An externality in an unregulated market leads to inefficiency and creates a deadweight loss. Chapter 9 explains the role of the government in markets where an externality is present and how government intervention can result in an efficient level of production.

1. Explain why negative externalities lead to inefficient overproduction and how property rights, pollution charges, and taxes can achieve a more efficient outcome.

Marginal private cost is the cost of producing an additional unit of a good or service that is borne by the producer of that good or service. Marginal external cost is the cost of producing an additional unit of a good or service that falls on people other than the producer. And marginal social cost, which is the marginal cost incurred by the entire society, is the sum of marginal private cost and marginal external cost. Producers take account only of marginal private cost and overproduce when there is a marginal external cost. Sometimes it is possible to reduce the inefficiency arising from an externality by establishing a property right where one does not currently exist. The Coase theorem is the proposition that if property rights exist, only a small number of parties are involved, and transactions costs are low, then private transactions are efficient and the outcome is not affected by who is assigned the property right. When property rights cannot be assigned, the three main methods that governments can use to cope with externalities are emission charges (which set a price per unit of pollution that a firm must pay), marketable permits (each firm is issued permits that allow a certain amount of pollution and firms can buy and sell the permits), and taxes (the government imposes a tax equal to the marginal external cost).

2. Explain why positive externalities lead to inefficient underproduction and how public provision, subsidies, vouchers, and patents can achieve a more efficient outcome.

Marginal private benefit is the benefit from an additional unit of a good or service that the consumer of that good or service receives. Marginal external benefit is the benefit from an additional unit of a good or service that people other than the consumer of the good or service enjoy. And marginal social benefit, which is the marginal benefit enjoyed by society, is the sum of marginal private benefit and marginal external benefit. External benefits from education arise because better-educated people are better citizens, commit fewer crimes, and support social activities. External benefits from research arise because once someone has worked out a basic idea, others can copy it. When people make decisions about how much schooling to obtain, they neglect its external benefit. The result is that if education were provided only by private schools that charged full-cost tuition, we would produce too few graduates. Four devices that governments can use to overcome the inefficiency created by external benefits are public provision, private subsidies, vouchers, and patents and copyrights.
CHECKPOINT 10.1

1. Explain why negative externalities lead to inefficient overproduction and how property rights, pollution charges, and taxes can achieve a more efficient outcome.

Quick Review

- Marginal external cost: The cost of producing an additional unit of a good or service that falls on people other than the producer.
- Efficiency: Efficiency is achieved when the marginal social benefit equals the marginal social cost.
- Coase theorem: If property rights exist, only a small number of parties are involved, and transactions costs are low, then private transactions are efficient and the outcome is not affected by who is assigned the property right.

Additional Practice Problems 10.1

1. The figure illustrates the unregulated market for paper. When the factories produce paper, they also create air pollution. The cost of the pollution is $1,500 per ton. The pollution is a marginal external cost.

   a. What is the quantity of paper produced in an unregulated market? What is the price of a ton of paper?
   b. Draw the marginal social cost curve in the figure. What is the efficient quantity of paper to produce?
   c. If the government imposed a tax on the firms, what must the tax equal to have the efficient quantity of paper produced? With this tax imposed, what is the equilibrium price of a ton of paper?

2. Two factories each emit 10 tons of the pollutant sulfur dioxide a week. The cost to eliminate a ton of sulfur dioxide to Factory A is $4 and to Factory B is $2. The government wants to eliminate 10 tons of sulfur dioxide a week.

   a. If the government requires that Firm A decrease emissions by 10 tons a week, what is the cost of eliminating the pollution?
   b. If the government requires that Firm B decrease emissions by 10 tons a week, what is the cost of the eliminating the pollution?
   c. If the government gives each firm 5 marketable permits, each good for 1 ton of pollution, what will occur?

Solutions to Additional Practice Problems 10.1

1a. The equilibrium is determined by the intersection of the demand and supply curves. So the equilibrium quantity is 4 tons of paper per week and the equilibrium price is $2,000 per ton.

