Q4. (i) $3\sqrt{13}$
(ii) $(-5, 1)$
(iii) $(-8, -3.5)$ and $(-2, 5.5)$

calculator questions

Q5. (i) $A(-6, -2.5)$, $B(4, 2.5)$
(ii) $(1, 5)$
(iii) $x - 2y + 9 = 0$ or $y = \frac{1}{2}x + \frac{9}{2}$
(iv) $(-3.54, 2.73)$
(v) 25.9
(vi) 3.58
(vii) 29.1

Q6. (i) $\pm\begin{pmatrix}6.84\\13.7\end{pmatrix}$
(ii) $\pm\begin{pmatrix}1.75\\8.77\end{pmatrix}$
(iii) $\begin{pmatrix}0\\0\end{pmatrix}$
(iv) $\begin{pmatrix}-4\\-8\end{pmatrix}$

Q7. (i) $A(12.2, 0)$, $B(0.935)$
(ii) $(6.12, 4.68)$
(iii) 114

Chapter 4
Functions

4.1 Basic properties

Q1. (1) yes (2) yes (3) yes (4) no (5) no (6) yes

Q2. (1) (i) $-4 < x \leq 4$
(ii) $-3 \leq y \leq 3$
(iii) $-2, 2.5$
(iv) $]-5, 1]$
(v) $[1, 4]$
(vi) —
(vii) $0, 1.5$

(2) (i) $-5 \leq x < 5$
(ii) $-3 \leq y < 2$
(iii) 3
(iv) $[-5, -1]$, $[2, 5[$
(v) —
(vi) $[-1, 2]$
(vii) $[-1, 2]$

(3) (i) $-5 < x \leq 5$
(ii) $1 \leq y < 2$
(iii) —
(iv) —
(v) $]-5, -3]$, $]-3, -1]$, $]-1, 1]$, $]1, 3]$, $]3, 5]$
(vi) —
(vii) —

(4) (i) $-5 \leq x < 5$
(ii) $\{-2, -1, 0, 1, 2, \}$
(iii) $[-1, 1[$
(iv) —
(v) —
(vi) $[-5, -3[$, $[-3, -1[$, $[-1, 1[$, $[1, 3[$, $[3, 5[$
(vii) —

(5) (i) $x \geq -5$
(ii) $-2 \leq y \leq 2$
(iii) -4
(iv) $[-5, -3]$
(v) $[-3, -1]$
(vi) $x \geq -1$
(vii) $-3.5 < x < -1$

(6) (i) $-4 < x \leq 2$
(ii) $-3 < y \leq 3$
(iii) -1
(iv) $-4 < x \leq 2$
(v) —
(vi) —
(vii) $-4 < x \leq -2$

(7) (i) $-5 \leq x \leq 2$
(ii) $-2 \leq y \leq 3$
(iii) $-3.5, -1$
(iv) $[-5, -2[$, $[-2, 2]$
(v) —
(vi) —
(vii) 1

(8) (i) $x \geq -5$
(ii) $y \geq -1$
(iii) $-3, -1.5$
(iv) $[-2, -1]$, $[4, +\infty[$
(v) $[-5, -2]$
(vi) $[-1, 4]$
(vii) $[-3, -1.5]$

(9) (i) $[-4, 5[$
(ii) $[-1, 2[$
(iii) $-\frac{10}{3}, -\frac{1}{2}, 4$
(iv) $[-4, -2[$, $[-2, 1[$
(v) $[3, 5[$
(vi) $[1, 3[$
(vii) $-\frac{8}{3}, 3$

(10) (i) $x \leq 5$
(ii) $y \leq 2$
(iii) $-3.5, -1.5$
(iv) $x \leq -3$
(v) $[-2, -1[$, $[-1, 0]$
(vi) $[-3, -2] \cup [0, 5]$
(vii) $x \leq -4$

(11) (i) $x \geq -4$
(ii) $y \leq 4$
(iii) 3
(iv) $[-2, -1]$
(v) $[-4, -2]$, $[-1, +\infty[$
(vi) –
(vii) $-4, -1.5, 0$

(12) (i) $-4 < x \leq 5$
(ii) $-2 \leq y < 3$
(iii) $-2.5, -1, 2$
(iv) $[-2, 1]$, $[4, 5]$
(v) $]-4, -2]$, $[1, 4]$
(vi) —
(vii) $-2, 3, 5$

