Review Question Solutions (corresponding with the end of chapter problems):

8.9 From the total cost curve, we can derive the average cost curve, $AC(Q) = 40 - 10Q + Q^2$. The minimum point of the AC curve will be the point at which it intersects the marginal cost curve, i.e. $40 - 10Q + Q^2 = 40 - 20Q + 3Q^2$. This implies that *AC* is minimized when $Q = 5$. By definition, there are economies of scale when the *AC* curve is decreasing (i.e. $Q < 5$) and diseconomies when it is rising ($Q > 5$).

8.17 Since we can assume an interior solution, the tangency condition must hold. Therefore the optimal bundle must be such that $\frac{K}{L+1} = \frac{w}{r}$. This means $L + 1 = \frac{rK}{w}$. Substituting this back into the production function, we see that $Q = \frac{rK^2}{w}$, so $K = \sqrt{\frac{Qw}{r}}$.

This implies that $L = \sqrt{\frac{Qr}{w}} - 1$. The total cost curve is then $TC = wL + rK = 2\sqrt{wrQ} - w$. If we substitute $2w$ and $2r$ in the place of w and r respectively, we get $TC_2 = 2\sqrt{(2w)(2r)Q} - (2w) = 4\sqrt{wrQ} - 2w = 2 * TC$, so total cost does indeed double when input prices double.

8.24 With *K* fixed at 20 units, the production function becomes $Q = 20L + M$. Thus, *L* and *M* are perfect substitutes. Since $MP_L/w = 1.25 > MP_M/s = 1$, the marginal product per dollar spent on labor is always higher than that on materials. So the cost-minimizing input combination is $M = 0$ with *L* solving $400 = 20L + 0$, or $L = 20$. The short run total cost is $C = 16(20) + 4(20) + 1(0) = 400$.

8.25 With *K* fixed at 20 and *M* fixed at 40, the production function becomes $Q = 20L + 40$. To produce 400 units, the firm needs to hire labor until $400 = 20L + 40$, or $L = 18$. The short-run total cost is $C = 16(18) + 4(20) + 1(40) = 408$.

9.11

a) The firm will not produce any output when the price falls below the point where *SMC* = *ANSC*, i.e. the minimum of the *ANSC* curve. Therefore $50/Q + 40 + 0.5Q = 40 + Q$

This implies $Q = 10$. The corresponding price, below which the firms will not produce, is equal to $MC(10) = ANSC(10) = 50$.

b) Each firm will produce according to the relation, $P = MC$, or $P = 40 + Q$. This means that each firm's supply curve is $Q = P - 40$ if $P \geq 50$ and zero if $P < 50$. Therefore market supply equals $12(P - 40)$ and in equilibrium this must equal market demand, $360 - 2P$. Therefore the equilibrium price is $P = 60$. At this price, each firm produces 20 units of output.

9.14 Total industry supply is the sum of the supply curves of the individual firms. Since we have 100 type *A* firms, total supply from type *A* firms is $100s_A(P) = 200P$, and since we have 30 type *B* firms, total supply from type B firms is $30s_B(P) = 300P$. The short-run industry supply curve is thus $S(P) = 200P + 300P = 500P$. The short-run market equilibrium occurs at the price at which quantity supplied equals quantity demanded, or $5000 - 500P = 500P$, or $P = 5$. At this price, a type *A* firm supplies 10 units, while a type *B* firm supplies 50 units.

9.17 If the firm operates at a point where its *SAC* curve is rising, it must mean that the marginal cost curve is above the *SAC* curve. And since the firm must set price=MC, it means that price is greater than average cost. Therefore the firm earns positive economic profit.

If it operates at a point where the *SAC* curve is falling, it means S*MC* < *SAC* and therefore price is less than average cost. Therefore the firm is making negative economic profit in the short run. However, the fact that the firm is still operating means that marginal cost must be above the average non-sunk cost curve, so that it is better for the firm to continue operating, albeit at a loss, than to shut down.

