Chapter 1.

Question 3.

(from instructor’s manual)

Positive economics  An approach to economics that seeks to understand behavior and the operation of systems without making judgment. It describes what exists and how it works.

Normative economics  An approach to economics that analyzes outcomes of economic behavior, evaluates them as good or bad, and may prescribe courses of action. Also called policy economics

(a) Positive (b) Normative
(c) That Chile should not be allowed to join NAFTA is a normative statement. The reasons given are examples of positive economic analysis.
(d) Positive (e) Positive (f) Normative

Question 4

\[ AC(q) = \text{Average Cost} \]
\[ MC(q) = \text{Marginal Cost} \]
\[ TC(q) = \text{Total Cost} \]

\[ AC(q) \equiv \frac{TC(q)}{q} = \frac{19.95}{17} \approx 1.17 \]

\[ ^1 \text{Textbook, P. 8} \]
\[ MC(q) = \frac{\Delta TC(q)}{\Delta q} = \frac{TC(q) - TC(q')}{q - q'} \]

Pick \( q' \) satisfying \( q' = q - 1 \). Then \( MC(q) \) becomes

\[ MC(q) = \frac{TC(q) - TC(q - 1)}{q - (q - 1)} = \frac{TC(q) - TC(q - 1)}{1} = 19.95 - 19.95 = 0 \]

**Question 7**

(from instructor's manual)

**Opportunity Cost** The best alternative that we forgo, or give up, when we make a choice or a decision\(^2\)

a. Tuition, (which could have been spent on other things), forgone wages, study time. Etc

b. All the money (gas, depreciation of the car, etc.) could have been spent on other items; time spent en route could have been used for other activities.

c. A better grade, no headache, perhaps admission to a better grad school, a higher-paying job. He has traded off an investment in human capital (staying in to study) for present consumption (going to the party).

d. The other things that $200 could buy

e. The $1 million could have been invested in other profit making ventures or projects or it simply could have been put into the bank or loaned out to someone else at interest

f. From the standpoint of the store, Alex is free. From Alex’s standpoint, he gives up other uses of time and wages that could be earned elsewhere.

\(^2\)Textbook P.2
Chapter 2

Question 3

a. b.

Table 1. Output/hour

<table>
<thead>
<tr>
<th></th>
<th>Kristin (K)</th>
<th>Anna (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wristbands (W)</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Potholders (P)</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Opportunity Cost = Loss / Gain

Example:
If Kristin works 1 hour more in Wristband
Gain = 15 wristbands
Loss = 3 potholders
Opportunity Cost of Kristin’s 1 wristband = 3/15 potholder.

Therefore the Opportunity Cost is given as

Table 2. Opportunity Cost

<table>
<thead>
<tr>
<th></th>
<th>Kristin (K)</th>
<th>Anna (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wristbands (W)</td>
<td>3/15P</td>
<td>2/12P</td>
</tr>
<tr>
<td>Potholders (P)</td>
<td>15/3W</td>
<td>12/2W</td>
</tr>
</tbody>
</table>

Simplifying, we get

Table 3. Opportunity Cost

<table>
<thead>
<tr>
<th></th>
<th>Kristin (K)</th>
<th>Anna (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wristbands (W)</td>
<td>1/5P</td>
<td>1/6P</td>
</tr>
<tr>
<td>Potholders (P)</td>
<td>5W</td>
<td>6W</td>
</tr>
</tbody>
</table>

Comparative advantage ⇒ lower opportunity cost

Answer to a. 5 < 6 ⇒ Kristin has comparative advantage in potholder production

Answer to b. 1/6 < 1/5 ⇒ Anna has comparative advantage in wristband production
c.

Let $H_w \equiv$ hours spent in W production, $H_p \equiv$ hours spent in P production. $H_w + H_p = 20$ for both Kristin and Anna.

Let

$W_k \equiv$ Kristin’s Wristband Production

$P_k \equiv$ Kristin’s Potholder Production

$W_a \equiv$ Anna’s Wristband Production

$P_a \equiv$ Anna’s Potholder Production.

Then,

Kristin’s production: $W_k = 15H_w, \quad P_k = 3H_p$

Anna’s production: $W_a = 12H_w, \quad P_a = 2H_a$

As we increase $H_p$ from 0 to 20, $H_w = 20 - H_p$ decrease. Each person’s production changes. The change is given in Table 4.

