

## Answers to 'Quantitative techniques' Test your understanding questions (CD-ROM)

### Test your understanding 1 (page 2)

- 1 (a) 57.3%; (b) 62.8%; (c) 124.7%; (d) 175.4%
- 2 (a) 33.3%; (b) 27.7%; (c) 269.2%; (d) 2.8%
- 3 (a) 0.245; (b) 0.25; (c) 0.99; (d) 1.25
- 4 (a)  $\frac{15}{25} \times 100\% = 0.6 \times 100\% = 60\%$ ; (b)  $\frac{10}{25} \times 100\% = 0.4 \times 100\% = 40\%$
- 5  $25\% = 0.25$ ;  $0.25 \times \$17\,000 = \$4250$
- 6  $14\% = 0.14$ ;  $0.14 \times 46.3 \text{ million} = 6.5$ , i.e. 6.5 million

### Test your understanding 2 (page 4)

- 1  $20\% = 0.2$ ;  $0.2 \times 30 \text{ Mnl} = 6 \text{ Mnl}$ , i.e. price increased by 6 Mnl, so the book's new price is  $30 \text{ Mnl} + 6 \text{ Mnl} = 36 \text{ Mnl}$ . Alternatively,  $30 \times 1.2 = 36 \text{ Mnl}$ .
- 2 (a)  $\frac{272 - 259}{259} \times 100 = \frac{13}{259} \times 100 = 0.050 \times 100 = 5.0\%$   
 (b)  $\frac{267 - 272}{272} \times 100 = \frac{-5}{272} \times 100 = -0.018 \times 100 = -1.8\%$
- 3  $7.2\% = 0.072$ ;  $0.072 \times 32.9 \text{ million} = 2.4 \text{ million}$  was the population increase. Therefore the population in 2010 was  $32.9 \text{ million} + 2.4 \text{ million} = 35.3 \text{ million}$ . Alternatively,  $32.9 \text{ million} \times 1.072 = 35.3 \text{ million}$ .
- 4  $\frac{1 - 1.2}{1} \times 100 = -0.2 \times 100 = -20\%$ .
- 5  $8\% = 0.08$ ;  $0.08 \times \$2.5 \text{ million} = \$0.2 \text{ million}$ , which is the increase in profits. Therefore 2010 profits =  $\$2.5 \text{ million} + \$0.2 \text{ million} = \$2.7 \text{ million}$ . Alternatively,  $\$2.5 \text{ million} \times 1.08 = \$2.7 \text{ million}$ .

### Test your understanding 3 (page 7)

Student's own answer.

**Test your understanding 4 (page 10)**

- (a) Positive relationship; income is independent variable, saving is dependent variable.
- (b) Negative relationship; price is independent variable; number of DVDs is dependent variable.
- (c) Positive relationship; years of working experience is independent variable; salary is dependent variable.
- (d) Positive relationship; temperature is independent variable; number of swimmers is dependent variable.

**Test your understanding 5 (page 14)**

- 1 (a) Movement along the  $D$  curve; (b)  $D$  shifts right; (c)  $D$  shifts left.
- 2 (a) Movement along the  $S$  curve; (b)  $S$  shifts right; (c)  $S$  shifts left.

**Test your understanding 6 (page 16)**

- (a) 70 units; (b) €280; (c) €280 – €150 = €130

**Test your understanding 7 (page 20)**

- 1  $Q_s = c + dP$ ;  $Q_s$  = quantity supplied;  $P$  = price;  $c$  = the horizontal intercept (the value of  $Q_s$  when  $P = 0$ );  $d$  = slope =  $\frac{\Delta Q_s}{\Delta P}$ .
- 2 The slope is the change in the dependent variable divided by the change in the independent variable between any two points on a straight line; when the dependent variable is plotted on the horizontal axis it refers to the change in the variable on the horizontal axis divided by the change in the variable on the vertical axis.
- 3 A positive slope means there is a positive (direct) relationship between the two variables.
- 4 In the equation  $Q_s = c + dP$ ,  $c = 50$ , and  $d = \frac{50}{25} = 2$ ; therefore the equation is  $Q_s = 50 + 2P$ .
- 5 (a)  $P = 17$ ,  $Q_s = 84$ ;  $P = 25$ ,  $Q_s = 100$ ;  $P = 37$ ,  $Q_s = 124$   
 (b)  $Q_s = 60$ ,  $P = 5$ ;  $Q_s = 75$ ,  $P = 12.5$ ;  $Q_s = 80$ ,  $P = 15$

- 6 To find points, use  $Q_s = 50 + 2P$ . Find points by setting  $P$  equal to various prices. For example: (i) when  $P = 10$ ,  $Q_s = 50 + 2(10) = 70$ ; this is point (70,10). (ii) When  $P = 20$ ,  $Q_s = 50 + 2(20) = 90$ ; this is point (90,20). (iii) When  $P = 30$ ,  $Q_s = 50 + 2(30) = 110$ ; this is point (110,30). Plot your points, making sure you put  $Q_s$  on the horizontal axis and  $P$  on the vertical axis. Your graph should look like the one in Figure 1.

