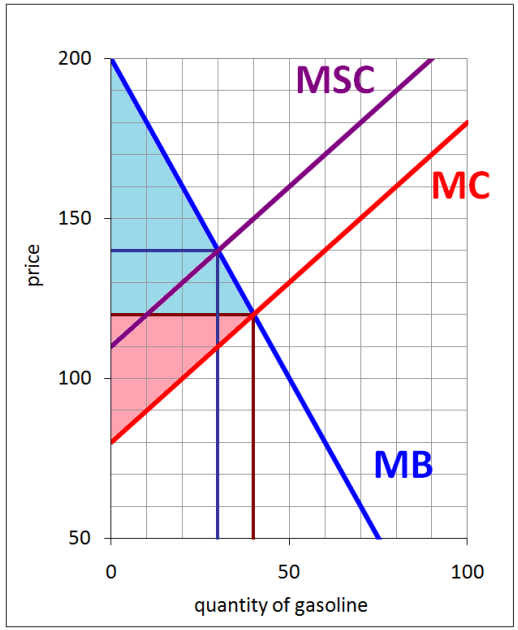
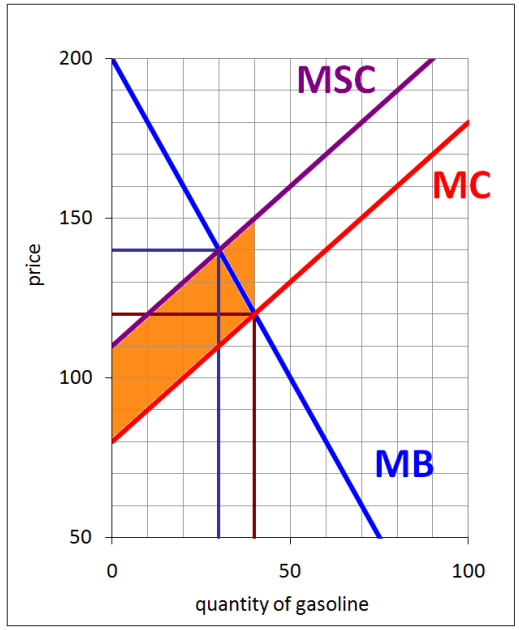
# Externalities, part 2

