

**Economics 101**  
**Answer to Homework #4**  
**Spring 2009**  
**Due 3/31/2009 at beginning of lecture**

**Directions:** The homework will be collected in a box **before** the lecture. Please place your name, TA name and section number on top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade. Please remember the section number for the section **you are registered**, because you will need that number when you submit exams and homework. Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!

**Question 1**

Staley is at a carnival. The following table gives the total utility that Staley gets from eating bratwursts at the carnival.

Number of Bratwursts	Total Utility	Marginal Utility
0	0	---
1	6	6
2	12	6
3	17	5
4	19	2
5	20	1
6	19	-1

- 1) Calculate the marginal utility of eating each unit of bratwurst.
- 2) If the bratwursts are free, how many bratwursts would Staley choose to eat?

*Staley will eat 5 Bratwursts.*

Suppose there is also free ice cream at the carnival. The following table gives the marginal utility of eating ice cream. Calculate the total utility of eating each unit of ice cream.

Ice Cream	Total Utility	Marginal Utility
0	0	----
1	5	5
2	9	4
3	12	3
4	14	2
5	15	1
6	15	0

- 3) Suppose now that Staley has to pay for the bratwursts and ice cream. Each bratwurst cost \$2 and each ice cream costs \$4. Staley's income equals \$16. How many bratwursts and ice cream would Staley consume?

*Staley will consume 2 units of ice cream and 4 units of bratwursts.*

- 4) Suppose the price of ice cream decreases to \$2. Holding everything else constant, how many bratwursts and ice cream would Staley consume?

*Staley will consume 4 bratwursts and 4 units of ice cream.*

- 5) Assume Staley's demand function for ice cream is linear. Using the results from part 3) and part 4), derive Staley's demand function.

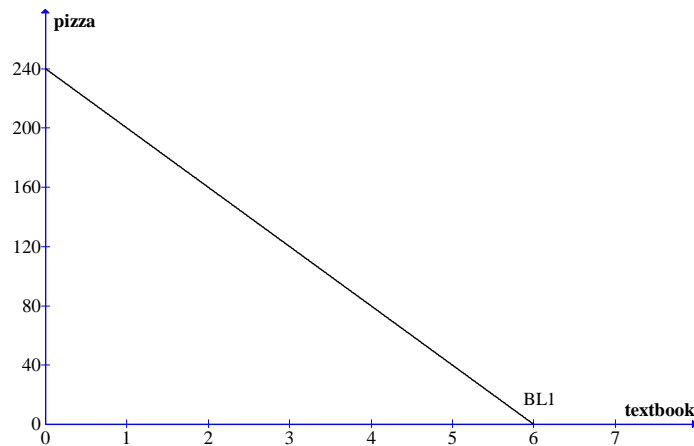
$$\text{Change in } P / \text{Change in } Q = (4-2)/(2-4) = -1.$$

$$P-2 = -1(Q-4) \Rightarrow P = -Q + 6$$

## **Q2: Budget Lines and Indifference Curves**

- A. Suppose Tayler has an income of \$480 to buy two goods: pizza and textbooks. The price of a slice of pizza is \$2, and the price of a textbook is \$80.

- 1) Draw Tayler's budget line (BL1) given her income is \$480. (Put textbooks on the X-axis and pizza on the Y-axis.) Assume Tayler's utility function is  $U(x,y)=xy^2$  (x is the purchase of the number of textbooks and y is the purchase of the number of slices of pizza). Tayler's marginal utility of consuming a slice of pizza is  $2xy$ . Tayler's marginal utility of consuming a textbook is  $y^2$ .



- 2) Derive Tayler's Marginal Rate of Substitution of textbooks for pizza.

$$MRS = MU_x / MU_y = y^2 / (2xy) = y / (2x)$$

- 3) Derive Tayler's budget line.

