- This exam contains 7 pages (including this cover page) and 11 questions. Check to see if any pages are missing.

- The exam is scheduled for 1 hour.

- This is a closed-book, closed-note exam, no calculator exam.

- Answer each multiple choice question by writing the correct answer on the line at the right margin of the corresponding question. Make sure that your answer is clearly written or it will be marked incorrect.

- Write your answers to the short answer questions in the spaces provided below them. If you don't have enough space, continue on the back of the page and state clearly that you have done so.

- Do not remove any pages or add any pages. No additional paper is supplied

- Show your work when applicable. Use diagrams where appropriate and label all diagrams carefully.

- You must use a pen instead of a pencil to be eligible for remarking.

- This exam is given under the rules of Penn's Honor system.

My signature certifies that I have complied with the University of Pennsylvania's Code of Academic Integrity in completing this examination.

Please sign here _____ Date _____

Question	Maximum	Grade
MC (Q1-9)	40	
1st SA (Q10)	25	
2nd SA (Q11)	35	
Total	100	

Multiple Choice Questions (best 8 out of 9: 40 points)

1. (5 points) Consider a profit-maximizing firm in a perfectly competitive market. The firm's variable cost is $VC = 2q + q^2$. The firm is currently producing $q = 3$ units, and at this quantity its total costs is equal to $20. Which of the following statements *can* be true?

   I. The average variable cost is equal to $5

   II. The average fixed cost is equal to $5

   III. The market price is is $4

   A. Only I   B. Only II   C. I and II   D. II and III   E. I and III   F. I, II and III   G. None

   1. _____**A**_____

2. (5 points) Fill in the blank with the correct statement. In the long run equilibrium, a perfectly competitive firm produces a quantity such that _____.
   A. $MC = ATC$ B. $MC = AVC$ C. $MC = AFC$ D. None of the above

   2. _____**A**_____

3. (5 points) Suppose a perfectly competitive firm has the following total cost: $TC = 100q$, where q is the firm's output. Which of the following statements must be true?

   I. The firm's variable cost is 0

   II. The shut-down price is the same as the break-even price

   III. The firm will always operate in the long run

   A. I only   B. II only   C. I and II   D. I, II, and III   E. none of the statements is true

   3. _____**B**_____

4. (5 points) At the start of 2017, the market for fidget spinners was emerging with just few producers and high firm profits. Since this time, which of the following are most likely to have occurred to begin bringing the industry to long run equilibrium (assume there are no barriers to entry):
   A. More producers entered the market   B. Market quantity produced increased
   C. Firm profits have fallen   D. A and B   E. All of the above

   4. _____**E**_____

5. (5 points) Minshen just starts a new food truck producing teriyaki and bubble tea combo at 38th and Locust Walk. Which of the following statements will allow him to make positive profits in the long run?

   I. There are many food trucks on campus, that sell all kinds of food

   II. Minshen patents his bubble tea recipe

   III. There are regulatory barriers to entry in the food truck industry (permits, licensing, insurance, ...)

   IV. Even though Minshen has no market power, he just found a very cheap supplier of tapioca balls (which are used in bubble tea), which decreases his costs sharply

   A. II only   B. III only   C. I and III   D. II and III   E. I, II and III   F. I, II, III and IV

   5. _____**D**_____

6. (5 points) Can a monopoly facing a downward sloping demand curve produce the socially efficient quantity?

   A. Yes, when there is a positive externality   B. Yes, when there is a negative externality
   C. Yes, when there is no externality   D. No, it is not possible

   6. __**B or C**__

7. (5 points) A perfectly price discriminating monopoly produces a quantity such that:

   I. Marginal cost and Marginal revenue intersect

   II. Producer surplus is maximized

   III. Profit is maximized

   IV. Total surplus is maximized

   A. I, II, III and IV   B. II, III and IV   C. III and IV   D. III only   E. IV only

   7. __**A**__

8. (5 points) The Government of Hooliganland gets a percentage cut of the revenues made by all monopolies in its provinces. It also has control over the pricing of its monopolies, which all face downward sloping market demands and positive marginal costs. In order to maximize its income, it should force monopolies to produce the quantity such that:

   A. MR equals MC   B. Demand equals MC   C. MR equals 0   D. Demand equals 0

   8. __**C**__

9. (5 points) Starbucks and Saxbys are two of the most popular spots for coffee on Penn's campus. Since most of their customers are students, both coffee chains are deciding whether or not they should offer a special "student discount" to anyone that shows the barista their Penn ID. Below is the following table showing the profits (in millions of dollars) for each strategy, where Saxbys' profit is written first and Starbucks' profit is written second:

<table>
<tr><td></td><td></td><td colspan="2" align="center">**Starbucks**</td></tr>
<tr><td></td><td></td><td align="center">No Discount</td><td align="center">Discount</td></tr>
<tr><td></td><td>No Discount</td><td align="center">$10, 15$</td><td align="center">$5, 22$</td></tr>
<tr><td>**Saxbys**</td><td>Discount</td><td align="center">$20, 8$</td><td align="center">$12, 18$</td></tr>
</table>

   Given the information above, which of the following statements is correct?

   A. If Starbucks does not offer the discount, Saxbys is better off with no discount
   B. If Saxbys does not offer the discount, Starbucks is better off with no discount
   C. There are two Nash Equilibrium outcomes
   D. Offering the student discount is a dominant strategy
   E. None of the above

   9. __**D**__

Short Answer Questions (60 points total)

10. Assume the market for ice cream in Philadelphia is perfectly competitive, and there are 40 firms in the market. The owner of Franklin Fountain, a local Philadelphia ice cream shop has asked you for help considering its economic situation.

The firm spends a set rate on rent each day of \$8 and the rest of its daily costs are as follows: $VC = 2q^2 + q$ and $MC = 4q + 1$.

(a) The market demand for ice cream in Philadelphia is $P = 25 - 0.1Q$. Please determine the short run market supply, as well as the market price and market quantity.

> **Solution:** The shutdown price is where $AVC = MC$ or minAVC: $AVC = \frac{2q^2+q}{q} = 2q + 1$. It is minimum for $q = 0$. There are 40 competitors so $Q = 40q$. Therefore, market supply equation is $P = 4Q/40 + 1 = 0.1Q + 1$. In equilibrium $0.1Q + 1 = 25 - 0.1Q \Rightarrow Q = 120 \Rightarrow P = \$13$.

(b) At this price, what quantity of ice cream does Franklin Fountain produce daily?

> **Solution:** Either use $40q = Q$ to get $q = 3$ or $4q + 1 = 13$, $q = 3$.

(c) What is Franklin Fountain's short run profit?

> **Solution:** $13 \times 3 - (2 \times 3^2 + 3 + 8) = \$10$

(d) What will happen in the long run in the ice cream market in Philadelphia? In the long run equilibrium, find the price p_{LR}, the firm's profit π_{LR}, the market quantity Q_{LR}, the firm's quantity q_{LR} and the number of firms in the market N_{LR}.

> **Solution:** In the long run, more firms will enter the market until long run profits are $\pi_{LR} = \$0$. The price will be at the minimum of the ATC. $ATC = 2q + 1 + 8/q$ reaches its minimum when it intersects the MC: $ATC = MC \Leftrightarrow 2q + 1 + 8/q = 4q + 1 \Rightarrow 8/q = 2q \Rightarrow q_{LR} = 2$. The corresponding ATC is equal to 9. Therefore the market price in the long run equilibrium is $p_{LR} = 9$. The market demand is $P = 25 - 0.1Q_D$ so the market quantity is $Q_{LR} = (25 - 9)/0.1 = 160$. The number of firms in the market is such that $N_{LR} = Q_{LR}/q_{LR} = 160/2 = 80$.

(e) Now suppose that there is an increase in all ice cream storefront rents in Philadelphia. As we move to the new long run equilibrium, what will happen to the firm quantity, market quantity, market price and number of firms? Compare these to q_{LR}, Q_{LR}, p_{LR}, and N_{LR}. Please answer with clear and concise sentences.

> **Solution:** Since rent is increasing, and this does not depend on quantity produced, the fixed cost for each firm will increase. Thus the ATC increases and becomes ATC. Note that an increase in FC will not affect the MC. In the short run firms are making a loss. Thus firms will start to exit as we move into the long run. Firms will keep exiting until the representative firm is making zero profits. Thus the market Supply curve will decrease, which will increase the market price, until until the representative firm is making zero profits (where the new market price hits the minimum of the new ATC curve). Since Supply decreases, price increases and market Quantity decreases. Since the price increases, firm quantity increases. Since firms exit, number of firms will be lower.