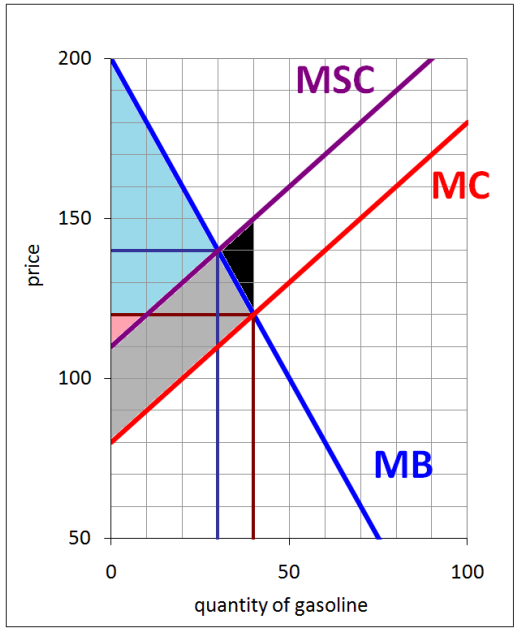
## Thursday, September 22

# NEGATIVE EXTERNALITY: TOTAL SURPLUS

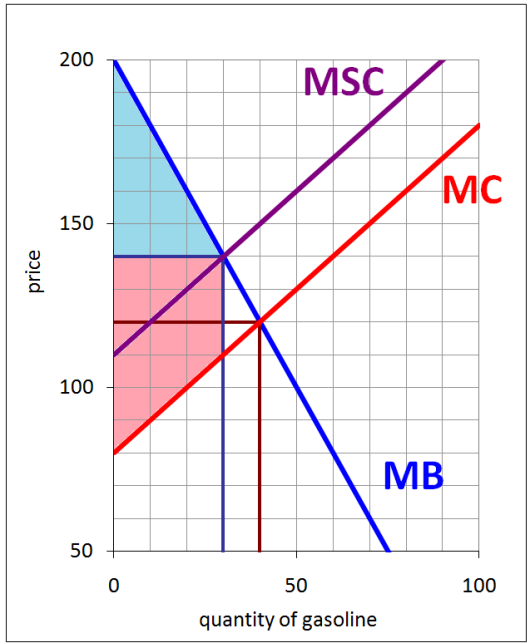
**market equilibrium**

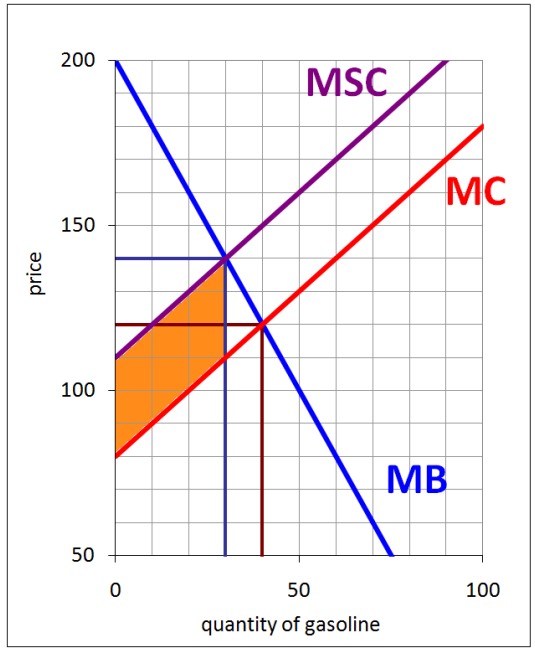


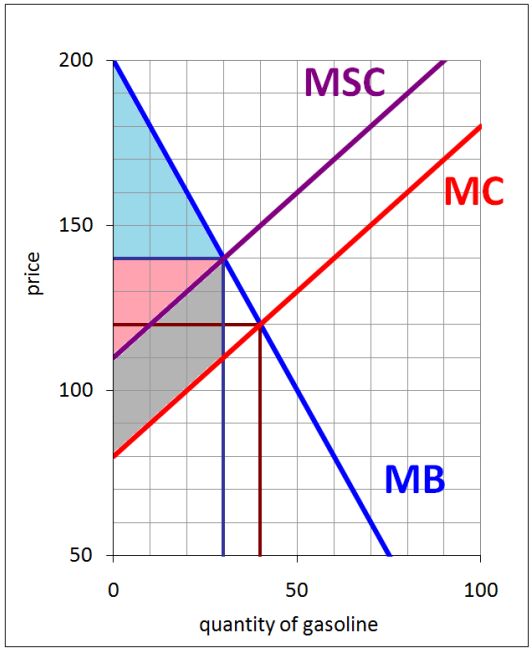



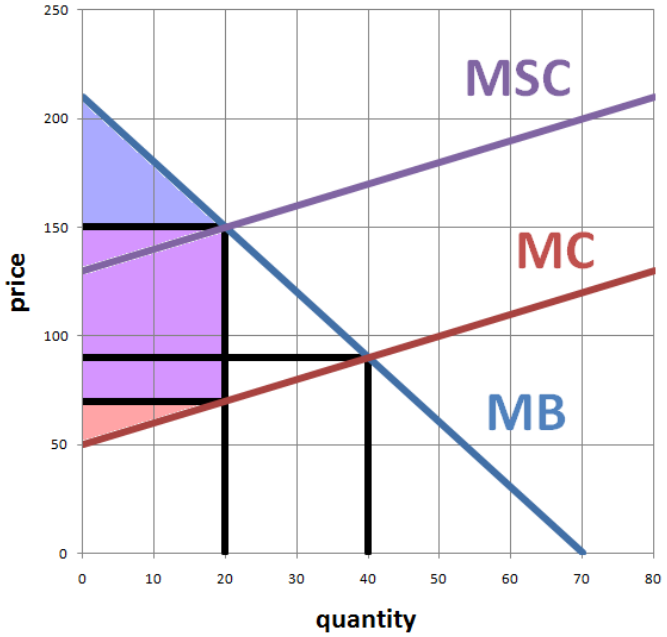

**social optimum**

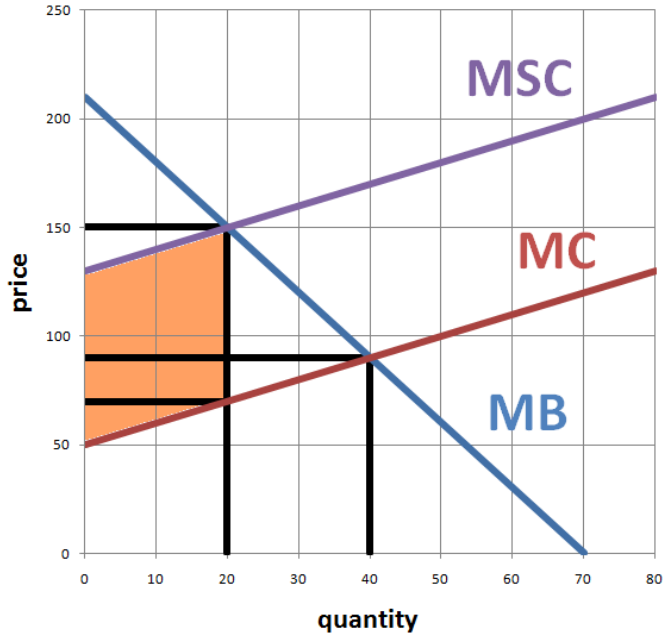


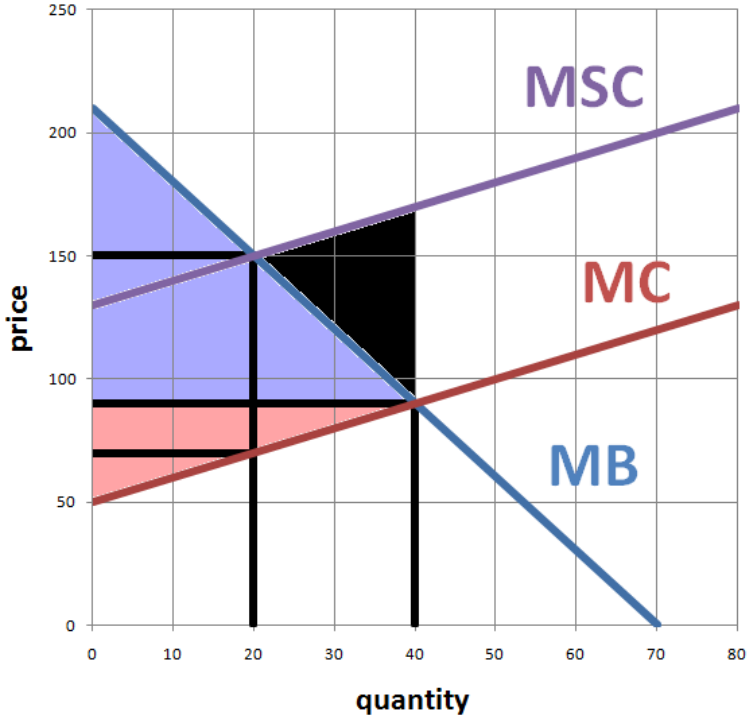



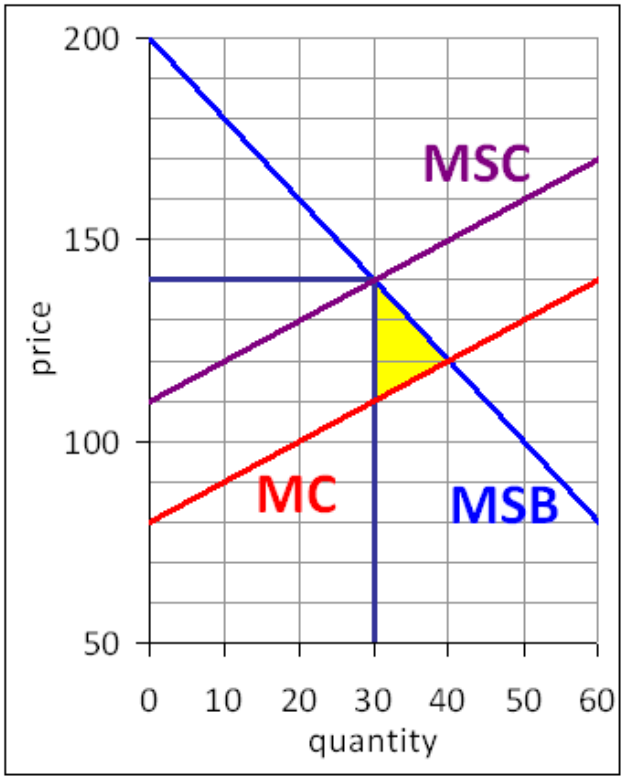
# ANOTHER EXAMPLE

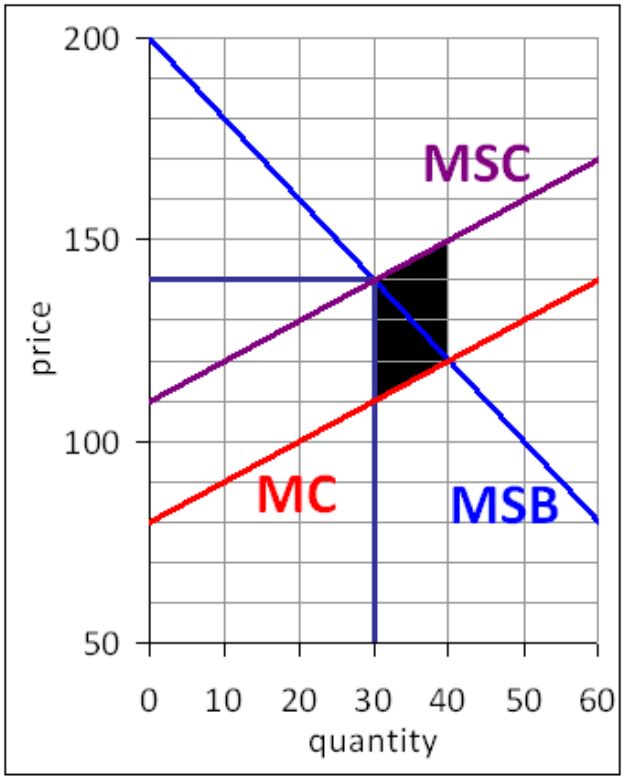


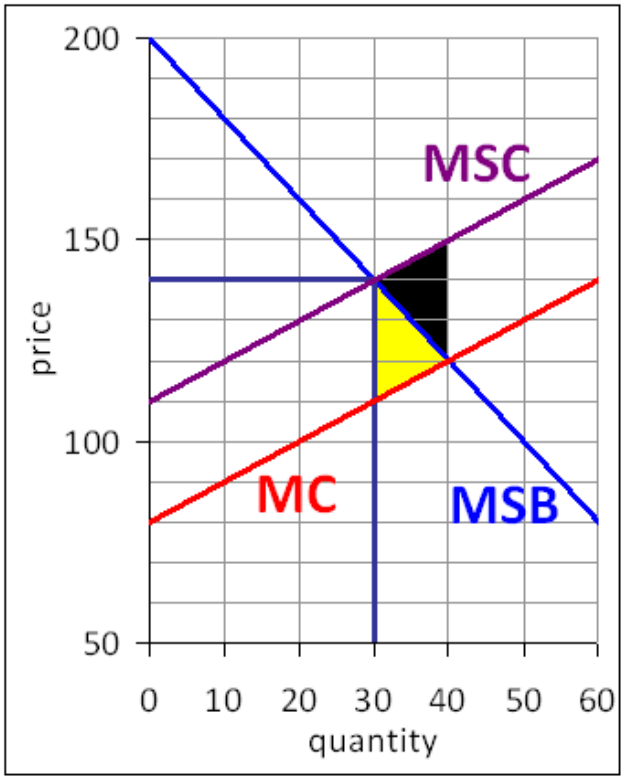



# COST AND BENEFIT OF REGULATION

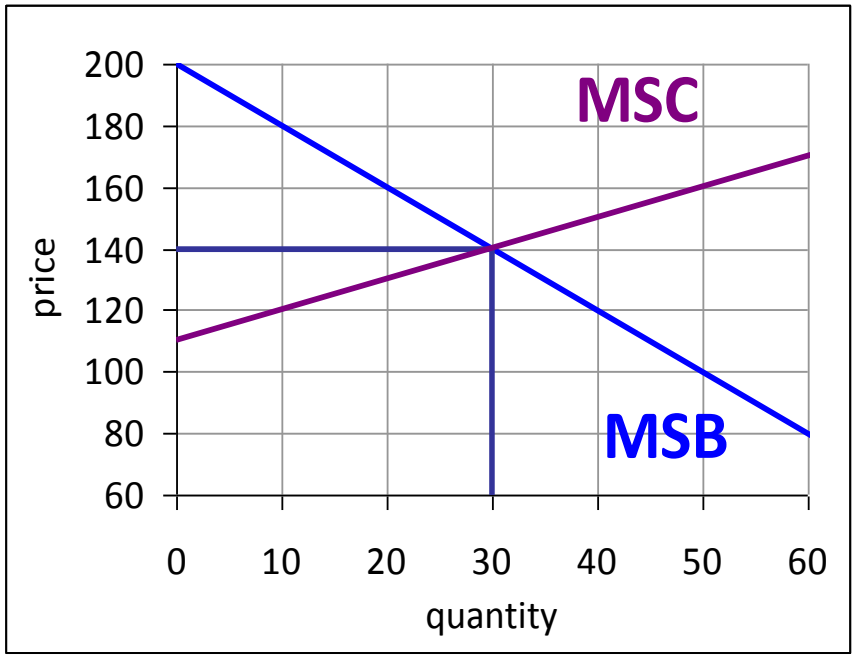


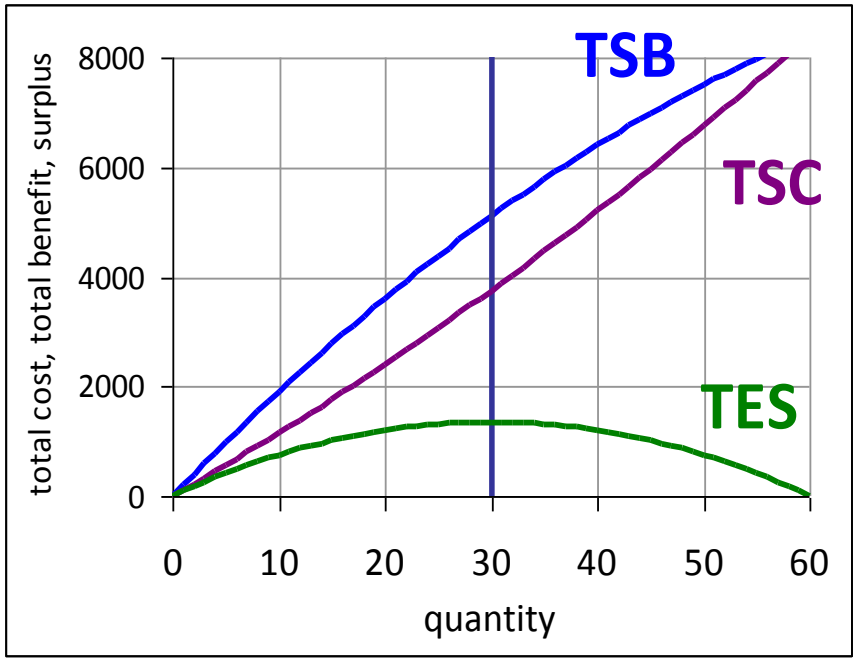




**The yellow area gives the loss in terms of consumer and producer surplus associated with reducing the quantity from $Q^*$ to $Q^o$. The black parallelogram gives the gain in terms of reducing external cost. The black triangle gives the difference between these values.**

