1. We say that a firm experiences *economies of scale* or increasing returns to size when ...

2. What is the shutdown rule for a firm in the short-run?

3. What are the conditions for a firm to minimize cost?

4. Complete the following statements about marginal and total product.
   a. When marginal product is negative, total product is ____________________.
   b. When marginal product is positive but falling, total product is ____________________.
   c. When marginal product is rising, total product is ____________________.
   d. When average product is rising, marginal product is ____________________.
   e. When average product is at its maximum point, marginal product is ____________________.

5. Complete the following about income and substitution effects.
   a. The substitution effect of a price change is the ____________________.
   b. The income effect of a price change is the ____________________.
   c. What can we say about the sign of the income effect of a price change?
   d. What can we say about the sign of the substitution effect of a price change?
6. Consider the following data on cocoa and lumber in Norway and Ghana where the data is production per time period. Assume that the production possibility frontier is linear. With no cocoa production, Norway can produce 90,000 board feet of lumber. With 3,000 kilograms of cocoa, Norway has no lumber production, etc.

<table>
<thead>
<tr>
<th></th>
<th>Cocoa</th>
<th>Lumber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>0</td>
<td>90,000</td>
</tr>
<tr>
<td>Norway</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>Ghana</td>
<td>0</td>
<td>50,000</td>
</tr>
<tr>
<td>Ghana</td>
<td>2,500</td>
<td>0</td>
</tr>
</tbody>
</table>

a. Who has the absolute advantage in cocoa production?

b. Who has the comparative advantage in lumber production?

<table>
<thead>
<tr>
<th></th>
<th>Cocoa</th>
<th>Lumber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>lumber</td>
<td>cocoa</td>
</tr>
<tr>
<td>Ghana</td>
<td>lumber</td>
<td>cocoa</td>
</tr>
</tbody>
</table>

c. If each country produced 1,000 kilograms of cocoa and then each used their remaining resources for lumber production, what would total lumber production be?

d. If Norway produced 500 kilograms of cocoa and Ghana produced 1,500 kilogram of cocoa, and each used their remaining resources for lumber production, what would total lumber production be?
7. Use the following table for this question. The table shows data for a specific firm. Y denotes output, FC denotes fixed cost, VC denotes variable cost, TC represents total cost, AFC is average fixed cost, AVC is average variable cost, ATC is average total cost, and MC is marginal cost. TR is total revenue, and MR is marginal revenue.

<table>
<thead>
<tr>
<th>Y</th>
<th>FC</th>
<th>VC</th>
<th>TC</th>
<th>AFC</th>
<th>AVC</th>
<th>ATC</th>
<th>MC</th>
<th>Price</th>
<th>TR</th>
<th>MR</th>
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<td>0.00</td>
<td>250.00</td>
<td>50.00</td>
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<td>50.00</td>
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<td></td>
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<tr>
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<td>88.00</td>
<td>338.00</td>
<td>44.00</td>
<td>169.00</td>
<td>42.00</td>
<td>99</td>
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<td>3.00</td>
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<td>382.00</td>
<td>44.00</td>
<td>127.33</td>
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<td>100.00</td>
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<td>41.67</td>
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<td>125.00</td>
<td>250.00</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. If this firm is a price setter, how much should it produce in the short run?

b. If this firm is a price setter, how much should it produce in the long run?

c. If $100 of the fixed cost is sunk ($150 is avoidable), how much should the firm produce in the short run?

d. If $25 of the fixed cost is sunk ($225 is avoidable), how much should the firm produce in the short run?
8. The following table is for use with this question. The underlying production function is

\[ y = 40x_1 + 10x_2 - x_1^2 + x_1x_2 - 2x_2^2 \]

The price of \( x_1 \) is $100 and the price of \( x_2 \) is $20. The price of the output of the firm is $5. The prices of inputs are given by \( w_1 \) and \( w_2 \). MC is the marginal cost of output. APP\(_i\) is the average physical product of the \( i \)th input while MPP\(_i\) is the marginal physical product of the \( i \)th input.

<table>
<thead>
<tr>
<th>( x_1 )</th>
<th>( x_2 )</th>
<th>( w_1 )</th>
<th>( w_2 )</th>
<th>Output</th>
<th>Cost</th>
<th>MC</th>
<th>APP(_1)</th>
<th>APP(_2)</th>
<th>MPP(_1)</th>
<th>MPP(_2)</th>
</tr>
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<tbody>
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<td>20</td>
<td>287</td>
<td>780</td>
<td>3.333</td>
<td>30</td>
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<td>800</td>
<td>3.357</td>
<td>41.571</td>
<td>58.200</td>
<td>31</td>
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</tr>
<tr>
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<td>6</td>
<td>100</td>
<td>20</td>
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<td>820</td>
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<td>41.571</td>
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<td>1000</td>
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<td>20</td>
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<td>100</td>
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<td>1640</td>
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<td>32.467</td>
<td>69.571</td>
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<td>100</td>
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<td>71.857</td>
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<td>100</td>
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<td>2380</td>
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<td></td>
<td></td>
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<td>9</td>
<td>100</td>
<td>20</td>
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<td>27.650</td>
<td>61.444</td>
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<td>-1</td>
</tr>
<tr>
<td>22</td>
<td>8</td>
<td>100</td>
<td>20</td>
<td>564</td>
<td>2360</td>
<td>17.056</td>
<td>25.636</td>
<td>70.500</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

a. What is the average product of \( x_2 \) when \( x_1 = 10 \) and \( x_2 = 5 \)?

