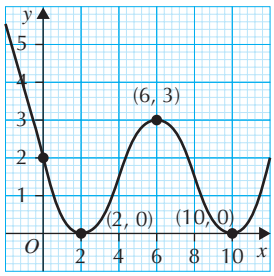
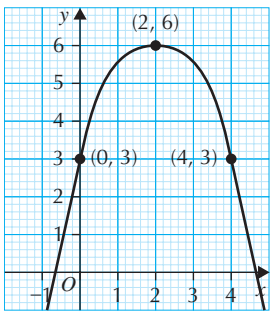
Chapter 3

Exercise 3A

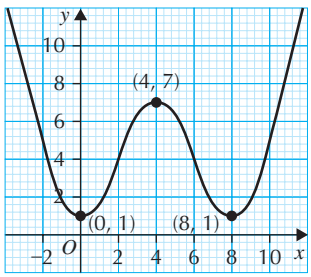
1 a



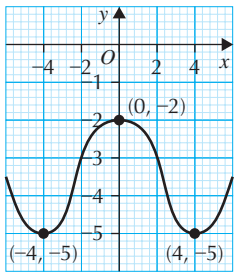
b



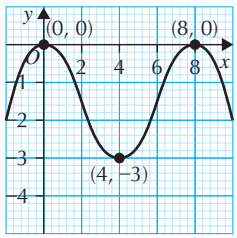
c



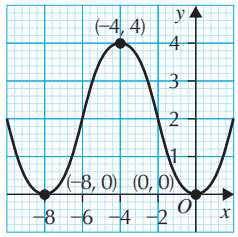
d



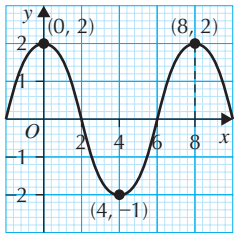
e



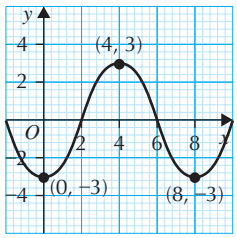
f



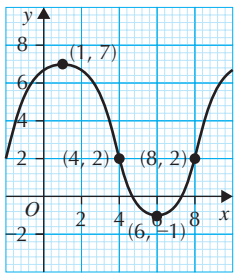
g



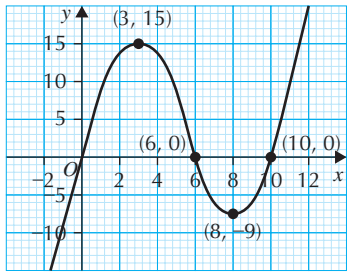
h



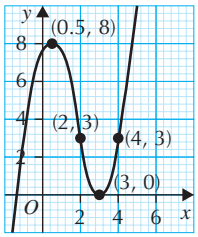
2 a



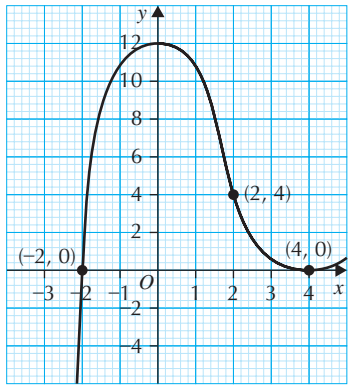
b



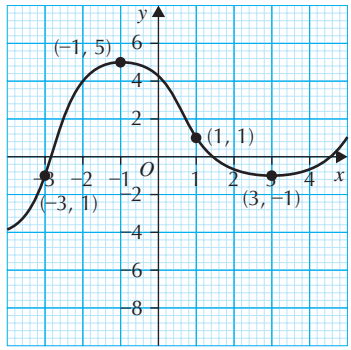
c



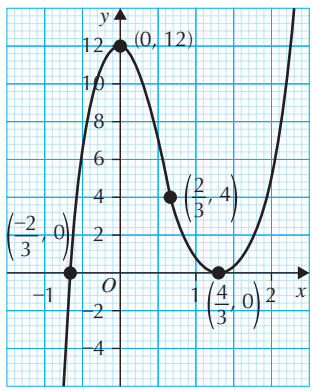
3 a



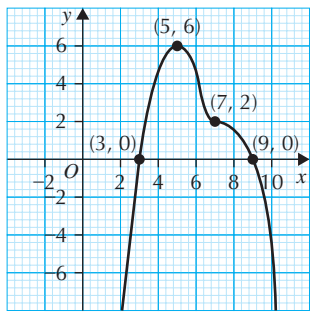
b



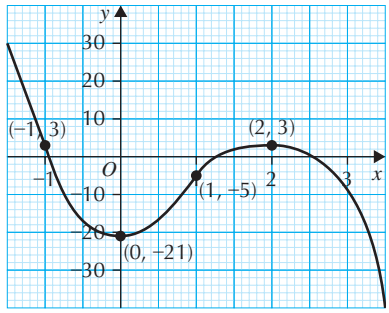
c



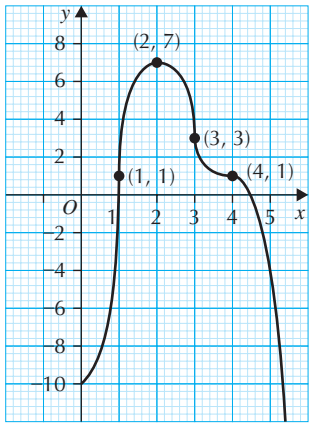
d



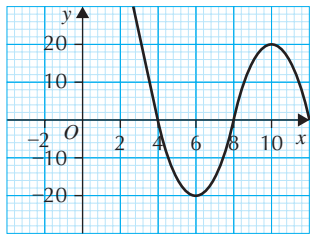
e



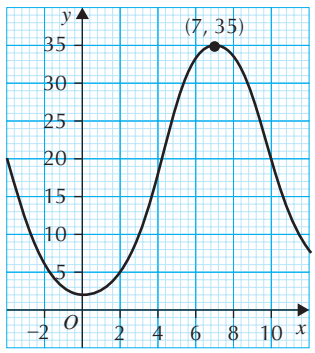
f



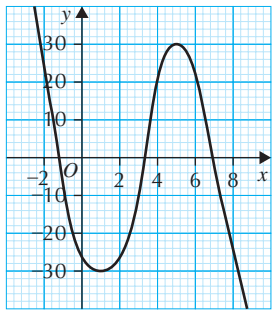
4 a



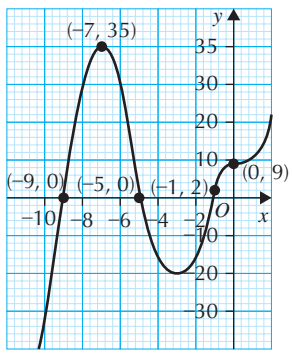
b



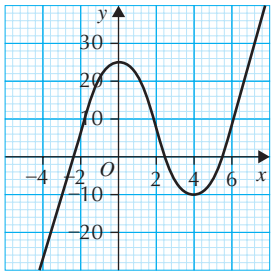
c



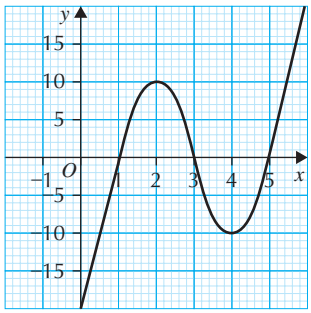
d



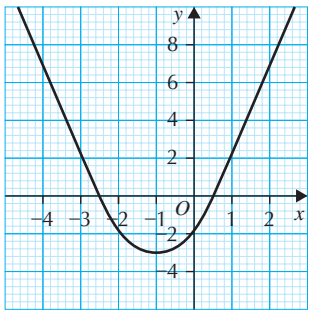
e



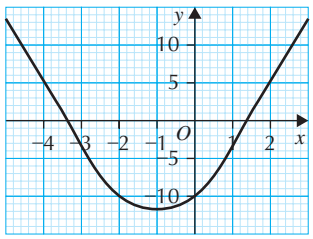
f



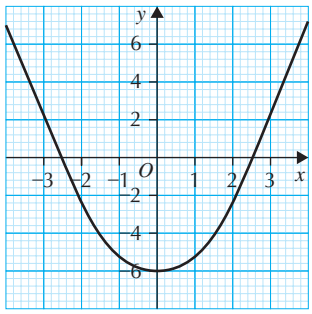
5 a



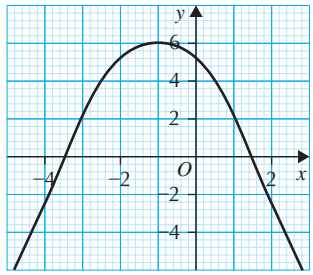
b



c



d



Exercise 3B

1 a $(x+2)^2-4$

b $(x-3)^2+1$

c $(x+4)^2-17$

d $(x+1)^2+4$

e $14-(x-2)^2$

f $16-(x+3)^2$

g $6-(x-3)^2$

h $\frac{49}{4}-\left(x+\frac{3}{2}\right)^2$

2 a $2(x+2)^2-5$

b $2(x-1)^2+13$

c $3(x+2)^2-17$

d $5(x-3)^2-9$

e $4\left(x-\frac{3}{2}\right)^2-8$

f $2\left(x+\frac{3}{2}\right)^2-\frac{27}{2}$

g $3\left(x+\frac{5}{2}\right)^2-\frac{47}{4}$

h $4\left(x+\frac{7}{2}\right)^2-42$

3 a $17-2(x+1)^2$

b $36-(x-6)^2$

c $7-4(x-1)^2$

d $4-3(x-2)^2$

e $\frac{11}{2}-2\left(x-\frac{3}{2}\right)^2$

f $44-4\left(x+\frac{5}{2}\right)^2$

g $\frac{23}{4}-7\left(x-\frac{1}{2}\right)^2$

h $\frac{3}{2}-2\left(x+\frac{3}{2}\right)^2$

4 a $\frac{49}{8} - 2\left(x - \frac{1}{4}\right)^2$

b $6\left(x + \frac{7}{12}\right)^2 - \frac{1}{24}$

c $3(x + 1)^2 - 8$

d $(x + 2)^2 + 10$

5 Completing the Square gives:

$$a\left(x + \frac{b}{2a}\right)^2 + c - \frac{b^2}{4a}$$

$$4a^2\left(x + \frac{b}{2a}\right)^2 = b^2 - 4ac$$

$$\left(x + \frac{b}{2a}\right)^2 = \frac{b^2 - 4ac}{4a^2}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Exercise 3C