# CHOOSING QUANTITY TO MAXIMIZE SOCIAL WELFARE




**Marginal social benefit**
**MSB = α – βQ**

**Total social benefit**
**TSB = αQ – .5βQ²**

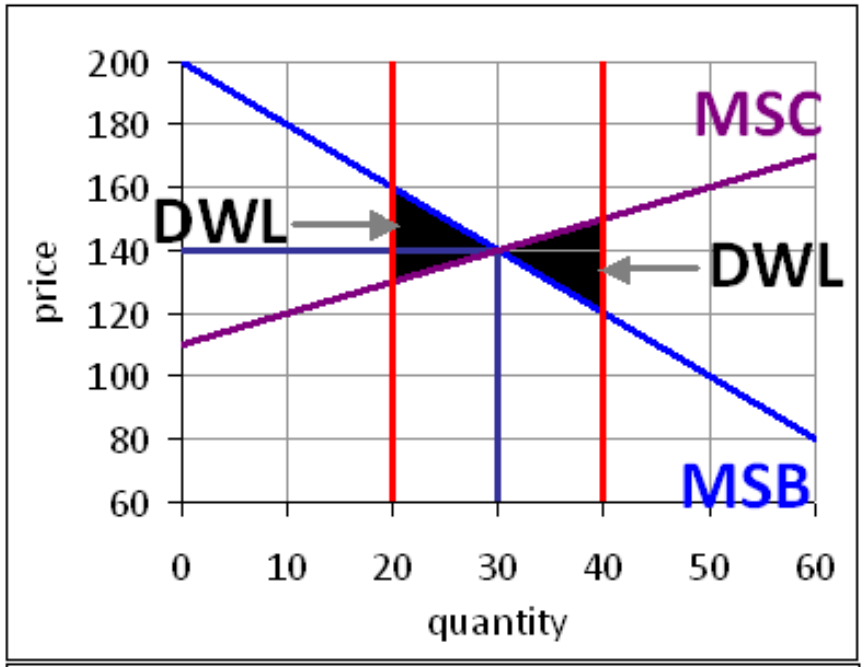
**Marginal social cost**
**MSC = γ + δ**

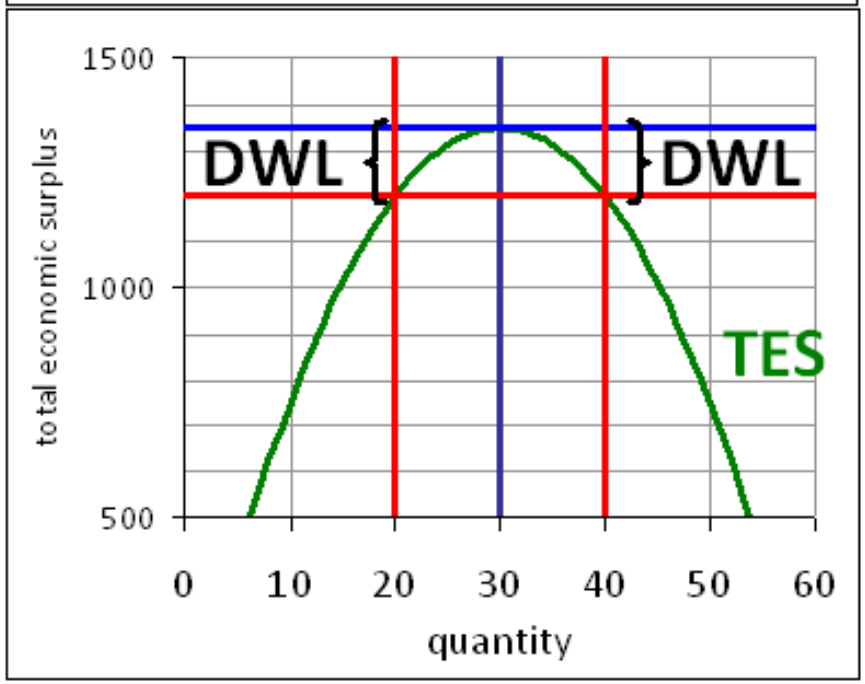
**Total social cost**
**TSC = γQ + .5δQ²**

**Total economic surplus**
**TES = TSB – TSC**
**TES = (α–γ)Q – .5(β+δ)Q²**

**Total surplus is maximized at Q°, where MSB = MSC.**

# OPTIMAL QUANTITY AND DEADWEIGHT LOSS



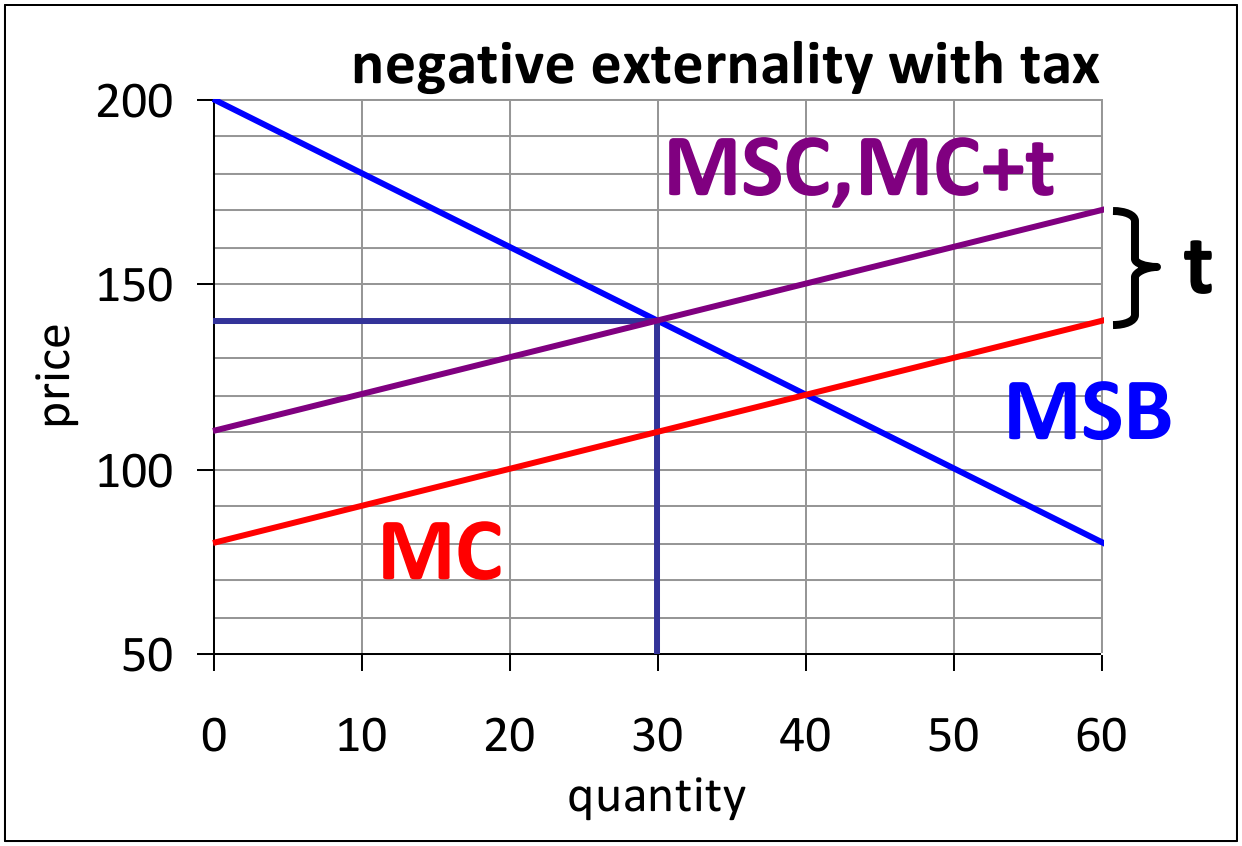




**Total surplus is maximized at Q°, where MSB = MSC.**

**As you get further from the optimal quantity in either direction, deadweight loss increases.**

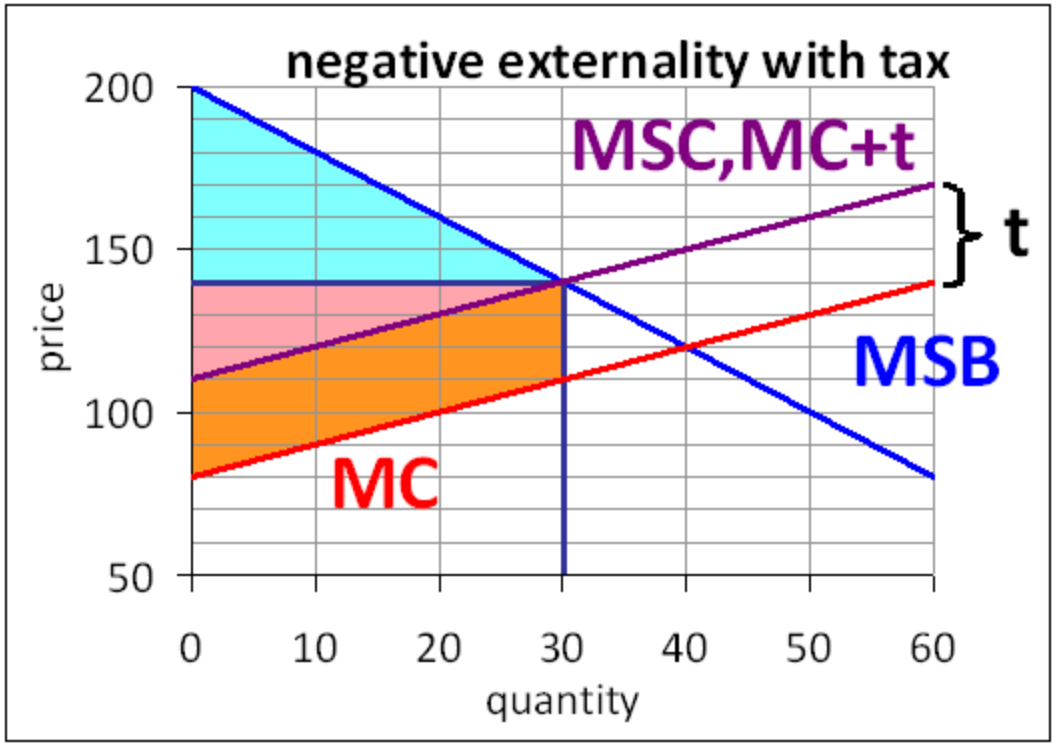
**The deadweight loss at Q is the distance between TES(Q) and the maximum value of TES (shown below), or the area between Q, Q°, the MSC curve, and the MSB curve (shown above).**

# NEGATIVE EXTERNALITY WITH TAX




**If part of the cost is external, then the private MC curve will be below the social MC curve, but adding precisely the right tax can shift it back up, and restore efficiency.**