1b. The figure shows the marginal social cost curve, labeled MSC. At 1 ton of paper this curve lies $1,500 above the supply curve; at 2 tons of paper it lies $3,000 above the supply curve; and so on. The efficient quantity is where the marginal social cost equals the marginal benefit, which the figure shows is 2 tons of paper.

1c. To lead to efficiency, the tax must equal the marginal external cost. So the tax should be $1,500 per ton. At the efficient quantity of 2 tons, the tax is $3,000. With this tax, the equilibrium price is $4,000 per ton of paper.

2a. The cost for Firm A to decrease emissions is $4 a ton multiplied by 10 tons, which is $40 a week.

2b. The cost for Firm B to decrease emissions is $2 a ton multiplied by 10 tons, which is $20 a week.
2c. Firm A is willing to buy permits from Firm B for any price less than $4 per permit; Firm B is willing to sell permits to Firm A for any price greater than $2 per permit. The two companies will settle on a price and Firm A will buy 5 permits from Firm B. Only Firm B will decrease its pollution and incur a cost of $20 a week.

**Self Test 10.1**

**Fill in the blanks**

Marginal social cost equals marginal private cost ____ (minus; plus) marginal external cost. A pollution externality creates an ____ (efficient; inefficient) equilibrium. According to the Coase theorem, if property rights exist, then private transactions are efficient and the outcome ____ (is; is not) affected by who is assigned the property right. By setting the tax rate equal to the marginal ____ (external; private; social) cost, firms can be made to behave in the same way as they would if they bore the cost of the externality directly.

**True or false**

1. All externalities are negative.
2. Smoking on a plane creates a negative externality.
3. Marginal social cost equals marginal private cost minus marginal external cost.
4. Copper mining creates land pollution. If the copper mining industry is unregulated, then the quantity of copper mined is less than the efficient quantity.
5. The Coase theorem concludes that if property rights to a polluted river are assigned to the polluter, the quantity of pollution will increase.
6. Emission charges allow the government to set the price for a unit of pollution.
7. By issuing marketable permits, the government sets the price for each unit of pollution produced.
8. If the government imposes a pollution tax on lead mining equal to its marginal external cost, the quantity of lead mined will be the efficient quantity.

**Multiple choice**

1. Which of the following best describes an externality?
   a. something that is external to the economy
   b. a sales tax on a good in addition to the market price
   c. an effect of a transaction felt by someone other than the consumer or producer
   d. anything produced in other countries
   e. a change from what is normal

2. Pollution is an example of a ____ externality.
   a. negative production
   b. positive production
   c. negative consumption
   d. positive consumption
   e. Coasian

3. The cost of producing one more unit of a good or service that is borne by the producer of that good or service
   a. always equals the benefit the consumer derives from that good or service
   b. equals the cost borne by people other than the producer.
   c. is the marginal private cost.
   d. is the external cost.
   e. is the marginal social cost.

4. The cost of producing an additional unit of a good or service that falls on people other than the producer is
   a. the marginal cost.
   b. represented by the demand curve.
   c. represented by the supply curve.
   d. the marginal external cost.
   e. the marginal social cost.
5. Which of the following is an example of something that creates an external cost?
   i. second-hand smoke
   ii. sulfur emitting from a smoke stack
   iii. garbage on the roadside
   a. i only.
   b. ii only.
   c. iii only.
   d. ii and iii.
   e. i, ii, and iii.

6. The marginal cost of production that is borne by the entire society is the marginal
   a. private cost.
   b. social cost.
   c. external cost.
   d. public cost.
   e. user cost.

7. If the marginal private cost of producing one kilowatt of power in California is five
   cents and the marginal social cost of each kilowatt is nine cents, then the marginal ex-
   ternal cost equals ____ a kilowatt.
   a. five cents
   b. nine cents
   c. four cents
   d. zero cents
   e. fourteen cents

8. When the production of a good has a marginal external cost, which of the following
   will occur in an unregulated market?
   i. Overproduction relative to the efficient
      level will occur
   ii. The market price will be less than the
      marginal social cost at the equilibrium
      quantity
   iii. A deadweight loss will occur
      a. i only.
      b. ii only.
      c. iii only.
      d. i and ii.
      e. i, ii, and iii.

