Solution Sheet to SAIS Math Self-Diagnostic Test:

Section I. Algebra and Functions:

1. Simplify: $4xy(x^2)^{2a+by}/y^{1/3}$

Answer: $4x^{4a+2by+1}y^{2/3}$, which is obtained by evaluating the terms involving the inner parentheses first, then combining terms with common bases (e.g., the term $y^{2/3}$ in the answer was the result of evaluating $y/y^{1/3} = y^1y^{-1/3} = y^{1-(1/3)} = y^{2/3}$).

2. Simplify: $(1 – a)/[5(a – 1)]^2$

Answer: -1/[25(a – 1)]or 1/[25(1 – a)]. Evaluate the term in the inner parentheses first, to get $[5(a – 1)]^2 = 25(a – 1)^2$. Then express the numerator (1 – a) as -(a – 1). The resulting fraction is thus $-(a – 1)/[25(a – 1)^2]$ which simplifies to -1/[25(a – 1)] or 1/[25(1 – a)].

3. Suppose $|x| + 3 < 5$. Which of the following describes valid values for x?

(a) $x < 2$
(b) $x < –2$ or $x > –2$
(c) $x < 2$ or $x > –8$
(d) $–2 < x < 2$
(e) None of the above

Answer: Simplify the expression to $|x| < 5 – 3$ => $|x| < 2$ and apply the definition of absolute value to get (d) as your answer.

4. What is definitely true of $(1/x)^{-1/2}$, if x > 1?

(a) It is less than $(1/x)^{-1/3}$
(b) It is less than $x^{-1/2}$
(c) It is equal to x^2
(d) It is equal to $1/x^{1/2}$
(e) None of the above

Answer: (e). Here one has to first see that $(1/x)^{-1/2}$ is just the same thing as $\sqrt{x}$ and then test each of the four possible answers individually to rule out false statements. Thus it is easy to see that (b) and (c) and (d) cannot be true in the range when x > 1. As for (a) note first that $(1/x)^{-1/3}$ is nothing else but the cube root of x, $\sqrt[3]{x}$. The problem assumes that x > 1 and in this range the values of $\sqrt{x}$ are strictly greater than the values of $\sqrt[3]{x}$, therefore (a) is also not true. The answer is (e).

5. You are looking for two numbers. The first, F, is 2 less than 5 times the second, S. This means:

(a) $-5S = F - 2$
(b) $F - 2 = 5S$
(c) $F + 2 = 5S$
(d) $F = 3S$
(e) None of the above

Answer: If F is 2 less than 5 times S, then $F = 5S - 2$. Rearranging this gives (c).

6. The following relationship describes output Y as a function of the amount of two inputs, capital K and labor L:

$$Y = AK^{\alpha}L^{1-\alpha}$$

If we define the average product of labor Z as Y/L, then Z is given by:

(a) $AK^{\alpha}L^{-1}$
(b) $AK^{\alpha}L^{2-\alpha}$
(c) $A(K/L)^{\alpha}$
(d) $A(K^{\alpha}/L^{1-\alpha})$
(e) $A(K^{\alpha}/L^{1-\alpha})^{-1}$

Answer: (c). This follows directly from carrying out the division of Y by L to get $Z = Y/L = AK^{\alpha}L^{1-\alpha}/L = AK^{\alpha}L^{1-\alpha-1} = AK^{\alpha}L^{-\alpha} = A(K/L)^{\alpha}$

Comments to Section I: Questions 1, 2, 3, 5, and 6 should be relatively easy and with a modicum of care you should have gotten the right answers. Setting aside minor errors due to carelessness, if you had trouble at the conceptual level with more than one of these questions it indicates that your basic math analysis skills are weak and you definitely need to do a careful review of Pre-Calculus concepts. Go through the Pre-Calculus DVD Course slowly and carefully re-learn your algebra.

Question 4 requires more careful thinking but students who have good Pre-Calculus skills should be able to get the answer to this question without too much trouble.