# NEGATIVE EXTERNALITY WITH TAX




**The blue and pink triangles (consumer and producer surplus) together represent the total amount of economic surplus generated by the market.**

**The orange parallelogram represents both the cost of the externality and the revenue received by the government; these approximately cancel out to a zero net welfare effect.**

# CHOOSING QUANTITY TO MAXIMIZE SOCIAL WELFARE

The social objective function is

$$TSB(Q) - TSC(Q)$$

(Total social benefit minus total social cost.) Maximizing this function under standard conditions implies

$$MSB(Q) = MSC(Q)$$

If MSB(Q) = MB(Q), and MSC(Q) = MC(Q) + MEC(Q), then this condition becomes

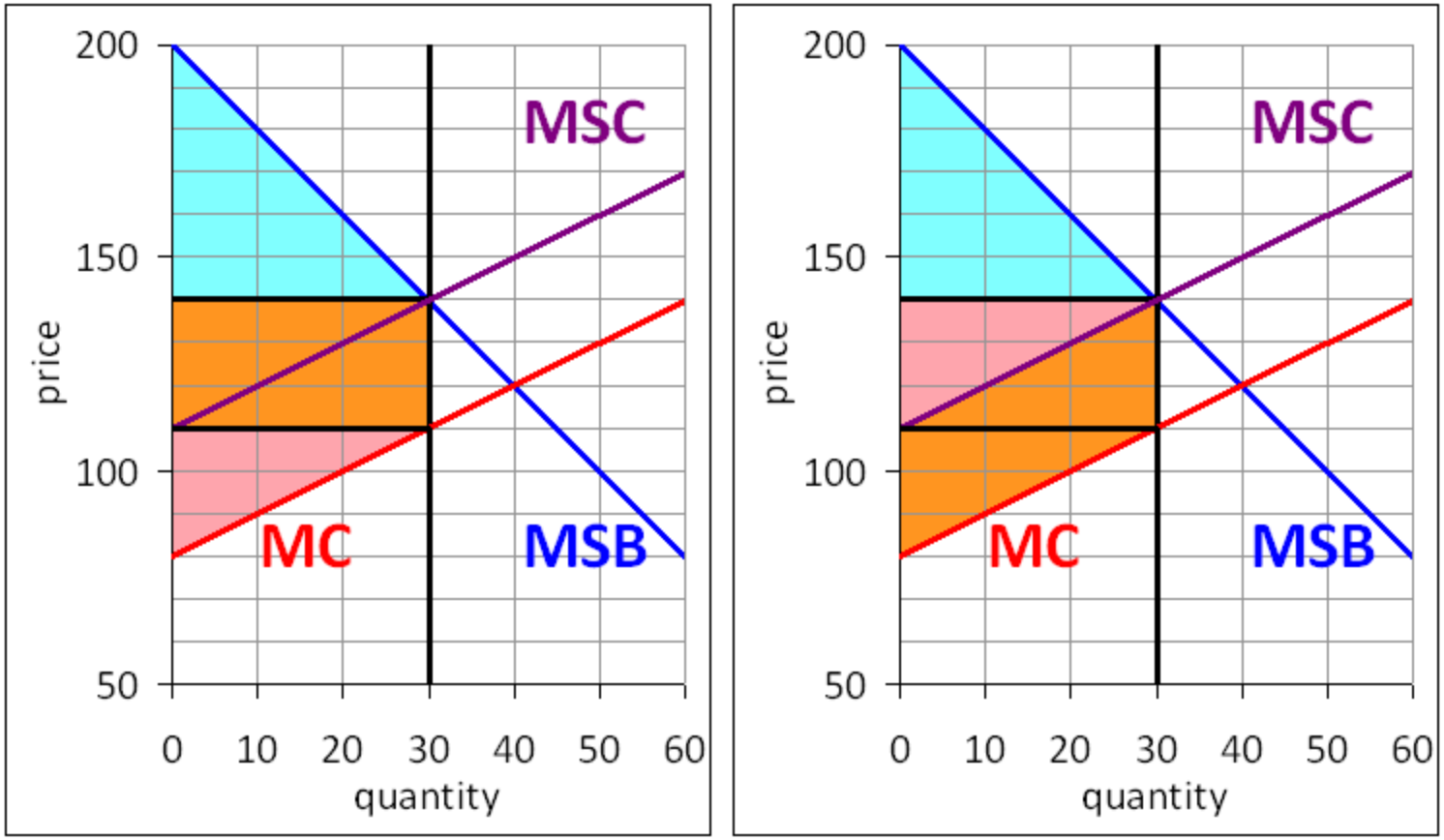
$$MB(Q) = MC(Q) + MEC(Q)$$

Given a per unit tax $\tau(Q)$, the market equilibrium quantity is given by

$$MB(Q) = MC(Q) + \tau(Q)$$

Therefore, charging $\tau(Q) = MEC(Q)$ makes the market equilibrium condition equivalent to the Pareto optimal condition, internalizing the externality and restoring efficiency.

# CAP AND TRADE




**Instead of imposing a per-unit tax on pollution, the government can limit the total amount of pollution, and then either auction or distribute permits that are required to legally create a certain amount of pollution. If it's an auction, the orange area is government revenue; if the permits are given to firms, it is producer surplus.**

**QUESTION 1 (negative externality: market equilibrium)**

**marginal private benefit function: MB = 400 – 5Q**

**marginal private cost function: MC = 100 + Q**

**marginal external cost: MEC = 60**

**Once again, we have the market for gasoline, which produces a negative externality of $60 per unit. If neither buyers nor sellers of gasoline are required to pay for this external cost, then what is the quantity of gasoline produced and consumed in market equilibrium?**

**A) 60**
**B) 55**
**C) 50**
**D) 45**
**E) 40**

## answer to question 1

**marginal private benefit function: MB = 400 – 5Q**

**marginal private cost function: MC = 100 + Q**

**marginal external cost: MEC = 60**

**Once again, we have the market for gasoline, which produces a negative externality of $60 per unit. If neither buyers nor sellers of gasoline are required to pay for this external cost, then what is the quantity of gasoline produced and consumed in market equilibrium?**

A) 60
B) 55
**C) 50**
D) 45
E) 40

$$MB = MC \rightarrow 400 - 5Q = 100 + Q$$

$$\rightarrow 6Q = 300 \rightarrow Q = 50$$

# QUESTION 2 (optimal pollution cap)

**marginal private benefit function: MB = 400 – 5Q**

**marginal private cost function: MC = 100 + Q**

**marginal external cost: MEC = 60**

**If you were asked to recommend a pollution cap (maximum quantity) for a cap and trade program to maximize total economic surplus, what cap would you recommend?**

**A) none**
**B) Q = 45**
**C) Q = 40**
**D) Q = 35**
**E) Q = 30**

# answer to question 2

**marginal private benefit function: MB = 400 – 5Q**

**marginal private cost function: MC = 100 + Q**

**marginal external cost: MEC = 60**

**If you were asked to recommend a pollution cap (maximum quantity) for a cap and trade program to maximize total economic surplus, what cap would you recommend?**

A) none
B) Q = 45
**C) Q = 40**
D) Q = 35
E) Q = 30

$$MB = MSC \rightarrow 400 - 5Q = 160 + Q$$

$$\rightarrow 6Q = 240 \rightarrow Q = 40$$

# QUESTION 3 (optimal pollution tax)

**marginal private benefit function: MB = 400 – 5Q**

**marginal private cost function: MC = 100 + Q**

**marginal external cost: MEC = 60**

**If, instead of a pollution cap, you were asked to recommend a per-unit pollution tax (again, to maximize total economic surplus), what tax would you recommend?**

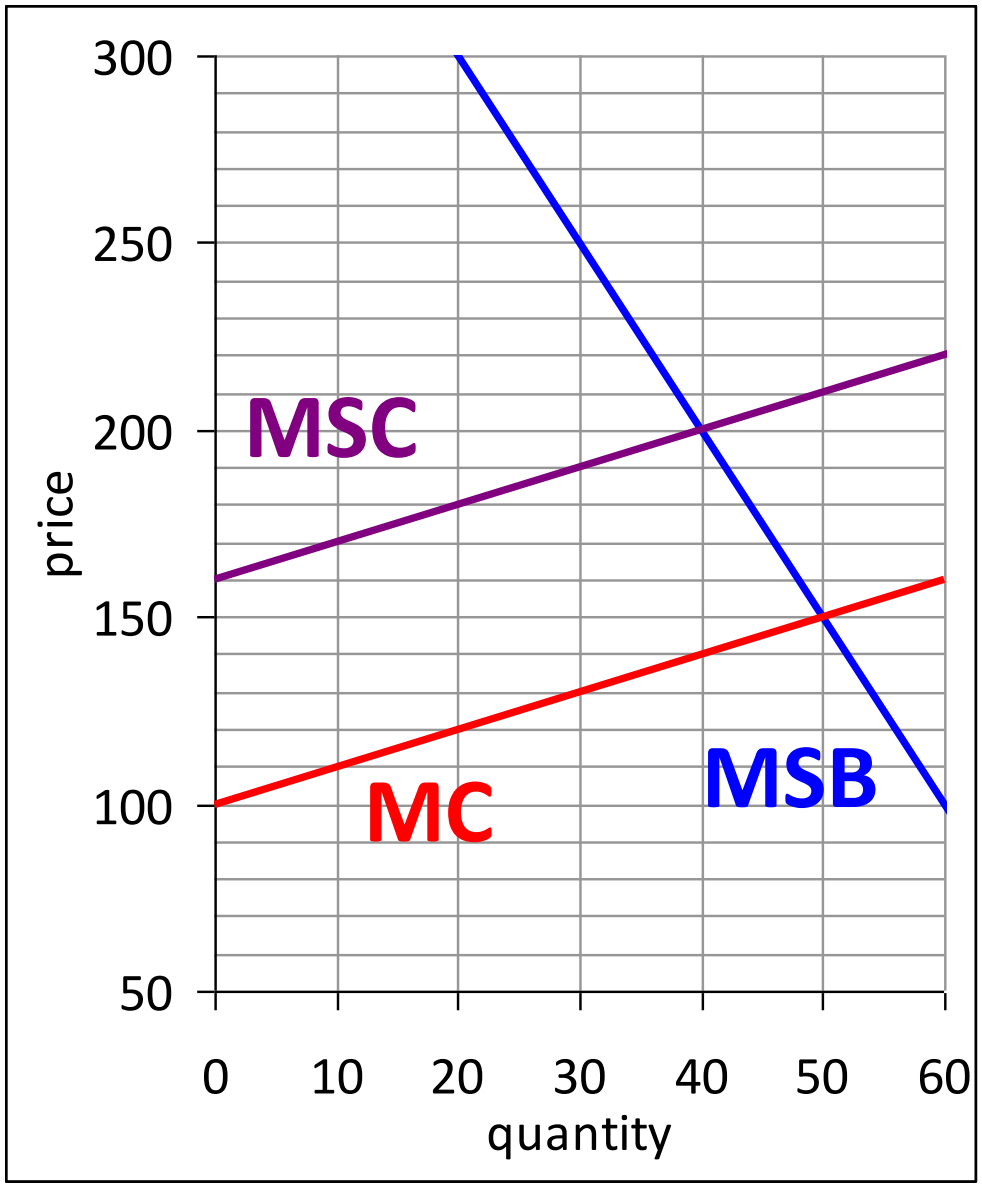
**A) $0**
**B) $50**
**C) $40**
**D) $100**
**E) $60**

