100 points total. Point values for each question are as indicated. Answer each question in the space provided. General advice: show your work, including any formulas or diagrams that you use in reasoning through your answers.

1. (15 pts.) First some facts from a July 2019 *WSJ* article on natural gas markets. Demand for natural gas has been growing slowly but steadily since 2005. In 2005 the price of natural gas in the U.S. was around $14 per million BTU's, and market equilibrium output was 22 trillion cubic feet. Despite the growth in demand, by 2019 market price had fallen to around $2 per million BTU's, with 30 trillion cubic feet being bought and sold. In the diagram below, illustrate the market equilibrium in 2005 and in 2019. Before you draw any supply or demand curves, think about how you are going to reconcile the market equilibrium points with continually growing demand. A quote from the article may help you illustrate and explain your answer: "producers in West Texas, drilling primarily for oil, are getting abundant natural gas as a byproduct." The fracking revolution has had a similar impact in other parts of the country. Carefully illustrate and explain what has occurred in this market over the past 15 years using supply and demand analysis.
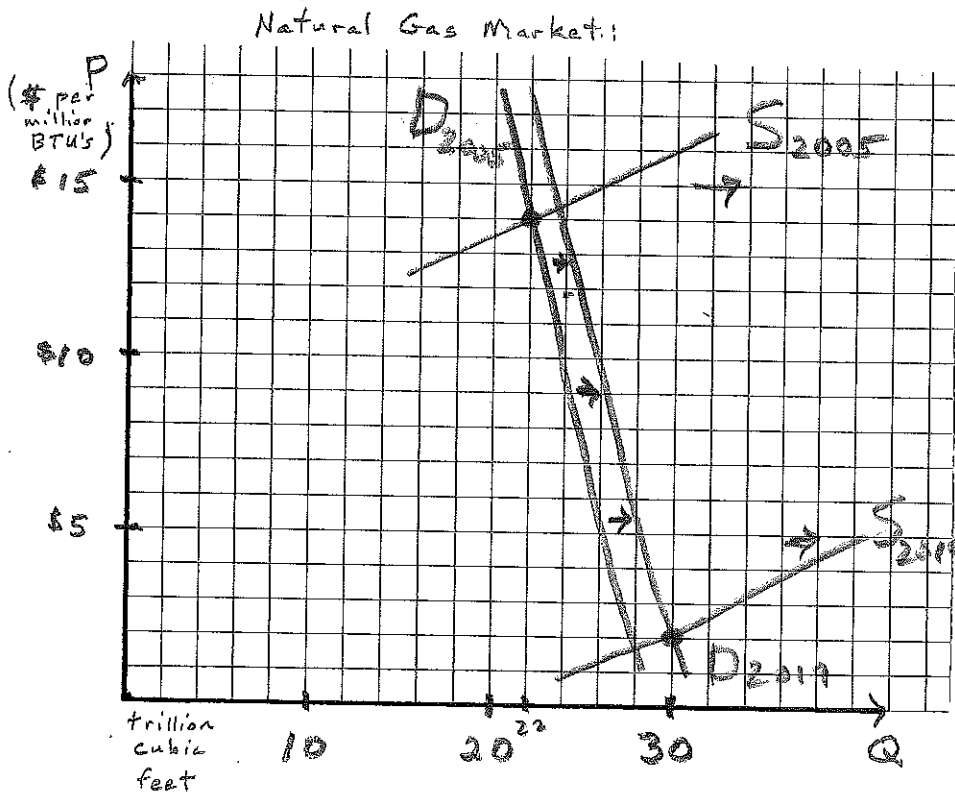
Demand grows from 2005 to 2019, so market demand for 2019 must lie to the right of demand for 2005. Over the same time period, supply increases dramatically, both because natural gas is a byproduct of many oil wells and also because fracking improves technology of producing gas. The 2005 demand and supply curves intersect at P=$14 and Q=22tr cu ft, and the 2019 demand and supply curves intersect at P=$2 and Q=30tr cu ft.

