

**EXAMINATION #3 VERSION B**  
**“Firms and Competition”**  
**October 28, 2021**

**INSTRUCTIONS:** This exam is closed-book, closed-notes. Calculators, mobile phones, and wireless devices are NOT permitted. Point values for each question are noted in brackets.

**I. MULTIPLE CHOICE:** Circle the one best answer to each question. Use margins for scratch work [1 pt each—15 pts total]

(1) Suppose a firm produces an output using capital and labor. The increase in output from a one-unit increase in labor input, while holding capital input constant, is called

- a. the marginal rate of substitution in production of labor for capital.
- b. the average product of labor.
- c. the price of labor.
- d. the marginal product of labor.

(2) Suppose a firm enjoys *constant returns to scale*. Then if all inputs are doubled, output

- a. less than doubles.
- b. more than doubles.
- c. exactly doubles.
- d. remains exactly constant.
- e. decreases.

(3) Suppose a firm uses both labor and capital to produce some output. Along the firm's *isoquant*, what is held constant?

- a. the firm's marginal rate of substitution in production.
- b. the firm's level of output.
- c. the firm's level of labor input.
- d. the firm's level of capital input.

(4) The absolute value of the slope of a firm's isoquant equals the firm's

- a. marginal cost.
- b. average cost.
- c. marginal rate of substitution.
- d. returns to scale.

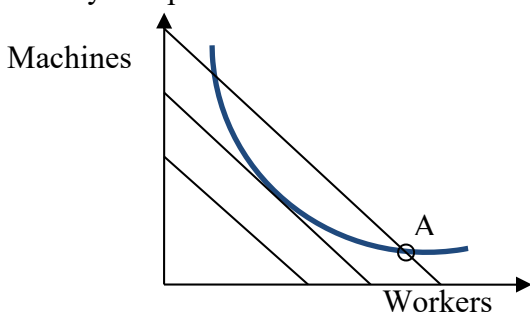
(5) Suppose a production function is given by  $q = 20 x_1^{1/4} x_2^{3/4}$ . The number (3/4) equals the

- a. returns to scale.
- b. partial elasticity of output with respect to input #2.
- c. average product of input #1.
- d. marginal product of input #2.
- e. marginal rate of substitution in production.

(6) Suppose a firm uses both labor and capital to produce some output. Along an *isocost line*, what is held constant?

- a. the firm's total output.
- b. the firm's average cost.
- c. the firm's marginal cost.
- d. the firm's total cost.

The next two questions refer to the following diagram of a firm's isocost lines and an isoquant. Suppose the firm is currently at input combination A.



- (7) This firm could lower its total cost, without reducing output, by
- using fewer machines and more workers.
  - using more machines and fewer workers.
  - either (a) or (b).
  - neither (a) nor (b).
  - cannot be determined.

(8) Let  $MP_1$  denote the marginal product of machines and  $MP_2$  the marginal product of workers for this firm. Let  $w_1$  denote the price of machines and  $w_2$  denote the price of workers. At input combination A,

- $MP_2/MP_1 < w_2/w_1$ .
- $MP_2/MP_1 > w_2/w_1$ .
- $MP_2/MP_1 = w_2/w_1$ .
- $MP_2 = MP_1$  and  $w_2 = w_1$ .
- cannot be determined from information given.

(9) *Diseconomies of scale* mean that the firm's average cost curve

- slopes up.
- slopes down.
- is horizontal.
- is vertical.

(10) Suppose a firm is now producing 500 units of output per day. Its marginal cost is \$8, its average cost is \$3, and it can sell its output at a price of \$6. If it increases its output to 501 units, its profit will

- increase by \$5.
- increase by \$3.
- increase by \$2.
- decrease by \$5.
- decrease by \$3.
- decrease by \$2.

(11) In the short run, a firm should shut down if its revenue falls below its

- total cost.
- producer surplus.
- fixed cost.
- variable cost.

(12) When firms exit an industry, the

- short-run supply curve shifts left.
- short-run supply curve shifts right.
- demand curve shifts left.
- demand curve shifts right.
- long-run supply curve shifts left.
- long-run supply curve shifts right.