# answer to question 3

**MB = 400 – 5Q**

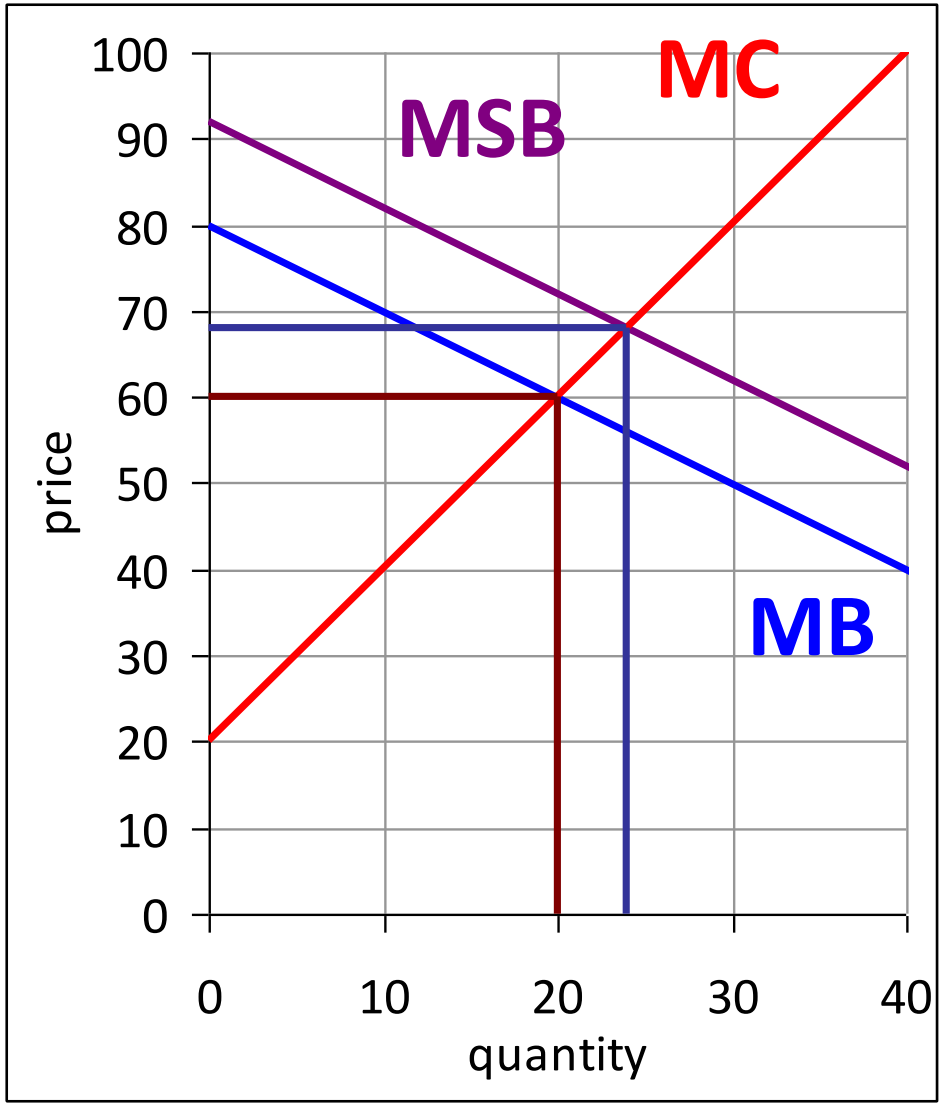
**MC = 100 + Q**

**MEC = 60**




A) $0
B) $50
C) $40
D) $100
**E) $60**

# POSITIVE EXTERNALITY: GRAPH



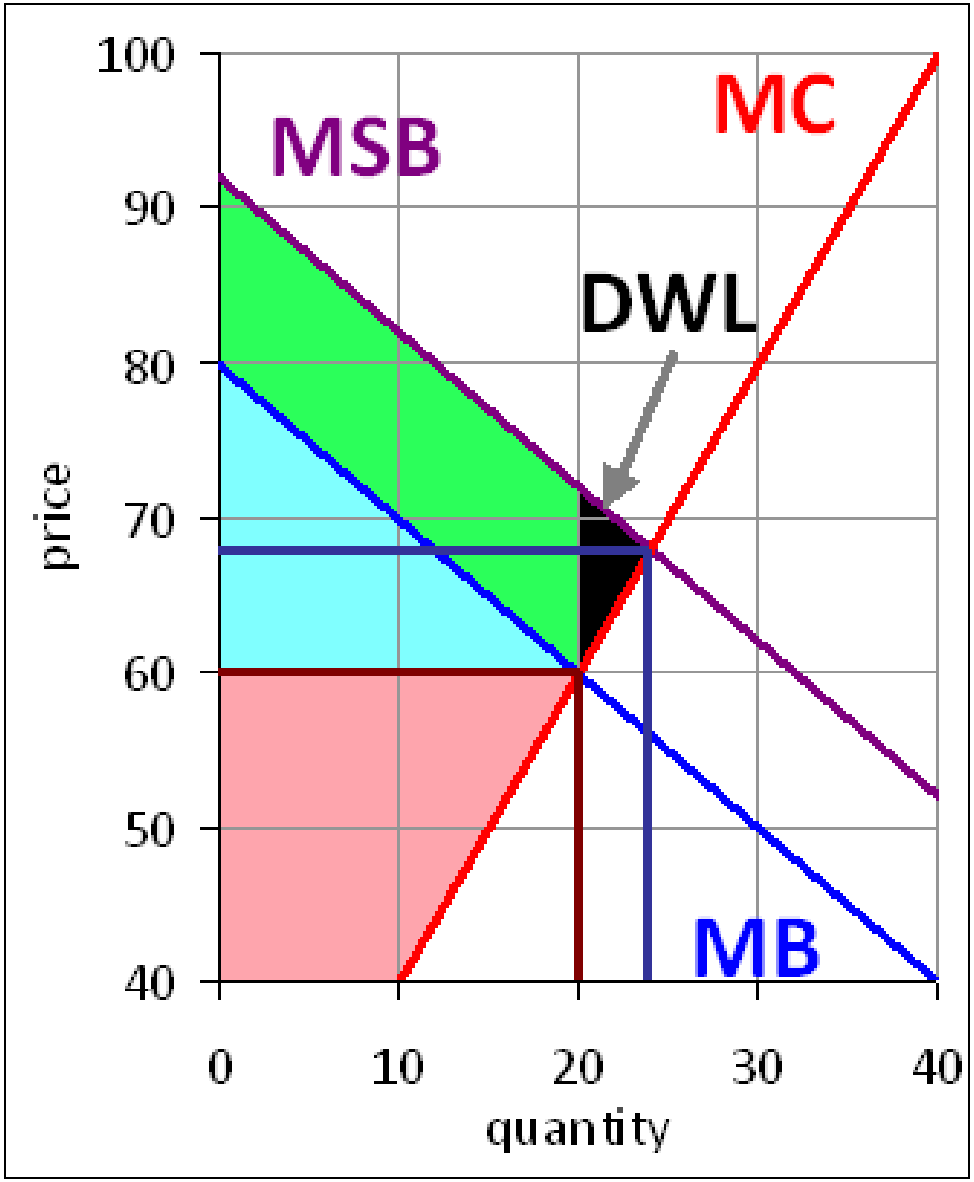

**marginal private benefit**
**MB = 80 – Q**

**marginal external benefit**
**MEB = 12**

**marginal social benefit**
**(private + external)**
**MSB = 92 – Q**

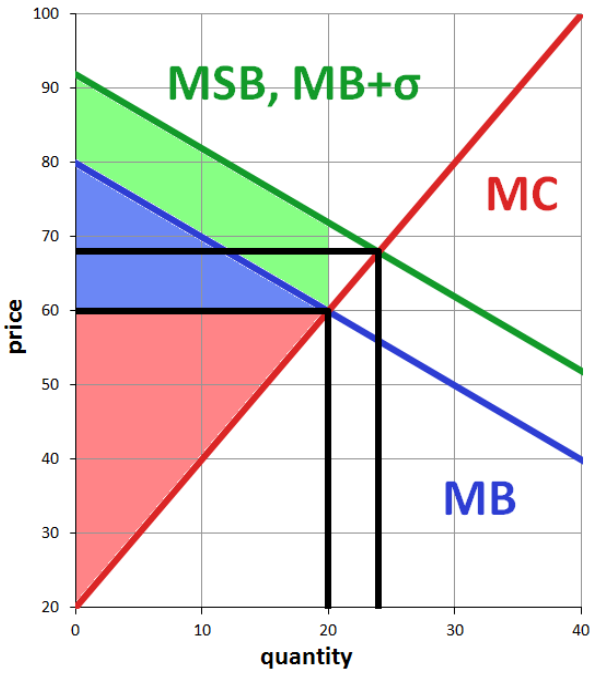
**marginal private cost**
**MC = 20 + 2Q**