2. (15 pts.) During the Great Recession of 2007-2009, average household incomes fell by around five percent. Recreational vehicle shipments in the U.S. fell from around 200,000 per year to 150,000 over the same period. Calculate income elasticity of demand for RV's, showing your work. Then explain what type of good RV's are, and what that implies during a recession for a community like Elkhart, IN where 65% of the RV's in the U.S. are manufactured.

$$\varepsilon_{X, Income} = \frac{\% \Delta X}{\% \Delta Income} \quad , \quad \% \Delta Income = -5\%$$

$$\% \Delta X = \frac{150 - 200}{\frac{1}{2}(150 + 200)} = -\frac{50}{175} = -28.6\%$$

$$\varepsilon_{X, Income} = \frac{-28.6\%}{-5\%} = 5.71$$

$\varepsilon_{X,I} > 1$ means that RV's are a normal good, but more specifically, a luxury good. As income goes up or down by a given percentage, RV sales will go up or down by five times that percentage! Elkhart, IN will have an extreme boom or bust economy.

3. (15 pts.) Janet opens a shop in Mt. Pleasant, SC that sells Christmas items to tourists. Her sales revenues are $400,000 per year. She incurs costs of $200,000 for cost of goods sold, $75,000 for wages paid to hourly employees, $20,000 for taxes and insurance, $25,000 for rent, and $10,000 for utilities. Janet works full time in the shop and doesn't pay herself a salary. Formerly she worked as office manager in a dentist's office earning $50,000 per year. She and her husband have $100,000 of their savings tied up as working capital in the business. They typically earn 5% on their investments in mutual funds.

a) What are Janet's accounting profits?

Explicit costs:

Cost of goods sold	$200,000
Wages	$75,000
Taxes and insurange	$20,000
Rent	$25,000
Utilities	$10,000
Total Explicit Costs	$330,000

Total revenue – total explicit costs = accounting profit

*Accounting profit = $400,000 - $330,000 = **$70,000***

b) What are Janet's economic profits? Should she continue in the business?

Implicit Costs:

Opportunity cost of Janet's time	$50,000
Foregone interest earnings	$5,000

Economic profit = Total Revenue – total explicit costs – total implicit costs

Economic profit** = $400,000 - $330,000 - $55,000 = **$15,000

In other words, by owning and operating this shop, Janet is $15,000 better off than if she were pursuing her next best job opportunity and keeping her money in the mutual fund instead of this shop.

c) After several years, Janet decides that she wants to retire. She offers to sell the business to her sister, who is a CPA earning $80,000 per year. Her sister evaluates the business and declares that to be a bad idea for her. Is she making a mistake? What would her economic profits be? (Assume that she would take $100,000 out of her own savings and pay Janet for her investment in the business.)

*For some who can earn $80,000 in an alternative job, this shop would be a loser. Implicit costs would be $80,000 for opportunity cost of time and $5,000 still for foregone interest on savings. That would result in **economic losses of $15,000** per year. Keep the CPA job.*

4. (20 pts.) Labor and capital are used to produce widgets according to the production table below:

		Labor Input
		1	**2**	**3**	**4**	**5**
Capital Input	**1**	20	40	55	65	70
	2	40	60	75	85	90
	3	55	75	90	100	105
	4	65	85	100	110	115
	5	70	90	105	115	120

a) Does this production process exhibit short-run diminishing returns? Pick a set of combinations of inputs to illustrate and explain your answer.

Short-run law of diminishing returns: add more and more labor to a fixed amount of capital and see if output increases by smaller and smaller amounts. Let K = 3, and increase labor from L=1 to L=2 to L=3 to L=4 to L=5. Output goes from 55 to 75 to 90 to 100 to 105. In other words, MP_L goes from 20 to 15 to 10 to 5, i.e. the marginal product of labor is diminishing.

b) Suppose capital is fixed at K=3 in the short run. Suppose also that the per unit price of capital is v=$20, and the per unit price of labor is w=$20. In the attached diagram, graph the firm's SRATC curve.

