, 95.24)$.

4. (b) Mr. A’s optimal consumption bundle is $(65.08, 130.16)$; he is a lender. Mr. B’s optimal consumption bundle is $(130.16, 65.08)$; he is a borrower.

4. (c) The savings supply curve places savings on the horizontal axis and the interest rate on the vertical axis. It is obtained from the savings supply function after fixing the other variables that determine the budget constraint.

Mr. A’s savings supply curve is $s_A(i) = \frac{100}{3} \left( \frac{i+2i}{1+i} \right); s = 33.33$ for $i = 0$ and $s = 50$ for $i = 1$.

Mr. B’s savings supply curve is $s_B(i) = \frac{100}{3} \left( \frac{-1+i}{1+i} \right); s = -33.33$ for $i = 0$ and $s = 0$ for $i = 1$. The aggregate savings supply curve is $s_A(i) + s_B(i) = 100 \left( \frac{i}{1+i} \right)$, an upward-sloping curve starting at the origin. See Solutions-Graphs file.

4. (d) Mr. A’s optimal consumption bundle is $(63.64, 133.33)$; Mr. A is better off than before.

Mr. B’s optimal consumption bundle is $(127.27, 66.67)$; Mr. B is worse off than before.
5. One possible savings function in which the consumer switches from being a borrower to a saver at a given interest rate. See Solutions-Graphs file. Hint: Why must the savings supply curve be strictly increasing when the consumer is a borrower, but not necessarily when he is a saver? Why can't a saver ever become a borrower in response to a raise in the interest rate?

6. A decrease in $\pi$ causes the budget line to rotate clockwise on the x-intercept while an increase in $i$ causes the budget line to rotate clockwise on the zero savings point. Analyze the substitution effect and income effect on $c_1$ and $c_2$ in each case. In the first case, you can't predict the direction of change either for a borrower or a saver. In the latter case, it is ambiguous for a saver, but a borrower will definitely borrow less.
Chapter 6 Solutions

1. (a) Her optimal consumption bundle is (25, 50). Her utility is 1,250.

1. (b) Her new consumption bundle is (25, 40).

1. (c) The subsidy should be $0.80 a pint or 20 percent.

2. (a) Her optimal consumption bundle is (15, 10). Her utility is 1,600.

2. (b) Her new consumption bundle is (18, 9). Her new utility is 1,558 < 1,600.

3. William is always made worse off by the tax, while Mary would be made worse off by the tax only if the original price of good $x$ were less than the price of good $y$.

4. (a) His optimal consumption bundle is (2, 16). His utility is 2,560.

4. (b) His new consumption bundle is (4, 16). His new utility is 40,960.

4. (c) The income effect is 34.052.

5. The first program yields a utility of $5.324 \cdot 10^8$, and the second program yields a utility of $6.25 \cdot 10^8$; the couple prefers the second program. The first program costs $3,000 and the second program costs $5,000.

6. Pre-policy, $x_A^* = y_A^* = 25$, $x_B^* = y_B^* = 20$, and $x_C^* = y_C^* = 15$. Post-policy, $x_A^{**} = y_A^{**} = 24$, $x_B^{**} = y_B^{**} = 20$, and $x_C^{**} = y_C^{**} = 16$. The welfare of the median consumer (Group B) is unchanged. Lower-income consumers (Group C) are better off and higher-income consumers (Group A) are worse off.
Chapter 7 Solutions

1. The equation for the indifference curve where \( u = 10 \) is \( x_2 = 10 - v(x_1) \), and the equation for the indifference curve where \( u = 5 \) is \( x_2 = 5 - v(x_1) \). The vertical distance between the two curves equals the difference in the value of \( x_2 \), that is, the difference of the two equations, which is 5.

2. The utility function is quasilinear, so each unit of good 2 contributes exactly one unit of utility (\( MU_2 = 1 \)). In addition, there is no income effect on the demand for good 1, so each additional unit of income will be spent on good 2. As a result, each additional unit of income increases utility exactly by one unit. It is as if utility were measured in dollars.

3. Decompose consumers’ surplus in the graph at the far right into two triangles with areas \( \frac{1}{2}ab \) and \( \frac{1}{2}cd \).

4. (a) When \( p = 0 \), the net social benefit is $1.5 million. When \( p = \frac{5 - \sqrt{5}}{2} \), the net social benefit is $1.309 million.