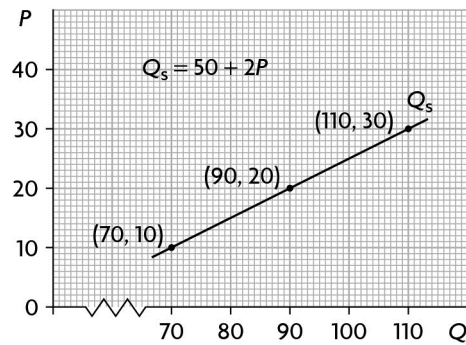


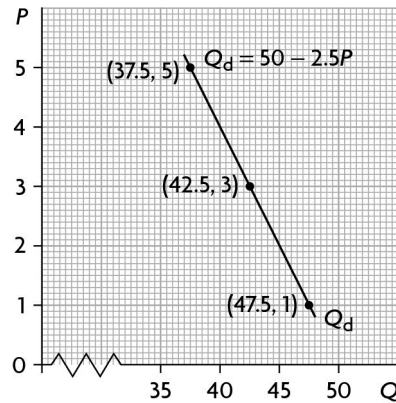
Figure 1

- 7 (a) In  $Q_s = 50 + 2P$ , the horizontal intercept is  $Q_s = 50$ , or the point (50,0).  
 (b) Corresponds to parameter  $c$  in the equation  $Q_s = c + dP$

### Test your understanding 8 (page 22)

- 1  $Q_d = a - bP$ ;  $Q_d$  = quantity demanded;  $P$  = price;  $a$  = the horizontal intercept (the value of  $Q_d$  when  $P = 0$ );  $-b$  = slope =  $\frac{\Delta Q_d}{\Delta P}$
- 2 A negative slope means there is a negative (indirect) relationship between the two variables.
- 3 In the equation  $Q_d = a - bP$ ,  $a = 50$ ,  $-b = -\frac{5}{2} = -2.5$ ; therefore the equation is  $Q_d = 50 - 2.5P$
- 4 (a)  $P = 3$ ,  $Q_d = 42.5$ ;  $P = 4.2$ ,  $Q_d = 39.5$ ;  $P = 11$ ,  $Q_d = 22.5$   
 (b)  $Q_d = 27.5$ ,  $P = 9$ ;  $Q_d = 35$ ,  $P = 6$ ;  $Q_d = 42.5$ ,  $P = 3$

- 5** To find points, use  $Q_d = 50 - 2.5P$ . Find points by setting  $P$  equal to various prices. For example: **(i)** when  $P = 1$ ,  $Q_d = 47.5$ ; this is point  $(47.5, 1)$ . **(ii)** When  $P = 3$ ,  $Q_d = 42.5$ ; this is point  $(42.5, 3)$ . **(iii)** When  $P = 5$ ,  $Q_d = 37.5$ ; this is point  $(37.5, 5)$ . Plot your points, making sure you put  $Q_d$  on the horizontal axis and  $P$  on the vertical axis. Your graph should look like the one in Figure 2 no matter what points you found.