11. Tesla is currently one of the largest players in the electric vehicle market. According to researchers, "Tesla will be given a near-monopolistic opportunity to gain market share and outcompete the incumbent automotive industry" by the mid-2020s.[1]. For the purposes of this question, assume we have reached the year in which Tesla becomes a complete monopoly of the electric cars market.

As the Head of Strategy at Tesla working alongside Elon Musk, you must help with pricing and other aspects of the business. You estimate that the marginal cost of producing each Tesla car is $MC = 2Q$ and the company will face a demand of $P = 120 - 2Q$.

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[1]Source: http://www.businessinsider.com/tesla-stock-price-berenberg-note-2017-6

(a) Model the market for electric cars graphically. Label MC, MR, and demand curves clearly.
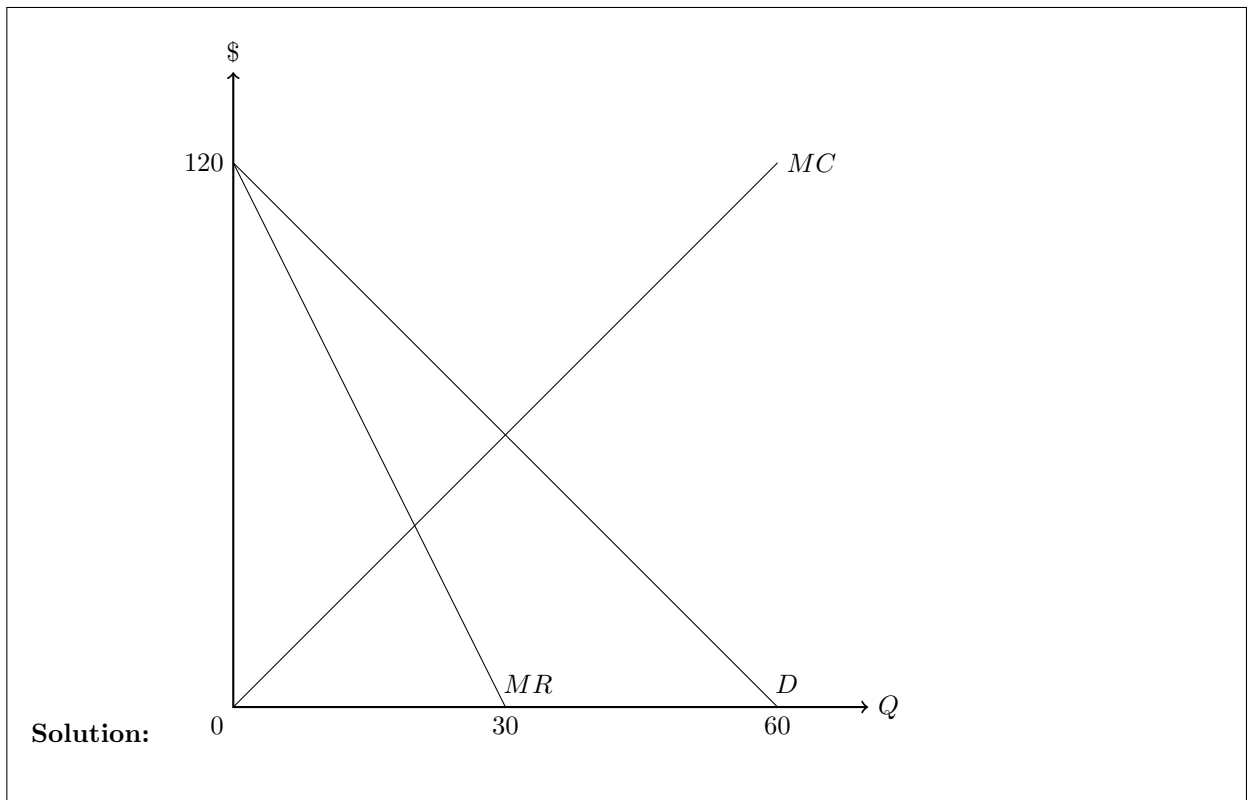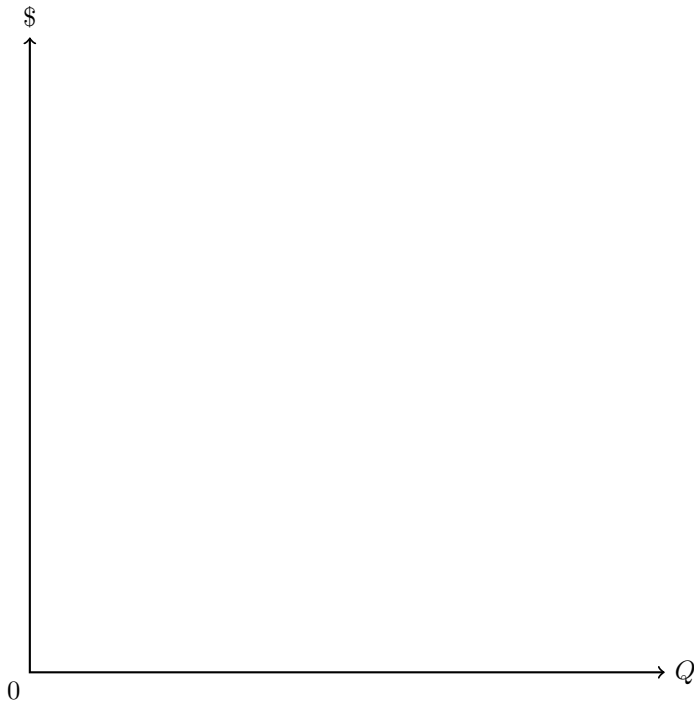
Solution:

(b) How many cars should Tesla produce each year as a profit-maximizing monopoly? What price should they charge per car?

> **Solution:** Tesla produces the quantity such that $MR = MC \Leftrightarrow 120 - 4Q = 2Q \Leftrightarrow Q = 20$. The price at this quantity would be $80.

(c) Does Tesla create a deadweight loss within the market? If so, shade it in on your graph and calculate it.

> **Solution:** The DWL is the triangle below demand and above MC between a quantity of 20 (produced by Tesla) and a quantity of 30 (socially efficient quantity): $DWL = (80 - 40) \times (30 - 20) \times 0.5 = \$200$.

Elon Musk calls you into his office and states: "I have spoken with leading environmentalists who say that our electric cars reduce greenhouse gas emissions and improve air quality." After doing some further research, you agree with Elon that your cars create a positive externality worth Q per car to society, such that $SMC = MC - Q$.

(d) In the graph below, model the new market for electric cars graphically with the positive externality. Label MC, SMC, MR, and the demand curves clearly. Be sure to include the socially efficient point as well (name it E).

$$\$ $$

$$\longrightarrow Q$$

0
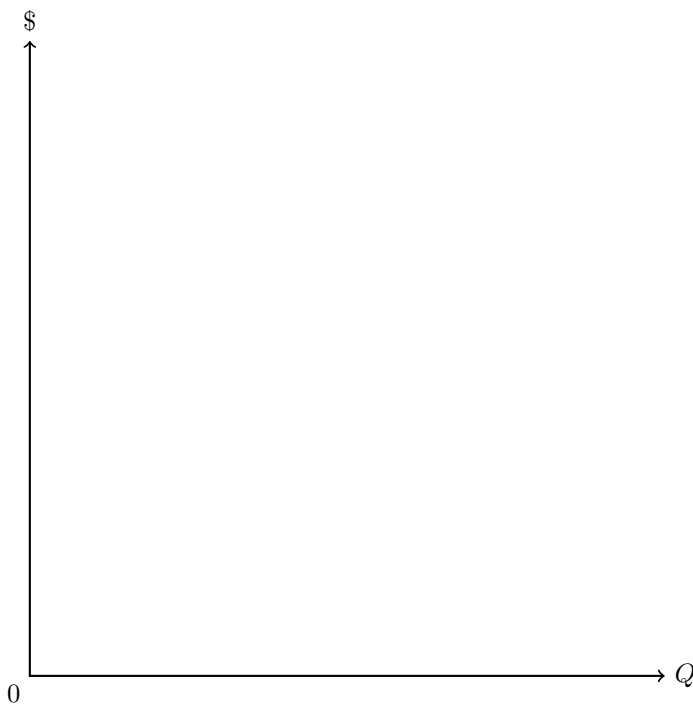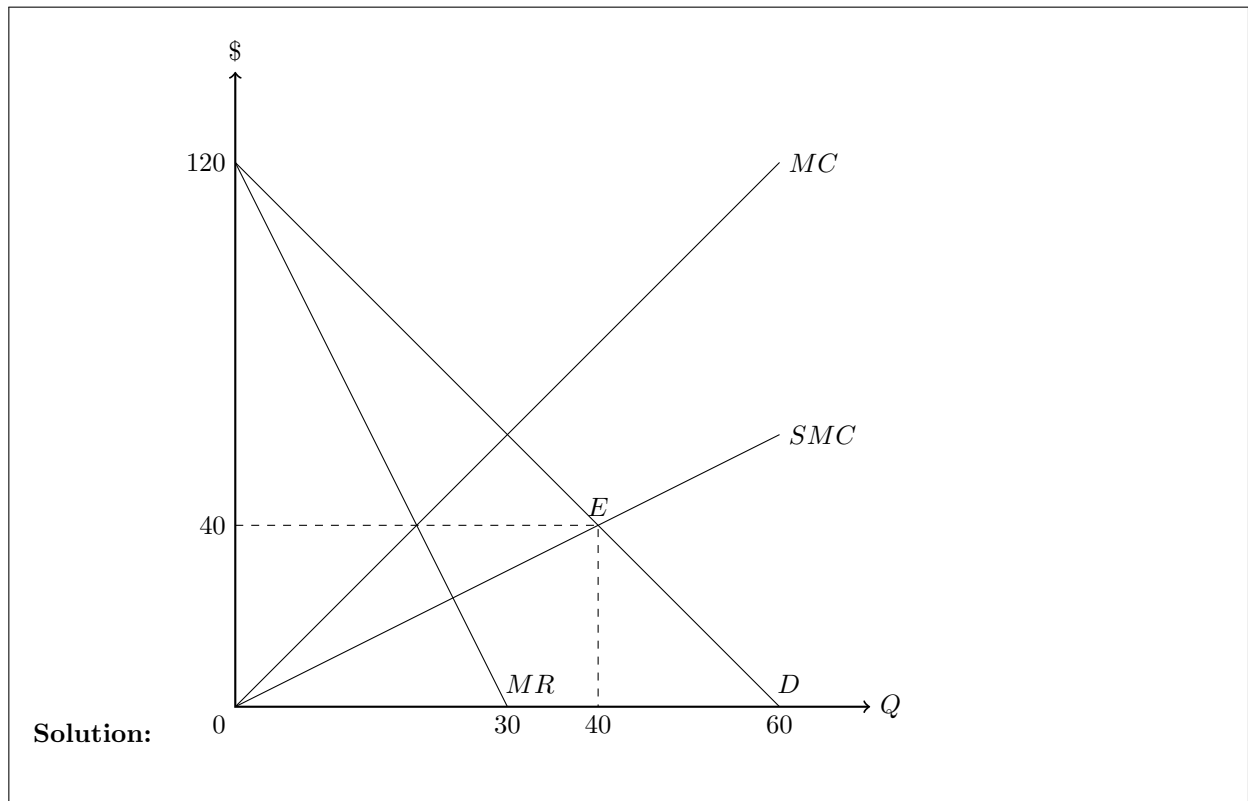
Solution:

(e) Calculate the socially efficient number of cars and the price charged, and label point E's intercepts on the graph from part (d).

Solution: The $SMC = MC - Q = Q$. The socially efficient number of visitors is such that $P = SMC \Leftrightarrow 120 - 2Q = Q \Leftrightarrow Q = 40$ and $P = 40$.

Being both a great businessman and humanitarian, Elon Musk decides to negotiate with the U.S. government regarding a subsidy so that he can both profit-maximize and reach the socially efficient number of Tesla cars in society.

(f) Calculate the subsidy Tesla would require in order to produce the socially efficient quantity of cars for the electric car market. What would be the total cost of that subsidy for the government?

Solution: The per car subsidy must be such that $MCs = MR$ at the socially efficient quantity of $Q = 40$: $2Q - s = 120 - 4Q$ for $Q = 40 \Rightarrow 80 - s = 120 - 160 \Rightarrow s = \$120$. The government would spend a total of $120 \times 40 = 4,800$.