(13) *Price equals marginal cost* in a competitive industry in both short-run and long-run equilibrium because

- business owners have a sense of fairness.
- individual firms adjust their output levels to maximize profit.
- consumers refuse to pay more than what is reasonable.
- positive profits encourage entry of new firms while negative profits encourage existing firms to leave the industry.
- the threat of government regulation causes firms to hold prices down.

- (14) A *potential Pareto improvement* (also called an *economically efficient change*) is defined as a change in the economy where
- everyone gains.
  - at least one person gains.
  - at least one person gains and no one loses.
  - the gains to the winners exceed the losses to the losers.

- (15) The amount of coal actually sold would decrease if the government enacted a
- a tax on coal.
  - a quota on sellers of coal.
  - a price ceiling (or legal maximum price) for coal.
  - a price floor (or legal minimum price) for coal.
  - all of the above.
  - none of the above.

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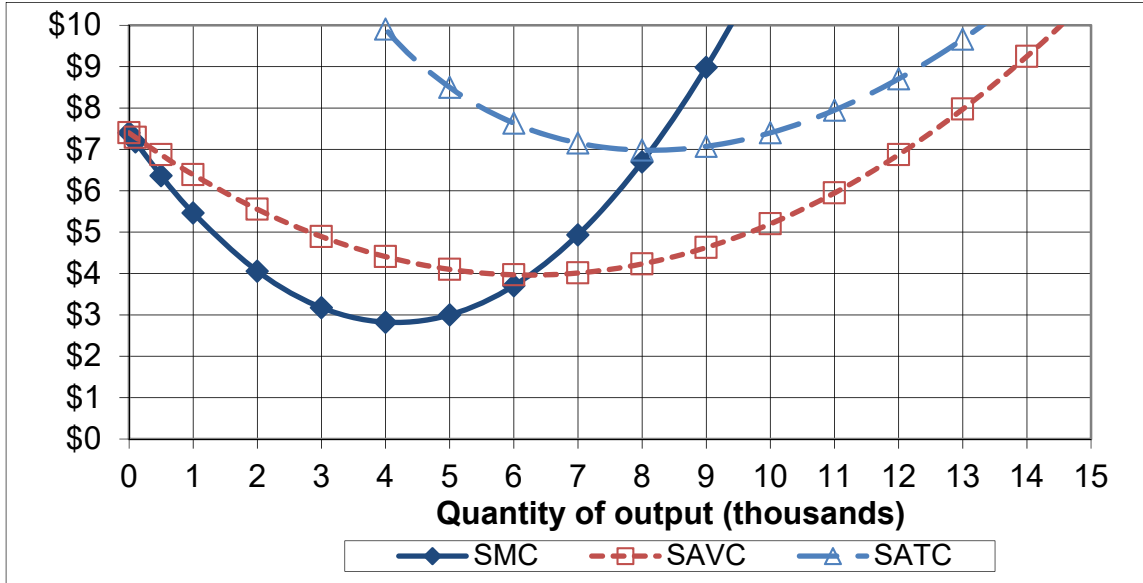
**II. SHORT ANSWER:** Please write your answers in the boxes on this question sheet. Use margins for scratch work.

(1) [Technical change: 4 pts] The elasticity of output with respect to labor input for the US economy as a whole is about  $2/3$ . The elasticity of output with respect to capital input is about  $1/3$ . Suppose labor input increases by 2% and capital input increases by 5%.

- By how much would output increase, without any technical change?
- Suppose output in fact increases by 7%. What is the increase in multifactor or total factor productivity (also called the Solow residual)?