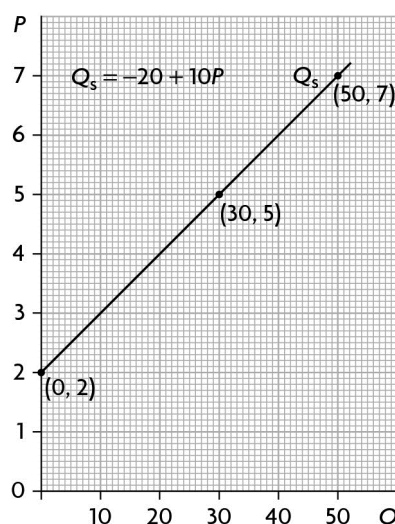


**Figure 2**

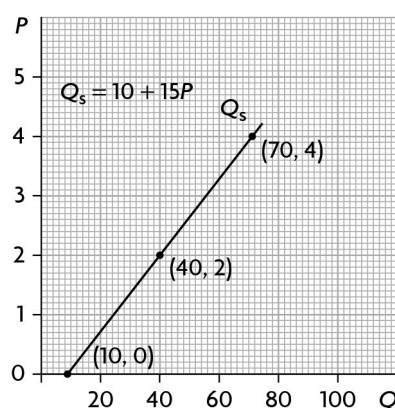
- 6** In  $Q_d = 50 - 2.5P$ , the horizontal intercept is  $Q_d = 50$ , or the point  $(50, 0)$ . The vertical intercept is the  $P$ -intercept, found when  $Q_d = 0$ . Using  $Q_d = 50 - 2.5P$ , when  $Q_d = 0$ , we have  $0 = 50 - 2.5P \Rightarrow 2.5P = 50 \Rightarrow P = 20$ , which is the  $P$ -intercept, or the point  $(0, 20)$ .
- 7** Corresponds to parameter  $a$  in the equation  $Q_d = a - bP$ .
- 8**
- (a)** Positive, because  $+7$  is a positive slope.
  - (b)** Negative, because  $-5$  is a negative slope.
  - (c)** Positive, because  $+15$  is a positive slope.

**Test your understanding 9 (page 23)**

- (a)  $Q_s = -20 + 10P$ . The horizontal intercept is  $Q_s = -20$ , which extends outside the  $S$  curve. Therefore set  $Q_s = 0$  to find the vertical intercept, which is the beginning of the  $S$  curve.  $0 = -20 + 10P \Rightarrow 20 = 10P \Rightarrow P = 2$ , or point  $(0, 2)$ . To find a second point, set  $P = 7$  (the upper limit of  $P$ ).  $Q_s = -20 + 10(7) = -20 + 70 = 50$ , giving point  $(50, 7)$ . To find a third point (as a check), set  $P$  equal to a price between  $P = 2$  and  $P = 7$  (the upper and lower limits), such as  $P = 5$ .  $Q_s = -20 + 10(5) = -20 + 50 = 30$ , giving point  $(30, 5)$ . These points are graphed in Figure 3.

**Figure 3**

- (b)  $Q_s = 10 + 15P$ . The horizontal intercept is  $Q_s = 10$ , giving point  $(10, 0)$ . Since the upper limit is  $P = 4$ , we have  $Q_d = 10 + 15(4) = 70$ , giving point  $(70, 4)$ . For a possible third point (as a check), set  $P = 2$  (in between the limits of  $P = 0$  and  $P = 4$ ), so that  $Q_s = 10 + 15(2) = 40$ , giving point  $(40, 2)$ . These points are graphed in Figure 4.

**Figure 4**

- (c)  $Q_d = 15 - 5P$ . The vertical intercept is the  $P$ -intercept. Setting  $Q_d = 0$ , we have  $0 = 15 - 5P \Rightarrow 5P = 15 \Rightarrow P = 3$ , which is the vertical intercept, giving point  $(0, 3)$ . The horizontal intercept is  $Q_d = 15$ , giving point  $(15, 0)$ . For a possible third point (as a check), set  $P = 2$  (in between  $P = 0$  and  $P = 3$ ), so that  $Q_d = 15 - 5(2) = 5$ , giving point  $(5, 2)$ . These points are graphed in Figure 5.

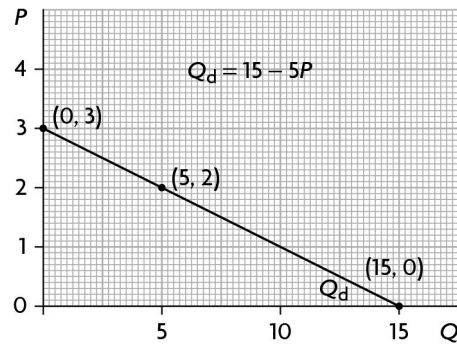


Figure 5

- (d)  $Q_d = 10 - 2P$ . When  $P = 1$ ,  $Q_d = 10 - 2 = 8$ , giving point  $(8, 1)$ . When  $P = 4$ ,  $Q_d = 10 - 2(4) = 2$ , giving point  $(2, 4)$ . For a possible third point (as a check), set  $P = 3$  (in between  $P = 1$  and  $P = 4$ ), so that  $Q_d = 10 - 2(3) = 4$ , giving point  $(4, 3)$ . These points are graphed in Figure 6.

