Eco 300 Intermediate Micro

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3. Please explain whether the following statements are true or false.

a. If the owner of a business pays himself no salary, then the accounting cost is zero, but the economic cost is positive.

b. A firm that has positive accounting profit does not necessarily have positive economic profit.

c. If a firm hires a currently unemployed worker, the opportunity cost of utilizing the worker’s services is zero.
Answers: a. True. The opportunity cost of owning one’s own business is at least the best salary the owner could get by working for another firm.

b. True. Because economic costs include opportunity costs, which accounting costs do not.

c. False. The opportunity cost to society of hiring this worker is the value that the worker could create in the next best occupation. It is possible that this is zero, but unlikely. If the unemployed worker values leisure, the opportunity cost is positive. However this opportunity cost is irrelevant to the firm hiring the worker. The firm cares only about opportunity costs of resources it owns, such as owner’s time and other property used for the firm. It does not care about society’s loss due to the worker’s loss of leisure.
4. Suppose that labor is the only variable input to the production process. If the marginal cost of production is diminishing as more units of output are produced, what can you say about the marginal product of labor?
Answer: The marginal product of labor must be increasing. Because the cost of an additional unit of output is approximately wage divided by marginal product of labor. So as marginal cost of production decreases, marginal product of labor increases.
5. Suppose a chair manufacturer finds that the marginal rate of technical substitution of capital for labor in her production process is substantially greater than the ratio of the rental rate on machinery to the wage rate for assembly-line labor. How should she alter her use of capital and labor to minimize the cost of production?
Answer: This means that $MP_K/MP_L > r/w$. So capital is more productive relative to its cost. Therefore she should increase the amount of capital used and decrease the amount of labor used in the production process, if she can (if she is already using only capital, she cannot do this).

As she increases the amount of capital and decreases the amount of labor, $MP_K$ will decrease and $MP_L$ will increase, until either $MP_K/MP_L = r/w$ or the boundary is reached.
9. If the firm’s average cost curves are U-shaped, why does its average variable cost curve achieve its minimum at a lower level of output than the average total cost curve?
Answer: The average total cost is still decreasing when the average variable cost begins to increase. This is because the average total cost equals average variable cost plus $FC/q$, which is decreasing everywhere. Therefore the minimum of the average variable cost lies to the left of the minimum of average total cost.
Another way to answer: The derivative of the average variable cost is \( d(VC(q)/q)/dq = (qVC'(q) - VC(q))/q^2 \). Setting it equal to zero, we get \( qMC(q) = VC(q) \).

The derivative of the average total cost curve is
\[
d((VC(q) + FC)/q)/dq = (qMC(q) - (VC(q) + FC))/q^2.
\]
Setting it equal to zero, we get \( qMC(q) = VC(q) + FC \).

Since \( VC(q) + FC > VC(q) \), and marginal costs are increasing at a minimum of both \( AVC \) and \( ATC \), the solution to \( qMC(q) = VC(q) + FC \) must be greater than the solution to \( qMC(q) = VC(q) \).
If in the long run a firm charges a price equal to its average cost, then its profit is necessarily
a. strictly positive.
b. strictly negative.
c. equal to 0.
d. the largest possible.
e. strictly positive if the firm’s technology exhibits increasing returns to scale.
f. strictly negative if the firm’s technology exhibits increasing returns to scale.
g. none of the above.
Answer: equal to 0. Profits in the long run equal revenue minus cost, which is $PQ - C(Q)$. Dividing this by $Q$, we get $P - C(Q)/Q = P - AC$. If $P - AC = 0$, then $PQ - C(Q) = 0$, so profits are zero.
In a single graph, draw possible short run marginal cost and average variable cost curves of a competitive firm and draw the firm’s short run supply curve. Justify the shapes and positions of all three curves you have drawn.
A competitive firm is using a long run profit-maximizing input combination. Then the price of its output and the prices of its inputs all rise by 30%. What is the effect on the input combination chosen by the firm? Show that your answer is correct.
Answer: If the output and input prices all rise by the same proportion, the same input combination still maximizes profit.