Section II. Systems of Equations:

7. Solve for x:

$x = 10y - 1$

$y = 2x + 2$

Answer: $x = -1$. Using the second equation substitute for y in the first equation to get $x = 10(2x + 2) – 1$ or $x = 20x + 20 – 1$ which simplifies further to $-19x = 19$. From this it is clear that $x = -1$.

8. Suppose that consumption C is a function of output Y according to the expression: $C = 100 + 0.75Y$. Output Y, in turn, is given by $Y = C + G$, where I is an unknown level of government spending.

(8a) If $G = 40$, what is C?

Answer: $C = 520$. This can be obtained by first "plugging" in the consumption function $C = 100 + 0.75Y$ into the expression $Y = C + G$ to get $Y = 100 + 0.75Y + G$. As $G = 40$, this last expression now becomes $Y = 140 + 0.75Y$. Solving for Y gives $.25Y = 140$, which in turn gives $Y = 140/.25 = 560$. The question asks, however for the value of C. This can now be calculated as $C = 100 + 0.75(560) = 100 + 420 = 520$.

(8b) What is $\Delta Y/\Delta G$? (The symbol "Δ" refers to the "delta" or "change" in a variable.)

Answer: $\Delta Y/\Delta G = 4$. This value is obtained by asking how much Y changes as G changes. The crude numerical way to arrive at this answer is to see how Y behaves as you increment G by 1 unit. In problem (8a) it was found that when $G = 40$ the corresponding value of Y was 560. You could then increment G by 1 unit to $G = 41$ and then solve for Y to get $Y = 564$. Thus $\Delta Y = 4$ and $\Delta G = 1$, so $\Delta Y/\Delta G = 4$.

But the more general and correct approach to getting $\Delta Y/\Delta G$ is to solve for Y analytically, as a function of G. Again "plug in" the consumption function $C = 100 + 0.75Y$ into the expression $Y = C + G$ to get $Y = 100 + 0.75Y + G$. Solve this out to get an expression where Y is only on the left-hand-side. That is, put all terms with Y on the left-hand-side to get $Y – 0.75Y = 100 + G$. This reduces to $0.25Y = 100 + G$. Next divide both sides by 0.25 to get $Y = 400 + 4G$. This is the solution for Y in terms of G, and it is apparent from this solution that any change in G will result in a final increase in Y equal to 4 times that change. Symbolically, $\Delta Y = 4\,\Delta G$, or $\Delta Y/\Delta G = 4$.

9. Suppose the demand for Volkswagen Beetles in Mexico is described by the function $Q^D = 11 – 2P$ where Q^D is the quantity or units of Beetles that will be demanded when the price is P. Suppose further that the supply of Volkswagen Beetles follows the functional relationship $Q^S = 2 + P$.

(9a) Solve for the equilibrium price P, which is the value of P at which demand would equal supply, i.e., at which $Q^D = Q^S$.

Answer: $P = 3$. The value of P at which $Q^D = Q^S$ is the value P that solves $11 – 2P = 2 + P$. Solving this equation for P gives $P = 3$.

(9b) How many Volkswagen Beetles will be produced at the equilibrium price?

Answer: Q = 5. This is the quantity that will be supplied to the market at the equilibrium price (and this quantity is also equal to the quantity demanded by the market at the equilibrium price, since at a true equilibrium price, Q^D and Q^S must be equal). To arrive at this equilibrium value of Q, simply substitute the equilibrium price P = 3 into the supply (or demand) equation. From the supply equation,

$$Q = Q^S \text{ (at } P = 3) = 2 + 3 = 5.$$

(9c) At what price P would demand exceed supply by the amount of 3 Volkswagen Beetles?

Answer: P = 2. This requires just slightly more thinking to solve. But basically excess demand would be the difference between quantity demanded and quantity supplied. Given the expressions for Q^D and Q^S supplied in the problem, this difference is:

$$Q^D - Q^S = (11 - 2P) - (2 + P)$$
$$= 9 - 3P$$

The problem essentially asks for the value of P that makes $Q^D - Q^S = 3$. So simply solve the equation

$$3 = 9 - 3P$$

for P to arrive at a value of P = 2.