4. (b) The price that maximizes revenue is \( p = 2.5 \), and the net social benefit is $0.875 million.

4. (c) Net Social Benefit = Consumer Surplus + Government Revenue - 1,000,000 = 1,500,000 - 100,000p^2. This function is maximized at \( p = 0 \).

5. Loss of consumer’s surplus is 7.2984.

6. Correction There is an error in the textbook, where Carter’s utility function is shown as \( u(x, y) = 10x + \frac{1}{3}x^3 + y \). The correct utility function is \( u(x, y) = 10x - \frac{1}{3}x^3 + y \). Also, assume throughout this problem that \( p_y = 1 \), and that Carter’s income \( M \) is at least 12 so that he consumes a positive amount of both goods. Here is the solution for the corrected problem:
6.(a) His demand function for $x$ is $x(p_x, p_y, M) = \sqrt{10 - \frac{p_x}{p_y}}$, and if $p_y = 1$, the demand curve is $x = \sqrt{10 - p_x}$. When $p_x = 1$, he consumes $x = 3$.

6.(b) His inverse demand function for $x$ is $p_x = 10 - x^2$. His consumer’s surplus from his consumption of $x$ is 18.

6.(c) He now consumes $x = 2$. His consumer’s surplus from his consumption of $x$ is now $\frac{16}{3}$. 
Chapter 8 Solutions

1.(a) Show that \( \frac{d^2y}{dx^2} < 0 \) for \( x \neq 0 \).

1.(b) \( C(y) = y^2; AC(y) = y; MC(y) = 2y. \)

1.(c) The supply curve is \( y = \frac{1}{2}p \) for \( p \geq 0 \).

1.(d) \( \pi = 25. \)

2.(a) \( C(y) = \left(\frac{1}{5}y + 6\right)^3; AC(y) = \frac{\left(\frac{1}{5}y + 6\right)^3}{y}; MC(y) = \frac{3}{5} \left(\frac{1}{5}y + 6\right)^2. \)

2.(b) The supply curve is \( y = 0 \) for \( p < 48.6 \), and \( y = 5\sqrt{\frac{5p}{3}} - 30 \) for \( p \geq 48.6 \).

3.(a) Show that \( \frac{d^2y}{dy^2} > 0. \)

3.(b) \( MP(x) = \frac{1}{\sqrt{x}}; AP(x) = \frac{1}{\sqrt{x}}. \)

3.(c) \( VMP(x) = \frac{5}{\sqrt{x}}; VAP(x) = \frac{10}{\sqrt{x}}. \)

3.(d) The input demand curve is \( x = 0 \) for \( w > 10 \), and \( x = \frac{25}{w^2} \) for \( w \leq 10 \).

3.(e) \( \pi = 25. \)

4.(a) \( MP(x) = \frac{1}{3} \left(\frac{2}{\sqrt{x}} + 1\right); AP(x) = \frac{1}{\sqrt{x}} + \frac{1}{3}. \)

4.(b) \( VMP(x) = 2 \left(\frac{2}{\sqrt{x}} + 1\right); VAP(x) = 2 \left(\frac{3}{\sqrt{x}} + 1\right). \)

4.(c) The input demand curve is \( x = 0 \) for \( w > 8 \), and \( x = \left(\frac{4}{w^2 - 2}\right)^3 \) for \( w \in (2, 8] \). If \( w < 2 \), the firm would like to hire an infinite amount of input.
5. In a \((y_1, y_2)\)- quadrant, a typical isofactor curve is concave to the origin (using the same amount of input, the more additional units of output \(y_1\) the firm wants to produce requires it to give up more units of output \(y_2\)). The isorevenue curves are downward-sloping straight lines of slope \(-p_1/p_2\). The solution to the revenue maximization problem, conditional on a level of input \(x\), is found at the tangency of the highest possible isorevenue line with the fixed isofactor curve. The solution to this revenue maximization problem yields the conditional output supply functions \(y_1(p_1, p_2, x)\) and \(y_2(p_1, p_2, x)\). Finally, the profit maximization problem is thus written:

\[
\max_x \pi = p_1 \cdot y_1(p_1, p_2, x) + p_2 \cdot y_2(p_1, p_2, x) - wx.
\]

Solving the maximization problem yields the input demand function, \(x(p_1, p_2, w)\).