<table>
<thead>
<tr>
<th>$H_p$</th>
<th>$H_w = 20 - H_p$</th>
<th>$P_k = 3H_p$</th>
<th>$W_k = 15H_w$</th>
<th>$P_a = 2H_a$</th>
<th>$W_a = 12H_a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
<td>0</td>
<td>300</td>
<td>0</td>
<td>240</td>
</tr>
<tr>
<td>1</td>
<td>19</td>
<td>3</td>
<td>285</td>
<td>2</td>
<td>228</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>6</td>
<td>270</td>
<td>4</td>
<td>216</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>9</td>
<td>255</td>
<td>6</td>
<td>204</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>12</td>
<td>240</td>
<td>8</td>
<td>192</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>15</td>
<td>225</td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>18</td>
<td>210</td>
<td>12</td>
<td>168</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>21</td>
<td>195</td>
<td>14</td>
<td>156</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>24</td>
<td>180</td>
<td>16</td>
<td>144</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>27</td>
<td>165</td>
<td>18</td>
<td>132</td>
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<tr>
<td>10</td>
<td>10</td>
<td>30</td>
<td>150</td>
<td>20</td>
<td>120</td>
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<tr>
<td>11</td>
<td>9</td>
<td>33</td>
<td>135</td>
<td>22</td>
<td>108</td>
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<tr>
<td>12</td>
<td>8</td>
<td>36</td>
<td>120</td>
<td>24</td>
<td>96</td>
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<tr>
<td>13</td>
<td>7</td>
<td>39</td>
<td>105</td>
<td>26</td>
<td>84</td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>42</td>
<td>90</td>
<td>28</td>
<td>72</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
<td>45</td>
<td>75</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>48</td>
<td>60</td>
<td>32</td>
<td>48</td>
</tr>
<tr>
<td>17</td>
<td>3</td>
<td>51</td>
<td>45</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>54</td>
<td>30</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>57</td>
<td>15</td>
<td>38</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>60</td>
<td>0</td>
<td>40</td>
<td>0</td>
</tr>
</tbody>
</table>

By plotting $(P_k, W_k)$ (third and forth column), we can get Krisitin’s PPF. Anna’s PPF can be obtained by plotting $(P_a, W_a)$ (fifth and sixth column).
Notice that the slope of PPF is the opportunity cost of one potholder production in terms of wristband. Also notice that the slope of Kristin’s PPF is flatter than that of Anna’s PPF. This means Kristin has comparative advantage in Potholder production.

It may be a good exercise to derive the equation of each PPF.

Kristin’s PPF: \( W_k = 300 - 5P_k \)
Anna’s PPF: \( W_a = 240 - 6P_a \)

d.

For both of Kristin and Anna, \( H_w = 10, \ H_p = 10 \),

Kristin’s production: \( W_k = 15H_w = 15 \times 10 = 150 \)
\( P_k = 3H_p = 3 \times 10 = 30 \)
Anna’s production: \( W_a = 12H_w = 12 \times 10 = 120 \)
\( P_a = 2H_a = 2 \times 10 = 20 \)

Therefore, total wristband production is \( W_k + W_a = 150 + 120 = 270 \), total potholder production is \( P_k + P_a = 30 + 20 = 50 \).

e.

For Kristin, \( H_w = 3, \ H_p = 17 \).
For Anna, \( H_w = 20, \ H_p = 0 \)

Kristin’s production: \( W_k = 15H_w = 15 \times 3 = 45 \)
\( P_k = 3H_p = 3 \times 17 = 51 \)
Anna’s production: \( W_a = 12H_w = 12 \times 20 = 240 \)
\( P_a = 2H_a = 2 \times 0 = 0 \)

Therefore, total wristband production is \( W_k + W_a = 45 + 240 = 285 \), total potholder production is \( P_k + P_a = 51 + 0 = 51 \).

f.

If Kristin works in Potholder production for 1 hour, she would got \( 5.5\times 3 = 16.5 \). If she works in Wristband production for 1 hour, she would got \( 1 \times 15 = 15 \). \( 16.5 > 15 \). Therefore, the more hours Kristin spend in Potholder production, the more revenue she would get.

If Anna works in Potholder production for 1 hour, she would got \( 5.5 \times 2 = 10 \). If she works in Wristband production for 1 hour, she would got \( 1 \times 12 = 12 \).
12 > 10. Therefore, the more hours Kristin spend in Wristband production, the more revenue she would get.