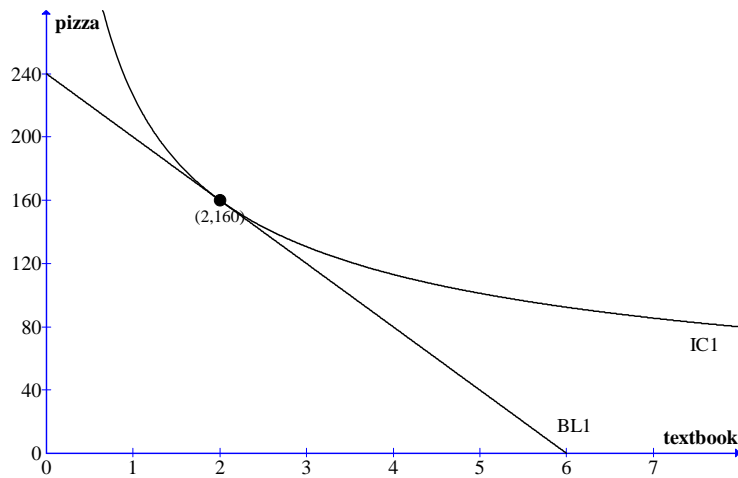
$$2y + 80x = 480$$

- 4) Find the optimal consumption point. What is Tayler's utility? On your graph draw the indifference curve (IC1).

$$MRS = P_x / P_y \Rightarrow y / (2x) = 80 / 2 \Rightarrow y = 80x.$$

$$\text{Substitute into budget line: } 2(80x) + 80x = 480 \Rightarrow 240x = 480 \Rightarrow x = 2, y = 160.$$

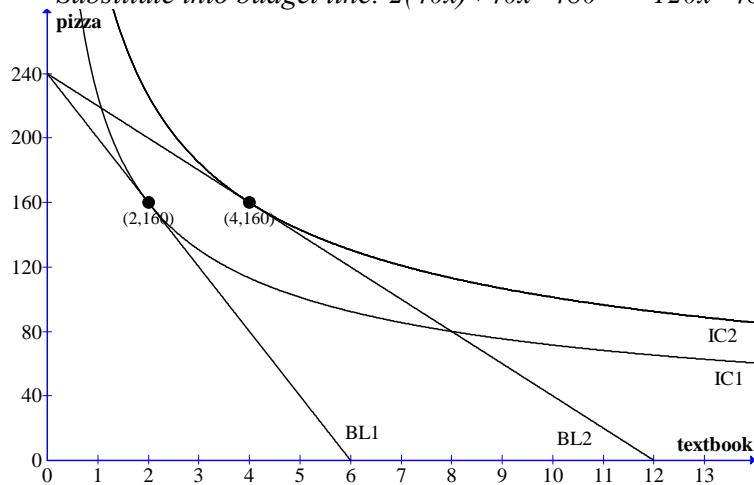
$$\text{Utility} = 2(160^2) = 51200$$



- 5) Suppose the price of textbooks decreases to \$40. Find the optimal consumption point given this new price for textbooks. Draw the new budget line (BL2) and indifference curve (IC2) on your graph. Label the budget line and indifference curve clearly.

$$MRS = P_x/P_y \Rightarrow y/(2x) = 40/2 \Rightarrow y = 40x.$$

$$\text{Substitute into budget line: } 2(40x) + 40x = 480 \Rightarrow 120x = 480 \Rightarrow x = 4, y = 160.$$



- 6) Given the price change described in part (4), if Tayler consumes optimally, how much income would be required for Tayler to obtain the same level of utility that she had in part (3)? After you calculate this compensated level of income, draw an imaginary budget line (BL3) using this new income and the new prices on your graph.