6.(a) \(C(y_1, y_2) = y_1^2 + y_2^2 + y_1 y_2; MC_1(y_1) = 2y_1 + y_2; MC_2(y_2) = 2y_2 + y_1\).

6.(b) \(y_1^*(p_1, p_2) = \frac{1}{3}(2p_1 - p_2); y_2^*(p_1, p_2) = \frac{1}{3}(2p_2 - p_1)\).

6.(c) \(y_1^*(1, 1) = \frac{1}{3}; y_2^*(1, 1) = \frac{1}{3}; \pi = \frac{1}{3}\).

6.(d) \(y_1^*(1, 2) = 0; y_2^*(1, 2) = 1; \pi = 1\).
Chapter 9 Solutions

1. Returns to scale are related to the way in which isoquants are labeled as we increase the scale of production moving out along a ray from the origin. Returns to scale is a meaningful concept because the labels on isoquants represent a firm’s level of output, and output is a cardinal measure. In contrast, indifference curves represent a consumer’s utility level and utility is an ordinal measure. The rate at which the utility number rises along a ray is therefore not particularly meaningful.

2. A price-taking firm will produce where price equals marginal cost. Furthermore, at profit-maximizing points the marginal cost curve cannot be downward sloping. Therefore, the firm’s output rises.

3.(a) Use the production function and tangency condition to solve for the long-run conditional factor demands.
3.(b) \( C(y) = w_1x_1 + w_2x_2 \).
3.(c) The supply curve is the \( MC(y) \) curve, if \( p \geq \min AC(y) \), and \( MC(y) \) is rising.

4.(a) This technology shows increasing returns to scale. The isoquants are symmetric hyperbolas; the isoquants get closer and closer to each other away from the origin.
4.(b) \( L^*(y) = 10\sqrt{y} \); \( K^*(y) = \sqrt{y} \).
4.(c) \( C(y) = 200\sqrt{y} \).
4.(d) If \( y = 1 \), then \( L^*(1) = 10 \), \( K^*(1) = 1 \), and \( C(1) = 200 \). If \( y = 2 \), then \( L^*(2) = 10\sqrt{2} \), \( K^*(2) = \sqrt{2} \), and \( C(2) = 200\sqrt{2} \).
4.(e) \( AC(y) = \frac{200}{\sqrt{y}} \); \( MC(y) = \frac{100}{\sqrt{y}} \). Both \( AC(y) \) and \( MC(y) \) are decreasing hyperbolas, and \( MC(y) < AC(y) \). There is no long-run supply curve.
5.(a) $x_1^*(y) = 0; x_2^*(y) = y; C(y) = y$.

5.(b) The long-run supply curve is $y = 0$ for $p < 1$, and $y \in [0, \infty)$ for $p = 1$.

5.(c) $C(y) = 2y; AC(y) = 2; MC(y) = 2$. The long-run supply curve is $y = 0$ for $p < 2$, and $y \in [0, \infty)$ for $p = 2$.

6.(a) $x_1^*(y) = x_2^*(y) = x_3^*(y) = y^{5/3}$.

6.(b) $C(y) = 3y^{5/3}$.

6.(c) The long-run supply curve is $y = (\frac{p}{5})^{3/2}$ for $p \geq 0$. 
Chapter 10 Solutions

1. (a) $AP(x_1|1) = \frac{[243+\frac{1}{9}(x_1-9)^3]}{x_1}; MP(x_1|1) = (x_1 - 9)^2.$

1. (b) $AP(x_2|x_1^0) = 243 + \frac{1}{3}(x_1^0 - 9)^3; MP(x_2|x_1^0) = 243 + \frac{1}{3}(x_1^0 - 9)^3.$

1. (c) In (a), $AP(x_1|1)$ and $MP(x_1|1)$ vary with $x_1$. In (b), $AP(x_2|x_1^0) = MP(x_2|x_1^0)$, and both average product and marginal product curves are constant for a given level of input 1.

2. (a) If $w_1$ rises, the firm produces less $y$, $x_1^*$ falls, and $\pi$ falls.

2. (b) If $w_2$ falls, this is a fall in the fixed cost, $x_1^*$ is unchanged, and $\pi$ rises.

2. (c) If $p$ rises, the firm produces more output, $x_1^*$ rises, and $\pi$ rises.

3. (a) $CS(y) = y^4 + 2$.

3. (b) The supply curve is the $MC^S(y)$ curve, if $p \geq \min AVC(y)$, and $MC^S(y)$ is rising.