9. Figure 10.1 shows the market for a good with an external cost. The external cost
   equals ____ per ton.
   a. $5
   b. $10
   c. $15
   d. $20
   e. $25

10. Figure 10.1 shows the market for a good with an external cost. If the market is un-
    regulated, the equilibrium quantity is ____ tons per year.
    a. 0
    b. 100
    c. 200
    d. 300
    e. 400

11. Figure 10.1 shows the market for a good with an external cost. The efficient quantity
    is ____ tons per year.
    a. 0
    b. 100
    c. 200
    d. 300
    e. 400
12. The Coase theorem is the proposition that if property rights exist and are enforced, private transactions are
a. inefficient.
b. efficient.
c. inequitable.
d. illegal.
e. unnecessary.

13. A marketable permit
a. allows firms to pollute all they want without any cost.
b. allows firms to buy and sell the right to pollute at government controlled prices.
c. eliminates pollution by setting the price of pollution permits above the marginal cost of polluting.
d. allows firms to buy and sell the right to pollute.
e. is the Coase solution to pollution.

14. If we compare air pollution today to air pollution in 1980, we see that
a. pollution of all forms has increased.
b. pollution of all forms has been substantially reduced.
c. pollution of most types has been decreased.
d. pollution from lead has increased.
e. pollution of most types has not changed.

15. If a polluting producer is forced to pay an emission charge or a tax on its output, what is the effect on the supply and demand curves for the product?
a. The quantity supplied along the firm’s supply curve will increase.
b. The firm’s demand curve shifts leftward.
c. The firm’s supply curve shifts rightward.
d. The firm’s supply curve shifts leftward.
e. Both the supply curve and the demand curve shift leftward.

<table>
<thead>
<tr>
<th>Quantity (megawatts per day)</th>
<th>Marginal private cost (dollars)</th>
<th>Marginal social cost (dollars)</th>
<th>Marginal benefit (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>3</td>
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<tr>
<td>4</td>
<td>20</td>
<td>40</td>
<td>20</td>
</tr>
</tbody>
</table>

1. The table above shows the marginal private cost, marginal social cost, and marginal benefit schedules for generating electricity.
a. In Figure 10.2, label the axes and then plot the marginal private cost curve, the marginal social cost curve, and the marginal benefit curve.

**FIGURE 10.2**

b. How much electricity will an unregulated market produce? What is the marginal external cost at this amount of production?
c. What is the efficient amount of electricity? Illustrate the deadweight loss resulting from the market equilibrium.
d. At the efficient quantity of electricity, what is the marginal external cost? If the government imposes a tax on producing electricity to produce the efficient quantity, what should be the amount of tax? How much electricity is generated and what is its price?
2. The table above shows the marginal private cost and marginal benefit schedules for producing PBDE, a chemical flame retardant. Suppose that there is an external cost of $100 per ton of PBDE produced.

<table>
<thead>
<tr>
<th>Quantity (tons per day)</th>
<th>Marginal private cost (dollars)</th>
<th>Marginal benefit (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>500</td>
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<td>3</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>300</td>
</tr>
</tbody>
</table>

a. In Figure 10.3, label the axes and then plot the marginal private cost curve, the marginal social cost curve, and the marginal benefit curve.

b. How much PBDE will an unregulated market produce? What is the equilibrium price? What is the amount of the marginal external cost at the equilibrium quantity of production?

c. What is the efficient amount of PBDE? At the efficient quantity, what is the amount of the marginal external cost?

d. If the government set an emission charge for producing PBDE, what must the charge equal to lead to the efficient quantity of PBDE?

Short answer and numeric questions

1. If the marginal social cost curve lies above the marginal private cost curve, is there an external cost or benefit from production of the good or service?