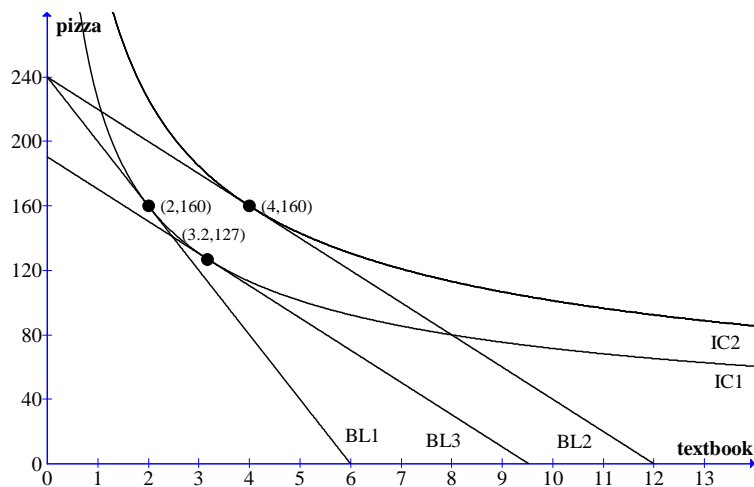
$$MRS = P_x/P_y \Rightarrow y/(2x) = 40/2 \Rightarrow y = 40x.$$

$$\text{To reach 51200 utility. } xy^2 = 51200 \Rightarrow 1600x^3 = 51200 \Rightarrow x = 32^{1/3} \approx 3.175.$$

$$Y = 40(32^{1/3}) \approx 126.992$$

$$\text{Income required} = 2y + 40x = 2 * 40(32^{1/3}) + 40(32^{1/3}) = 120(32^{1/3}) \approx 380.976$$

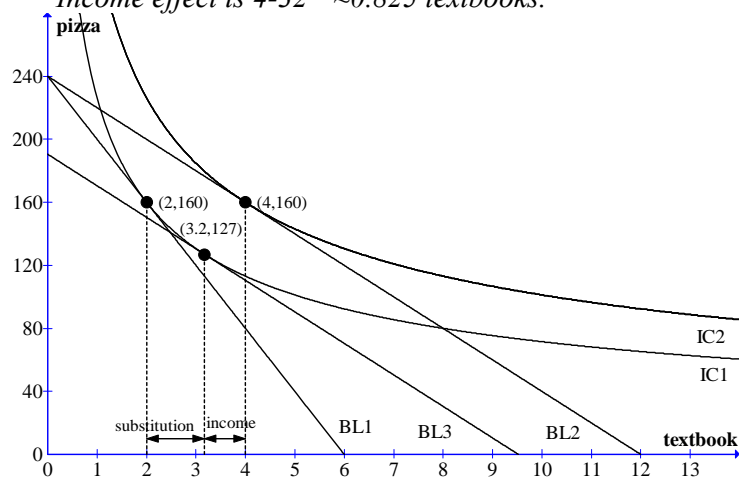
$$\text{Imaginary budget line is } 2y + 40x = 120(32^{1/3})$$



- 7) What is the substitution and income effect in textbook consumption due to the change in the price of textbooks? Illustrate the effect on your graph.

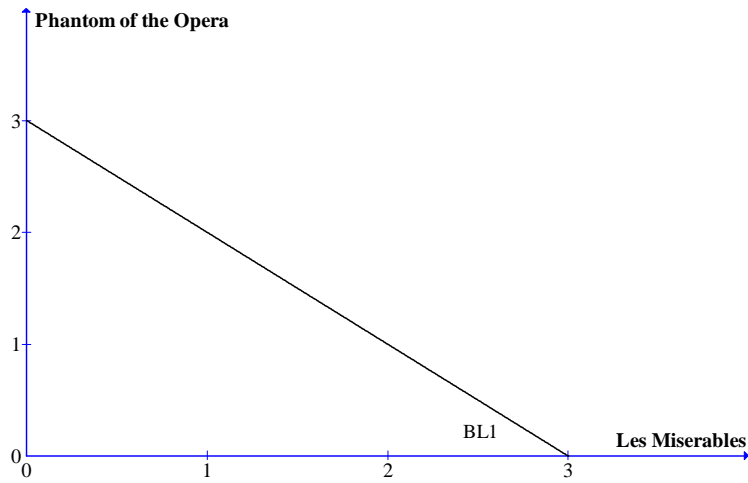
*Substitution effect is  $32^{1/3} - 2 \approx 1.175$  textbooks.*