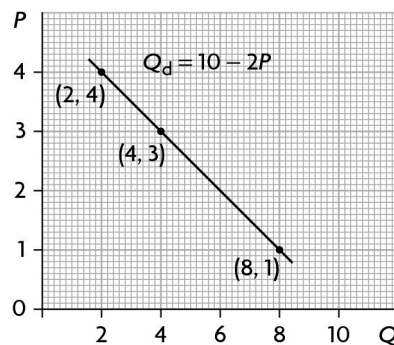
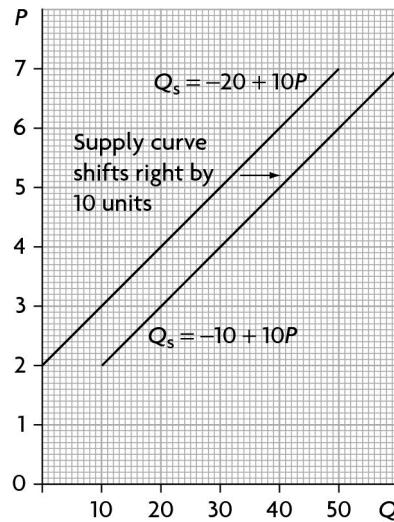


Figure 6

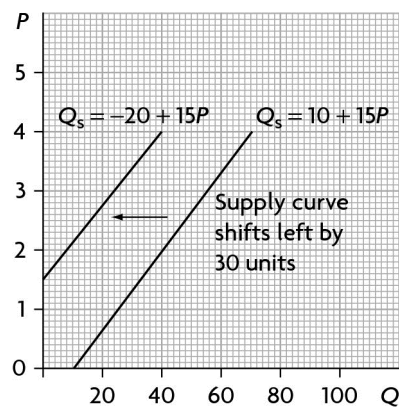
**Test your understanding 10 (page 25)**

- 1 (a) The supply curve shifts to the right by 10 units at each price, as shown in Figure 7.



**Figure 7**

- (b) The supply function shifts to the left by 30 units at each price, as shown in Figure 8.



**Figure 8**



- (c) The demand function shifts to the left by 5 units at each price, as shown in Figure 9.

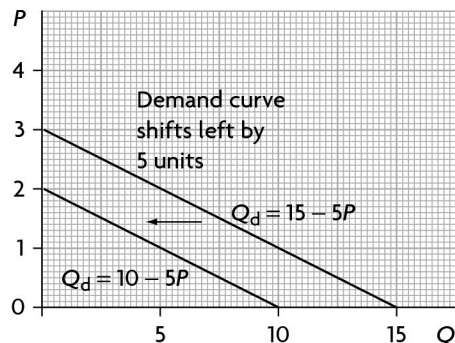


Figure 9

- (d) The demand function shifts to the right by 2 units at each price, as shown in Figure 10.

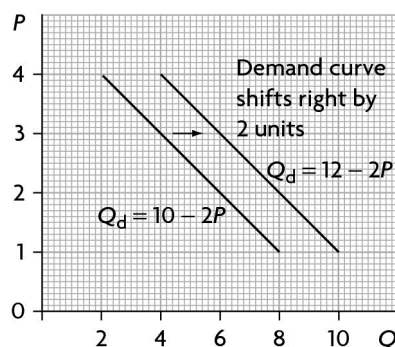


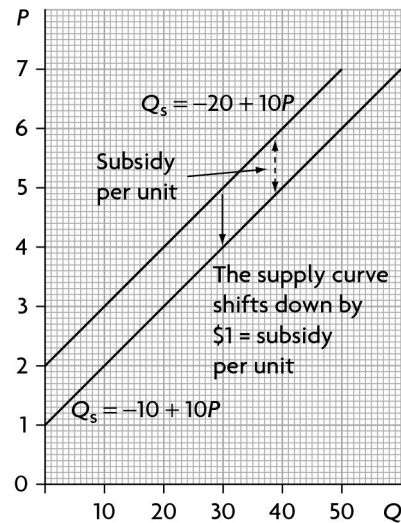
Figure 10

- 2
- (a) In  $Q_s = -20 + 10P$ , add 10 to the parameter  $c$ , so the new equation is  $Q_s = -10 + 10P$ .
  - (b) In  $Q_s = 10 + 15P$ , subtract 30 from the parameter  $c$ , so the new equation is  $Q_s = -20 + 15P$ .
  - (c) In  $Q_d = 15 - 5P$ , subtract 5 from the parameter  $a$ , so the new equation is  $Q_d = 10 - 5P$ .
  - (d) In  $Q_d = 10 - 2P$ , add 2 to the parameter  $a$ , so the new equation is  $Q_d = 12 - 2P$ .