<table>
<thead>
<tr>
<th>Quantity (tons of pesticide per day)</th>
<th>Marginal private cost (dollars per ton)</th>
<th>Marginal external cost (dollars per ton)</th>
<th>Marginal social cost (dollars per ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>___</td>
<td>130</td>
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<tr>
<td>2</td>
<td>120</td>
<td>40</td>
<td>___</td>
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<td>3</td>
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<td>4</td>
<td>190</td>
<td>___</td>
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<tr>
<td>5</td>
<td>240</td>
<td>120</td>
<td>___</td>
</tr>
</tbody>
</table>

2. The table above shows the costs of producing pesticide. Complete the table.

3. According to the Coase theorem, when are private transactions efficient?

4. What is a marketable permit? What advantage do marketable permits have over the government assigning each firm a limit on how much it can pollute?

5. The production of fertilizer creates water pollution. How do emission charges and taxes result in an efficient quantity of production? What information must the government possess to use emission charges and taxes effectively?

CHECKPOINT 10.2

Explain why positive externalities lead to inefficient underproduction and how public provision, subsidies, vouchers, and patents can achieve a more efficient outcome.

Quick Review

- Marginal external benefit: The benefit from an additional unit of a good or service that people other than the consumer of the good or service enjoy.
Additional Practice Problems 10.2
1. The figure shows the marginal private benefit, marginal social benefit, and marginal cost of a college education.
   a. How much does the marginal external benefit equal?
   b. If colleges are private and government has no involvement in college education, how many people will undertake a college education and what will be the tuition?
   c. What is the efficient number of students?
   d. If the government decides to provide public colleges, what tuition will these colleges charge to achieve the efficient number of students? What is the marginal cost of educating this many students? Why is it justified to charge a tuition that is less than the marginal cost?

2. A vaccine for chicken pox was recently developed. The company that developed the vaccine, Merck Incorporated, was required to submit a document comparing the costs and benefits of vaccinating children. The government would approve the drug only if the benefit of vaccination exceeded the cost. The producer reports that the marginal cost of a dose of vaccine is $80. The marginal benefit to the child being vaccinated is estimated to be $30 and an additional marginal benefit to the child’s parents is estimated at $60.
   a. How much is the marginal private benefit and the marginal external benefit?
   b. Based on these data, should the government have approved the vaccine?

Solutions to Additional Practice Problems 10.2
1a. The marginal external benefit equals the vertical distance between the marginal social benefit curve, $MB$, and the marginal private benefit curve, $MB$. In the figure the difference is $8,000, so the marginal external benefit equals $8,000.
1b. If the government has no involvement, the equilibrium tuition and number of students is determined by the equilibrium between supply and demand. The supply curve is the marginal private cost curve, $S = MC$, and the demand curve is the marginal private benefit curve, $MB$. The figure shows that the equilibrium tuition equals $8,000 a year and the equilibrium enrollment is 200,000 students a year.
1c. The efficient number of students is 300,000 because this the quantity at which the marginal cost equals the marginal social benefit.
1d. The demand curve, which is the same as the marginal private benefit curve, shows that tuition must be $4,000 in order for 300,000 students to attend college. The marginal cost of educating 300,000 students is $12,000 students per year. It is justified to charge a tuition that is less than the marginal cost because education has external benefits so that society as well as the student benefits from the college education.
2a. The marginal private benefit is the benefit to the child being vaccinated and is $30. The marginal external benefit is the benefit to the child’s parents and is $60.
2b. Based on the data that were submitted, the government should have approved the vaccine. The marginal social benefit equals the marginal private benefit to the child of $30 plus the marginal external benefit to the parent of $60, which is $90. The marginal social benefit from the vaccine is greater than the marginal cost.
Self Test 10.2

Fill in the blanks
Marginal ____ (social; external) benefit is the benefit enjoyed by society from one more unit of a good or service. If the government leaves education to the private market, ____ (overproduction; underproduction) occurs. A payment that the government makes to private producers that depends on the level of output is ____ (a subsidy; public provision). The property rights of the creators of knowledge and other discoveries are ____ (intellectual property; patent property) rights.