*Income effect is  $4 - 32^{1/3} \approx 0.825$  textbooks.*

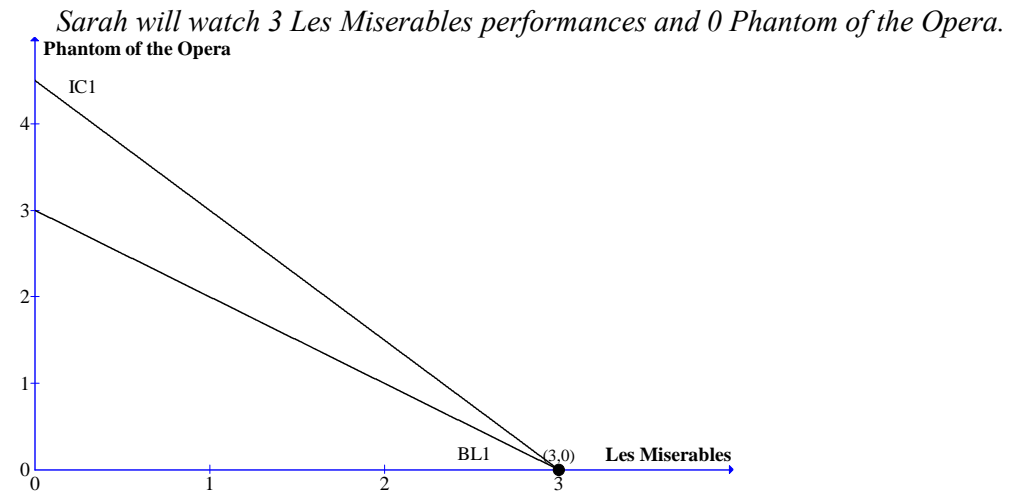


- B. Sarah loves musicals. Sarah receives 15 units of utility for every *Les Miserables* performance she goes to. Sarah receives 10 units of utility for every *Phantom of the Opera* performance she goes to. Suppose Sarah's income is \$300. The price of either shows is \$100 each. Assume that the utility from consumption of an additional unit of either good is constant.

- 1) Draw Sarah's budget line (BL1) given her income is \$300. (Measure *Phantom of the Opera* on the Y-axis and *Les Miserables* on the X-axis.)

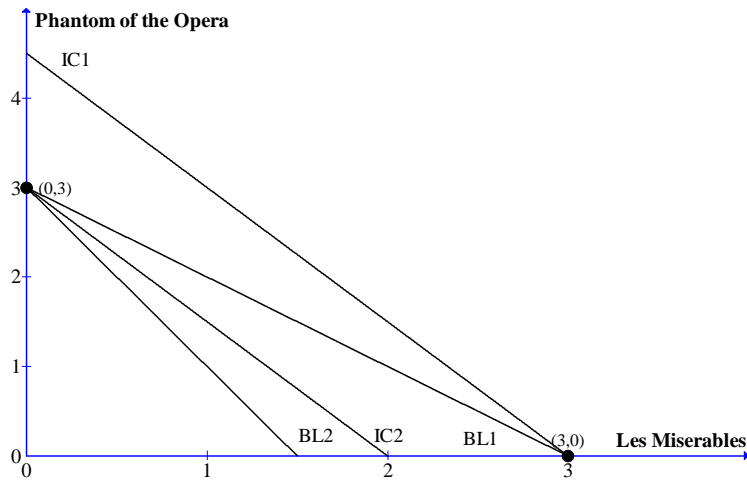


- 2) Please find the utility maximization point and draw an indifference curve (IC1) through the utility maximization point on your graph.