To maximize the joint Revenue, Kristin should concentrate on Potholder production, and Anna should concentrate on Wristband Production. Joint Revenue becomes

\[
R = 5.5 \times P + 1 \times W \\
= 5.5 \times 3 \times 20 + 1 \times 12 \times 20 \\
= 16.5 \times 20 + 12 \times 20 \\
= 570
\]

**Question 5**

**a**

Let \( L_X \) be the number of workers working in X production, and \( L_Y \) be the number of workers working in Y production. Given conditions can be summarized as

\[
X = 5L_X \\
Y = 10L_Y \\
L_X + L_Y = 100
\]

As we increase \( L_X \) from 0 to 100, the X, Y production changes accordingly. The change of production is given in table 5.

<table>
<thead>
<tr>
<th>( L_X )</th>
<th>( L_Y = 100 - L_X )</th>
<th>( X = 5L_X )</th>
<th>( Y = 10L_Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>1</td>
<td>99</td>
<td>5</td>
<td>990</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>500</td>
<td>0</td>
</tr>
</tbody>
</table>

By plotting \((X, Y)\), we can get PPF. As we can see from table 5., PPF intersects Y axis at \((X, Y) = (0, 1000)\). When economy is at this point, every worker works in Y production. PPF intersects X axis at \((X, Y) = (500, 0)\). When economy is at this point, every worker works in X production. Graph is attached.

**b.**

(From instructor’s manual) Unemployment or underemployment of labor would put the society inside the PPF. Full employment would move the society to some point on PPF.
c. (From instructor’s manual) Answers will vary, but the decision should be based on the relative value of necessities and luxuries, and the degree of concern that all fellow citizens have enough necessities.

d. (From instructor’s manual) If left to the free market, prices would (at least ideally) be determined by market forces; income would be determined by a combination of ability, effort, and inheritance. It would be up to each individual find a job and determine how to spend the income.

Question 7. (From instructor’s manual)

<table>
<thead>
<tr>
<th>description</th>
<th>Figure 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>c</td>
</tr>
<tr>
<td>b</td>
<td>a d e f</td>
</tr>
<tr>
<td>c</td>
<td>probably d f</td>
</tr>
<tr>
<td>d</td>
<td>e</td>
</tr>
<tr>
<td>e</td>
<td>b c d e f</td>
</tr>
<tr>
<td>f</td>
<td>b</td>
</tr>
</tbody>
</table>

a. **inefficient production** Inside the PPF.: c  
b. **Production efficiency** On the PPF : a d e f  
c. **An inefficient mix of output** Not efficient in terms of “distribution”. Strictly speaking, we can’t tell from Figure 1. Assume that people want to have both of meat and fish, instead of only fish or only meat, d and f could be considered as inefficient output mix.  
d. **Technological Advances** PPF is moving away from origin. : e.  
e. **law of increasing opportunity cost** The slope of PPF is increasing. : b c d e f  
f. **impossible production** Out of PPF : b
Question 8

Table 6. PPF of Bread(B) and Oven(O)

<table>
<thead>
<tr>
<th>before Tech Adv</th>
<th>after Tech Adv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread(B)</td>
<td>Oven(O)</td>
</tr>
<tr>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>15</td>
<td>36</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>45</td>
<td>22</td>
</tr>
<tr>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>75</td>
<td>0</td>
</tr>
</tbody>
</table>

a.

attached

b.

We can see from the table.

c.

(From the instructor's manual) Over time, as the number of ovens increases, the capacity to produce bread with same quantity of other resources will also increase. Thus, the PPF curve will shift out horizontally. The vertical intercept (maximum possible oven production) will remain unchanged, but the horizontal intercept (maximum possible bread production) will increase.

Consider oven as a Capital good, and Bread as a Consumption good. Economic growth arises mainly from capital good accumulation and Technological Advancement\(^3\). Question 8.c. is a capital good accumulation case. 8.d. is a Technological Advancement case.

d.

attached

e.

Before Tech Adv. \( B = 45 \), After Tech Adv. \( B = 60 \). Bread production increased by 15(millions of loaves).

\(^3\)Textbook p.34
Chapter 3

Question 2

a. attached

b. price cut. But it is not clear if price cut would increase quantity demanded enough to fill the ballpark. Even if price cut can increase quantity demanded that much, the revenue could decrease. All depend on the demand curve.

(From instructor’s manual) It depends on whether demand responds to the lower price and by how much. If demand is "elastic" enough, the quantity demanded will increase by more than the fall in ticket price and revenue will rise. If demand is not responsive enough, the quantity demanded may not increase enough to offset the fall in ticket prices, and revenue will fall. The easiest example of the latter would occur if demand were "perfectly elastic", which implies that no one else would come to the game despite the lower price.

c. Price system didn’t work since excess demand existed.