With two inputs, labor and capital, the firm’s profit is $pF(L, K) - wL - rK$. The profit function is multiplied by 1.3 due to the price change. If $(L, K)$ is a solution to the problem

$$\text{Max } pF(L, K) - wL - rK$$

then it is a solution to the problem

$$\text{Max } (1.3)(pF(L, K) - wL - rK).$$

Thus if $(L, K)$ yielded a profit maximizing level of output before the price change, then they still yield a profit maximizing level of output after the price change.
Suppose that a firm’s average total cost curve is a horizontal line. What does the firm’s marginal cost curve look like?
Bakery A accused bakery B of predatory pricing (pricing low to drive the other firm out of business and be able to charge monopoly prices).

a. In the trial it was revealed that bakery B had the following costs: Rent for the building, electricity, gas, ingredients, packaging materials, labor (baking and delivery), labor (management), a fleet of delivery trucks and fuel, and advertising.

Which of the above costs are sunk, variable or fixed over a 3-month period?

b. If you had data on all the costs, what numbers would you compare to determine whether firm B was engaging in predatory pricing?
Cost minimization with varying output levels

Now analyze how firm’s costs depend on output level.

Calculate minimum cost for each output level.

Suppose 1 hour of labor costs \( w = \$10 \) and 1 hour of capital costs \( r = \$20 \).

Then each of the firm’s isocost lines has the equation

\[ C = 10L + 20K \]

for varying \( C \).
Each of points A, B and C is a point of tangency between an isocost line and an isoquant. Then each of points A, B and C represents the minimum cost way of producing 100 units, 200 units and 300 units of output.
Expansion path

\[ q_1 = 100 \]
\[ q_2 = 200 \]
\[ q_3 = 300 \]

Labor per year

Capital per year

A

B

C

q_1 = 100

q_2 = 200

q_3 = 300

Expansion path
The firm’s **expansion path** shows the cost-minimizing combinations of capital and labor that a firm will choose at each output.

With constant returns to scale, the expansion path is a straight line.

This is because: The cost-minimization problem is

$$\min_{(L,K)} wL + rK \text{ subject to } F(L, K) = q.$$  

Since $$F(2L, 2K) = 2F(L, K),$$ the solution when $$q = 2$$ is twice the solution when $$q = 1.$$ In general, the solution when $$q = 2\bar{q}$$ is twice the solution when $$q = \bar{q}.$$
To go from the expansion path to the total cost curve:

Choose an output level \( \bar{q} \).

Find the point of tangency of the isoquant corresponding to \( \bar{q} \) with an isocost line.

Find the cost represented by that isocost line.

That cost is the minimum cost it takes to produce the given output level.
Long-run and short-run cost curves

Remember that short run average cost curves tend to have a U shape.

Long run average cost curves (LAC) often have a similar shape.

However, suppose a firm has constant returns to scale at all input levels.

Then average cost of production is the same for all output levels - because input prices stay the same at all input levels.

In that case the long-run average cost curve is a horizontal line.
Suppose a firm has increasing returns to scale at all input levels. Then average cost of production decreases - to double output, less than double of the input is necessary. So with increasing returns to scale, \( \frac{TC}{q} \) is decreasing as output increases.

Suppose a firm has decreasing returns to scale at all input levels. Then average cost of production increases. To double output, more than double of the input is necessary. So \( \frac{TC}{q} \) is increasing as the amount of output increases.
If a firm has first increasing, then decreasing returns to scale, the long-run average cost curve is first decreasing, then increasing - it is U-shaped.

Remember, the short-run average cost curve was U-shaped because of first increasing, then decreasing returns to labor (or whichever factor is variable) as output increases.