10. Solve for x in terms of the parameter k:

$y = x + 4k$

$x = -4k^2/y$

Answer: $x = -2k$. To see this, rewrite the second equation as $y = -4k^2/x$. Replace for y in the first equation to get $-4k^2/x = x + 4k$. Multiply both sides by x to get $-4k^2 = x^2 + 4kx$. Rearrange to get $x^2 + 4kx + 4k^2 = 0$. This is a quadratic equation which factors out exactly to $(x + 2k)^2 = 0$. This implies $x = -2k$.

Comments to Section II: Question 7 is a question that anyone who understands how to solve systems of equations should be able to answer. If you had trouble with Question 7, you clearly need to review basic algebra, specifically how to handle systems of algebraic equations. You definitely need to go through the Pre-Calculus DVD closely, especially the section where solving a system of equations is discussed. Questions 8 and 9 are questions that now ask you to interpret and apply your algebra knowledge to solve a more concrete economics-oriented problem. Nonetheless, the techniques and logical reasoning that lead to the right answer are still based on the basic skill of solving a system of two equation in two unknowns. If you had trouble with either of these questions *but not* Question 7,

it could indicate you just lack practice in applying math knowledge in a more practical or concrete context. In this case, we suggest you pay attention to the more applied exercises that are done on the Pre-Calculus DVD, and do any similar exercises that you see in whatever basic microeconomics or macroeconomic text you may have used in the past.

Question 10 above is a bit more difficult than Question 7 as it requires that you remember how to factor a quadratic equation, but students with good algebra skills should be able to handle it without too much trouble.

Section III. Series and Growth Rates:

11. Write out the terms of this series and then determine its total value:

$$\sum_{j=1}^{3}(1+j)^2$$

Answer: Increment the summation index j beginning at 1 all the way up to 3 and evaluate the resulting sum: $(1+1)^2 + (1+2)^2 + (1+3)^2 = 2^2 + 3^2 + 4^2 = 4 + 9 + 16 = 29$

12. Write out the terms of this series and then determine its total value when x = 2 and r = .10 :

$$\sum_{j=0}^{2} x^{j-1}/(1+r)^j$$

Answer: First write out the terms of the entire sequence: $[x^{0-1}/(1 + r)^0] + [x^{1-1} /(1 + r)^1] + [x^{2-1}/(1 + r)^2]$. Simplifying a bit gives $x^{-1} + 1/(1 + r) + x/(1+r)^2$. Now evaluate this sum letting x = 2 and r = .10

$$\begin{aligned} x^{-1} + 1/(1 + r) + x/(1+r)^2 &= (2)^{-1} + [1/(1+.10)] + [2/(1 +.10)^2] \\ &= (1/2) + (1/1.10) + [2/(1.10)^2] \\ &= 0.5 + 0.9091 + 1.6529 \\ &= 3.0620 \end{aligned}$$

13. The US consumer price index (CPI) in 2005 was set at a value of 100. Suppose the CPI in 2008 had a value of 114. If consumer price inflation is the rate of change of the CPI per unit of time, what was the average annual rate of inflation experienced by the US over this 3-year period?

(a) 4.67%
(b) about 0.4%
(c) 0.14%
(d) 14%
(e) There is insufficient information to answer

Answer: (a). At the end of 3 years, the CPI is 114 while at the beginning it was 100. The 3-year percent change in the CPI is thus (114 – 100)/100 = .14 or 14%. This is the total inflation rate over three years. The average annual rate of inflation is just this total percentage change divided by 3, i.e., .14/3 = .4666 or 4.67%.

14. Suppose that at the end of December last year 1 euro was worth 1.5 US dollars. Suppose that the euro appreciates by 5% in January, depreciates by 2% in February, and then appreciates 1% in March.

(14a) What is 1 euro worth by end-March?

Answer: 1 euro at the end of January would equal 1.5 × (1 + .05) US dollars. By the end of February the same euro is now worth [1.5 × (1 + .05)] × (1 – .02) US dollars. By the end of March 1 euro is now worth {[1.5 × (1 + .05)] × (1 – .02)} × (1 + .01) US dollars. Evaluating this final expression gives

1 euro at end-March = 1.5(1 .05)(.98)(1 .01) = 1.5589 US dollars.