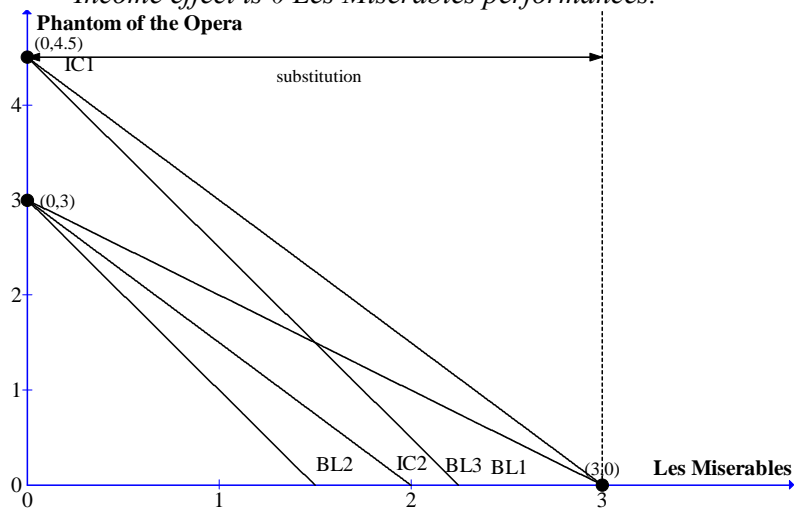
- 3) Suppose the price of a *Les Miserables* performance increases to \$200, draw Sarah's new budget line (BL2) and find her new utility maximization consumption bundle on your graph.

*Sarah will watch 3 Phantom of the Opera performances and 0 Les Miserables.*



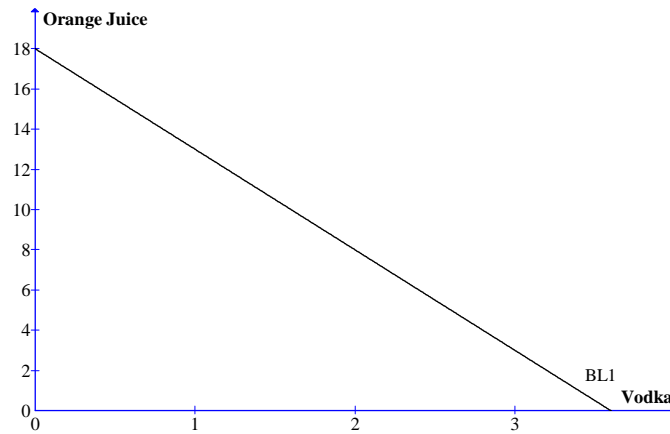
- 4) Draw an imaginary budget line (BL3) parallel to the new budget line (BL<sub>2</sub>) and make it touch the initial indifference curve (IC<sub>1</sub>) at the lowest possible income level. Calculate and show the income and substitution effects in the consumption of *Les Miserables* performances due to the price increase.

*Substitution effect is -3 Les Miserables performances.*  
*Income effect is 0 Les Miserables performances.*

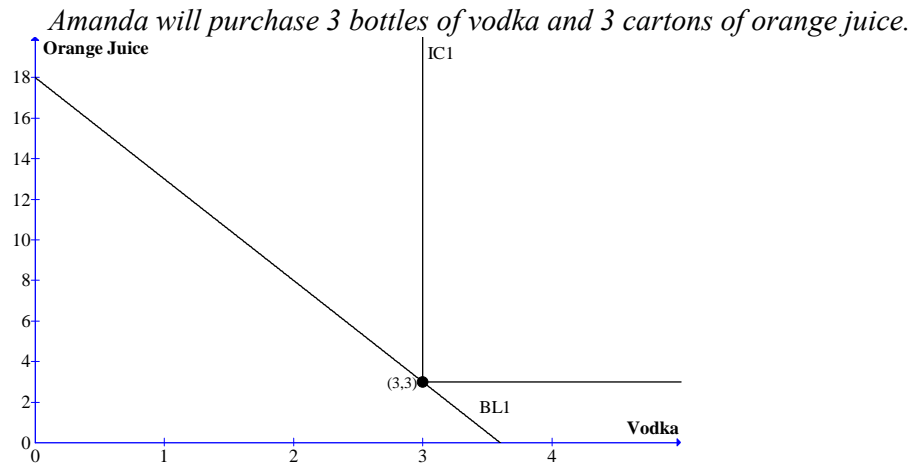


- C. Amanda is buying orange juice and vodka to mix drinks. She wants 1 bottle of vodka for every carton of orange juice. She does not like orange juice by itself and she does not like drinking straight vodka. The price of a carton of orange juice is \$2, and the price of a bottle of vodka is \$10.