The long-run average cost curve is U-shaped because of first increasing, then decreasing returns to scale as output increases.
Long-run marginal cost curve (LMC) measures the change in long run total cost as output increases by small units.

To get LMC from the long run total cost curve, take its derivative. When LAC is decreasing, LMC curve lies below LAC curve. When LAC is increasing, LMC curve lies above LAC curve. So the LMC curve intersects the LAC curve at the minimum of the LAC curve.

If the long run average costs are constant, then so are the long run marginal costs and they equal the long run average costs.
Economies and Diseconomies of scale

It is probable that as output increases from zero, firm’s average cost of production decreases at least until some point.

This is because:

1. Indivisibility - each job can be divided into a number of different tasks (parts of the job) which are indivisible in the following sense: a certain amount of time must be spent on each task. Otherwise the productivity of the task is nothing.
Similarly, machines must function as a whole, they cannot be divided into fractions.

So if one tries to divide every input by two, one gets much less than half the output. Therefore, if one multiplies by two from that half input, one gets much more than twice the output.

An example of an indivisible input is information. For instance, information about how to run a machine. One either knows the right way or not. If one spends half of the necessary cost of getting the information, one may have no useful information.

Once the information is obtained, it can be used often at no additional cost.
2. Specialization - when firm operates on larger scale, workers and machines can specialize in certain tasks. When firm operates on small scale, workers and machinery may have to divide time between different tasks. Switching between tasks takes time and preparation.

Skills are acquired by repetition. Switching often between tasks prevents such skill acquisition.

3. Cost of inputs may be lower at a larger scale because input providers may sell more input at a lower per-unit price.

4. Flexibility - A bigger scale allows the firm to rearrange the inputs in different combinations so as to get the output maximizing combination.
It is possible that after some point of output production, firm’s average cost of production begins to increase.

This is because:

1. limited amount of factory/office space may constrain workers when there are too many of them.

2. More difficulties arise for the oversight of a very large firm. Manager must consolidate a huge amount of information to ensure efficient running of the firm. This job becomes more complex are more inputs are used.

3. When very large amounts of inputs being purchased, the supply may become limited and costs may start to increase rather than decrease.
A firm experiences **economies of scale** when it can double output for less than 2 times the cost.

Firm experiences **diseconomies of scale** when to double the output, it must pay more than 2 times the cost.

A firm experiences **locally increasing returns** at the input combination \((L_1, K_1)\) with output \(q\) if there is a number \(d > 1\) such that the input combination \((cL_1, cK_1)\) for any \(1 < c < d\) results in output level greater than \(cq\).
In reality, most firms experience economies of scale over a wide range of output levels if all inputs are counted.

One of the largest indivisibilities leading to economies of scale is the organization itself—its standard operating procedures, reputation and established relations among employees and with suppliers and customers. These cannot be divided into subunits and take a long time to duplicate.
Because of these scale economies there is a puzzle why all outputs are not produced by one enormous firm. One idea is that there are some fixed inputs related to the information and incentives of top managers. This is will be discussed in the chapter on asymmetric information.

Diseconomies of scale most often arise because some inputs are fixed by nature.

For instance the land that the firm owns - to expand it may be impossible.
Relationship between short-run and long-run cost

Suppose a firm doesn’t know the future demand for its product. It needs to build a plant, and considers building three different plant sizes.

Short run average (total) cost curves for each of the three plants given by $SAC_1$, $SAC_2$ and $SAC_3$. 
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Once a plant has been built, firm will not be able to change plant size for a long time.

Which plant size to build depends on how much output the firm plans to produce (in the long run).

At each potential output level, the firm should choose the plant size that has least short run average (total) cost. For a small output, this will be the smallest plant size. For some medium output, the medium plant size is optimal and for a large output, the large plant size is best.
At each potential output level at which firm decides to produce, it can choose the plant size that allows it to produce at minimum average cost.