	%
	%

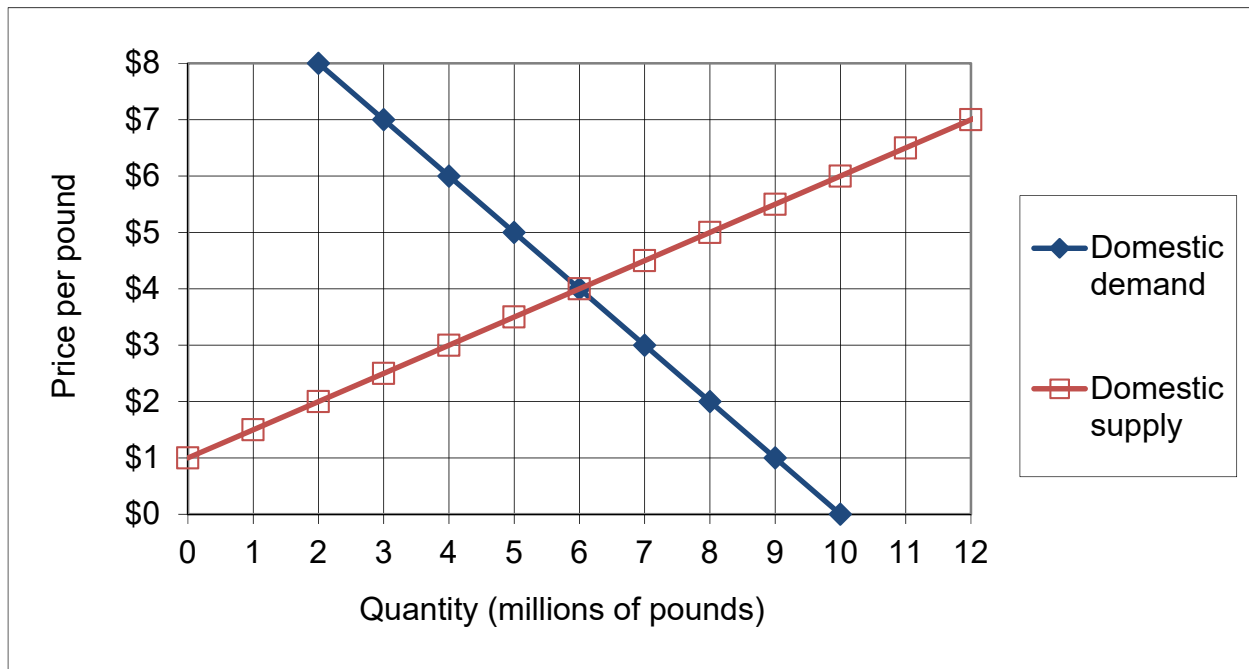
(2) [Short-run cost curves and supply: 10 pts] The following graph shows ACME Manufacturing Company's short-run average total cost (SATC), short-run average variable cost (SAVC), and short-run marginal cost (SMC). Assume ACME maximizes its profit while taking the market price as given.



- If the market price is \$5, about how much output will ACME try to produce (to the nearest thousand)?
- If the market price is \$9, about how much output will ACME try to produce (to the nearest thousand)?
- If the market price is \$3, about how much output will ACME try to produce (to the nearest thousand)?
- What is ACME's *breakeven price*—that is, the lowest price at which ACME can produce output without making losses in the short run?
- What is ACME's *shutdown price*—that is, the lowest price at which ACME will continue to operate in the short run?

thousand
thousand
thousand
\$
\$

(3) [Welfare effects of international trade: 16 pts] The following graph shows domestic demand and supply for cheese in some country.



At first, international trade in cheese is not permitted. Then this industry is opened to international trade and the international price of cheese turns out to be \$ 6.

- Will this country now *export* or *import* cheese?
- How much?
- Does consumer surplus in this country *increase* or *decrease* from international trade in cheese?
- By how much?
- Does producer surplus in this country *increase* or *decrease* from international trade in cheese?
- By how much?
- Does total social welfare in this country *increase* or *decrease* from international trade in cheese?
- By how much?

	million pounds
\$	million
\$	million
\$	million

**III. PROBLEMS:** Please write your answers in the boxes on this question sheet. Show your work and circle your final answers.

(1) [Production functions: 12 pts] Suppose a production function is given by  $q = 8 x_1^{3/4} x_2^{3/4}$ .

- a. Find an expression for the marginal product of input 1. Are there diminishing returns to input 1? Justify your answer.

- b. Find an expression in terms of  $x_1$  and  $x_2$  for the marginal rate of substitution in production of input 2 for input 1—that is, the absolute value of the slope of an isoquant, with  $x_1$  on the vertical axis and  $x_2$  on the horizontal axis. Does production show a diminishing marginal rate of substitution? Justify your answer.

- c. Does this production function have *constant* returns to scale, *increasing* returns to scale, or *decreasing* returns to scale? Justify your answer.

(2) [Fixed-proportions technology: 11 pts] Suppose a particular machine can produce 20 parts per hour if it is operated by **four** workers. This machine cannot be operated by fewer than four workers, and extra workers on the same machine add nothing to output. A firm can use as many machines as desired, with no loss in output per machine, provided each machine is operated by at least four workers. Let  $x_1$  denote the number of machines and  $x_2$  denote the number of workers employed by the firm. Let  $q$  denote the number of parts produced.