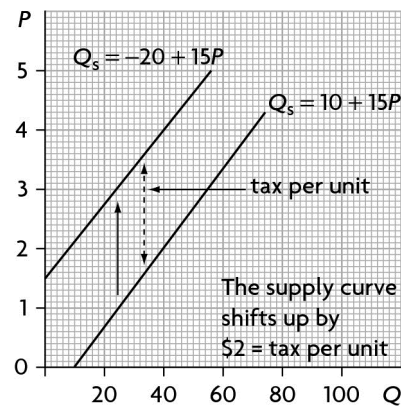


**Test your understanding 11 (page 27)**

- 1 (a) The supply curve shifts downward by \$1 for each quantity, as shown in Figure 11.

**Figure 11**

- (b) The supply curve shifts upward by \$2 for each quantity, as shown in Figure 12.

**Figure 12**

- 2 (a) Initial supply equation is  $Q_s = -20 + 10P$ . Subsidy is \$1 per unit, so the new equation is  $Q_s = 20 + 10(P + 1) = -20 + 10P + 10 = -10 + 10P$ , giving the new equation  $Q_s = -10 + 10P$ .
- (b) Initial supply equation is  $Q_s = 10 + 15P$ . Tax is \$2 per unit, so the new equation is  $Q_s = 10 + 15(P - 2) = 10 + 15P - 30 = -20 + 15P$ , giving the new equation as  $Q_s = -20 + 15P$ .
- 3 The supply curves in Figure 11 are the same as those in Figure 7, because a rightward shift of the supply curve showing an increase in supply is equivalent to a downward shift due to the granting of the subsidy. The supply curves in Figure 12 are the same as those in Figure 8, because a leftward shift of the supply curve showing a decrease in supply is equivalent to an upward shift due to the imposition of a tax. The equations are also the same for the same reasons.

### Test your understanding 12 (page 28)

- 1 (a) The equation  $Q_s = -20 + 10P$  becomes  $Q_s = -20 + 25P$ .
- (b) The equation  $Q_d = 15 - 5P$  becomes  $Q_d = 15 - 10P$ .
- 2 (a) steeper; (b) steeper; (c) flatter; (d) steeper.

### Test your understanding 13 (pages 29–30)

- 1  $Q_d = 10 - 2P$
- (a) The horizontal intercept is  $Q_d = 10$ . The vertical intercept is found by setting  $Q_d = 0$  and solving for  $P$ . We therefore have  $0 = 10 - 2P \Rightarrow 2P = 10 \Rightarrow P = 5$ , which is the vertical intercept, at point (0,5).
- (c) The slope is  $-2$ .
- (d) Graph is shown in Figure 13.

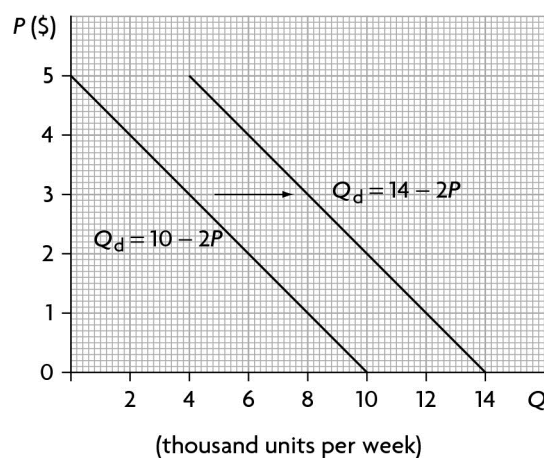


Figure 13

- (e) This is a negative relationship; the slope is negative.
- (f) See Figure 13, showing the shift. This means that demand for Beta has increased by 4000 units per week; therefore the demand curve shifts to the right.
- (g)  $Q_d = 14 - 2P$
- (h)  $Q_d = 10 - P$ . The new demand curve will be steeper.

2  $Q_s = -3 + 3P$

- (a) Horizontal intercept is  $Q_s = -3$ . This should not be included in the supply curve graph as it is a negative number.
- (b) The vertical intercept is found by setting  $Q_s = 0$  and solving for  $P$ . We therefore have  $0 = -3 + 3P \Rightarrow 3P = 3 \Rightarrow P = 1$ , which is the vertical intercept, at point (0,1).
- (c) Slope = 3
- (d) Graph is shown in Figure 14.