K=3, L=1, TC=$80, Q=55, SRATC=80/55=$1.45
K=3, L=2, TC=$100, Q=75, SRATC=100/75=$1.33
K=3, L=3, TC=$120, Q=90, SRATC=120/90=$1.33
K=3, L=4, TC=$140, Q=100, SRATC=140/100=$1.40
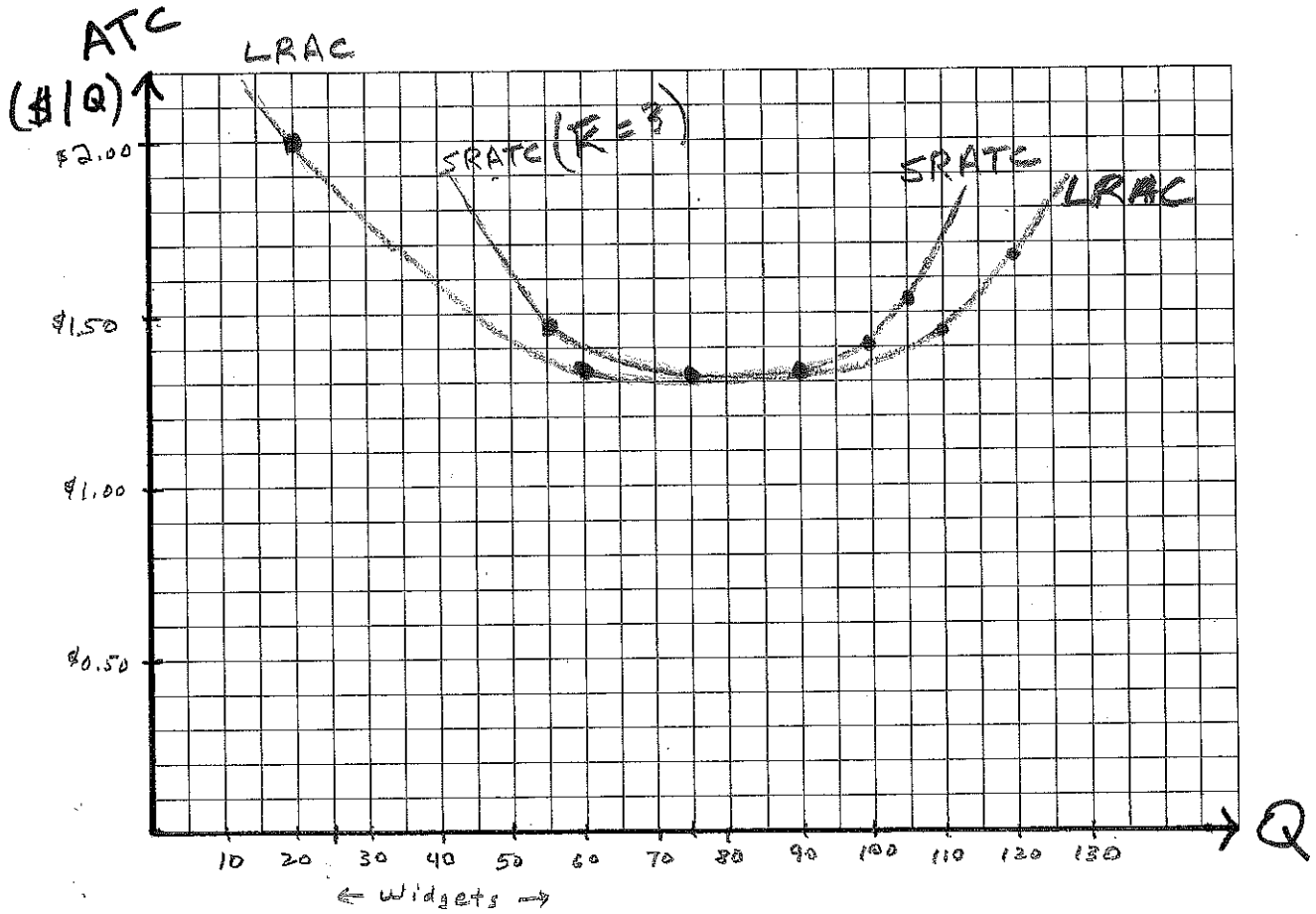*K=3, L=5, TC=$160, Q=105, SRATC=160/105=$1.52*

c) Does this production function exhibit increasing, constant, or decreasing returns to scale? Pick a set of combinations of inputs to illustrate and explain your answer.