(14b) What is the average monthly percentage gain/loss of the euro in relation to the US dollar?

Answer: The total % gain/loss over the 3 month period is (1.5589 – 1.5)/1.5 = .0393 or 3.93%. This was earned over 3 months therefore the average monthly percentage gain was 3.93% ÷ 3 = 1.31%.

15. Which of the equations below exhibits a constant 5% rate of growth over time? (Below "ln x" is the "natural logarithm" of x and the variable "t" refers to "time" in periods)

(a) y = 0.05t
(b) y = 5 ln(t)
(c) ln(y) = 0.05t
(d) ln(y) = 0.05ln(t)
(e) None of the above

Answer: (c). To explain this, first a preliminary note: the exponential function (exp(x) or e^x) and the natural logarithm function(ln(x) or $\log_e(x)$) are so-called inverse functions, in that application of one function after first applying the other will give back the original variable or number: i.e.,

$$e^{\ln x} = x$$

and

$$\ln(e^x) = x$$

where e is the constant number 2.7183, called the base of the natural logarithm, or Euler's constant.

Now, if a variable y grows at a constant rate over time, it will follow an equation of the general form

$$y = ke^{rt}$$

where r is its rate of growth per unit of time t, k is some constant number, and e is Euler's constant.

So to answer Question 15 one can test each individual choice presented above to see if it can be transformed into an expression that looks like $y = ke^{rt}$. For instance, choice (a) above can be put into an equivalent exponential form by exponentiating both sides of the equality y = .05t to get:

$$e^{y} = e^{.05t}$$

But this does not achieve the form $y = ke^{rt}$, so (a) is not the answer to Question 15. Neither is choice (b), y = 5ln(t), as exponentiation of both sides of this equality gives:

$$e^{y} = e^{(5\ln t)} = e^{5}\cdot e^{\ln t} = e^{5}\cdot t$$

where the last equality above follows from the inverse property of log and exponential functions. The resulting equation

$$e^{y} = e^{5}t$$

is not of the constant growth rate form either, so (b) is not the answer. Choices (c) and (d) look very similar. However applying exponentiation to choice (d), ln(y) = .05ln(t), gives:

$$e^{\ln(y)} = e^{.05\ln(t)}$$

$$y = e^{.05}\cdot e^{\ln(t)}$$

$$y = e^{.05}t$$

A careful inspection of the last line above shows that choice (d) does not conform to the constant growth rate form either, and therefore isn't the answer. Choice (c), ln(y) = .05t, however does give back the desired form:

$$e^{\ln(y)} = e^{.05t}$$

$$y = e^{.05t}$$

which indeed follows the constant growth rate form $y = ke^{rt}$ once we recognize that k = 1 and r = .05.

Therefore (c) is the answer to Question 15.

Comments to Section III: Questions 11 and 12 are examples of the use of the summation operator

$$\sum_{j=1}^{N} f(j)$$

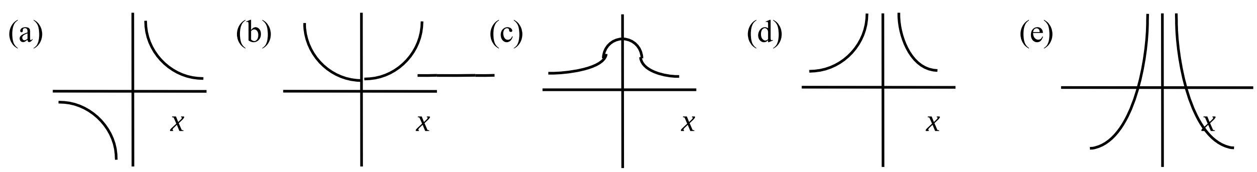
If you are unfamiliar with the summation operator, or had trouble expressing the series comprising the sum, you should work through the relevant sections of the Pre-Calculus DVD.

Questions 13 and 14 are fairly elementary questions on growth rates. If you had trouble calculating just the total 3-year growth rate (and not even the annual average) in Question 13, your math skills are likely weak and a full and careful review of Pre-Calculus concepts is warranted. Most entering students should be able handle Questions 13 and 14 without too much trouble as long as some care is exercised especially as regards compounding growth/decay rates in (14a).