True or false
1. The marginal private benefit from a good or service must exceed the marginal external benefit.
2. The expanded job opportunities from a college degree is a marginal private benefit enjoyed by college graduates.
3. A flu vaccination has an external benefit, so the marginal private benefit curve for flu vaccinations lies above the marginal social benefit curve for flu vaccinations.
4. An unregulated market underproduces products with external benefits, such as education.
5. A public community college is an example of public provision of a good that has an external benefit.
6. To overcome the inefficiency in the market for a good with an external benefit, the government can either tax or subsidize the good.
7. Vouchers can help overcome the inefficiency created by a good with an external cost but not the inefficiency created by a good with an external benefit.
8. A patent protects intellectual property rights by giving the patent holder a monopoly.

Multiple choice
1. The benefit the consumer of a good or service receives is the
   a. social benefit.
   b. external benefit.
   c. private benefit.
   d. public benefit.
   e. consumption benefit.

2. An external benefit is a benefit from a good or service that someone other than the ____ receives.
   a. seller of the good or service
   b. government
   c. foreign sector
   d. consumer
   e. market maker

3. When Ronald takes another economics class, other people in society benefit. The benefit to these other people is called the marginal ____ benefit of the class.
   a. social
   b. private
   c. external
   d. opportunity
   e. extra

4. Marginal social benefit equals
   a. marginal external benefit.
   b. marginal private benefit.
   c. marginal private benefit minus marginal external benefit.
   d. marginal private benefit plus marginal external benefit.
   e. marginal external benefit minus marginal private benefit.

5. If an external benefit is present, then the
   a. marginal private benefit curve lies above the marginal private cost curve.
   b. marginal social benefit curve lies above the marginal private benefit curve.
   c. marginal social cost curve lies above the marginal private benefit curve.
   d. marginal social benefit is equal to the marginal social cost.
   e. marginal social benefit curve is the same as the marginal private benefit curve.
6. In an unregulated market with an external benefit, the
   a. quantity produced is greater than the efficient quantity.
   b. price charged is too high for efficiency.
   c. quantity produced is less than the efficient quantity.
   d. producer is causing pollution but not paying for it.
   e. government might impose a tax to help move the market toward the efficient amount of production.

9. Figure 10.4 shows the market for research and development. The efficient quantity of R&D is ____ units per day.
   a. 0
   b. 2
   c. 3
   d. 4
   e. 5

10. If all education in the United States were provided by private, tuition-charging schools,
   a. too much education would be consumed.
   b. too little education would be consumed.
   c. the efficient level of education would be provided.
   d. the government would provide both students and schools with vouchers.
   e. education would no longer have an external benefit.

11. Which of the following is a method used by government to cope with the situation in which production of a good creates an external benefit?
   a. removing property rights
   b. paying subsidies
   c. issuing marketable permits
   d. running a lottery
   e. imposing a Coasian tax

12. If tuition at a college is $30,000 and the external benefit of graduating from this college is $10,000, then
   i. in the absence of any government intervention, the number of students graduating is less than the efficient number
   ii. the government could increase the number of graduates by giving the college a $10,000 subsidy per student
   iii. the government could increase the number of graduates by giving the students $10,000 vouchers
   a. i only.
   b. i and ii.
   c. i and iii.
   d. ii and iii.
   e. i, ii, and iii.
13. Public universities are a service that is an example of
   a. patent protection.
   b. vouchers.
   c. private subsidies.
   d. public provision.
   e. an emission charge.

14. Which of the following is an example of a voucher?
   a. the postal service
   b. police services
   c. social security
   d. food stamps
   e. a patent on a pharmaceutical drug

15. Which government device is associated with intellectual property rights?
   a. public provision
   b. private subsidies
   c. vouchers
   d. patents and copyrights
   e. taxes

Complete the graph

**Figure 10.5**

1. Figure 10.5 illustrates the market for honey.
   a. Label the curves in the figure.
   b. Based on Figure 10.5, does the production of honey create an external cost? An external benefit?
   c. What is the efficient quantity of honey? What is the quantity that will be produced in an unregulated market?
   d. Shade the area that equals the deadweight loss in an unregulated market.