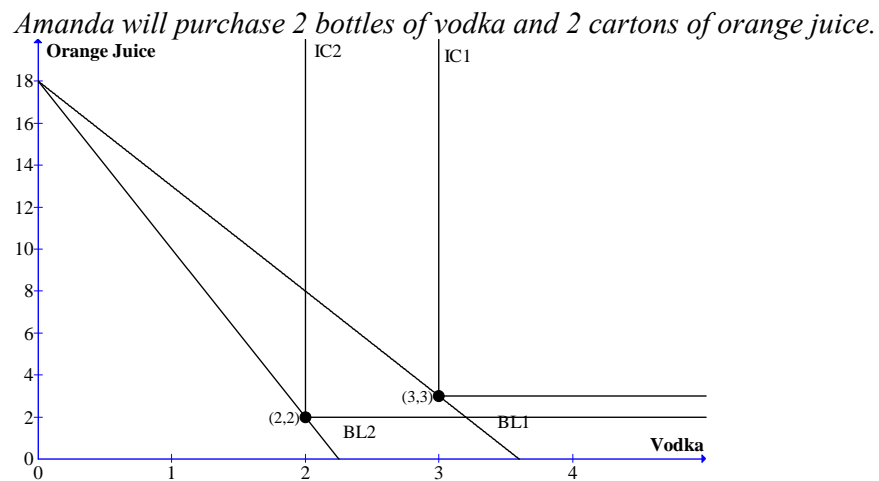
- 1) Draw Amanda's budget line (BL<sub>1</sub>) given her income is \$36. (Put vodka on the X-axis and orange juice on the Y-axis.)



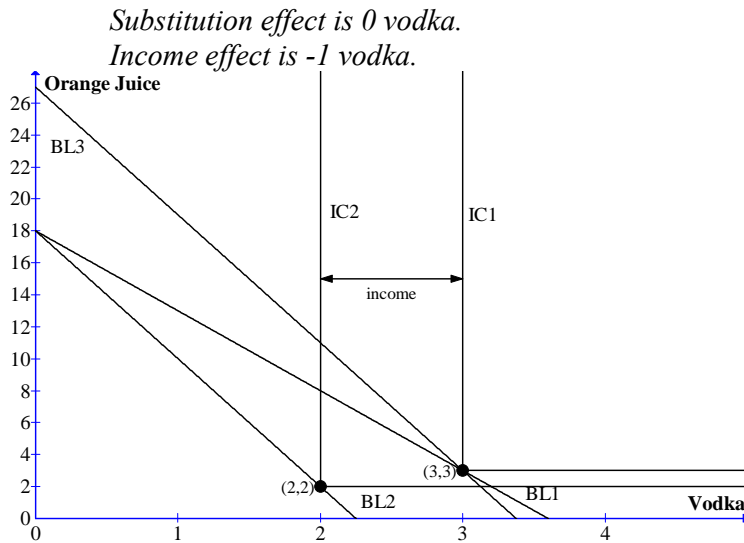
- 2) Please find the utility maximization point and draw an indifference curve ( $IC_1$ ) through the utility maximization point.



- 3) Suppose the price of a bottle of vodka increases to \$16, draw Amanda's new budget line ( $BL_2$ ) and find her new utility maximization consumption bundle.



- 4) Draw an imaginary budget line ( $BL_3$ ) parallel to the new budget line ( $BL_2$ ) and make it touch the initial indifference curve ( $IC_1$ ) at the lowest income level possible. Calculate and show the income and substitution effects on the consumption of vodka due to the price change in vodka.



### Q3: Production Cost I

The following table gives cost information for a firm. Assume that labor is paid a constant wage and capital is paid a constant price, i.e., our firm is a price-taker both in the labor and capital markets.

