Quiz 2 Solutions

1. (5 pts) “While cost always increases in output quantity, sometimes the quantity of an input decreases when output increases.” Illustrate this statement with a picture with isoquants and isocost lines on it. Assume that one isoquant is associated with one more unit of output that the other isoquant. Label all parts of your diagram. Carefully explain how your diagram illustrates the statement. (hint: input prices don’t change)

Grading Policy: One point for correctly labeling all parts of your graph. Two points for correctly showing two parallel isocost lines with tangent isoquants and higher output associated with the higher isoquant. One point for clearly and correctly showing that one input increases and one input decreases as output increases on your graph. One point for the explanation.

When output quantity increases, the new isoquant \((Q_1)\) will lie above the original isoquant \((Q_0)\). The point of tangency with the isocost lines, as well as the shape of the firm’s isoquant, will determine the chosen input bundles. In the graph above the production cost to produce \(Q_1\) has increased because the isocost line shifts out parallel to produce more output, but the quantity of input 1 (denoted \(L\)) has decreased.

2. Explain whether each statement below is true, false, or uncertain. Be sure to explain your answer.

Grading Policy: for each question, half a point for getting true, false or uncertain correctly and half a point for the explanation.

a. (1pt) Competitive firms always choose their price so that price equals marginal cost.

FALSE. Competitive firms are price takers and do not choose their price. They take price as given and only choose quantity. They will produce up to where price equals marginal cost.
b. (1pt) A question of the form “How much are you willing to pay to....” elicits an answer that is compensating variation.

UNCERTAIN. It depends if the change is positive or negative. If the change is positive, then a question of the form “How much are you willing to pay to....” elicits an answer that is compensating variation. However if the change is negative, then a question of the form “How much are you willing to pay to....” elicits an answer that is equivalent variation.

c. (1pt) A technology based effluent standard costs more than a tax that causes the same reduction in pollution, with output held constant.

FALSE. A technology based effluent standard costs less than a tax that causes the same reduction in pollution, with output held constant.

d. (1pt) The shutdown point is at the minimum point of average cost.

FALSE. The shutdown point is at the minimum point of average variable cost. You also got full credit if you said that this statement is UNCERTAIN because in the long run firms will shutdown for any price below the minimum point of average cost.

You also got full credit if you said that:

i) this statement is UNCERTAIN because in the long run firms will shutdown for any price below the minimum point of average cost.

ii) this statement is UNCERTAIN because it depends on what you assume about fixed costs (if they are zero or not)

e. (1pt) Drinking milk causes heroin usage. We know this because essentially all heroin users first drank milk.

FALSE. Drinking milk is a necessary condition to heroin usage in this example. However, it is not sufficient. Correlation does not imply causation. Therefore we cannot conclude that drinking milk causes heroin usage.

3. You are asked to find a monetary value for Elephant seals, both use and non-use values. These seals reach 5m in length and weigh up to 2700kg. They can be found on many Pacific beaches. (1 pt) Why would someone ask you to make such a study, and what method would you use? (4 pts) What are the steps you would take to conduct your study. Name at least four separate steps needed to produce a valid study.

Grading Policy: Half a point for saying that you should use the contingent valuation method and half a point for saying that you would want to conduct such a study to find a money measure of the benefits people derive from Elephant seals. One point for each step you say should be done to produce a valid study. If you mention more than four, any four correct steps are sufficient to get the points.
Though elephant seals are a non-market good, people may derive both use and non-use values from them. You may be asked to conduct a contingent valuation study in order to estimate a money measure of the benefits people derive from elephant seals. There are several key steps you should conduct in your contingent valuation study to produce valid results. These include: (i) describing a specific project or good the interviewee will be asked to value; (ii) describing a specific payment method; (iii) reminding the interviewee that their money can be used for several competing purposes; (iv) asking them a willingness to pay question; and (v) conducting a debriefing to ensure the respondent understood the questions or check whether protest responses were made. The debrief typically also includes questions about the respondent’s characteristics, such as income, education level, and attitude towards environmental issues.