1 a (3, 2), min

b (–3, –7), min

c (–4, 12), max

d (5, 3), min

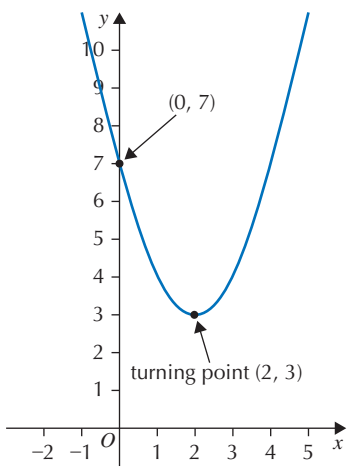
e (5, 5), max

f (–5, 7), max

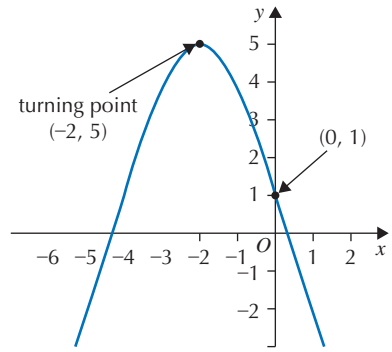
g (2, 9), min

h (–7, 13) max

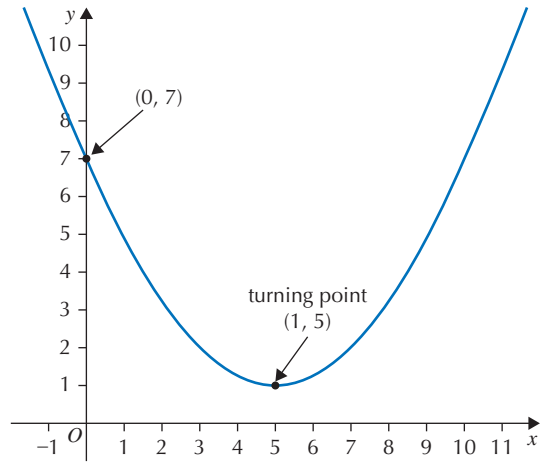
2 a



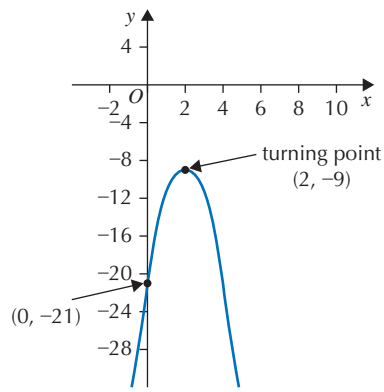
b



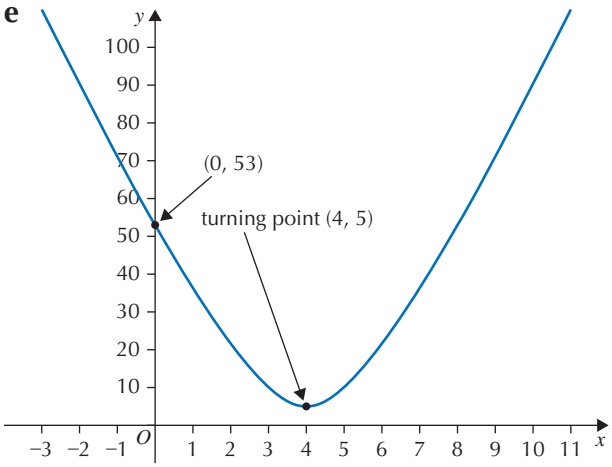
c



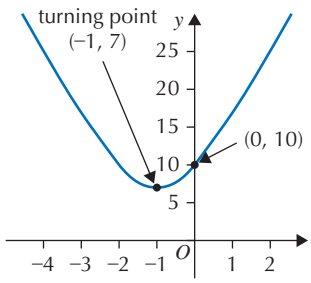
d



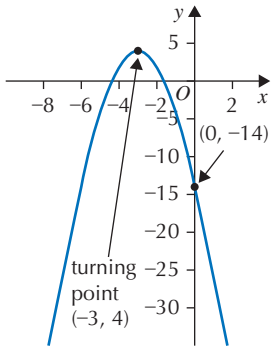
e



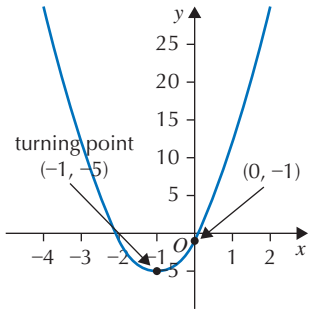
f



g

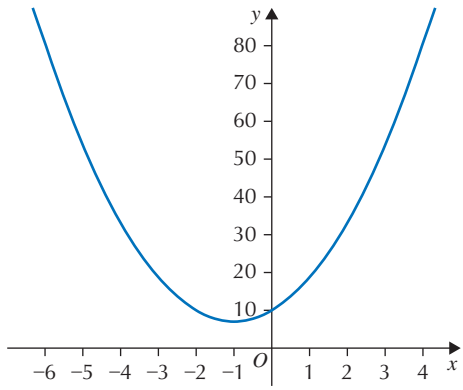


h



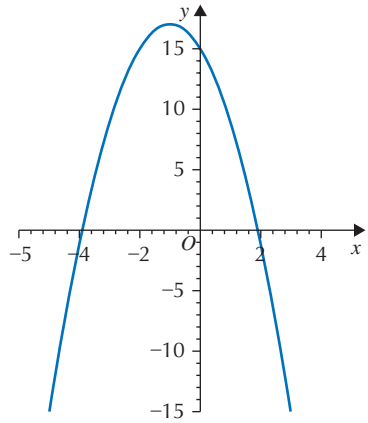
3 a $3(x+1)^2+7$

b



4 a $17-2(x+1)^2$

b



5 a $y=(x-2)^2+1$

b $y=27-2(x-3)^2$

c $y=3(x+5)^2+1$

d $y=3(x-2)^2+5$

e $y=-2(x-3)^2-1$

f $y=9-2(x-2)^2$

6 a $y=3(x+1)^2-5$

b $(-1,-5)$

7 a $y=\frac{29}{4}-\left(x-\frac{3}{2}\right)^2$