# POSITIVE EXTERNALITY: UNREGULATED

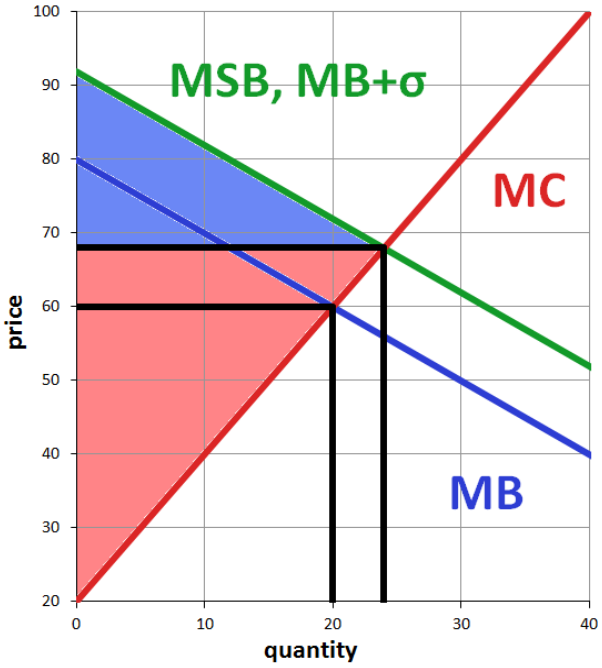



**The blue and pink areas are consumer and producer surplus. The green area is external benefit. The black area is deadweight loss from not increasing provision of the good to its socially optimal level.**

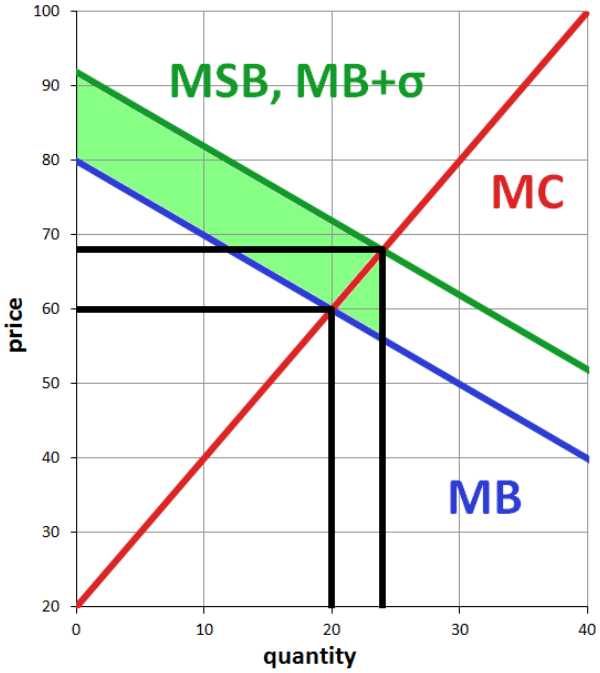
# POSITIVE EXTERNALITY WITH SUBSIDY




w/o subsidy




w/ subsidy: PS&CS




w/ subsidy: EB & –G

**The blue and pink areas are consumer and producer surplus. The green area is external benefit. In the third graph, it is both external benefit and revenue lost by the government, which cancel each other out.**

# QUESTION 4 (market equilibrium quantity)

**marginal private benefit: MB = 100 – Q**

**marginal external benefit: MEB = 20**

**marginal private cost: MC = 20 + Q**

**If neither buyers nor sellers are compensated directly for the external benefits that they provide to others, then what is the market equilibrium quantity?**

**A) 20**

**B) 25**

**C) 30**

**D) 35**

**E) 40**

# answer to question 4

**marginal private benefit: MB = 100 – Q**

**marginal external benefit: MEB = 20**

**marginal private cost: MC = 20 + Q**

**If neither buyers nor sellers are compensated directly for the external benefits that they provide to others, then what is the market equilibrium quantity?**

**A) 20**

**B) 25**

**C) 30**

**D) 35**

**E) 40**

# QUESTION 5 (socially optimal quantity)

**marginal private benefit: MB = 100 – Q**

**marginal external benefit: MEB = 20**

**marginal private cost: MC = 20 + Q**

**What quantity maximizes total economic surplus?**

**A) 10**

**B) 20**

**C) 30**

**D) 40**

**E) 50**

# answer to question 5

**marginal private benefit: MB = 100 – Q**

**marginal external benefit: MEB = 20**

**marginal private cost: MC = 20 + Q**

**What quantity maximizes total economic surplus?**

A) 10

B) 20

C) 30

D) 40

**E) 50**

# QUESTION 6 (optimal subsidy)

**marginal private benefit: MB = 100 – Q**

**marginal external benefit: MEB = 20**

**marginal private cost: MC = 20 + Q**

**Suppose that consumers receive a subsidy of $σ for each unit of the good they buy. What value of σ will cause the market to settle on the socially optimal quantity?**

**A) 100 B) 20 C) 1**
**D) 40 E) 0**

# answer to question 6

**marginal private benefit: MB = 100 – Q**

**marginal external benefit: MEB = 20**

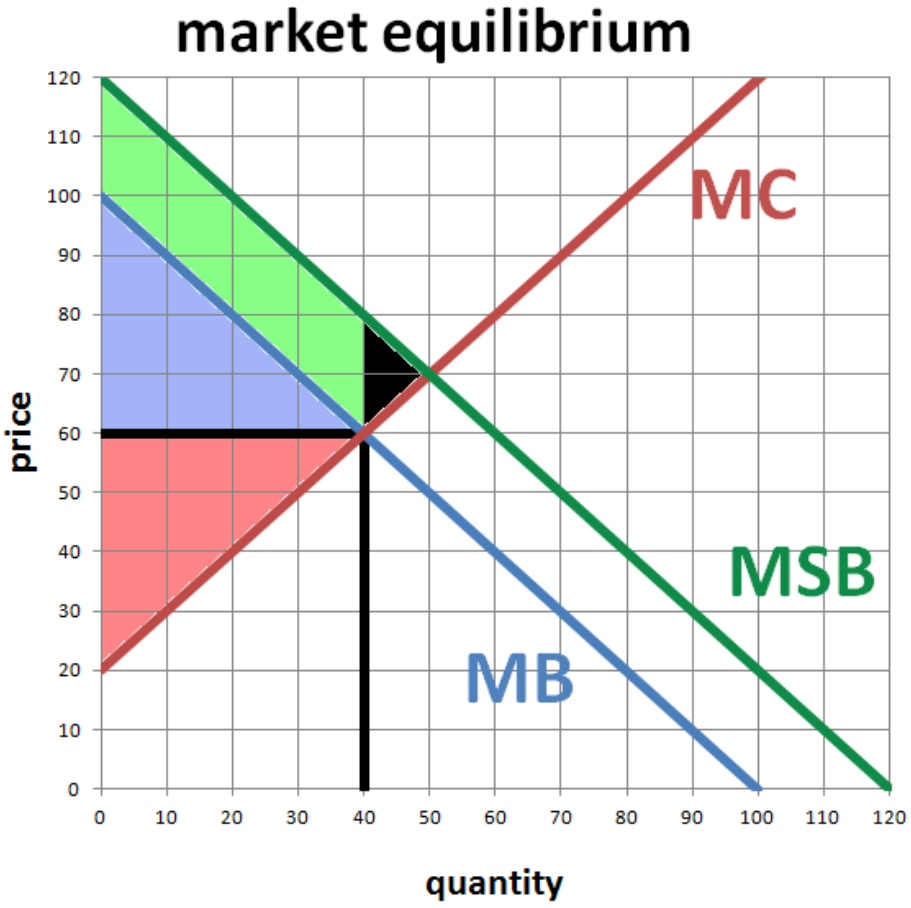
**marginal private cost: MC = 20 + Q**

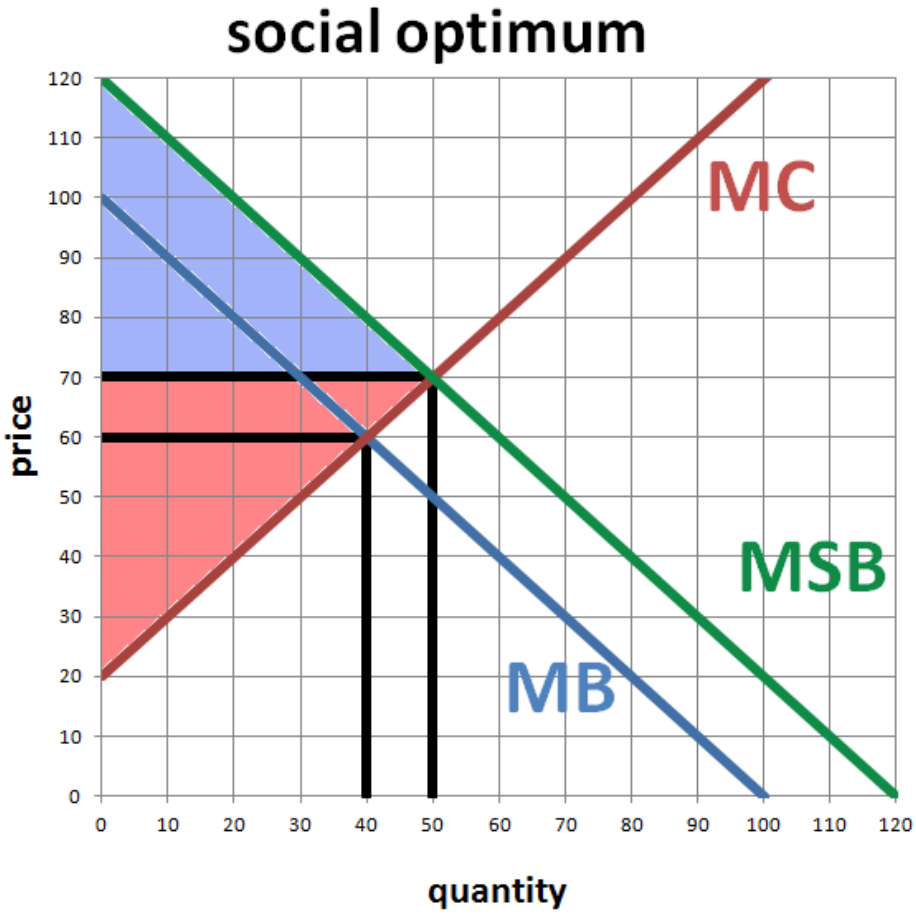
**Suppose that consumers receive a subsidy of $σ for each unit of the good they buy. What value of σ will cause the market to settle on the socially optimal quantity?**