4. (a) $CS(y) = 100y + 100.$

4. (b) $ATC(y) = 100 + \frac{100}{y}; AVC(y) = 100; MC^S(y) = 100.$ The short-run supply curve is infinitely elastic at $p = 100$. That is, the firm’s short-run supply is flat at that price.

5. (a) $ATC(y) = \frac{100}{y} + 10 - 2y + y^2; AVC(y) = 10 - 2y + y^2; MC^S(y) = 10 - 4y + 3y^2.$ $ATC(y)$ is a U-shaped parabola starting at $(0, \infty)$ with a minimum around $y = 4$. $AVC(y)$ is a U-shaped parabola starting at $(0, 10)$ with a minimum at $(1, 9)$. $MC^S(y)$ is a U-shaped parabola starting at $(0, 10)$ with a minimum at $y = \frac{2}{3}$.

5. (b) The short-run supply curve is $y = 0$ for $p < 9$, and $y = \frac{2}{3} + \sqrt{3p - 26}$ for $p \geq 9$.

6. If the output price is below $\min ATC(y)$ but above $\min AVC(y)$, the firm recoups some of the fixed cost if it produces output. Therefore, in the short run, the firm produces output as long as the output price is above $\min AVC(y)$.
Chapter 11 Solutions

1.(a) The equilibrium price and quantity both increase.

1.(b) The equilibrium price increases and the quantity decreases.

1.(c) The equilibrium price decreases and the quantity increases.

2.(a) Use the production function and tangency condition to solve for the conditional factor demands, and find the cost curves. You should get that $C(y) = 4y$.

2.(b) $y = 996,000$.

3.(a) $K^*(h) = \frac{1}{64}h; L^*(h) = 8h; C(h) = 12h$. The long-run individual and market supply are infinitely elastic at $p = 12$.

3.(b) $p = 12; h^* = 3,000$. Each producer earns zero profit. The amount produced by each firm is indeterminate; all we know is that the total amount supplied is 3,000.

3.(c) $p = 12; h^{**} = 2,000$. As before, each producer earns zero profit and the amount produced by each firm is indeterminate. It is possible that the number of firms has changed, but there is not enough information to give an exact answer.

4.(a) The representative firm’s supply curve is $y = 0$ for $p < 24$, and $y = \frac{1}{6} \left(1 + \sqrt{1 + 12p}\right)$ for $p \geq 24$.

4.(b) In the long run, the number of firms adjusts to drive the market to the zero-profit equilibrium. The long-run market supply curve is horizontal at $p = \min AC(y) = 24$. Each firm produces $y_i = 3$. At equilibrium, market supply equals market demand: $y = 900$. Therefore, there are 300 firms in the market.
5.(a) \( \pi(y) = 100y - \frac{1}{2}y^2 - 2,450 \).

5.(b) \( y^* = 100 \).

5.(c) \( \pi^* = 2,550 \).

5.(d) The number of firms in the rocking horse industry will rise since profits are positive.

6.(a) \( y^{**} = 70 \).

6.(b) \( p^{**} = 110 \).

6.(c) Calculate profits when \( y^{**} = 70 \).

6.(d) The firm’s profits are unaffected by the tax, but Dakota may drop out of the market. In either case, its profit will be zero.
Chapter 12 Solutions

1. The markup (and thus price) will be higher for the group with the lower elasticity of demand, which is Group B.

2. \( h = 950; \ p = 31; \ \pi = 18,050.\)

3. The monopolist will produce where \( MR_1 = MC_1 \) and \( MR_2 = MC_2.\)

4.(a) \( x_B = 49.50; \ x_F = 7.25; \ p_B = 50.50; \ p_F = 15.50; \ \pi = 2,555.37.\)

4.(b) Consumers’ surplus = 1,277.69; Producer’s surplus = 2,555.37.

4.(c) \( x = 49.50; \ p = 50.50; \ \pi = 2,450.25.\) Note that the monopolist serves only one group of consumers.

4.(d) Consumers’ surplus = 1,225.12; Producer’s surplus = 2,450.25. Society is worse off after this change is introduced.

5.(a) \( y^* = 30.\)

5.(b) \( p^* = 85.\)

5.(c) \( \pi^* = 1,350.\)

5.(d) Consumers’ surplus = 225.