b $\left(\frac{3}{2},\frac{29}{4}\right)$

8 a $y=3(x+2)^2+42$

b $(-2,42)$

9 a $y=4\left(x-\frac{1}{2}\right)^2-16$

b $\left(\frac{1}{2},16\right)$

10 $(x+2)^2+5$ has minimum value of 5

11 $16-(x+1)^2$ is never greater than 16

12 $2\left(x+\frac{3}{2}\right)^2+\frac{13}{2}$ is never less than $\frac{13}{2}$

13 $p\left(x+\frac{q}{2p}\right)^2+r-\frac{q^2}{4p}$

turning point is at

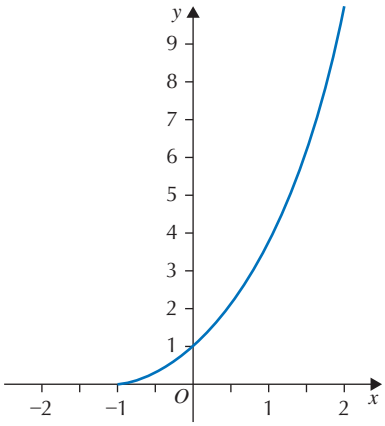
$x=-\frac{q}{2p}$

$y=r-\frac{q^2}{4p}$

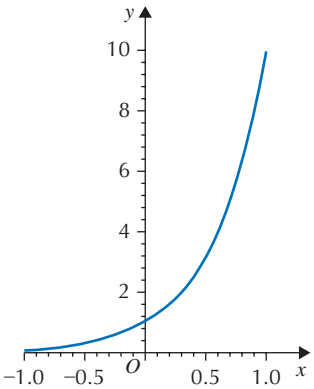
Exercise 3D

1

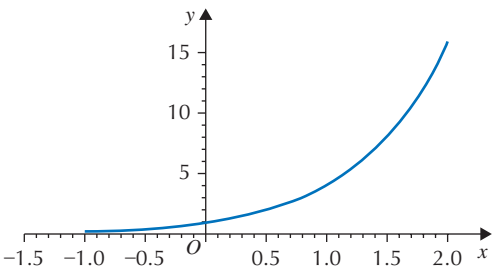
a



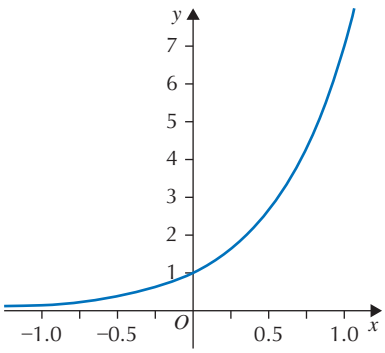
b



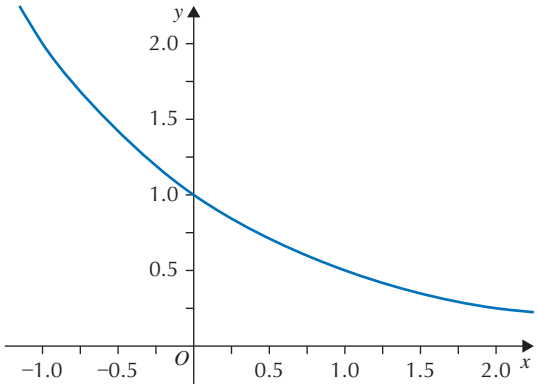
c



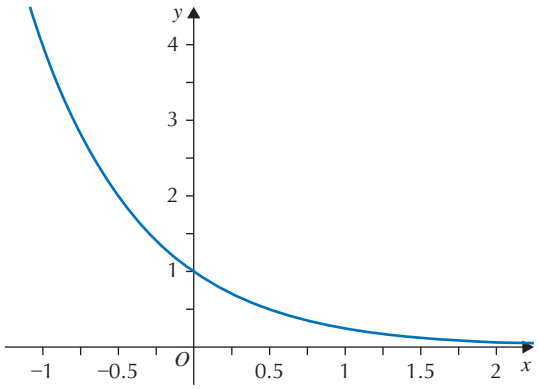
d



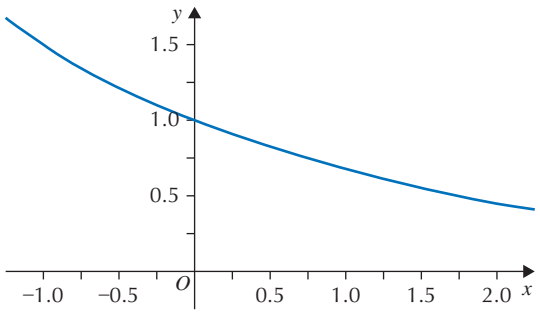
e



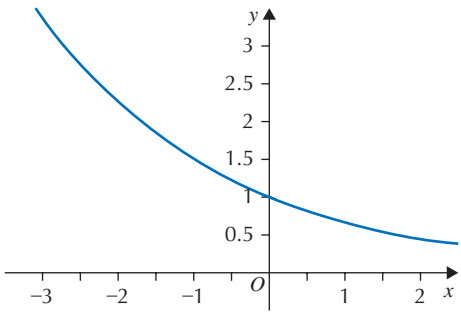
f



g



h



2 $y = a^x$; values of a follow:

a 6

b 3

c 4

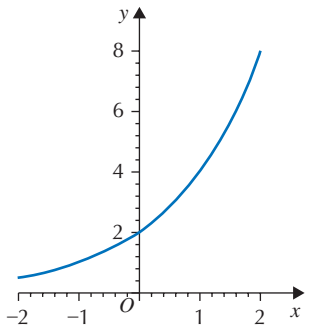
d 2

e $\frac{1}{2}$

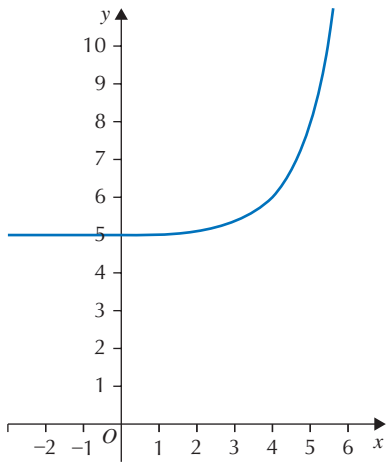
f $\frac{1}{3}$

3

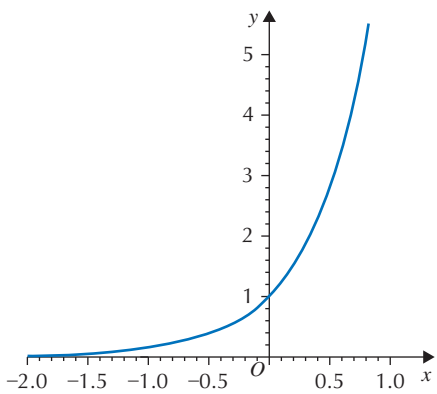
a


y
8
6
4
2
−2
−1
O
1
2
x

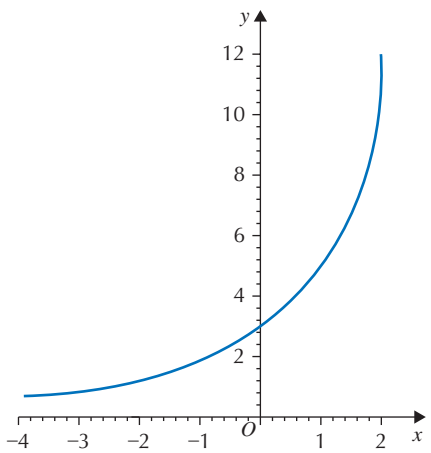
b


y
10
9
8
7
6
5
4
3
2
1
−2
−1
O
1
2
3
4
5
6
x

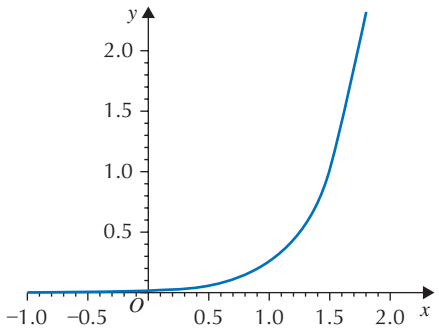
c


y
5
4
3
2
1
−2.0
−1.5
−1.0
−0.5
O
0.5
1.0
x

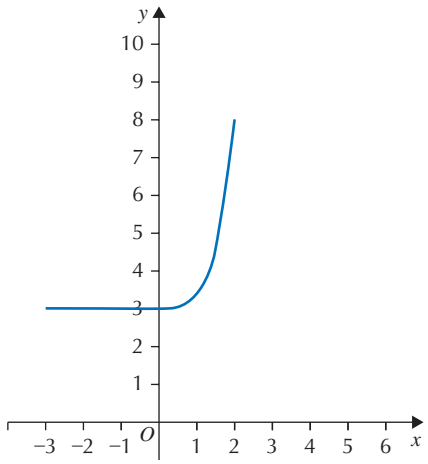
d


y
12
10
8
6
4
2
−4
−3
−2
−1
O
1
2
x

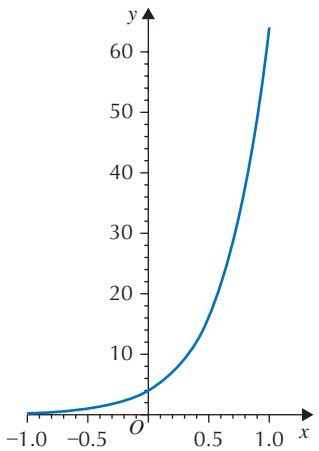
e


y
2.0
1.5
1.0
0.5
−1.0
−0.5
O
0.5
1.0
1.5
2.0
x

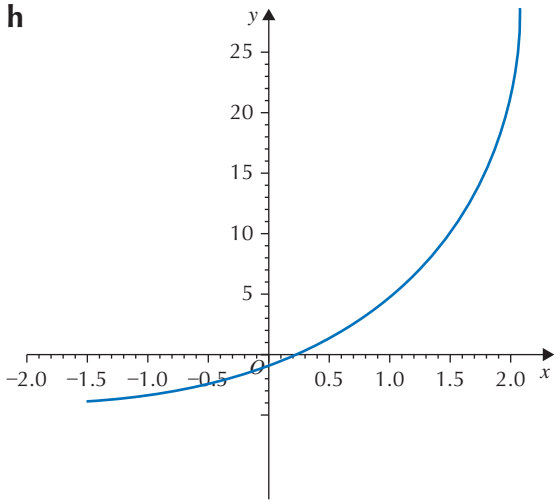
f


y
10
9
8
7
6
5
4
3
2
1
−3
−2
−1
O
1
2
3
4
5
6
x

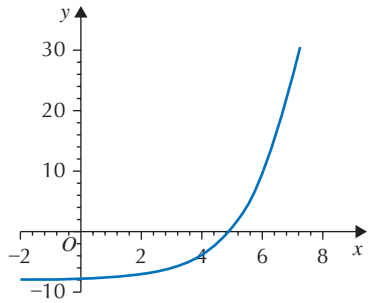
g


y
60
50
40
30
20
10
−1.0
−0.5
O
0.5
1.0
x

h

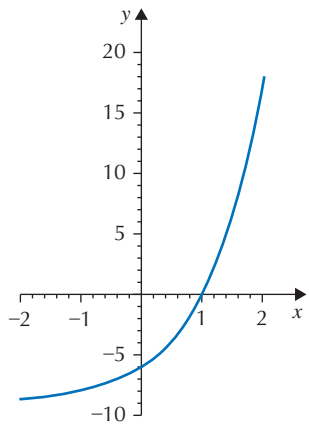

y
25
20
15
10
5
−2.0
−1.5
−1.0
−0.5
O
0.5
1.0
1.5
2.0
x

4



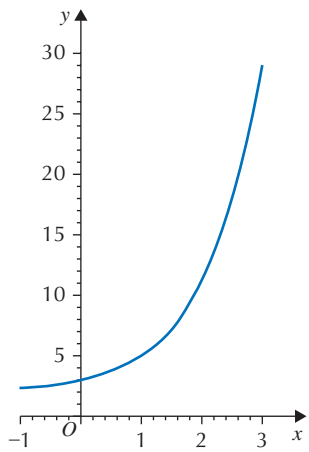
Cuts x axis at $x = 5$

5



Cuts x axis at $x = 1$

6

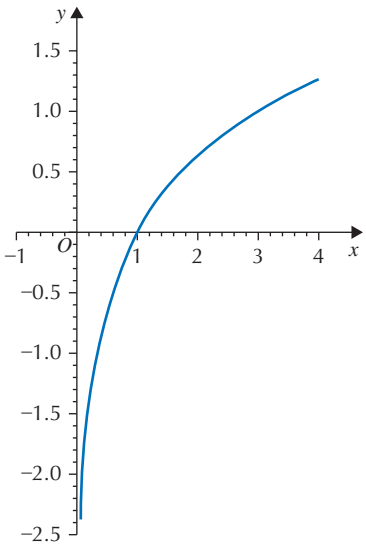


$y = 3^x + 2$ so $a = 3$, $b = 2$.