**Short answer and numeric questions**

<table>
<thead>
<tr>
<th>Quantity (units of R&amp;D per day)</th>
<th>Marginal private cost (dollars per unit of R&amp;D)</th>
<th>Marginal private benefit (dollars per unit of R&amp;D)</th>
<th>Marginal social benefit (dollars per unit of R&amp;D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
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<tr>
<td>500</td>
<td>240</td>
<td>50</td>
<td>140</td>
</tr>
</tbody>
</table>

1. The table above shows the benefits and costs of research and development, R&D.
   a. Based on the table, what is the amount of the marginal external benefit?
   b. If the market for R&D was left unregulated, what would be the competitive amount of R&D?
   c. What is the efficient amount of R&D?
   d. Would a subsidy or a tax be the proper government policy to make the market for R&D more efficient?

2. Is efficiency guaranteed when production is such that the marginal private benefit equals the marginal private cost? Or does efficiency require that the marginal social benefit equal the marginal social cost?

3. Most elementary schools require that children be vaccinated before allowing the child to attend school. Can this policy be justified using economic analysis?

4. Is a private subsidy or a tax the correct government policy for a product that has an external benefit?

5. What is a voucher? How do vouchers work? Why is a voucher a proper policy to deal with the inefficiency created by a good or service that has an external benefit?
SELF TEST ANSWERS

CHECKPOINT 10.1

Fill in the blanks
Marginal social cost equals marginal private cost plus marginal external cost. A pollution externality creates an inefficient equilibrium. According to the Coase theorem, if property rights exist, then private transactions are efficient and the outcome is not affected by who is assigned the property right. By setting the tax rate equal to the marginal external cost, firms can be made to behave in the same way as they would if they bore the cost of the externality directly.

True or false
1. False; page 242
2. True; page 243
3. False; page 244
4. False; page 246
5. False; page 248
6. True; page 250
7. False; page 250
8. True; page 251

Multiple choice
1. c; page 242
2. a; page 242
3. c; page 244
4. d; page 244
5. e; page 244
6. b; page 244
7. c; page 244
8. e; page 246
9. b; page 245
10. c; page 246
11. b; page 246
12. b; page 248
13. d; page 250
14. c; page 249
15. d; page 251

Complete the graph
1. a. Figure 10.6 shows the MSC, MC, and MB curves; page 246.
b. An unregulated market will produce 4 megawatts of electricity a day. The marginal external cost at this production is $20 per megawatt; page 246.
c. The efficient amount of electricity is 3 megawatts a day. The deadweight loss is illustrated in the figure; page 246.
d. At the efficient quantity of electricity, the marginal external cost is $15 a megawatt. The tax is $15 a megawatt. With the tax, 3 megawatts of electricity are produced and the price is $30 per megawatt; page 251.

2. a. Figure 10.7 shows the MSC, MC, and MB curves; page 246.
b. An unregulated market will produce 3 tons of PBDE a day. At this quantity the marginal external cost is $300; pages 245-246.

c. The efficient quantity of PBDE is 2 tons per day. At this quantity the marginal external cost is $200; pages 245-246.

d. The emission charge will equal $100 per ton of PBDE; page 250.

Short answer and numeric questions

1. If the marginal social cost curve lies above the marginal private cost curve, production of the good creates an external cost; page 245.

<table>
<thead>
<tr>
<th>Quantity (tons of pesticide per day)</th>
<th>Marginal private cost (dollars per ton)</th>
<th>Marginal external cost (dollars per ton)</th>
<th>Marginal social cost (dollars per ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
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<td>130</td>
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<tr>
<td>5</td>
<td>240</td>
<td>120</td>
<td>360</td>
</tr>
</tbody>
</table>

2. The completed table is above; page 244.

3. According to the Coase theorem, if property rights are assigned, the number of people involved is small, and transactions costs are low, then private transactions are efficient; page 248.