(From instructor’s manual). Some other rationing devices must have been used. Perhaps people stood in line or queued. Perhaps there was a lottery. In all likelihood there would be a secondary market for the tickets ("scalers"). You could no doubt find them for sale online at a high price.

Question 8.

a. demand decrease case: price and quantity decreases
b. demand increase case: price and quantity increases
c. supply decrease case: price increases, quantity decreases
d. demand increase case: price and quantity increases
e. supply increase case: price decrease, quantity increase

Question 10.

\[ Q_d = 100 - 20P \]
\[ Q_s = 10 + 40P \]
a.

<table>
<thead>
<tr>
<th>$P$</th>
<th>$Q_d$</th>
<th>$Q_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>1</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>1.5</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>2.5</td>
<td>50</td>
<td>110</td>
</tr>
</tbody>
</table>

b.

We can read from the table that $P_E = 1.5$, $Q_E = 70$.

c.

Attached.

**Question 12.**

\[
\begin{align*}
Q_d &= 300 - 20P \\
Q_s &= -100 + 20P
\end{align*}
\]

a.

<table>
<thead>
<tr>
<th>$P$</th>
<th>$Q_d = 300 - 20P$</th>
<th>$Q_s = -100 + 20P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>200</td>
</tr>
</tbody>
</table>

By connecting $(Q, P) = (200,5)$, $(Q, P) = (0,15)$, we can get Demand curve. Also, by connecting $(Q, P) = (0,5)$, $(Q, P) = (200,15)$, we can obtain Supply curve. Graph is attached.

b.

Let $P_E=\text{equilibrium price}$, $Q_E=\text{equilibrium quantity}$. Then $P_E,Q_E$ satisfies demand and supply equation at the same time.

\[
\begin{align*}
Q_E &= 300 - 20P_E \\
Q_E &= -100 + 20P_E \\
300 - 20P_E &= -100 + 20P_E \\
400 &= 40P_E \\
P_E &= 10
\end{align*}
\]
Plug $P_E = 10$ into demand equation, we get

$$Q_E = 300 - 20P_E = 300 - 20 \times 10 = 300 - 200 = 100$$

c.

$$P = 15$$

$$Q_s = -100 + 20 \times 15 = 200$$

$$Q_d = 300 - 20 \times 15 = 0$$

Excess supply $= 200 - 0 = 200$

Since there is excess supply, price decrease. As price decreases, quantity supplied increases and quantity demanded decrease until they come to the equilibrium.

d.

<table>
<thead>
<tr>
<th></th>
<th>Old demand</th>
<th>New Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Denote new demand equation as $Q_d = mP + b$,

$$m = \frac{Q_{d2} - Q_{d1}}{P_2 - P_1} = \frac{400 - 0}{5 - 15} = -40$$

Then, new demand equation becomes $Q_d = -40P + b$. $(Q_d, P) = (0, 15)$ is on this new demand curve. By plugging $(Q_d, P) = (0, 15)$ into $Q_d = -40P + b$, we can get

$$0 = -40 \times 15 + b = -600 + b$$

$$b = 600$$

Therefore, new demand equation is $Q_d = -40P + 600$. 

11
e.

Find the solution to the system of equations.

\[
\begin{align*}
Q_E &= 600 - 40P_E \\
Q_E &= -100 + 20P_E \\
600 - 40P_E &= -100 + 20P_E \\
700 &= 60P_E \\
P_E &= \frac{70}{6}
\end{align*}
\]

Plug \( P_E = 10 \) into either demand (or supply) equation, we get

\[
Q_E = 600 - 40P_E = 600 - 40 \times \frac{70}{6} = 133.33
\]

**Extra Question 4.**

a.

Schedule A is downward sloping. Schedule B is upward sloping. So, Schedule A is a demand schedule and Schedule B is a supply schedule.

For the rest, \( Q'_d \) is increased demand. \( Q'_s \) is increased supply. Demands and supplies are on the following table.