Question 15 requires familiarity with logarithms and exponential functions. While these two functions are at the intermediate level of Pre-Calculus knowledge, they are used frequently enough in economic analysis that they are worth knowing better. So If you had trouble with this question, it would be helpful to review the section on exponentials and logarithms in your Pre-Calculus DVD.

Section IV. Graphs and Analytical Geometry:

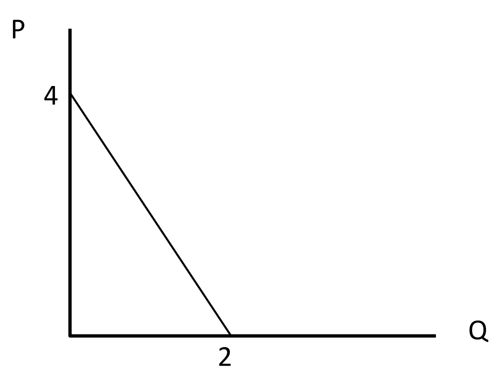
16. The graph of $1/x^2$ looks most like:



Answer: (d). The ratio $1/x^2$ approaches zero as x goes to $-\infty$ and also approaches zero as x goes to $+\infty$. This rules out graphs (b) and (e).

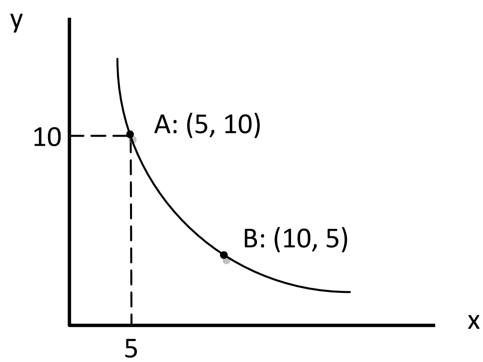
In addition when x approaches zero from either the positive or negative direction , the ratio $1/x^2$ goes to $+\infty$. The only remaining graph for which this is true is (d), which is the answer here.

17. Consider the following equation: Q = 2 − .5P. For positive values of P and Q, graph this function on the axes below:



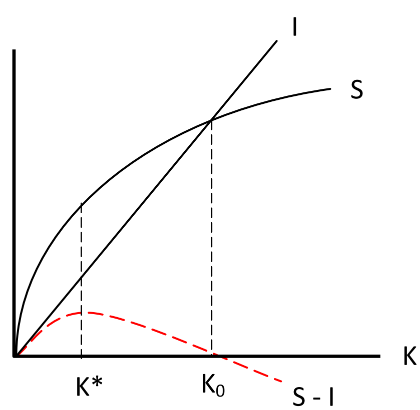
Answer: The correct curve is already displayed above. The equation Q = 2 − .5P defines a line with a P-intercept of 4 (obtained by setting Q = 0 and finding P) and a Q-intercept of 2 (obtained by setting P = 0 and finding Q). The slope of the line is clearly -2, which is visible from consideration of the intercepts but also from rearranging the equation in the standard linear equation format: P = 4 – 2Q (in the graph P is the y-axis variable and Q is the x-axis variable).

18. Graph the function U = 2xy for the value of U = 100:



Answer: The correct curve is already displayed above. For the value U = 100 that is posited in the problem, the above equation becomes 100 = 2xy, or xy = 50. So all points (x,y) on the correct curve should have x- and y-values that when multiplied together equal 50. Two such points are isolated on the curve above: the point A, with coordinates x = 5, y = 10 and the point B with coordinates x = 10, y = 5.

19. Suppose that saving S and investment I are both increasing functions of capital K, and both are as illustrated below:



On the same graph above, show as a dashed curve the function S – I (i.e., the difference of S and I).