4. Consider two firms with two cost functions, \( C(Q) \) and \( C^*(Q) = C(Q) + tQ \), where \( t \) is a tax per unit output. (The tax can be levied to compensate for pollution, but that is not essential to what follows.) Assume that \( C(Q) \) has U-shaped average costs. (2 pts) Draw one picture with \( AC, MC \) for both cost functions. Draw them on the same picture and carefully show the relation of one to the other (hint: where does \( t \) come in on your diagrams?).

Now redraw your picture because you will be adding an additional curve. (1 pt) Assume that the price is set so that the low cost firm, the one with costs \( C(Q) \), makes zero profits. Label the price \( P \) on your graph. (2 pts) Show what level of output the high cost firm makes if it produces at all. Call that quantity \( Q' \). First assume that \( AFC(Q') > t \). With this assumption place \( AVC \) on your diagram. Now show the profits of the high cost firm. Now suppose \( AFC(Q') < t \). What are profits now? Explain in words.

**Grading Policy:** One point for correctly drawing the the low cost firm’s \( AC, MC \) curves and one point for drawing the high cost firm’s curves. One point for adding the \( P=MC \) at the minimum point of the low cost firm’s \( AC \) curve. One point for showing and explaining that if \( AFC(Q') > t \) profit will be negative but the firm will still produce a positive amount. One point for explaining that if \( AFC(Q') < t \) the firm will shut down (and profit will be \(-FC\)). Your graphs need to be clearly and correctly labeled to get full points.

The first thing you need to figure out is that the high cost firm’s marginal and average cost curves will be \( t \) units higher than those for the low cost firm. To get the point you could have shown this mathematically or just directly put it on your graph without showing the math. Either way, you have to draw your graph to get the points. Here is how to show this mathematically. We denote the high cost firm’s costs as \( AC^* \) and \( MC^* \), and the low cost firm’s cost functions as \( AC \) and \( MC \).

\[
AC^*(Q) = \frac{C^*(Q)}{Q} = \frac{C(Q) + tQ}{Q} = \frac{C(Q)}{Q} + t = AC(Q) + t
\]

So the high cost firm’s \( AC \) curve is just vertically displaced \( t \) units above the low cost firm’s curve. We can show the same for marginal cost:

\[
MC^* = C(Q+1) + t(Q+1) - C(Q) + tQ = C(Q+1) - C(Q) + t(Q+1 - Q) = C(Q+1) - C(Q) + t = MC + t
\]

Now we can combine these two facts to show graphically what the two firms’ \( AC \) and \( MC \) curves will look like. See the first figure below. \( AC, MC \) are the low cost firm’s curves and \( AC+t, MC+t \) are the high cost
firm’s curves.

Since you are told the low cost firm makes zero profits, it must be the case that price is equal to the minimum AC of the low cost firm. So price intersects MC where MC=AC. This is shown on the second graph below. For the next step you need to use the fact that the difference between the average cost (AC) and the average variable cost (AVC) will always be equal to the average fixed cost (AFC): AC - AVC = AFC.

\[ C(Q) = VC(Q) + FC \Rightarrow AC(Q) = \frac{C(Q)}{Q} = \frac{VC(Q)}{Q} + \frac{FC}{Q} = AVC(Q) + AFC \Rightarrow AFC = AC(Q) - AVC(Q). \]

This means that when you draw AVC for the high cost firm on your diagram, the difference between AC+t and AVC will be the AFC. So when AFC(Q') > t, the high cost firm’s AVC curve will be below the low cost firm’s AC curve because the difference between AC+t and AC is t. This is AVC_0 on your graph. In this situation price will cross MC + t at a point above AVC_0, and the high cost firm will produce Q'. The firm is going to lose money (i.e. make negative profit) but it will make fewer losses than if it produced nothing. The light shaded box is the firm’s loss from producing Q'. If the firm produced nothing the losses would be the combination of the light and dark shaded boxes. So it is better off producing the positive quantity Q'.

Finally, when AFC(Q') < t, the AVC curve will be above the low cost firm’s AC curve. This is AVC_1 on your graph. In this situation price will cross MC + t at a point below AVC_1, and the high cost firm will be better off shutting down because profits will be more negative than -FC, which is the profit from shutting down. So Q' will be zero in this case, and profits will be -FC.