L	K	Q	VC	FC	TC	AVC	AFC	ATC	MC	MPL
0	5	0	0	100	100	---	---	---	---	---
1	5	225	100	100	200	$4/9$	$4/9$	$8/9$	$4/9$	225
2	5	600	200	100	300	$1/3$	$1/6$	$1/2$	$4/15$	375
3	5	900	300	100	400	$1/3$	$1/9$	$4/9$	$1/3$	300
4	5	1140	400	100	500	$20/57$	$5/57$	$25/57$	$5/12$	240
5	5	1340	500	100	600	$25/67$	$5/67$	$30/67$	$1/2$	200
6	5	1400	600	100	700	$3/7$	$1/14$	$1/2$	$5/3$	60

- 1) Suppose output is equal to zero. Why does the firm still incur costs in the short run when output is equal to zero? What is the fixed cost of this firm? What is the price of a unit of capital?

*Fixed cost is always incurred. Fixed cost is 100. Price per unit of capital is \$20.*

- 2) What is the wage rate?



*Wage is \$100*

3) Please complete the above table with specific numbers.

4) At what level of output and labor usage is AVC at its minimum?

*Output = 900, labor = 3*

5) At what level of output and labor usage is ATC at its minimum?

*Output = 1140, labor = 4*

6) At what level of labor usage does the law of diminishing returns first occur?

*Occurs at the 3 unit of labor.*

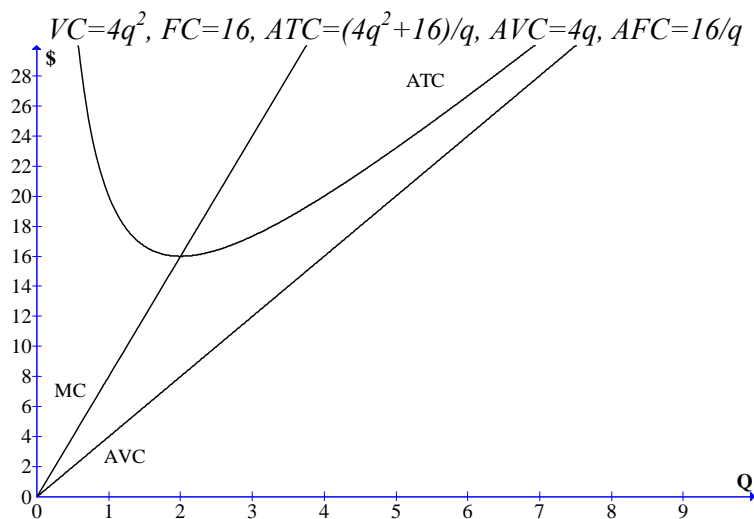
7) According to the table, what is the minimum price for the firm to be willing to hire the fourth unit of labor? According to the table, what is the minimum price for the firm to be willing to hire the fifth unit of labor? What is the price range of the product if the optimal number of labor hired by the firm is 4?

*Price is at least  $5/12$  and strictly less than  $1/2$ .*

#### **Q4: Perfect Competition**

Suppose a perfectly competitive firm's cost function is  $C(q)=4q^2+16$ . Marginal cost for the firm is given by  $MC=8q$ .

1) Find equations for variable cost, fixed cost, average total cost, average variable cost and average fixed cost for this firm. Illustrate on a graph the firm's average variable cost curve, average total cost curve, and marginal cost curve.



- 2) Find the outputs that minimize average total cost, average variable cost and average fixed cost.

*ATC is minimized at  $(4q^2+16)/q=8q \Rightarrow (4q^2+16)=8q^2 \Rightarrow 4=q^2 \Rightarrow q=2$ .*

*AVC is minimized at  $q=0$ .*

*ATC is minimized as  $q$  approaches infinity.*

- 3) What is the shutdown price for this firm?

*Shutdown price is 0.*

- 4) What is the breakeven price for this firm?

*Breakeven price is 16.*

- 5) If the price of the output is \$32, how many units will this firm produce? What is the firm's profit?

*$32=8q \Rightarrow q=4$ .*

*$Profit = 4*32 - 4(4^2)-16= 48$*

- 6) Suppose market demand for this good is given as  $P=300-Q$  and all firms in the market are identical. How many firms are active in the market in the long run?

*$P=16$ .  $Q=300-16=284$ .  $n=284/2=142$ .*