The long-run average cost curve resulting if plants of any size could be built is U-shaped - this represents a typical production process. First economies of scale, then diseconomies of scale.
The long run average cost curve touches each of the short run average cost curves at some point and never goes above them. The point where the long run average cost curve touches a short run average cost curve need not be the minimum of the short run average cost curve.

The long run average cost curve is the lower envelope of all possible short run average cost curves resulting from different choices of factory size.

This means that the long run average cost curve is the highest curve that lies on or below every short run average cost curve.

Put another way, at each point of output, the long run average cost is the cost of the short run average cost curve that has lowest cost at that point among all short run average cost curves.
Note that long run marginal cost curve is not the envelope of short run marginal cost curves. Short run marginal cost curves apply to just one plant whereas long run marginal cost curves apply to all plant sizes. There is no particular relationship between long run marginal cost curve and short run marginal cost curves.
Economies of Scope

How can a firm that produces more than one product save on costs by jointly producing/ marketing those products?

The same fixed costs can apply to several different products.

Example: Airlines have hubs, which are cities to and from which they have many flights. This is a cheaper way to operate than to have a flight between every pair of cities.

Here the different products are flights from a base city to different cities.
By using hubs, some of the costs of different flights are shared - ticket agents, checking baggage, maintaining the planes, etc.

Suppose an automobile company produces cars and tractors. Both use capital and labor as inputs.

Firm must choose how much of each to produce.
A product transformation curve shows what combinations of two goods (here, cars and tractors) can be produced with a given input of labor and capital.

The product transformation curves are curved outward, and they have negative slope.

The negative slope is because to get more of one output, the firm must give up producing some of other output.

The outward curve shape is because the firm has economies of scope. If the curve were a straight line, it would mean that two smaller companies, one producing cars and another tractors, would generate the same amount of output as a larger company producing both.
But here, the bowed-outwards shape shows that the joint production has advantages enabling the firm to produce more of both cars and tractors than two companies each producing one good.

This is because inputs can be shared in production

A firm has **economies of scope** if the joint output of a single firm is greater than what can be produced by two single firms each producing one type of output.

A firm has **diseconomies of scope** if the joint output of a single firm is less than what can be produced by two single firms each producing a single product.
Monopoly

**Market power**: a seller or a buyer has market power if they can on their own influence the price of a good.

Monopoly and monopsony are examples of markets where some agents have market power.

Monopoly is a market with only one seller. Monopsony is a market with only one buyer.

Competition can be viewed as a special case of monopoly where the demand curve is horizontal.

Therefore we discuss monopoly first, then competition.
In reality, purely competitive markets are rare. Most markets have buyers, sellers with some degree of power to affect price of good.

The monopoly model can be used to describe the output (or pricing policy) of firms that have sufficient market power so that they don’t have strategic interactions with rival firms.

Strategic interaction means that a firm must consider responses by other firms to a change in price or quantity of its own good.
Microsoft can be considered a monopoly with its operating system.

Despite the fact that there are substitutes to the Microsoft operating system (Linux, Apple), the products are differentiated enough so that people still buy Microsoft even though the Linux operating system is free.

The compatibility between Microsoft programs and the Linux operating system is not perfect. This causes many people who use Microsoft programs to stay with the Microsoft operating system.
The classic example of a monopsony is a one-employer town. For example, a mining town where the only work is in the mine.

The employing firm would also have a monopoly in the sale of food and other goods to its workers. They could keep workers at subsistence level by raising prices whenever wages increased.

Now in the United States, the availability of cars has allowed workers in such communities not to buy at the company store, thus breaking the monopoly power of such firms.
A firm doesn’t need to be the only employer in a town to have monopsony power.  

For example, if every family has one member working for a certain firm, that firm can exert monopsony power by threatening to lay off large numbers of workers if they don’t accept low wages.
In this class, we will concentrate on monopoly.

The special thing about the demand curve for a monopolist’s output is that it is the market demand curve (you have to define the market to be small enough).