6.(a) \( y^{**} = 36 > 30 = y^*.\)

6.(b) \( p^{**} = 82 < 85 = p^*.\)

6.(c) \( \pi^{**} = 1,296 < 1,350 = \pi^*.\)

6.(d) Consumers’ surplus = \( \frac{1}{2}(36)(100 - 82) = 324 > 225.\)

6.(e) Total welfare = 1,620 > 1,575.
Chapter 13 Solutions

1.(a) \( h_1 = 500 - \frac{1}{2}h_2 \); \( h_2 = 400 - \frac{1}{2}h_1 \).

1.(b) \( h_1^* = 400 \); \( h_2^* = 200 \); \( p^* = 30 \); \( \pi_1^* = 8,000 \); \( \pi_2^* = 2,000 \).

2.(a) \( h_1^* = 500 \); \( h_2^* = 0 \); \( p^* = 35 \); \( \pi_1^* = 12,500 \); \( \pi_2^* = 7,500 \); \( \pi_2^* = 5,000 \).

2.(b) In principle, both firms have an incentive to cheat since the cartel agreement is not on either reaction function. In this case, clearly Corleone has an incentive to break the agreement by producing the monopoly output but not sending the check to the other family. Chung would be happy to receive the check from Corleone, but his best response to Corleone’s cartel output is not zero, and hence he would also like to deviate. The answer may be more complex, as a function of the assumptions on observability of deviations and the kind of game that is actually being played after such deviations take place.

3.(a) \( y_1^* = 3.75 \); \( y_2^* = 249,998.12 \); \( p^* = 7.50 \); \( \pi_1^* = 14.06 \); \( \pi_2^* = 624,995.31 \).

3.(b) \( y_1^C = 3.75 \); \( y_2^C = 249,998.12 \). Note that the two answers are basically the same. The explanation is that MBI suffers from such a large cost disadvantage compared to Pear that MBI benefits very little from its first-mover advantage.

4.(a) \( p_1^* = 128 \); \( p_2^* = 192 \); \( y_1^* = 48 \); \( y_2^* = 32 \); \( \pi_1^* = 2,304 \); \( \pi_2^* = 1,024 \).

4.(b) \( p_1^* = 146.67 \); \( p_2^* = 213.33 \); \( y_1^* = 40 \); \( y_2^* = 20 \); \( \pi_1^* = 2,666.67 \); \( \pi_2^* = 1,066.67 \); \( \pi^* = 3,733.33 \).

5.(a) \( p_1^* = 36 \); \( p_2^* = 39 \); \( y_1^* = 11 \); \( y_2^* = 19 \); \( \pi_1^* = 132 \); \( \pi_2^* = 361 \).

5.(b) \( p_1^* = 35.62 \); \( p_2^* = 39.73 \); \( y_1^* = 11.62 \); \( y_2^* = 18.08 \); \( \pi_1^* = 135.02 \); \( \pi_2^* = 356.72 \).
6. For homogeneous goods markets, we rank the models in order of increasing output and decreasing price: collusion (if successful), the Cournot and Stackelberg models, and the Bertrand model. For differentiated goods, collusion, price leadership, and the Bertrand model.
Chapter 14 Solutions

1.(a)

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Player 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macho</td>
<td>Macho</td>
</tr>
<tr>
<td>Macho</td>
<td>0, 0</td>
</tr>
<tr>
<td>Chicken</td>
<td>2, 7</td>
</tr>
</tbody>
</table>

1.(b) Neither player has a dominant strategy.

1.(c) The Nash equilibria are (Macho, Chicken) and (Chicken, Macho).

2.(a)

<table>
<thead>
<tr>
<th>Jack</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build</td>
<td>Build</td>
</tr>
<tr>
<td>1, 1</td>
<td>-1, 2</td>
</tr>
<tr>
<td>Don’t Build</td>
<td>2, -1</td>
</tr>
</tbody>
</table>

2.(b) Both of them have a dominant strategy, which is “Not Build.” The Nash equilibrium is (Not Build, Not Build).

2.(c) This game resembles the Prisoner’s Dilemma. The Nash equilibrium (Not Build, Not Build) is not socially optimal. Both of them would be better off at (Build, Build).

3.(a) This is a sequential game where Sam is the first mover.

3.(b) $X < 0$.

4.(a) This is a sequential game with payoffs occurring only when the game is terminated at $t = 1, ..., 99$, and $t = 100$. 
4.(b) Use backward induction to show that player 1 chooses “Terminate” at \( t = 1 \).