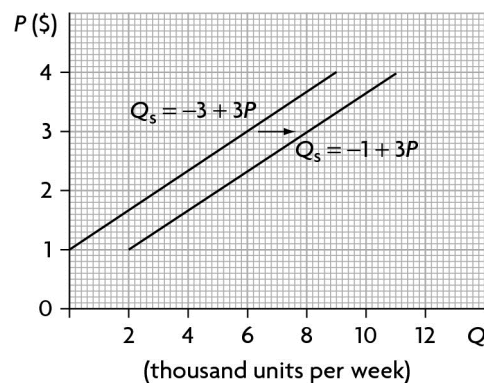


Figure 14

- (e) This is a positive relationship because the slope is positive.
- (f) If the parameter  $-3$  changes to  $-1$ , this means that supply has increased by 2000 units per week; therefore the supply curve shifts to the right. See Figure 14, showing the shift.
- (g)  $Q_s = -1 + 3P$
- (h)  $Q_s = -3 + 2P$ . The new supply curve will be steeper.

3 (a)  $Q_d = 10 - 2P$

$$Q_s = -3 + 3P$$

Since  $Q_d = Q_s$  at the point of intersection, we have  $10 - 2P = -3 + 3P \Rightarrow 13 = 5P \Rightarrow P = \frac{13}{5} = 2\frac{3}{5}$  or  $P = 2.6$ . To find  $Q$ , substitute  $P = 2.6$  into the demand (or supply)

equation:  $Q_d = 10 - 2(2.6) \Rightarrow 10 - 5.2 = 4.8$ . As a check we can substitute  $P = 2.6$  into the second equation:  $Q_s = -3 + 3(2.6) = 4.8$  (the results match). Therefore equilibrium  $P = \$2.6$  and equilibrium  $Q = 4.8$  thousand (or 4800) units of Beta per week. Alternatively, we can say that equilibrium is at point (2.6, 4.8).

(b) See the graph below. The point of intersection is the same.

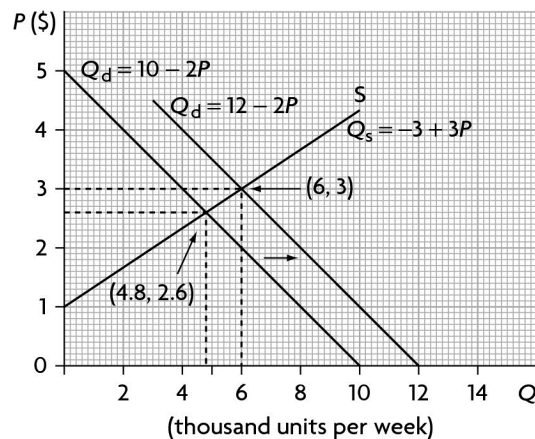


Figure 15

4 (a) If  $P = \$4$ ,  $Q_d = 10 - 8 = 2$ .  $Q_s = -3 + 12 = 9$

(b) The excess quantity of Beta supplied is  $9 - 2 = 7$ , or 7000 units of Beta per week.

5 (a) If  $P = \$2$ ,  $Q_d = 10 - 4 = 6$ .  $Q_s = -3 + 6 = 3$

(b) The excess quantity of Beta demanded is  $6 - 3 = 3$ , or 3000 units of Beta per week.

6 (a)  $Q_d = 12 - 2P$

(b) Using  $Q_d = 12 - 2P$  and  $Q_s = -3 + 3P$ , and setting  $Q_d = Q_s$ , we have  $12 - 2P = -3 + 3P \Rightarrow 5P = 15 \Rightarrow P = 3$ . Substituting  $P = 3$  into the demand equation, we have  $Q_d = 12 - 6 = 6$ . Substituting into the supply equation (as a check), we have  $Q_s = -3 + 9 = 6$ . Therefore at the new equilibrium  $P = \$3$  and  $Q = 6000$  units of Beta per week.

(c) See Figure 15. The calculations match with the diagram.

- 7      $Q_s = 10 + 5P$ ;  $Q_d = 50 - P$ . Setting  $Q_d = Q_s$ , we have  $10 + 5P = 50 - 5P \Rightarrow 10P = 40 \Rightarrow P = 4$ . Substituting  $P = 4$  into the demand equation, we have  $Q_d = 50 - 20 = 30$ . Substituting into the supply equation (as a check), we have  $Q_s = 10 + 20 = 30$ . Therefore at equilibrium  $P = 4$  and  $Q = 30$ .

**Test your understanding 14 (page 36)**

Student's own answer.