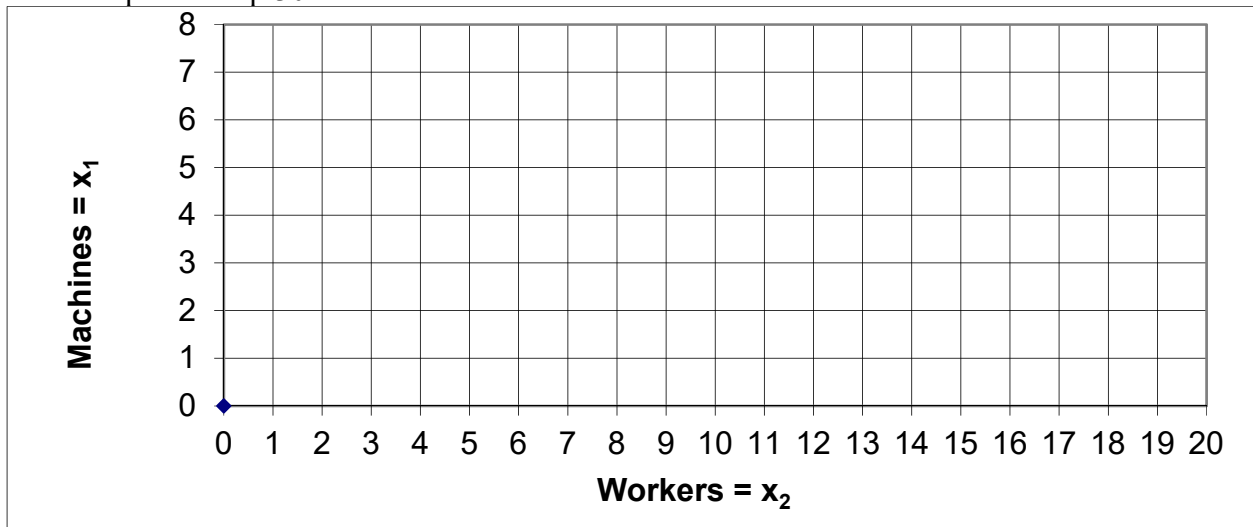
a. Give an equation for the firm's so-called "expansion path"—that is, the efficient relationship between  $x_1$  and  $x_2$ .

b. If there are plenty of workers, what is the relationship between parts produced  $q$  and the number of machines  $x_1$ ? Give an equation with  $q$  on the left side.

c. If there are plenty of machines, what is the relationship between parts produced  $q$  and the number of workers  $x_2$ ? Give an equation with  $q$  on the left side.

d. Give an equation for the firm's production function using the minimum function " $\min\{, \}$ ".

e. [3 pts] Draw and label (i) the firm's expansion path, (ii) the isoquant for  $q=10$ , and (iii) the isoquant for  $q=30$ .



(3) [Cost minimization: 10 pts] Suppose a firm wishes to produce 30 units of output per hour at minimum cost. The firm's hourly production function is given by  $q = 5 x_1^{1/2} x_2^{1/2}$ , where  $x_1$  denotes the number of machines and  $x_2$  denotes the number of workers. Machines cost \$5 per hour to rent and workers must be paid \$20 per hour.

- a. Give an equation for the firm's target isoquant. The variables  $x_1$  and  $x_2$  should be the only unknowns.

- b. Find a formula for the firm's marginal rate of substitution in production of workers for machines—that is, the slope of the firm's isoquant with machines on the vertical axis and workers on the horizontal axis. The variables  $x_1$  and  $x_2$  should be the only unknowns. Circle your final answer.

- c. [4 pts] Solve for the number of machines ( $x_1^*$ ) and workers ( $x_2^*$ ) required to produce the firm's target output at minimum cost. Circle your final answers.

- d. Compute the total cost to produce 30 units of output,  $TC(30)$ .