If the output is not a Giffen good, the demand curve does not slope upward. The demand curve for the output of a single competitive firm is a horizontal line.
A monopolist can control the price of its product by controlling the amount of output supplied. Monopolists can take advantage of this control to get more profit in general than a competitive firm. In general the price of a product under monopoly will be higher, quantity supplied lower, than in competitive market.

Look at how the monopolist chooses output quantity to maximize profit.
To choose the profit-maximizing quantity, firm must know its average revenue and its marginal revenue as well as its marginal cost.

**average revenue** is the revenue received per unit sold.

Monopolist’s average revenue is the market demand $P(Q)$. Revenue equals $Q \times P(Q)$, so average revenue is $\frac{Q \times P(Q)}{Q} = P(Q)$.

Monopolist’s marginal revenue is the additional revenue it gets from an additional unit sold.
The marginal revenue curve lies below the demand curve.

To see this, note that marginal revenue is the derivative of revenue with respect to quantity.

Revenue is given by $QP(Q)$, the quantity of the good sold times the price it was sold at.

Differentiating revenue with respect to quantity, we get

$$d(QP(Q))/dQ = QP'(Q) + P(Q).$$

Since demand is downward-sloping (for a non-Giffen good), $P'(Q) < 0$ at all $Q$. So for positive $Q$,

$$MR = QP'(Q) + P(Q) < P(Q).$$
Consider a monopolist whose demand curve is given by the equation

\[ P = 6 - Q \]

There are two ways to calculate the marginal revenue for this firm. The first way is to take the difference between revenues for successive units of output sold.

At \( P = \$6 \), no unit is sold.

At \( P = \$5 \), 1 unit is sold. So the marginal revenue at 1 unit of output is the price of the first unit sold, which is \( \$5 \).

At \( P = \$4 \), 2 units are sold. The marginal revenue at 2 units of output is the difference between revenue at 2 units and revenue at 1 unit. This is \( 2 \times 4 - 1 \times 5 = \$3 \).
At $P = $3, 3 units are sold. The marginal revenue at 3 units of output is $3 \times 3 - 8 = 1$.

At $P = $2, 4 units are sold. The marginal revenue at 4 units of output is $4 \times 2 - 9 = -1$. So the marginal revenue has become negative for 4 units of output sold.

Graphing the marginal revenue curve with the demand curve, it can be seen that marginal revenue curve lies below the demand curve and both are downward-sloping.
The other way to get the marginal revenue for this particular demand function is to take the derivative with respect to $Q$ of the revenue function. This is
\[ d(QP(Q))/dQ = d/dQ(6Q - Q^2) = 6 - 2Q. \]

To compare with the marginal revenue we got in the other way, we calculate the marginal revenue for $Q = 1, 2, 3, 4$.

At $Q = 1$, it is $4$. At $Q = 2$, it is $2$. At $Q = 3$, it is $0$.

The marginal revenue found in this way is clearly not the same as the marginal revenue found the other way.

This way gives the exact marginal revenue. The other way gives an approximation.
How does the monopolist decide how much to produce?
The monopolist chooses the output level that sets marginal cost equal to marginal revenue.

This is the solution to the first-order condition for maximizing revenue minus cost.

The firm wants to maximize profit, which is revenue minus cost.

This can be written \( \Pi(Q) = QP(Q) - C(Q) \). To maximize it, find the value of \( Q \) at which its derivative equals zero. For this to be a maximum and not a minimum, the second derivative has to be negative (i.e. the function is concave).
\[ \frac{d\Pi}{dQ} = QP'(Q) + P(Q) - C''(Q) = 0. \] So \( MR(Q) = C''(Q) \) at the solution, which means marginal revenue equals marginal cost.

To see if this is a maximum, take the second derivative of profit. This is \( QP''(Q) + 2P'(Q) - C'''(Q) \). If this is negative, then the solution to \( \frac{d\Pi}{dQ} = 0 \) is a profit-maximizing quantity.