5.(a) Use backward induction to show that the winning strategy for player X is to take the total to \( 100 - 11a \) at \( t = n - 2a \).

5.(b) There is a first-mover advantage in this game.

6. Show that the unique Nash equilibrium is \( (p_1 = \frac{1}{2}, p_2 = \frac{1}{2}) \) and \( y_1 = y_2 = \frac{1}{2}y \).
Chapter 15 Solutions

1.(a) The Edgeworth box is a square, and each side is 6 units long, with Michael’s origin on the lower left hand corner. The endowment point would be \((x_M, y_M) = (5, 1); (x_A, y_A) = (1, 5)\)

1.(b) Their indifference curves are L-shaped, with kinks where \(x_i = y_i\).

1.(c) Any allocation in the area bounded by the indifference curves through the initial endowment is a Pareto improvement. There are many such allocations.

2.(a) Use the tangency condition and the feasibility condition to show this.

2.(b) Show that \(x_g = \alpha, x_f = \alpha p_y/p_x\). Use the market-clearing condition to show this.

3.(a) Duncan’s suggested allocation has the right totals: \(x'_r + x'_t = x'^0_r + x'^0_t = 5; y'_r + y'_t = y'^0_r + y'^0_t = 5\).

3.(b) Rin’s utility is unchanged at 4, and Tin’s utility falls from 27 to 16. Duncan’s suggested equilibrium allocation is not a Pareto improvement over the endowment.

3.(c) Rin’s budget constraint is \(x_r + y_r = 4\). His optimal consumption bundle is \((x''_r, y''_r) = (2, 2)\).

3.(d) Tin’s budget constraint is \(x_t + y_t = 6\). His optimal consumption bundle is \((x''_t, y''_t) = (2, 4)\).

3.(e) Duncan’s suggested allocation and prices is not a competitive equilibrium. The totals add up, but consumers are not maximizing their utilities.

4.(a) Rin’s budget constraint is \(x_r + p_y y_r = 2 + 2p_y\). His optimal consumption bundle is 
\[
(x'_r, y'_r) = \left(1 + p_y, \frac{1 + p_x}{p_y}\right).
\]

4.(b) Tin’s budget constraint is \(x_t + p_y y_t = 3 + 3p_y\). His optimal consumption bundle is 
\[
(x'_t, y'_t) = \left(1 + p_y, \frac{2(1 + p_x)}{p_y}\right).
\]
4.(c) \( x_r^* + x_t^* = x_r^0 + x_t^0 \iff p_y = \frac{3}{2}. \)

4.(d) \((x_r^*, y_r^*) = \left(\frac{5}{2}, \frac{5}{3}\right); (x_t^*, y_t^*) = \left(\frac{5}{2}, \frac{10}{3}\right); p_y = \frac{3}{2}.\)

5.(a) The original endowment is Pareto optimal. Shepard cannot be made better off without making Milne worse off.

5.(b) Milne’s new budget constraint is \( x_m + p_y y_m = 4p_y. \) His optimal consumption bundle is \((x_m^*, y_m^*) = (p_y, 3).\)

5.(c) Shepard’s new budget constraint is \( x_s + p_y y_s = 4. \) His optimal consumption bundle is \((x_s^*, y_s^*) = \left(2, \frac{2}{p_y}\right).\)

5.(d) \((x_m^*, y_m^*) = (2, 3); (x_s^*, y_s^*) = (2, 1); p_y = 2\)

5.(e) Since \( MRS^m = MRS^s = \frac{1}{2} \) and all goods are being consumed, the new equilibrium allocation is Pareto optimal.

6. Consider the case of an individual starting out with nothing. To induce him to consume positive amounts with per unit subsidies, you would have to sell him one or both goods at negative net prices.
Chapter 16 Solutions

1. (a) $x = 1; l = 1$.
   
   1. (b) $x = 1; l = 1; w = \frac{1}{2}; \pi = \frac{1}{2}$.

2. (a) $x = \frac{16}{9}; l = \frac{64}{27}$.
   
   2. (b) $x = \frac{16}{9}; l = \frac{64}{27}; w = \frac{1}{2}; \pi = \frac{16}{27}$.

3. (a) The Pareto efficient allocation is the tangency of the indifference curve and the production function.
   