b. What is the average product of \( x_1 \) when \( x_1 = 7 \) and \( x_2 = 4 \)?

c. What is the least cost way to produce 287 units of output?

d. Is the least cost way to produce 291 units of output contained in the table? If so, what are the input levels?

e. Is the least cost way to produce 447 units of output contained in the table? If so, what are the input levels?

f. How could one show the result in part e without using the cost column or computing the cost directly?


g. What is the slope of the isoquant for \( y = 447 \) when \( x_1 = 13 \) and \( x_2 = 8 \)?

h. What is the profit maximizing level of output?

i. What would be the least cost way to produce 375 units of output if \( w_1 = 50 \) and \( w_2 = 10 \)?
9. Consider the perfectly competitive industry which produces dress shirts. The market demand in the industry is given by a linear demand function \( Q^D = 400 - 2P \) where \( Q^D \) is the demand for dress shirts. The inverse demand is \( P = 200 - \frac{1}{2} Q \). There are 16 identical manufacturers of dress shirts. Each manufacturer has the same production costs and there is only one size of plant for all firms. The long-run total and marginal cost functions are:

\[
\begin{align*}
TC(q) &= 100 + 10q + q^2 \\
MC(q) &= 10 + 2q.
\end{align*}
\]

a. What is the supply equation for a firm in the industry?

b. What will be the industry supply function?

c. What will be the equilibrium price in this industry?

d. How much will each firm produce?

e. What will be the profits of each firm?

\[
\pi = R - \text{Total Cost} = pq - [100 + 10q + q^2] = 
\]

f. Will firms want to enter this industry?

g. What will be the industry supply function if there are 72 firms in the industry?

h. What will be the equilibrium price in this industry?

i. How much will each firm produce?
j. What will be the profits of each firm?

k. Will firms want to enter this industry?

l. What can you say about the number of firms which will be in this industry in the long run?
   The number of firms is greater than _________ and less than _________>

m. What will be the industry supply function if there are 34 firms in the industry?

n. What will be the equilibrium price in this industry?

o. How much will each firm produce?

p. What will be the profits of each firm?

q. Will firms want to enter this industry?
10. Consider a firm with the following cost function.

\[ cost(y) = 32 + 8y + 0.5y^2 \]

Assume that in the long run, all costs are avoidable. Marginal cost is given by

\[ MC(y) = 8 + y \]

Average cost reaches its minimum at the point where it is equal to marginal cost. In the short run $24 of the fixed costs are sunk, so $8 of the fixed costs are avoidable. Average avoidable cost also reaches its minimum at the point where it is equal to marginal cost.

a. From a long-run perspective, what is the level of y at which average cost is minimized.

b. From a long-run perspective, what is the level of average cost when it is minimized.

c. From a short-run perspective, what is the level of y at which average avoidable cost is minimized.

d. From a short-run perspective, what is the level of average avoidable cost when it is minimized.

e. What is this firm's long-run supply function? (It will have two parts.)

f. What is this firm's short-run supply function? (It will have two parts.)
11. Consider a firm with the following cost function.

\[ cost(y) = 16 + 10y + y^2 \]

Assume that in the long run, all costs are avoidable. Marginal cost is given by

\[ MC(y) = 10 + 2y \]

In the short run $7 of the fixed costs are sunk, so $9 of the fixed costs are avoidable. Average avoidable cost reaches its minimum at the point where it is equal to marginal cost.

a. From a long-run perspective, what is the level of \( y \) at which average cost is minimized.

b. From a long-run perspective, what is the level of average cost when it is minimized.

c. From a short-run perspective, what is the level of \( y \) at which average avoidable cost is minimized.

d. From a short-run perspective, what is the level of average avoidable cost when it is minimized.

e. What is this firm's long-run supply function? (It will have two parts.)

f. What is this firm's short-run supply function? (It will have two parts.)
12. What is the long run supply function for an industry made up of the firms in questions 10 and 11?

13. What is the short run supply function for an industry made up of the firms in questions 10 and 11?

14. Now consider the short run equilibrium in this market. Assume that industry demand is given by $Q^d = 27 - p$.

   a. What is the short run equilibrium price in this market?

   b. How much will each firm produce?

   c. What are the Returns minus avoidable costs of each firm?

   \[ \text{ROAvdC} (\text{Firm 1}) = R_i - \text{Avoidable Cost}_i = p y_i - [ 8 + 8y_i + 0.5y_i^2 ] = \]

   \[ \text{ROAvdC} (\text{Firm 2}) = \]

   d. Will both firms stay in the market in the short run?
15. Now consider the long run equilibrium in this market. Assume that industry demand is given by $Q^D = 27 - p$.

a. What is the long run equilibrium price in this market if both firms continue to produce? (Answer is the same as 14a)

b. How much will each firm produce? (Answer is the same as 14b)

c. What are the profits of each firm?
\[ \pi_i = R_i - \text{Total Cost}_i = py_i - [32 + 8y_i + 0.5y_i^2] = \]

d. Will both firms stay in the market in the long run?

e. Find the competitive equilibrium market price by setting the supply equation for this firm equal to the market demand equation.

f. How much will this firm produce?

g. What will be the profits of the firm?

h. What is inverse demand for this market?

i. If the firm acts like a monopolist and sets marginal cost equal to marginal revenue how much will it produce?

j. What will be the market price?

k. What will be the profits of the firm?