A) 100 **B) 20** C) 1

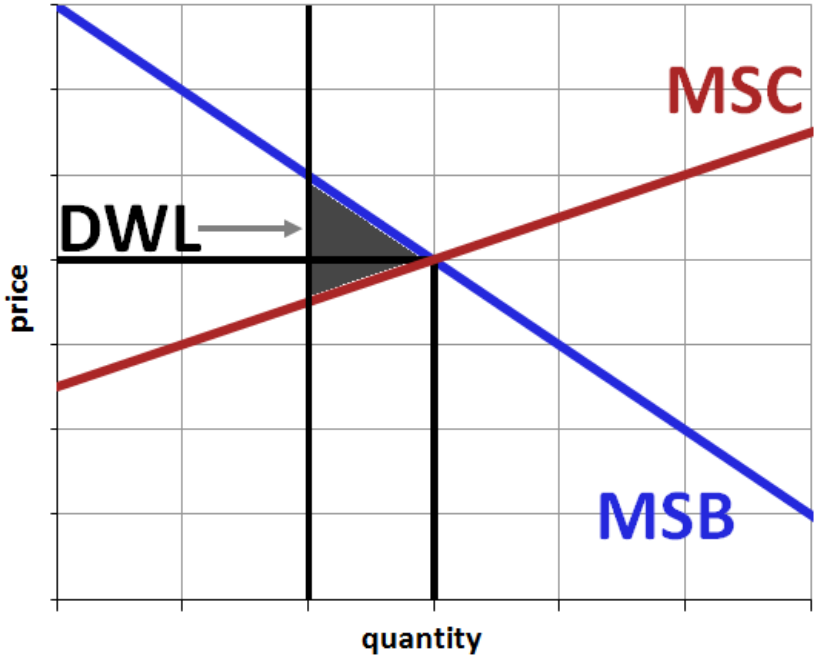
D) 40 E) 0

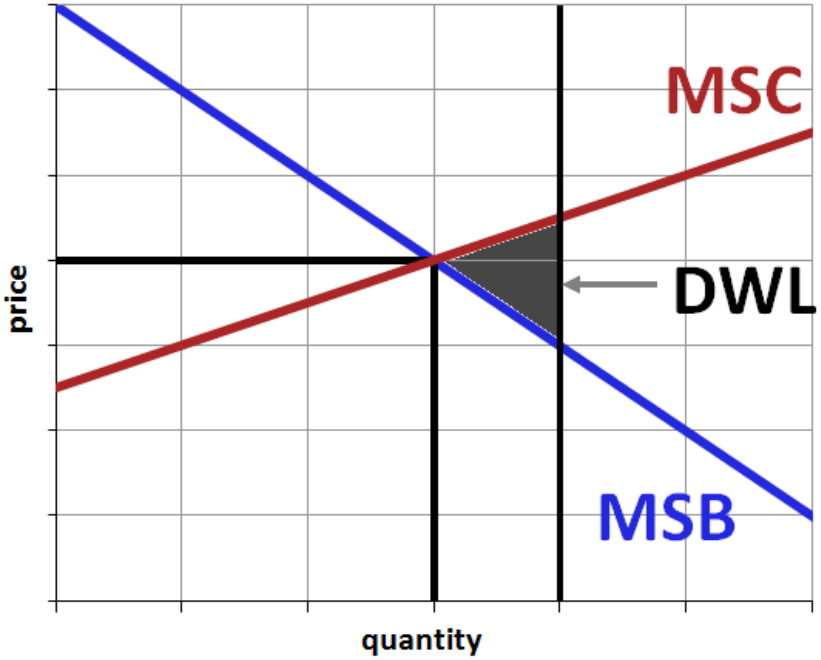
# graphs for questions 4-6



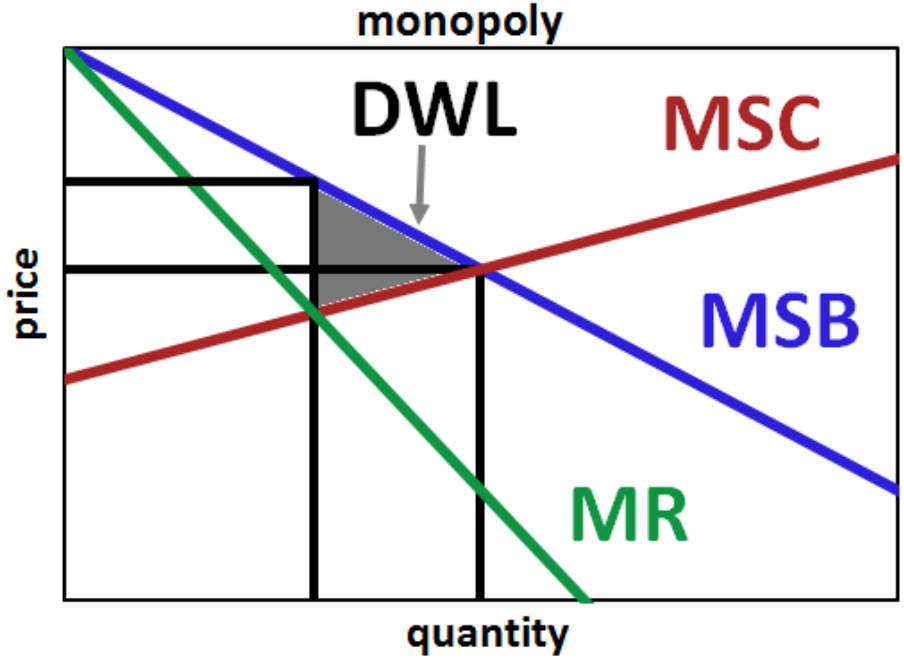
# REASONS WHY OPTIMUM MIGHT NOT BE REACHED

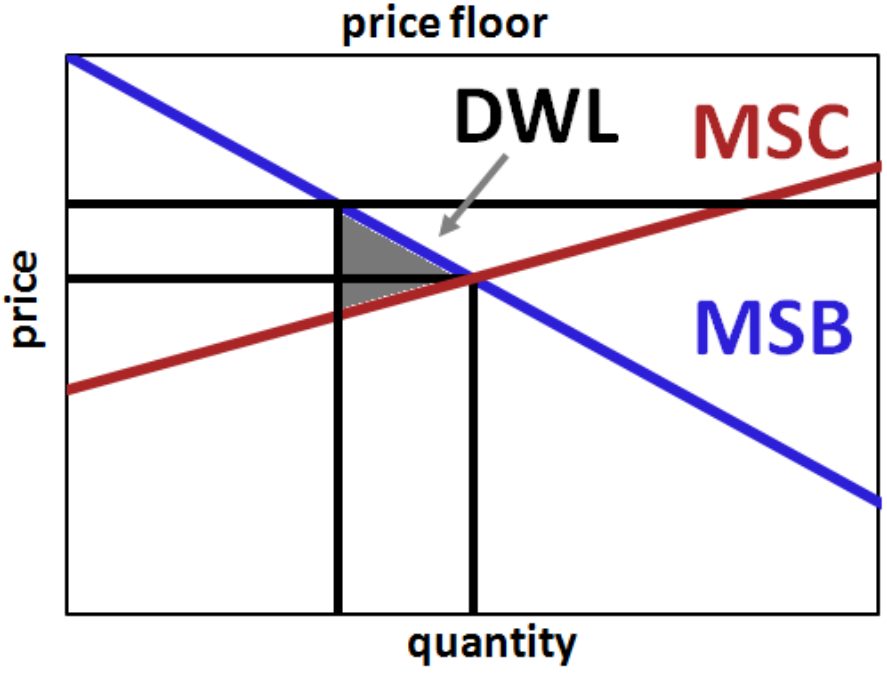


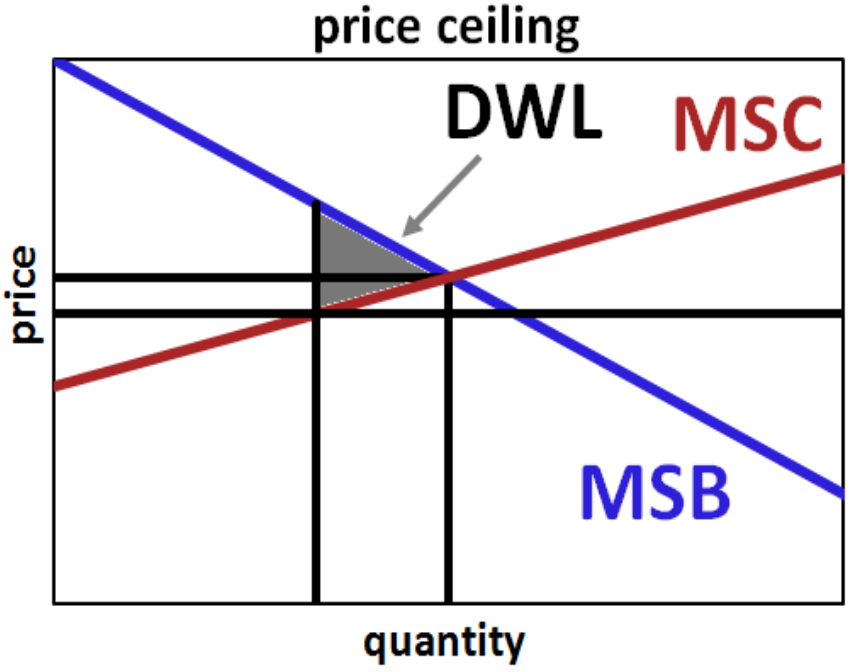




| quantity tends to be below optimum | quantity tends to be above optimum |
| --- | --- |
| positive externality | negative externality |
| tax | subsidy |
| monopoly (any market power) | |
| price control (floor, ceiling) | |
| public good | |