   3. (b) $x = \frac{3}{2}; l = \frac{1}{4}; w = 1; \pi = \frac{5}{4}$.

4. (a) $l_x = l_y = 2$.

4. (b) She studies $\sqrt{2}$ chapters of economics and $\sqrt{2}$ chapters of mathematics.

4. (c) $u = 0$.

4. (d) $u = 1.17$.

5. (a) $x^S = \frac{2}{5}p_y - \frac{2}{5}p_x; y^S = \frac{3}{5}p_x - \frac{2}{5}p_y$.

5. (b) $x^D = 1; y^D = 1; l^S = 5$.

5. (c) $p_x = p_y = 5$.

6. Robinson solves the following profit maximization problem:

$$\max_{x,y,z} \pi = p_x x + p_y y + p_z z - w l \quad \text{subject to} \quad l(x, y, z).$$

He solves the following utility maximization problem:

$$\max_{x,y,z} u = u(x, y, z) \quad \text{subject to} \quad p_x x + p_y y + p_z z \leq w l + \pi.$$
Chapter 17 Solutions

1.(a) $u_m(2) = 2; u_l(2) = 4; u_c(2) = -5.$
1.(b) $u_m(3) = 5; u_l(3) = 9; u_c(3) = -10.$
1.(c) The function $x^2 - 2x + 1$ has no maximum; they should fill their house with puppies.

2.(a) $p^M = 18; h = 9.$
2.(b) $u_S = 324; u_G = 135.$
2.(c) The efficient number of plants is 26, and $p^* = 26.$

3.(a) Each person blasts music 2 hours per day. Music is blasting 22 hours per day.
3.(b) $u_i = 2.$
3.(c) $m^* = \frac{5}{4}.$ Note that everyone’s utility is 3.125.

4.(a) $f^M = 8; b^M = 9; \pi_f^M = 275; \pi_b^M = 650.$
4.(b) $f^* = 17.2; b^* = 15.6; \pi_f^* = 140; \pi_b^* = 1,070.$
4.(c) Beatrice transfers between $135 and $420 to Flo.

5.(a) $c^M = 60; b^M = 90.$
5.(b) $c^* = 50; b^* = 100.$
5.(c) Since $\pi^* > \pi^M$, market profits are lower than the joint profit maximization outcome from (b), which gives the highest possible joint profit. The equilibrium is not Pareto optimal.
5.(d) Clyde pays the tax, which should be set at the marginal external cost at the efficient outcome. The negative externality imposed on Bonnie by Clyde is now internalized by Clyde.

5.(e) Bonnie pays Clyde an amount between 500 and 950 to cut his output back to 50 units, from $c^M$ to $c^*$.

6. Please note two corrections of the problem in the text:

   (1) After the second sentence, insert the following sentence: “The total pollution level had been at 60.”

   (2) In the next to last sentence, change “pollution produced” to “pollution abated.”

$x_1 = 10; x_2 = 20.$
Chapter 18 Solutions

1.(a) Correction. The textbook should read: “What condition or conditions must hold for the TV to be considered a public good?” The answer is: Nonexclusivity in use.

1.(b) The Nash equilibrium is (Don’t Pay, Don’t Pay).

$$\begin{array}{c|cc}
\text{Paolo} & \text{Pay} & \text{Don’t Pay} \\ \hline 
\text{Fabio} & & \\ 
\text{Pay} & 50, 50 & -100, 200 \\ 
\text{Don’t Pay} & 200, -100 & 0, 0 \\
\end{array}$$

1.(c) There are now two Nash equilibria: (Pay, Don’t Pay) and (Don’t Pay, Pay).

$$\begin{array}{c|cc}
\text{Paolo} & \text{Pay} & \text{Don’t Pay} \\ \hline 
\text{Fabio} & & \\ 
\text{Pay} & 250, 250 & 100, 400 \\ 
\text{Don’t Pay} & 400, 100 & 0, 0 \\
\end{array}$$

2. Correction There are two errors in the textbook. The original utility function is shown as $u_i = \sqrt{x_iy_i}$. The correct utility function is $u_i = \sqrt{x_i} + y_i$. The new utility function, where movie streaming is a public good, is shown as $u_i = \sqrt{xy_i}$. The correct utility function is $u_i = \sqrt{x + y_i}$. Delete part (d). Here is the solution for the corrected problem:

2.(a) $(x_f, y_f) = (0.25, 9.75)$; $(x_p, y_p) = (0.25, 19.75)$; $u_f = 10.25$; $u_p = 20.25$.