4. A marketable permit is a government-issued permit given to firms that allows the company to pollute up to the limit of the permit. Permits can be bought and sold amongst firms. The advantage marketable permits have over assigning each firm a limit for its pollution is information. In order to assign each firm a limit and achieve efficiency, the government must know each firm’s marginal cost schedule. Marketable permits do not require that the government know this information; page 250.

5. Emission charges and taxes are designed to charge polluting firms the cost of their pollution. By forcing a firm to pay this cost, the firm’s marginal private cost becomes equal to the marginal social cost. To use emission charges or taxes to overcome the problem of pollution, the government must know the marginal external cost at different levels of output; page 250.

CHECKPOINT 10.2

Fill in the blanks

Marginal social benefit is the benefit enjoyed by society from one more unit of a good or service. If the government leaves education to the private market, underproduction occurs. A payment that the government makes to private producers that depends on the level of output is a subsidy. The property rights of the creators of knowledge and other discoveries are intellectual property rights.

True or false

1. False; page 254
2. True; page 254
3. False; page 254
4. True; page 255
5. True; page 256
6. False; page 256
7. False; page 258
8. True; page 259

Multiple choice

1. c; page 254
2. d; page 254
3. c; page 254
4. d; page 254
5. b; page 254
6. c; page 255
7. b; page 254
8. c; page 255
9. d; page 255
10. b; page 255
11. b; page 256
12. e; pages 256-258
13. d; page 256
14. d; page 258
15. d; page 259
Complete the graph

**FIGURE 10.8**

<table>
<thead>
<tr>
<th>Price (dollars per pound of honey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50</td>
</tr>
<tr>
<td>2.00</td>
</tr>
<tr>
<td>1.50</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
</tr>
</tbody>
</table>

- **S = MC**
- **MSB**
- **D = MB**

**Quantity (tons of honey per year)**

1. a. Figure 10.8 labels the curves; page 255.
   
   b. The production of honey has an external benefit but no external cost; page 255.
   
   c. The efficient quantity of honey is 300 tons, a year, at the intersection of the MSB curve and the **S = MC** curve. In an unregulated market, the equilibrium quantity is 200 tons a year, at the intersection of the **D = MB** curve and the **S = MC** curve; page 255.
   
   d. Figure 10.8 shades the deadweight loss; page 255.

**Short answer and numeric questions**

1. a. The marginal external benefit equals the difference between the marginal social benefit and the marginal social cost, so it is $90 per unit of R&D; page 254.
   
   b. The competitive equilibrium is where the marginal private cost (which determines the supply) equals the marginal private benefit (which determines the demand), so the equilibrium amount of R&D is 300 units per day; page 255.
   
   c. The efficient quantity is produced when the marginal social benefit equals the marginal cost, so the efficient amount is 400 units of R&D per day; page 255.
   
   d. A subsidy would be a proper government policy; page 257.

2. Efficiency is not guaranteed when production sets the marginal private benefit equal to the marginal cost. The efficient quantity is produced when the marginal social benefit equals marginal cost; page 255.

3. Vaccination protects not only the child who is vaccinated, but also makes it less likely for classmates to catch the disease. So a vaccination has an external benefit. Although the marginal cost of a vaccination can be greater than the marginal private benefit of a vaccination, the marginal social benefit exceeds the marginal private benefit. The market might be efficient when vaccination is required; page 255.

4. The correct government action to deal with a good or service that has an external benefit is a private subsidy, not a tax; page 256.

4. A voucher is a token that the government gives to households which they can use to buy specified goods or services. Vouchers increase the demand for the product and shift the demand curve (which is the same as the marginal private benefit curve, or **MB** curve) rightward, closer to the marginal social benefit curve. Vouchers reduce the inefficiency created by a good or service with an external benefit; page 258.