Answer: The correct curve is already displayed above as the dashed nonlinear curve labeled S – I. Essentially this curve is obtained by getting the vertical distance between the two curves S and I at each value of K. We observe that there are two values of K at which the curves S and I intersect, one is at K = 0 and the other is at the level K_0 indicated above. At those values of K, the difference between S and I is zero, and this correspond to the K-intercepts of the difference function S – I. Also, there is a value of K at which the difference S – I is at a maximum. That occurs at the point where the slope of the curve S equals the slope of the line I. In the above diagram, this value of K is indicated as K*.

Comments to Section IV: Questions 16 – 17 are fairly easy questions that test your ability to represent an analytical function in graphical form. If you had trouble with either question this indicates that you need to thoroughly review your understanding of functions. A careful study of the material on functions and graphs in the Pre-Calculus DVD is recommended.

Questions 18 and 19 are slightly more difficult, but should be doable for most people with a good understanding of algebra/analytic geometry. If you were able to answer these last two questions to a fair degree of accuracy, your grasp of functions and graphs is at a satisfactory level for the economic analyses you will encounter in your first courses at SAIS.

Section V. Calculus:

20. $y = (10x^2 + 2x – 7)/x$. What is dy/dx?

Answer: There is more than one way to arrive at the answer here. Easiest is to rewrite the above expression as $y = 10x + 2 – 7x^{-1}$, apply the rules of differentiation to each term in the sum on the right-hand-side to get $dy/dx = 10 + 7x^{-2}$.

21. y = ln[x/(1 + kx)], where k is a constant and "ln" is the "natural logarithm" of x. What is dy/dx when x approaches the value k?

Answer: $dy/dx = 1/[k(1 + k^2)]$. There is more than one way to arrive at the answer here. The easiest way is to use the rule that ln(a/b) = ln(a) – ln(b) to rewrite the expression y = ln[x/(1+kx)] as

$$y = \ln(x) – \ln(1 + kx)$$

Taking first derivatives of both sides gives

$$dy/dx = 1/x – k/(1+kx)$$

where we have used the rule for the derivative of a log of a variable: dln(z)/dz = 1/z. The above expression can be further simplified:

$$dy/dx = [(1+kx) – kx]/x(1 + kx)$$
$$= 1/[x(1 + kx)]$$

As x approaches the value k, we would have

$$dy/dx = 1/[k(1 + k^2)]$$

which is the answer to Question 21.

A second, somewhat more involved way to get at the answer is to apply the “chain rule” of differentiation to the complex expression y = ln[x/(1 + kx)], as follows:

Let z = x/(1 + kx). The above expression is thus y = ln(z). By the chain rule of differentiation, the derivative of y = ln(z) with respect to x is can be calculated as the chained product of the separate individual derivatives dy/dz and dz/dx:

$$dy/dx = (dy/dz)\cdot(dz/dx).$$

We need dy/dz and dz/dx. By the rule for differentiation of a log function, y = ln(z) implies that dy/dz = 1/z. Since z = x/(1 + kx), the derivative dy/dz must be

$$dy/dz = (1 + kx)/x.$$

What remains to find the derivative dz/dx. As z = x/(1 + kx), its derivative with respect to x is

$$dz/dx = [(1 + kx) – xk]/(1 + kx)^2$$

$$= 1/(1 + kx)^2$$

Now combining our expressions for dy/dz and dz/dx in the chain rule dy/dx = (dy/dz)·(dz/dx) yields:

$$dy/dx = [(1 + kx)/x] \cdot [1/(1 + kx)^2]$$

$$= (1 + kx)/[x(1 + kx)^2]$$

$$= 1/[x(1 + kx)]$$

As x approaches the value k, we can replace x with k in the above expression to get

$$dy/dx = 1/[k(1 + k^2)]$$

Comments to Section V: Question 20 is a simple application of basic differential calculus. If you could answer this question then you have a working knowledge of calculus. If you couldn't then we encourage you to begin learning calculus techniques by working through the Basic Calculus for Economists DVD Course. You will have an opportunity to learn calculus techniques when you take the SAIS microeconomics course, as that course will include training in basic differential calculus and maximization. However, as has been pointed out by many previous SAIS students, learning calculus from studying the Calculus DVD in advance of seeing it in the microeconomics course is highly beneficial.