10.3 The incidence of a tax can be summarized quantitatively by

$$\frac{\Delta P^d}{\Delta P^s} = \frac{\varepsilon_{Q^s,P}}{\varepsilon_{Q^d,P}}$$

From the given information, $\Delta P^d = 4$, $\Delta P^s = 0$, and $\varepsilon_{Q^d,P} = -0.5$. These price changes imply that 100% of the burden of the tax is borne by the consumer, implying the elasticity of supply must be infinite. Supply is perfectly elastic.

10.5. Consider the market for crude oil. Suppose the demand curve is described by $Q^d = 100 - P$, where Q^d is the quantity buyers will purchase when the price they pay is P (measured in dollars per barrel). The equation representing the supply curve is $Q^S = P/3$, where Q^S is the quantity that producers will supply when the price they receive is P. The market for crude oil is initially in equilibrium, with no tax and no subsidy. Because it regards the price of oil as too high, the government wishes to help buyers by announcing that it will give producers a subsidy of 4 dollars per barrel. A local television station reporter

announces that the subsidy should lower the price consumers pay by 4 dollars per barrel. Analyze the reporter's claim by determining the price buyers pay before and after the subsidy, and provide intuition to explain why the reporter is correct or incorrect.

Before the subsidy, the price buyers pay is the same as the price producers receive; call this price P. The equilibrium can be found by setting supply equal to demand: $P/3 = 100 - P$. Thus, in equilibrium buyers pay P = \$75 / barrel.

In an equilibrium with the subsidy, the price producers receive (P^S) will be \$4 per barrel *more* than price buyers pay (P^d); thus $P^S = P^d + 4$. The market will clear when the quantity bought at a price P^d (i.e., $100 - P^d$) equals the quantity purchased at a price P^S = (i.e., $P^S/3$). Thus, $100 - P^d = P^S/3$, or $100 - P^d = (P^d + 4)/3$. In equilibrium the price paid by buyers is \$74, and the price received by producers is \$78. So the reporter's claim is false; the subsidy reduces the price buyers pay by only \$1 per barrel (from \$75 to \$74 per barrel). The reason that the price does not fall by \$4 per barrel is that neither the demand nor the supply is totally inelastic. Thus the incidence of the subsidy (akin to the incidence of a tax) is shared by buyers and sellers. The price buyers pay falls by \$1, while the price producers receive rises by \$3.

10.14. Which of these programs would lead to a less than 10,000 units exchanged in the market? Briefly explain.

Program I: The excise tax will increase the price consumers pay to a level above \$25, and lower the price producers receive to a level below \$25; thus, the quantity exchanged in the market will fall below 10,000 units.

Program II: With the subsidy, the price producers receive will increase to a level above \$25; the price consumers receive will fall below \$25. Thus, the equilibrium quantity exchanged will rise to a level above 10,000.

Program III. With the price floor of \$30, consumers will buy less than 10,000 gizmos, so fewer than 10,000 will be exchanged in the market.

Program IV. With the price ceiling of \$20, producers will supply less than 10,000 gizmos, so fewer than 10,000 will be exchanged in the market.

Program V. By government fiat, fewer than 10,000 gizmos will be exchanged.

10.15. Under which of these programs will the market clear? Briefly explain.

With the excise tax or the subsidy, the market will clear (Programs I and II).

With the price floor (Program III) there will be excess supply, so the market will not clear.

With the price ceiling (Program IV) there will be excess demand, so the market will not clear.

With the production quota (Program V) the price consumers pay will exceed $25, so there will be excess supply. The market will not clear.

10.16. Which of these programs would surely lead to an increase in consumer surplus? Briefly explain.

With the excise tax (Program I) the price consumers pay will rise, so consumer surplus will surely fall.

With the subsidy (Program II) the price consumers pay will fall, so consumer surplus will surely rise.

With the price floor (Program III) the price consumers pay will rise, so consumer surplus will surely fall.

With the price ceiling (Program III) the price consumers pay will fall, but so will the quantity produced. Consumer surplus may fall. This can occur if the price floor is so low that very few units are produced (and thus available for purchase by consumers).

With the production quota (Program V) the price consumers pay will rise, so consumer surplus will surely fall.