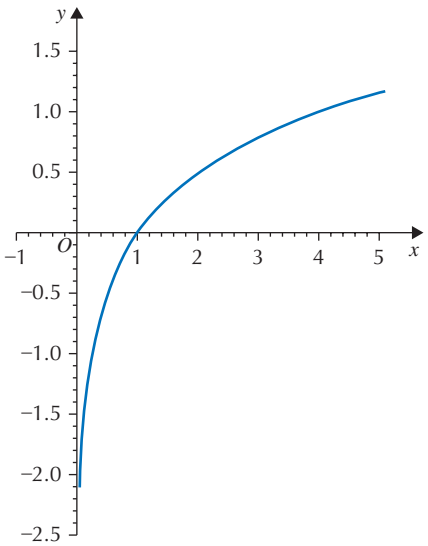
Exercise 3E

1

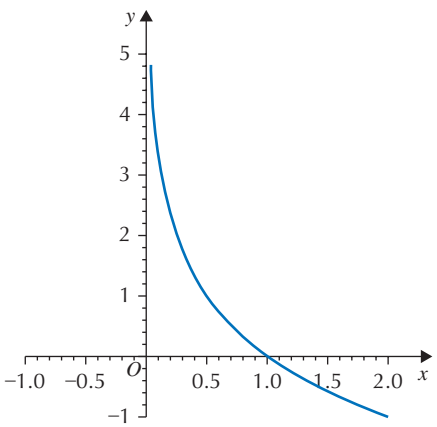
a



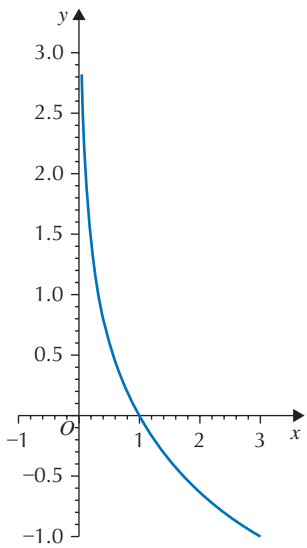
b



c



d



2 **a** $y = \log_6 x$

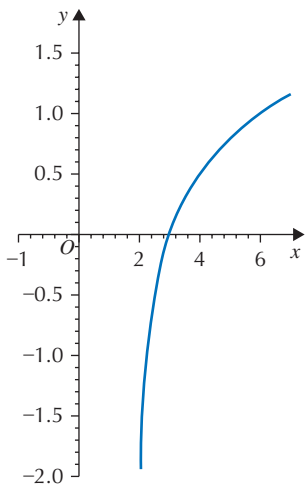
b $y = \log_{10} x$

c $y = \log_{\frac{3}{4}} x$

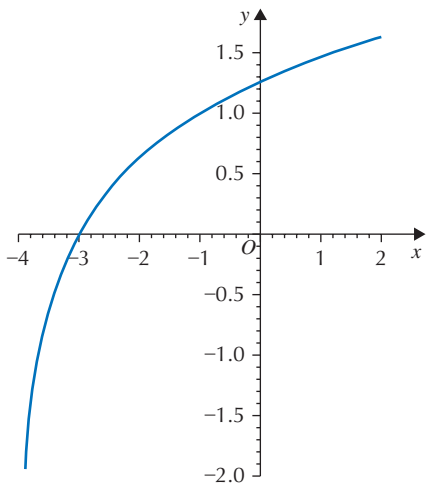
d $y = \log_{\frac{1}{5}} x$

3

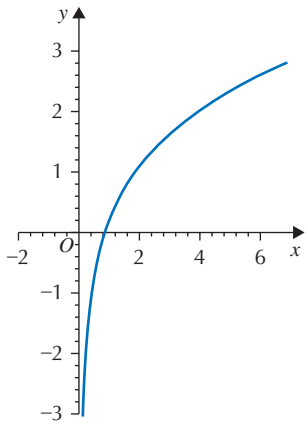
a



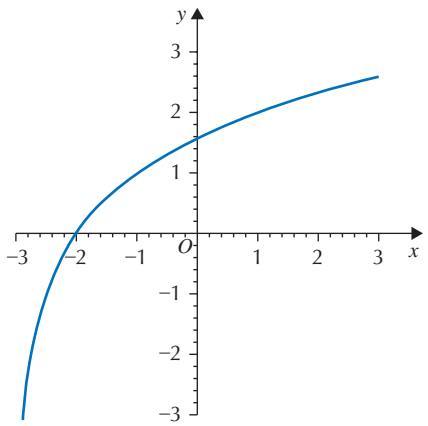
b



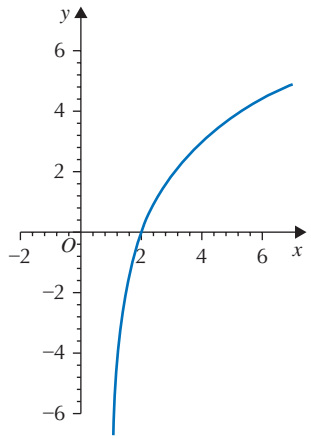
c



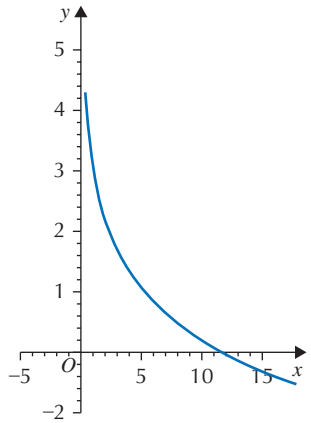
d



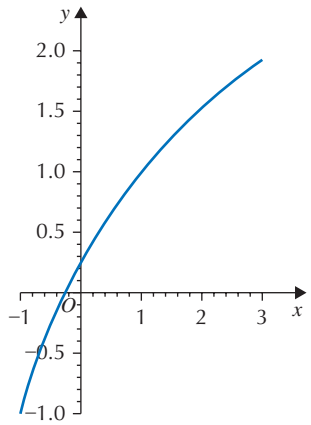
e


y
6
4
2
−2
O
2
4
6
x
−2
−4
−6

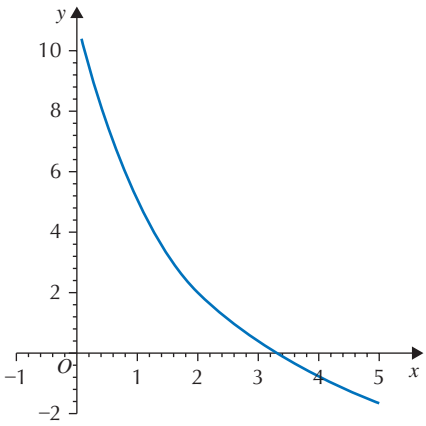
f


y
5
4
3
2
1
−5
O
5
10
15
x
−2

g

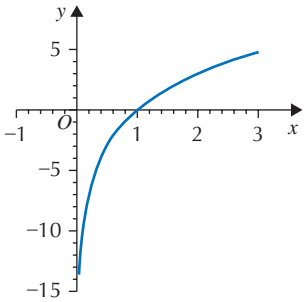

y
2.0
1.5
1.0
0.5
−1
O
1
2
3
x
−0.5
−1.0

h

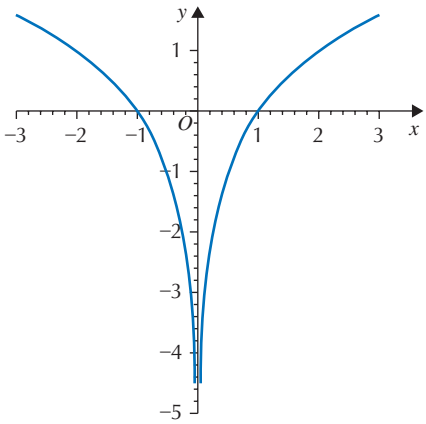

y
10
8
6
4
2
−1
O
1
2
3
4
5
x
−2

4