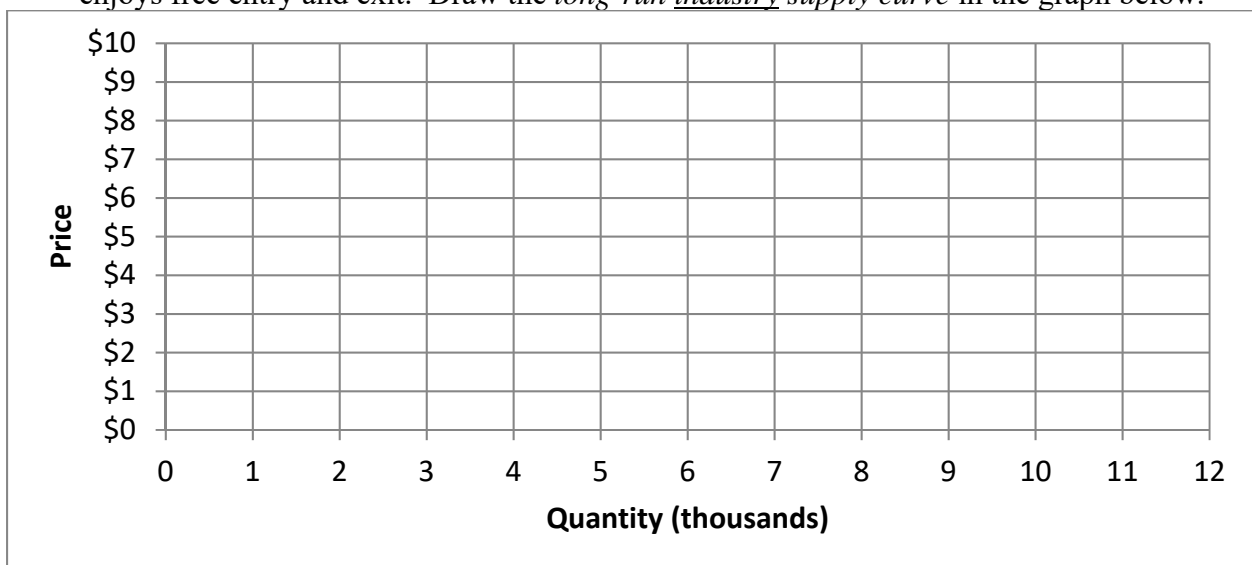
(4) [Long-run profit maximization and supply: 8 pts] Suppose a typical firm faces a (long-run) total cost function given by  $TC(q) = 0.01 q^3 - 0.8 q^2 + 22 q$ .

- a. Compute the typical firm's efficient scale  $q_{ES}$ . Show your work and circle your final answer.

- b. Compute the firm's breakeven price—the minimum price at which it will avoid losses. Show your work and circle your final answer.

- c. Describe with equations the *firm's supply curve*. [Hint: What happens when the market price is above the breakeven price? When the market price is below the breakeven price?]

- d. Suppose all firms in this industry have the same costs, and these costs are not affected by other firms in the same industry or by total industry output. Further assume the industry enjoys free entry and exit. Draw the *long-run industry supply curve* in the graph below.



(5) [Welfare effects of tax or subsidy: 10 pts] Suppose demand and supply for a good are given by the following equations. (Use the graph at right for scratch work.)

Demand:

$$P_D = 16 - (Q/10)$$

Supply:

$$P_S = 1 + (Q/20)$$



First consider the market without government intervention.

a. Compute the equilibrium price and quantity.

Now suppose the government gives a **subsidy of \$3 per unit**.

b. Compute the new equilibrium quantity.

c. Does consumer surplus *increase* or *decrease* as a result of the subsidy? By how much?

d. Does producer surplus *increase* or *decrease* as a result of the subsidy? By how much?

e. Does society as a whole (including the government) *gain* or *lose* as a result of the subsidy?  
By how much?

**IV. CRITICAL THINKING:** Answer just *one* of the questions below (your choice). [4 pts]

(1) Suppose supply of a good is *perfectly elastic*. If the good is taxed, who bears the burden of the tax—buyers, sellers, or both? Justify your answer with a supply-and-demand graph. Label all axes and curves.

(2) Consider the following claim: “Profit per unit of output equals price minus average cost. So to maximize total profit, a firm that takes price as given should operate at the output level where its average cost is lowest.” Do you agree or disagree? Justify your answer with a graph of a typical firm’s cost curves. Label all axes and curves.

Circle the question you are answering and write your answer below. Full credit requires good grammar, legible writing, accurate spelling, and correct reasoning.



[end of exam]