Returns to scale is a long-run concept, whereby you change all inputs by a given proportion and see if output increases the same, a larger, or a smaller proportion. If we use L=K=1, Q=20. If we double L and K, output more than doubles to Q=60. Hence increasing returns to scale. Starting at L=K=2, if we increase the use of L and K by a factor of 1.5 to L=K=3, output goes from 60 to 90, a factor of 1.5. Hence constant returns to scale. If we use L=K=4, Q=110. Increase L and K by a factor of 1.2 to L=K=5, and Q=120. Output increases by a factor of 120/110=1.09. Hence decreasing returns to scale.

d) Now for a question about the LRAC curve. When input prices are the same, the long-run least cost combination of inputs occurs where K=L, i.e. the amount of capital used equals the amount of labor used. Graph five points on the firm's LRAC curve in your diagram.

K=1, L=1, TC=$40, Q=20, LRAC=40/20=$2.00
K=2, L=2, TC=$80, Q=60, LRAC=80/60=$1.33
K=3, L=3, TC=$120, Q=90, LRAC=120/90=$1.33
K=4, L=4, TC=$160, Q=110, LRAC=160/110=$1.45
K=5, L=5, TC=$200, Q=120, LRAC=200/120=$1.67

Diagram for Question #4

ATC
($/Q)

LRAC

SRATC (K=3)

SRATC

LRAC

$2.00

$1.50

$1.00

$0.50

10 20 30 40 50 60 70 80 90 100 110 120 130   Q

← widgets →

5. (10 pts.) You use fertilizer and insecticide to grow roses in your garden. Given the amounts of each that you are currently using, another pound of fertilizer applied to your rose bushes would yield an additional 10 roses, while an additional quart of insecticide would increase your rose output by 25. Insecticide costs $5 per quart, and fertilizer costs $2 per pound. What can we conclude from this information about the economic efficiency of the mix of fertilizer and insecticide you are currently using? Show any formula that you use in arriving at your answer.

If you are combining fertilizer and insecticide efficiently, it will be the case that marginal productivity of fertilizer per dollar spent is equal to marginal productivity of insecticide per dollar spent, or

$$MP_F/P_F = MP_I/P_I$$

$MP_F = 10$ and $P_F = \$2$, and $MP_I = 25$ and $P_I = \$5$.

Hence $MP_F/P_F = 10/2 = 5$ and $MP_I/P_I = 25/5 = 5$.

Since they are equal, you are currently using the cost-minimizing combination of fertilizer and insecticide to grow your roses.

6. (5 pts.) TFC = $2000, AVC = $10, and ATC = $12. What is Q?

At the current output, if $AVC = \$10$, and $ATC = \$12$ then $AFC = \$2$. If $AFC = \$2$ and $TFC = \$2000$, the firm must be producing $Q = TFC/AFC = \$2000/2$, or $Q = 1000$.

7. (5 pts.) Why might Kentucky Kingdom lower prices if it hoped to increase total revenue from the sale of tickets in the upcoming season? In other words, what assumption must they be making about demand for their product?

Total Revenue will increase when you lower price if demand is elastic, i.e. if the percentage increase in quantity demanded is greater than the percentage decrease in price. So Kentucky Kingdom must think that demand for their amusement park is elastic, $\varepsilon_{x,p} = \%\Delta X / \%\Delta P_x > 1$.

8. (5 pts.) Pick a reason why a firm might experience economies of scale and briefly explain it.

One of the following:

- Product-level economies:
  Fixed set-up costs
  Specialization of inputs
  Learning by doing
- Plant-level economies:
  Engineering relationships
  Economies of massed reserves (inventories)
  "Meshing" or indivisibilities
- Firm-level economies:
  Multi-plant operations
  Economies in input procurement
  Economies in sales promotion

9. (10 pts.) On the first day of class, your group chose a country and discussed its economic organization, in terms of the decision-making process and the ownership of resources. Briefly tell me what country your group chose and what you concluded about how its economy is organized.

Your answer should include a discussion of the decision-making process: (1) what goods will be produced and in what amounts; (2) how will these goods be produced, i.e. what production techniques will be used; and (3) for whom will the goods be produced, i.e. who will get the goods that are produced. Market systems decentralize the decision-making process while command systems centralize the decision-making process. Your answer should also include a discussion of the ownership of resources. Economic systems where scarce resources are privately owned are called capitalism, and economic systems where scarce resources are commonly or publicly owned are called socialism.