2.(b) $u_f = 10.46 > 10.25$; $u_p = 20.46 > 20.25$.

2.(c) Use the Samuelson optimality condition to show that the allocation from part (a) is not Pareto optimal.

3.(a) The maximum amount each pig is willing to contribute is as follows: $h_1 = \frac{1}{4}M_1$; $h_2 = \frac{1}{3}M_2$; $h_3 = \frac{1}{2}M_3$. To do this, one should find the point at which each pig is indifferent between getting the house making the payment, and having no house.
3. (b) It is unclear. What we can say is that, if each pig pays the maximum amount he is willing to pay, they can just afford the house.

4. (a) \( MRS_{x,y_i} = \frac{1}{10\sqrt{x}} \).

4. (b) \( x^* = 10,000 \).

5. Consider the case when agent 1 buys the public good first. After agent 1 chooses, agent 2 will never respond with zero.

6. (a) \( T_1 = 100; T_2 = 200; T_3 = 300; T_4 = 400 \).

6. (b) The park gets built. \( T_4 = 400 \). Family 4’s net benefit is zero, just as in part (a).

6. (c) The park does not get built. \( T_4 = 0 \). Family 4’s net benefit is zero, just as in part (a).

6. (d) The Samuelson optimality condition states that the sum of the marginal benefits from the public good equals the marginal cost of the public good.
Chapter 19 Solutions

1. Show that if consumer $i$ pays consumer $k$ $13 to bear the risk, both of them would be better off.

2.(a) $E(L) = 185$

2.(b) $u_g(L) = 42,087.5$.

2.(c) $P \approx 290.13$.

2.(d) George is risk loving.

3.(a) $E(L) = 2.5$.

3.(b) $u_a(L) = 11; u_i(L) = 5$.

3.(c) Jack prefers to hike up the hill, and Jill prefers to draw water at the foot of the hill.

3.(d) Jack is risk loving; $P_a > E(L)$. Jill is risk neutral; $P_i = E(L)$.

4.(a) $E(L) = 4$.

4.(b) $u_a(L) = 1; u_m(L) = 4; u_s(L) = 256$.

4.(c) Adam and Michael will buy protection. Stella will not buy protection.

4.(d) $P \leq 4.95$.

5. He does not accept the lottery.

6. The net expected value of Will’s lottery ticket is $-\frac{1}{3}$.
Chapter 20 Solutions

1.(a) Harry is willing to pay $2,000, and he ends up buying type B and type C cars.

1.(b) Harry is willing to pay $1,500, and he ends up buying type C cars only.

2.(a) The market price for used cars would be $1,500.

2.(b) The market price for uninspected used cars would be $X/2.

2.(c) $X = 600.$

2.(d) Any car worth less than $600 will not get inspected, and there are 200 such cars. Each uninsured car will be sold for $300.

3.(a) The expected loss for Placido is 600,000; for Jose is 200,000; and for Luciano is 100,000.

3.(b) Placido and Jose are risk loving; Luciano is risk averse.

3.(c) The expected payout per person is 300,000.

3.(d) Only Placido will buy insurance. The insurance company will make a loss because $E(Payout) = 600,000 > 300,000 = Price.$

4.(a) Kevin will lock his door 100 percent of the time.

4.(b) $100.$

4.(c) $300.$

4.(d) In equilibrium, insurance policies cost $300. Kevin locks his door 80 percent of the time, and his net benefit is $H - 200.$
4.(e) If homeowners lock their doors 100 percent of the time, policies cost $100, and each homeowner’s net benefit is \( H - 100 > H - 200 \). The benefit from having to lock the door only 80% of the time is only $100, and yet it raises the cost of insurance by $200. Even so, once insured, everyone will lock the door only 80% of the time.

5.(a) \( c \approx 0.1844; \ E(\pi, e = 1) \approx 4.49 \).

5.(b) \( c \approx 0.4245; \ E(\pi, e = 1) \approx 5.47 \).

5.(c) \( c \geq 182.04\% \). The scheme is not workable, as the agent would have to be paid more than 100% of the output.

6.(a) Wage = 1,600, the expected productivity.

6.(b) \( X < 600 \) and \( Y < 600 \).

6.(c) \( X > 400 \) and \( Y < 400 \).