It will be negative as long as the marginal cost curve is higher than the demand curve somewhere and at some price quantity demanded is zero.
Intuitively we can explain why MR should equal MC in the following way:

Let $Q^*$ be the quantity at which MR = MC.

Suppose the monopolist produces at $Q_1 < Q^*$. Then $MR > MC$. The monopolist could increase profit by the amount $MR - MC$ by producing slightly more. It could keep on increasing profit in this way until it reaches $Q^*$.

Suppose the monopolist produces at $Q_2 > Q^*$. Then $MR < MC$. The monopolist could increase profit by $MC - MR$ by producing slightly less, until it reaches $Q^*$.

So the monopolist will produce at $Q^*$, the output at which marginal revenue equals marginal cost.
To determine the price the monopolist will charge, the monopolist first chooses its output level as the output level $Q^*$ that sets marginal revenue equal to marginal cost.

Then, using the demand curve, the firm determines at what price $Q^*$ units of output will be bought. That is the price that the monopolist charges.

Monopolist’s profit is $(AR(Q) - AC(Q)) \times Q$. 
Example:

Suppose $C(Q) = 50 + Q^2$. This means that there is a fixed cost of production of $50$ and the variable cost is $Q^2$.

Suppose demand is given by $P(Q) = 40 - Q$.

Set marginal revenue equal to marginal cost to find profit maximizing output.

Draw total cost, marginal cost, marginal revenue, demand (average revenue), and profit curves. Show graphically the monopolist’s profit.
A rule for pricing

In practice, managers of a firm may not know exactly what demand and costs are. Thus they don’t know their exact marginal revenue and marginal cost functions.

To find a rule for pricing, notice that marginal revenue equals $\frac{d(PQ)}{dQ} = P + Q\frac{dP}{dQ} = P(1 + (Q/P)\frac{dP}{dQ}) = P(1 + \epsilon_d)$, where $\epsilon_d$ is the firm’s price elasticity of demand.

Setting marginal revenue equal to marginal cost gives $P(1 + \epsilon_d) = MC$, or $\frac{P - MC}{P} = -\frac{1}{\epsilon_d}$.

Then $P = MC/(1 + 1/\epsilon_d)$. 
This is a helpful way of judging whether current prices should be changed.

If the marginal cost is significantly lower than before and managers have no reason to think that elasticity of demand has changed, they should probably lower prices.

As a rough estimate, firms often assume that elasticity of demand does not vary too much with quantity sold.
Example: Suppose marginal cost is initially $2, optimal price is $3. What must the elasticity of demand be for this product? What if the marginal cost decreased to $1 with no change in elasticity. How would the firm change the price?
Shifts in demand

In a competitive market, the relationship between price and quantity supplied is given by a supply curve.

A monopoly has an optimal output quantity for each demand curve. In the special case of a competitive firm, each demand curve is determined by the output price, so the ”monopoly” (the special monopoly that is a competitive firm) response to changes in demand curves is the competitive response to changes in prices.

Effect of a shift in the demand curve - show graphically.
A shift in the demand curve will often have an effect on both the price and the output.

The shift in demand curve changes the marginal revenue, which changes the output level at which marginal revenue equals marginal cost (assuming the marginal cost function stays the same).

The amount of output bought at each price will also be different from before the shift.
The effect of a tax

In a monopoly, the price change due to a tax can sometimes be larger than the amount of the tax.

Suppose a tax of $t$ dollars per unit of output sold is imposed on a monopolist.

The firm’s marginal and average costs are increased by the amount $t$. So, if $MC$ is the original marginal cost function, the new profit maximizing quantity $Q$ should solve $MR(Q) = MC(Q) + t$.

The marginal cost curve shifts upward by the amount $t$. This results in smaller quantity and higher price. The increase in price may exceed the amount of the tax. This could not happen in a competitive market.