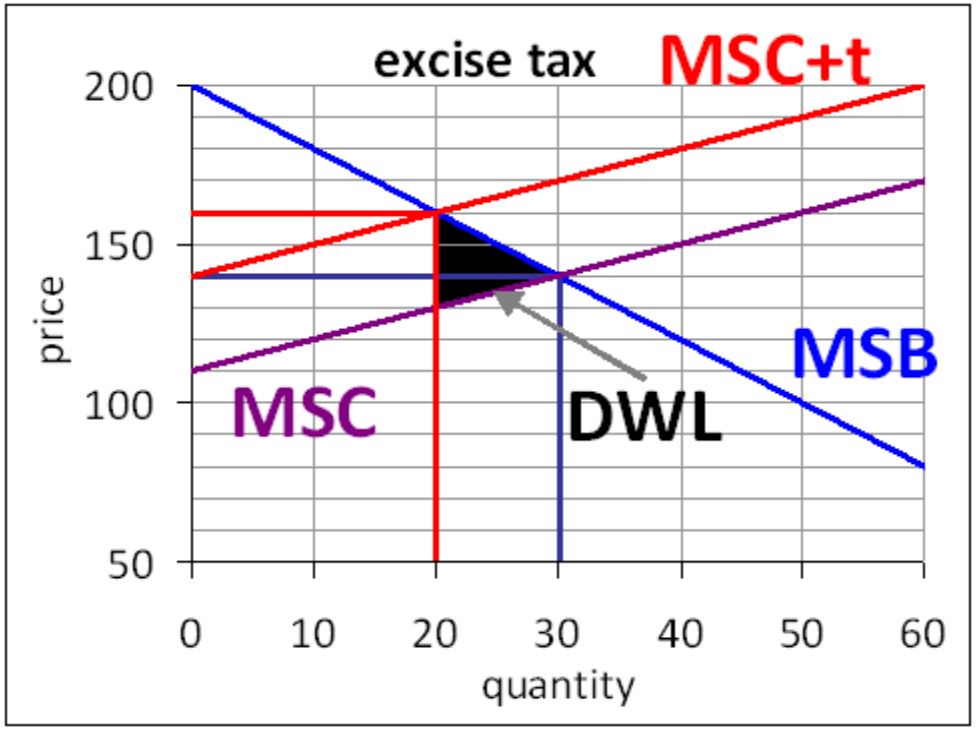
# BELOW-OPTIMUM QUANTITIES

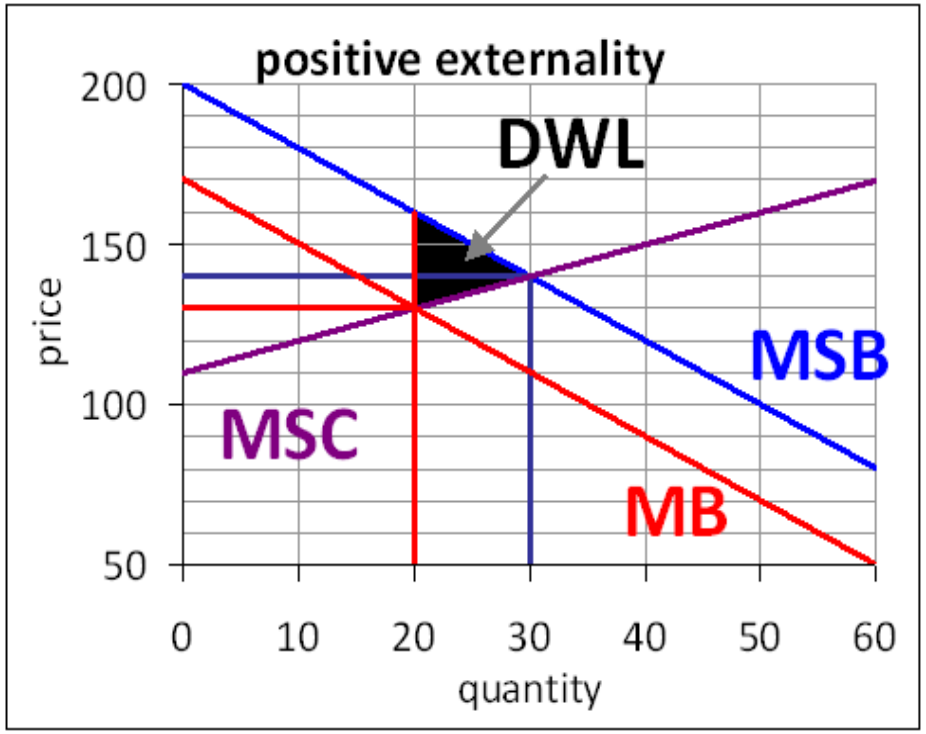


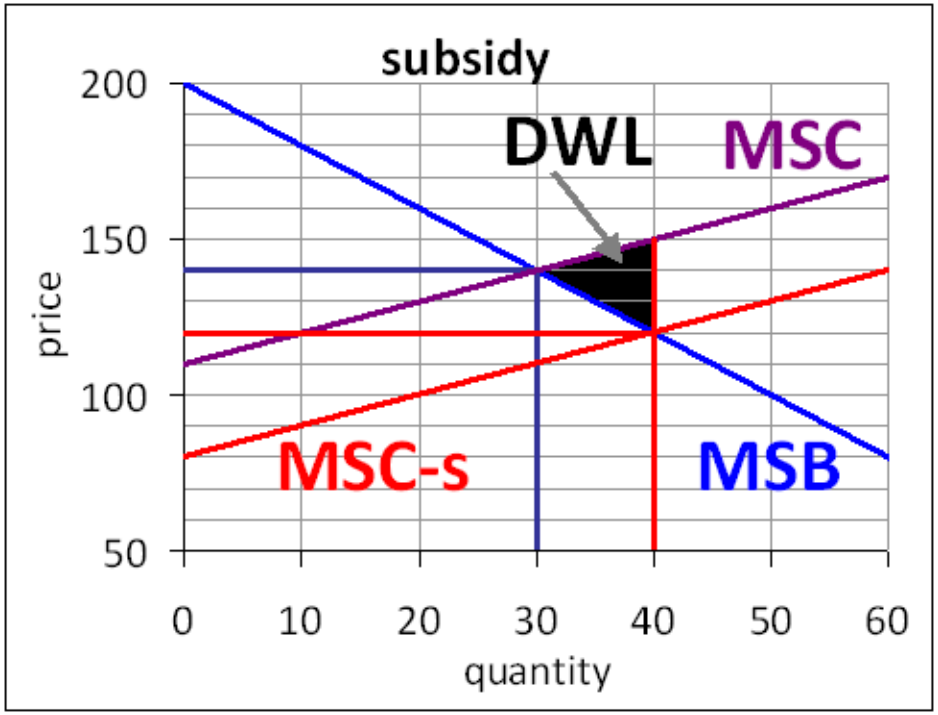



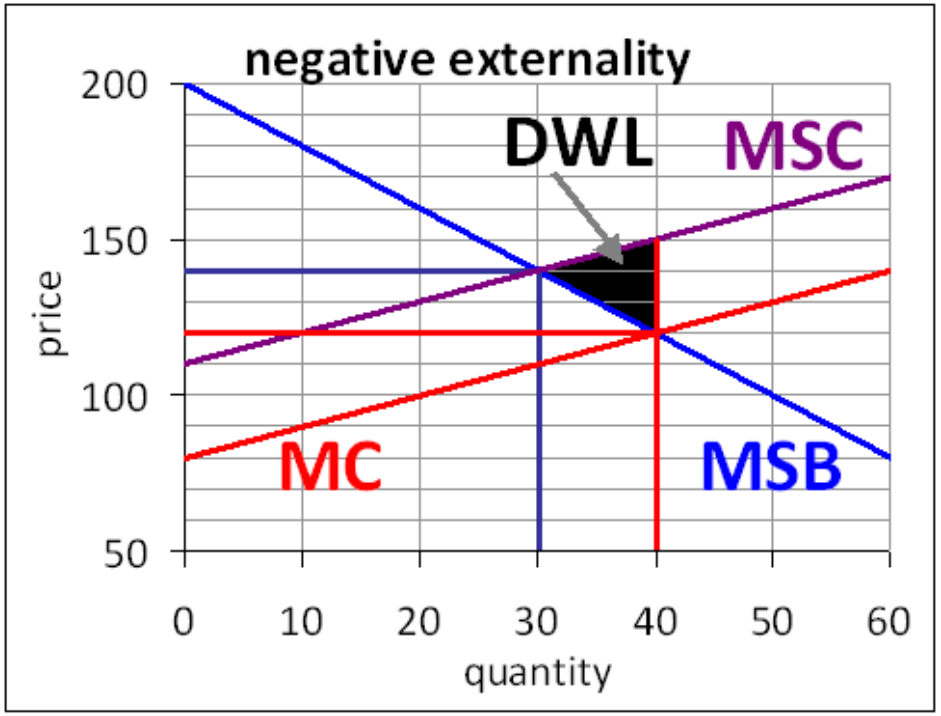
# BELOW-OPTIMUM QUANTITIES



# ABOVE-OPTIMUM QUANTITIES



# QUESTION 6

**Fill in the blanks, assuming that the market was efficient to begin with.**

**When firms exercise monopoly power, then the equilibrium quantity tends to be _____ the optimum quantity;**

**When there is a negative externality, then the equilibrium quantity tends to be _____ the optimum quantity.**

**A) above; above**

**B) above; below**

**C) below; above**

**D) below; below**

# answer to question 6

**Fill in the blanks, assuming that the market was efficient to begin with.**

**When firms exercise monopoly power, then the equilibrium quantity tends to be _____ the optimum quantity;**

**When there is a negative externality, then the equilibrium quantity tends to be _____ the optimum quantity.**

A) above; above

B) above; below

**C) below; above**

D) below; below

# QUESTION 7

**Fill in the blanks, assuming that the market was efficient to begin with.**

**When a binding price ceiling is imposed, then the equilibrium quantity tends to be _____ the optimum quantity;**

**When there is a positive externality, then the equilibrium quantity tends to be _____ the optimum quantity.**

**A) above; above**

**B) above; below**

**C) below; above**

**D) below; below**

# answer to question 7

**Fill in the blanks, assuming that the market was efficient to begin with.**

**When a binding price ceiling is imposed, then the equilibrium quantity tends to be _____ the optimum quantity;**

**When there is a positive externality, then the equilibrium quantity tends to be _____ the optimum quantity.**

**A) above; above**

**B) above; below**

**C) below; above**

**D) below; below**