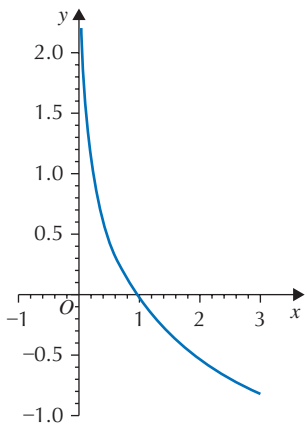
a


y
5
−1
O
1
2
3
x
−5
−10
−15

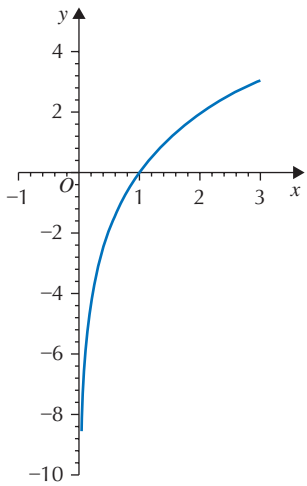
b


y
1
−3
−2
−1
O
1
2
3
x
−1
−2
−3
−4
−5

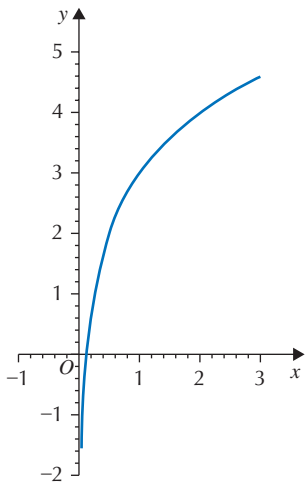
c



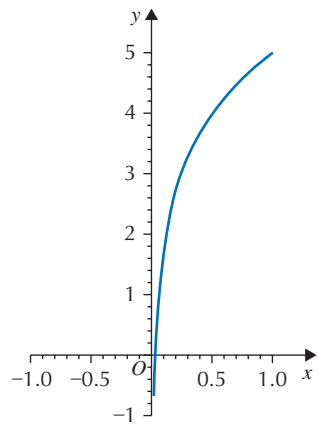
d



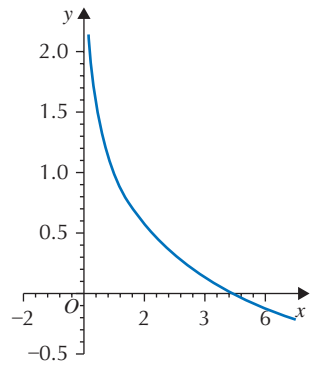
e



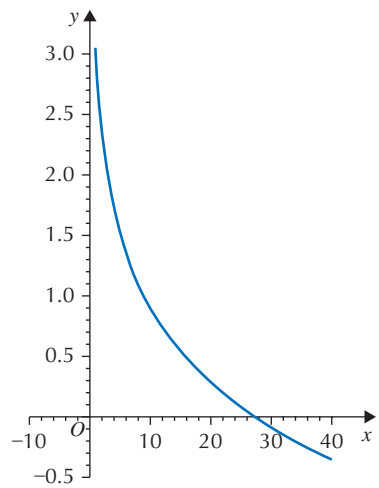
f



g



h

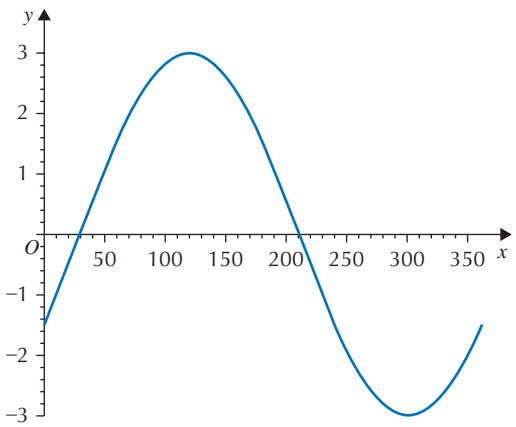


5 $a = 4$

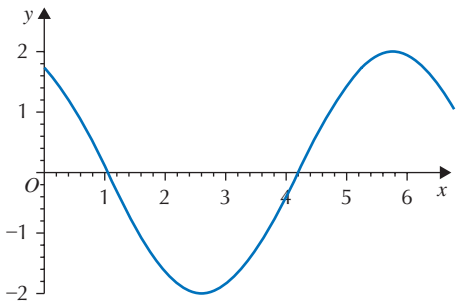
$b = 4$

Exercise 3F

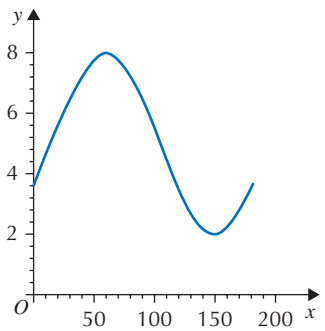
1 a



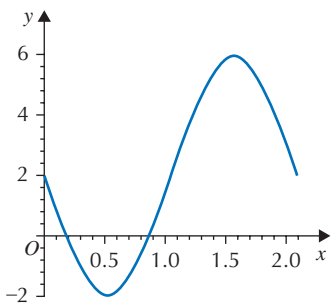
b



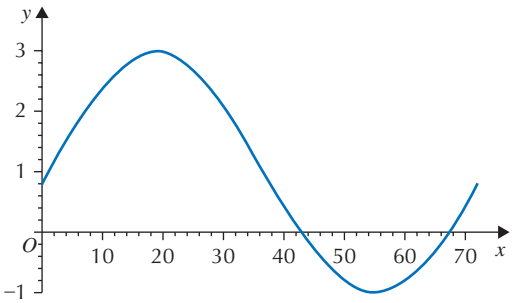
c



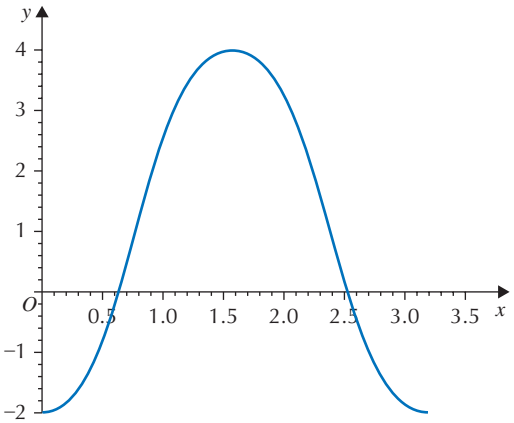
d



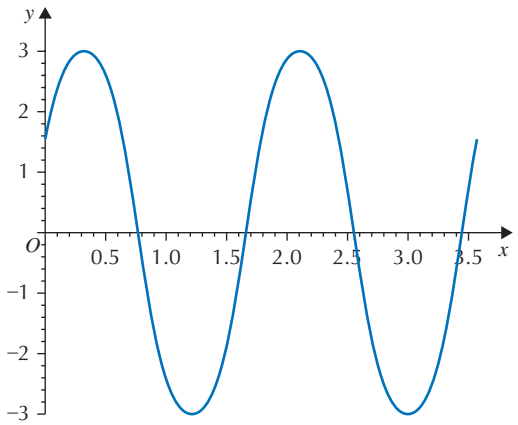
e



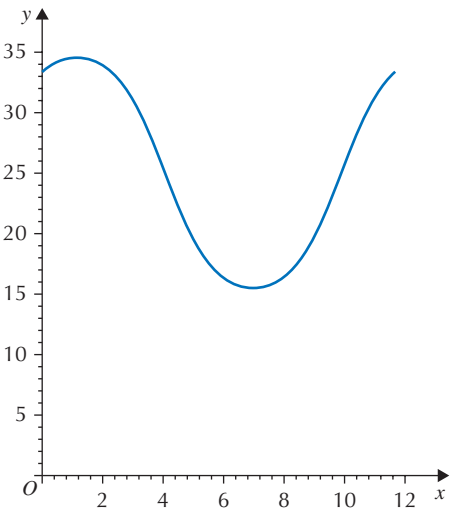
f



2



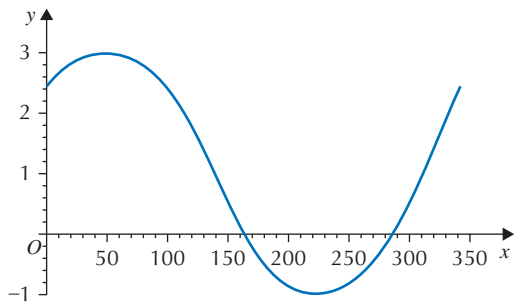
3



34.5 max at $t = 1$ => January

15.5 min at $t = 7$ => July

4



$A = 2$, $b = 45$, $c = -1$