<table>
<thead>
<tr>
<th>( P )</th>
<th>( Q_d )</th>
<th>( Q_d = Q_d + 5 )</th>
<th>( P )</th>
<th>( Q_s )</th>
<th>( Q'_s = 1.5 \times Q_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>0</td>
<td>5</td>
<td>( 2 )</td>
<td>2</td>
<td>( 3 )</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>6</td>
<td>( 5 )</td>
<td>3</td>
<td>( 4.5 )</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>7</td>
<td>( 8 )</td>
<td>4</td>
<td>( 6 )</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>8</td>
<td>( 11 )</td>
<td>5</td>
<td>( 7.5 )</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>9</td>
<td>( 14 )</td>
<td>6</td>
<td>( 9 )</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>10</td>
<td>( 17 )</td>
<td>7</td>
<td>( 10.5 )</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>11</td>
<td>( 20 )</td>
<td>8</td>
<td>( 12 )</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>12</td>
<td>( 23 )</td>
<td>9</td>
<td>( 13.5 )</td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>13</td>
<td>( 26 )</td>
<td>10</td>
<td>( 15 )</td>
</tr>
</tbody>
</table>

b.

We can read from the table. At \( P = 8 \), \( Q_d = Q_s = 4 \). We are at equilibrium. Diagram is attached.
c.
Let’s try $P = mQ + b$ form. The equation for Demand curve is given as $P = mQ_d + b$

$$m = \frac{P_2 - P_1}{Q_{d2} - Q_{d1}} = \frac{16 - 14}{0 - 1} = -2$$

Then, new demand equation becomes $P = -2Q_d + b$. $(Q_d, P) = (0, 16)$ is on this new demand curve. By plug $(Q_d, P) = (0, 16)$ to $P = -2Q_d + b$, we can get

$$16 = -2 \times 0 + b = b$$
$$b = 16$$

Therefore, our demand equation is $P = -2Q_d + 16$. Following the same step, we can derive supply equation $P = 3Q_s - 4$.

d.
Solution to the system of equations. Find $(P_E, Q_E)$ satisfying the following two equations.

$$P_E = -2Q_E + 16$$
$$P_E = 3Q_E - 4$$

Following the similar steps in the solution for question 12.e. of Chapter 3,

$$3Q_E - 4 = -2Q_E + 16$$
$$5Q_E = 20$$
$$Q_E = 4$$
$$P_E = 3 \times 4 - 4 = 8$$

e.1.
The equation for the new Demand curve is given as $P = mQ'_d + b$

$$m = \frac{P_2 - P_1}{Q'_{d2} - Q'_{d1}} = \frac{16 - 14}{5 - 6} = -2$$
Then, new demand equation becomes $P = -2Q_d' + b$. $(Q_d', P) = (5, 16)$ is on this new demand curve. By plugging $(Q_d', P) = (5, 16)$ into $P = -2Q_d' + b$, we can get

\[
\begin{align*}
16 &= -2 \times 5 + b = b - 10 \\
 b &= 16 + 10 = 26
\end{align*}
\]

Therefore, new demand equation is $P = -2Q_d' + 26$.

e.2.

Attached

e.3.

Find $(P_E, Q_E)$ satisfying the following two equations.

\[
\begin{align*}
P_E &= -2Q_E + 26 \\
P_E &= 3Q_E - 4
\end{align*}
\]

Following the similar steps in 4.d.

\[
\begin{align*}
3Q_E - 4 &= -2Q_E + 26 \\
5Q_E &= 30 \\
Q_E &= 6 \\
P_E &= 3 \times 6 - 4 = 14
\end{align*}
\]

f.1.

The equation for the new supply curve is given as $P = mQ_s' + b$

\[
m = \frac{P_2 - P_1}{Q_{s2} - Q_{s1}} = \frac{2 - 8}{3 - 6} = 2
\]

Then, new demand equation becomes $P = 2Q_s' + b$. $(Q_s', P) = (3, 2)$ is on this new demand curve. By plugging $(Q_s', P) = (3, 2)$ to $P = -2Q_s' + b$, we can get

\[
\begin{align*}
2 &= 2 \times 3 + b = b + 6 \\
b &= 2 - 6 = -4
\end{align*}
\]

Therefore, new supply equation is $P = 2Q_s' - 4$. 
f.2. Attached

f.3. Find \((P_E, Q_E)\) satisfying the following two equations.

\[
\begin{align*}
P_E &= -2Q_E + 16 \\
P_E &= 2Q_E - 4
\end{align*}
\]

Following the similar steps in 4.d.

\[
\begin{align*}
2Q_E - 4 &= -2Q_E + 16 \\
4Q_E &= 20 \\
Q_E &= 5 \\
P_E &= 2 \times 5 - 4 = 6
\end{align*}
\]