Question 21 involves differentiation of a more complex function and uses more intermediate calculus techniques. If you were able to answer this question you are probably quite good at differential calculus already. You may want to consider taking the accelerated versions of micro and macroeconomics.

Section VI. Optimization:

22. Find the minimum of the following function: $C(x) = 16/x + x^2$, for the range of positive values of x.

Answer: x = 2. To see this, first take the first derivative of C to get $dC/dx = -16/x^2 + 2x$. Now set this to zero (which is the first-order requirement for a maximum/minimum), and then solve for x, viz.:

$$-16/x^2 + 2x = 0$$

$$-16/x^2 = -2x$$

$$-16 = -2x^3$$

$$x^3 = 8$$

$$x = 2$$

(To be complete, we should check the sign of the second derivative of C, which is $d^2C/dx^2 = 32/x^3 + 2$. This is positive in sign at the value of x = 2. Therefore x = 2 is indeed a minimum, not maximum, point.)

23. Suppose profits π are given by the equation π = pY – wL – rK where Y is units of output, L is units of labor, and K is units of capital. The remaining terms p, w, and r are positive fixed parameters representing per unit output price, labor wage, and capital rent. We assume L and K are used only in nonnegative amounts.

(23a) Suppose $Y = AK^{0.5} L^{0.5}$ and K = 100. Derive an expression for the value of L that maximizes profits, in terms of the parameters p, w, r, and A.

Answer: Denote profit as π. Using $Y = AK^{0.5} L^{0.5}$ and K = 100 to replace for Y and K in the definition of profits, π = pY – wL – rK, will give profits as a function only of labor L and parameters p, w, r, and A:

$$\pi = 10pAL^{0.5} - wL - 100r$$

To find the value of L that maximizes profits, we take the first derivative of π with respect to L, treating p, w, r, and A as constants:

$$d\pi/dL = 10pA(0.5L^{-0.5}) - w$$

$$= 5pAL^{-0.5} - w$$

Next, set this derivative to zero since maximum profits will occur only when the derivative of the profit function is zero:

$$5pAL^{-0.5} - w = 0$$

(In principle one should also check that the second derivative is negative in sign at the maximum point to confirm that one has a maximum and not a minimum. This second derivative is $d^2y/dx^2 = -2.5pAL^{-1.5}$ or $-2.5pA/L^{1.5}$. Under the assumptions of the problem, the positivity of the parameters p, w, r, and A will ensure that this second derivative will always negative in the range where L > 0. Hence the "second-order condition" for a maximum will be satisfied here.)

Solving now for the value of L at which profits are at a maximum gives

$$L^{-0.5} = w/5pA$$

or,

$$L^{0.5} = (5pA/w)$$

or,

$$L = (5pA/w)^2$$

This is the "optimal" value of L as a function of the parameters p, w, r, and A.

(23b) Derive an expression for the (maximum) profit function in terms of parameters p, w, r, and A

Ans: Using your answer to (23a), the maximum profit function in terms of just the parameters p, w, r, and A can now be obtained by "plugging in" the expression for optimal L into the original profit function. Recall that the original profit function π was:

$$\pi = 10pAL^{0.5} - wL - 100r$$

Now replacing for L gives:

$$\pi = 10pA[(5pA/w)^2]^{0.5} - w(5pA/w)^2 - 100r$$

$$\pi = 10pA[(5pA/w)] - w(5pA/w)^2 - 100r$$

$$\pi = 50(pA)^2/w - 25(pA)^2/w - 100r$$

$$\pi = 25(pA)^2/w - 100r$$

The last expression is the maximized value of the original profit function π or, simply, *the* profit function.

Comments to Section VI: Question 22 is a straightforward minimization problem. If you were able to do this question you are probably quite competent at basic differential calculus and may want to consider taking the accelerated versions of micro and macroeconomics.

Question 23 is a more extensive application of the techniques of optimization and is a good example of what basic mathematical economic analysis is like. If in addition to Question 22 you were able to solve Question 23 (either a or b, but especially if you were able to do both) your technical skills are already developed enough that you should definitely be taking the accelerated versions of micro and macroeconomics at SAIS.