5 $p = 4$, $q = 30$, $r = -1$

6 $a = 2.2$, $b = -30$, $c = 3.6$

7 **a** max (48, 4); min (228, −2)

b max (120, 27); min (300, 13)

c $\max\left(\frac{\pi}{4}, 25\right)$; $\min\left(\frac{5\pi}{4}, -15\right)$

d $\max\left(\frac{5\pi}{6}, 35\right)$; $\min\left(\frac{11\pi}{6}, -25\right)$

e $\max(126, 11)$; $\min(36, -3)$

f $\max(30, 6)$; $\min(12, -2)$

g $\max(11, 60)$; $\min(5, -40)$

h $\max\left(\frac{\pi}{24}, 4\right)$; $\min\left(\frac{\pi}{8}, -6\right)$

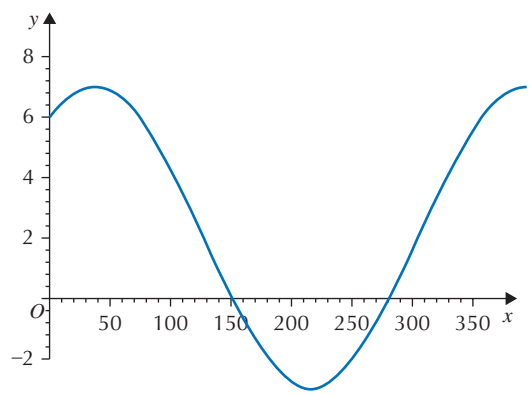
8 40cm at 8am

9 **a** max = 120; min = 80

b 80 bpm

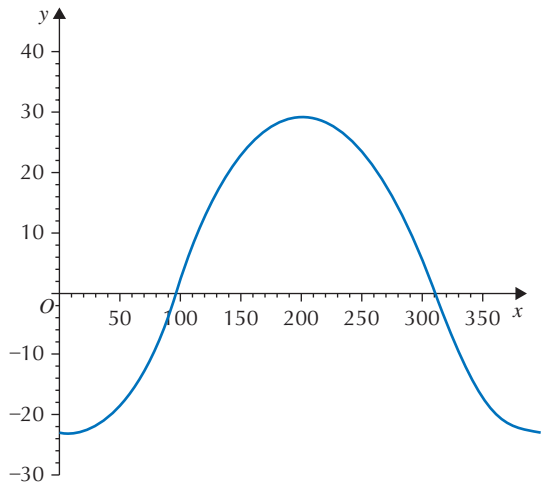
10a $5\cos(x - 36.87)$

b Max(36.87, 7); Min(216.87, 3)



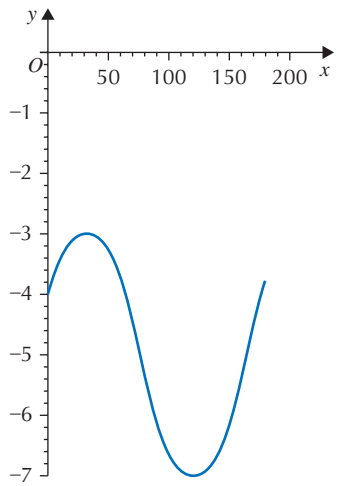
11a $13\sin(x + 67.38)$

b



c Min (22.62, −23); Max (202.62, 29)

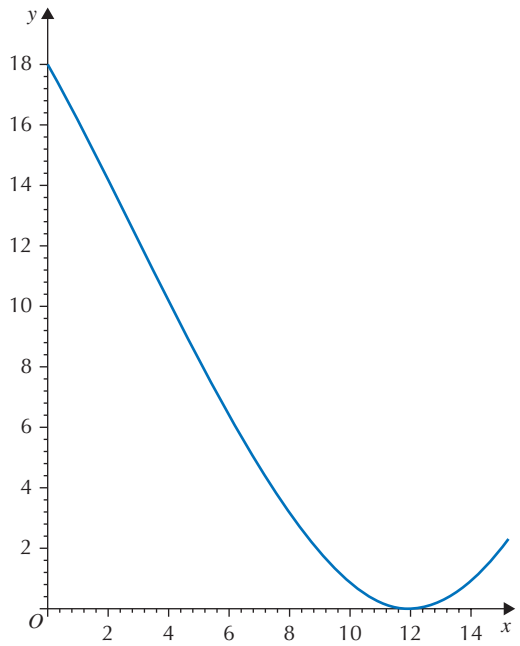
12a $2\sin(2x + 30)$



b Max(30, 1); Min(120, −11)

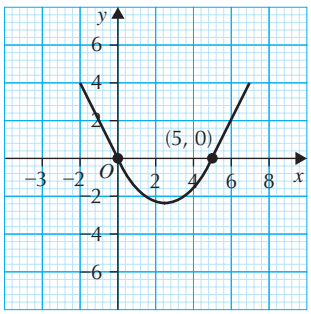
13 a $5\sin(12x - 53.13)$

b

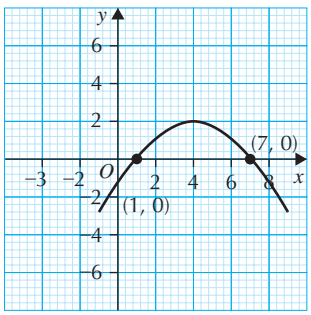


Exercise 3G

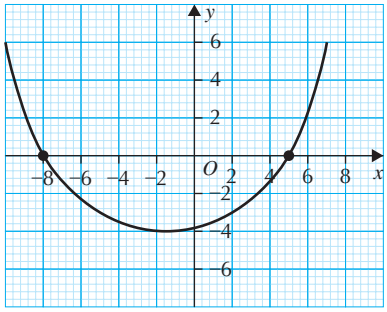
1 a



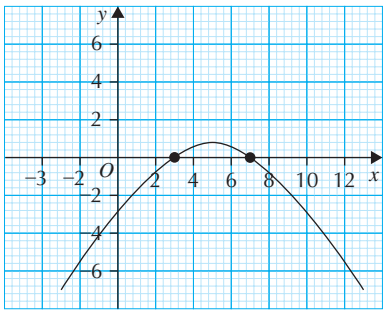
b



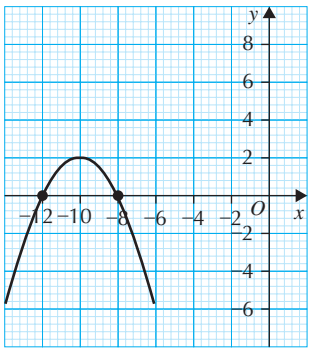
c



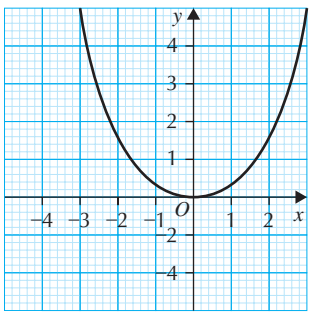
d



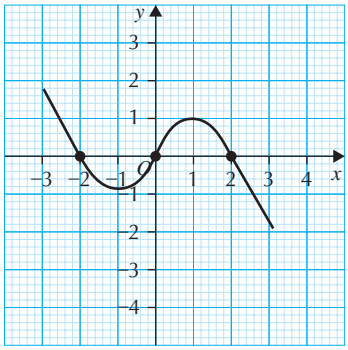
e



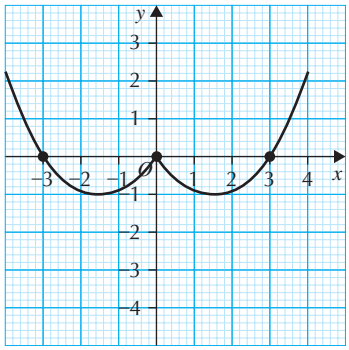
f



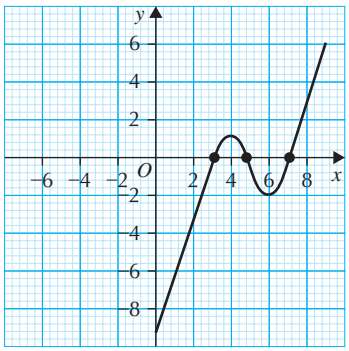
2 a



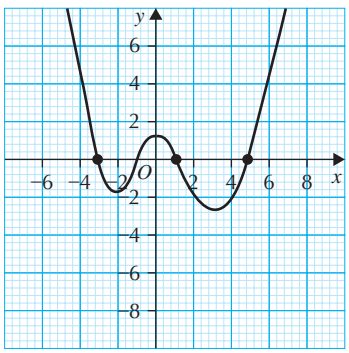
b


y
x
O
−3 −2 −1 1 2 3 4
3 2 1 −1 −2 −3 −4

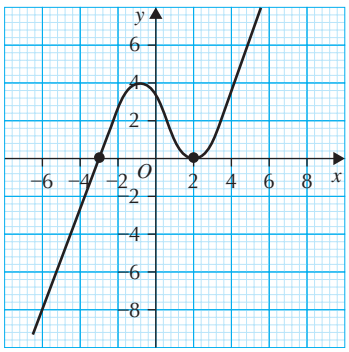
c


y
x
O
−6 −4 −2 2 4 6 8
6 4 2 −2 −4 −6 −8

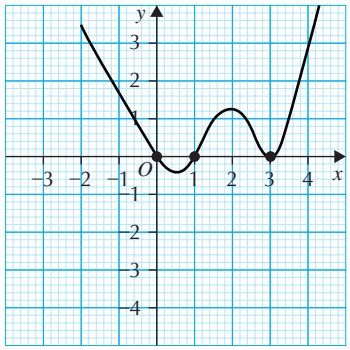
d


y
x
O
−6 −4 −2 2 4 6 8
6 4 2 −2 −4 −6 −8

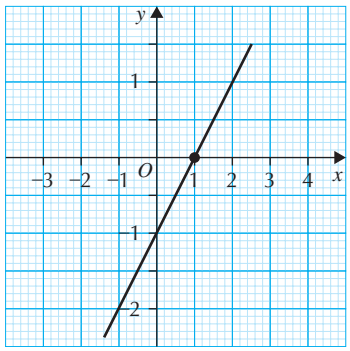
e


y
x
O
−6 −4 −2 2 4 6 8
6 4 2 −2 −4 −6 −8

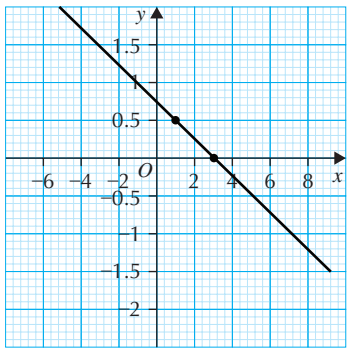
f


y
x
O
−3 −2 −1 1 2 3 4
3 2 1 −1 −2 −3 −4

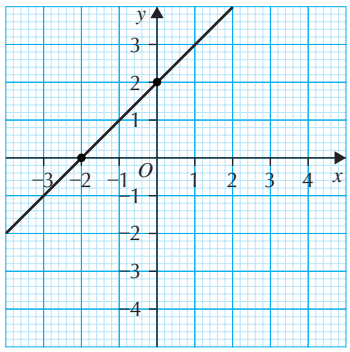
3 a


y
x
O
−3 −2 −1 1 2 3 4
1 −1 −2

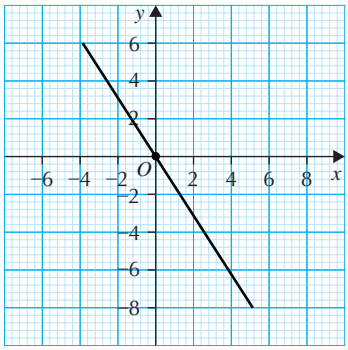
b


y
x
O
−6 −4 −2 2 4 6 8
1.5 1 0.5 −0.5 −1 −1.5 −2

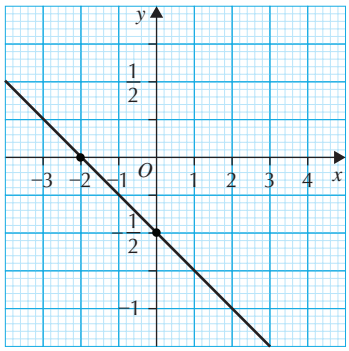
c


y
x
O
−3 −2 −1 1 2 3 4
3 2 1 −1 −2 −3 −4

d



e



f