(13) (i) $x \leq 4$
(ii) $y \leq 3$

(iii) $-4, -2$
(iv) $]-\infty, -3]$, $[-2, 0]$, $[3, 4]$
(v) $[-3, -2]$, $[0, 3]$
(vi) —
(vii) $-3, -1, 1, 3.5$

(14) (i) $-4 \leq x < 5$
(ii) $-2 < y \leq 2$
(iii) $-2, -1, 4$
(iv) $[2, 3]$
(v) $[-4, -3[$, $[-3, -2]$, $]-2, -1]$, $]-1, 0[$, $[0, 2]$, $[3, 5[$
(vi) —
(vii) $-4, -3, 0, 3$

(15) (i) $-5 < x < 3$
(ii) $-2 \leq y \leq 2$
(iii) $-4, -1, 2$
(iv) $]-5, -3]$, $[1, 3[$
(v) $[-3.1]$
(vi) —
(vii) -3

(16) (i) $-4 < x < 4$
(ii) $-3 < y \leq 3$
(iii) $-3, 1$
(iv) $]-4, -1]$, $[2, 3]$
(v) $[-1, 2]$, $[3, 4[$
(vi) —
(vii) —

(17) (i) $-4 \leq x \leq 3$
(ii) $-2 \leq y \leq 3$
(iii) $-3.5, 1$
(iv) $[-4, -2]$
(v) $[-2, 3]$
(vi) —
(vii) $[-4, 3[\cup]0, 3]$

(18) (i) $-4 < x \leq 3$
(ii) $-2 \leq y \leq 2$
(iii) $-2, 0, 3$
(iv) $]-4, -1]$, $[1, 3]$
(v) $[-1, 1]$
(vi) —
(vii) $]-4, -3[\cup]-0.5, 2[$

(19) (i) $-5 < x \leq 3$
(ii) $1 \leq y \leq 3$
(iii) —
(iv) $]-5, -3]$, $[-1, 1]$
(v) $[-3, -1]$, $[1, 3]$
(vi) —
(vii) $]-5, -3[\cup]-3, 0[\cup]2, 3]$

(20) (i) $-5 \leq x \leq 3$
(ii) $-2 \leq y \leq 2$
(iii) 2, between -4 and -3, between -2 and -1
(iv) $[-3, 0]$, $[2, 3]$
(v) $[-5, -3]$, $[0, 2]$
(vi) —
(vii) $]-5, -1[\cup]1, 3[$

(21) (i) $-4 < x \leq 3$
(ii) $0 \leq y \leq 2$
(iii) 3
(iv) $]-4, -3]$
(v) $[-3, -2]$, $[1, 3]$
(vi) $[-2, 1[$
(vii) $[-2, 1[\cup\{2\}$

(22) (i) $x \leq 2$
(ii) $y \geq -1$
(iii) $-3, -1$
(iv) $[-2, 0]$
(v) $]-\infty, -2]$
(vi) $[0, 2]$
(vii) $]-3, -1[$

(23) (i) $-4 < x \leq 4$
(ii) $-1 < y \leq 1$
(iii) $-3, -1, 1, 3$
(iv) $]-4, -2]$, $]-2, 0]$, $]0, 2]$, $]2, 4]$
(v) —
(vi) —
(vii) $\{-2, 0, 2, 4\}$

(24) (i) $-3 \leq x < 1$
(ii) $\{-1, 0, 1, 2\}$
(iii) $[-1, 0[$
(iv) —
(v) —
(vi) $[-3, -2[$, $[-2, -1[$, $[-1, 0[$, $[0, 1[$
(vii) $[-1, 1[$

(25) (i) $-4 \leq x \leq 4$
(ii) $-3 \leq y \leq 2$
(iii) $-1, 0, 3$
(iv) $[-4, -1]$, $[0, 1[$
(v) $]-1, 0]$, $[1, 4]$
(vi) —
(vii) $[-4, 1[\cup[1, 2]$

(26) (i) $-4 < x \leq 3$
(ii) $-2 \leq y \leq 2$
(iii) $-3.5, 2$
(iv) $]-4, 1]$, $]-1, 1]$
(v) $[1, 3]$
(vi) —
(vii) $-4 < x \leq 3$

(27) (i) $-3 \leq x < 2$, $2 < x \leq 3$
(ii) $y = -1$, $0 \leq y \leq 2$
(iii) -2
(iv) $[-2, -1]$
(v) $[1, 2[$
(vi) $[-3, -2[$, $[-1, 1]$, $]2, 3]$
(vii) $[-3, -2]\cup]2, 3]$

(28) (i) $-4 < x \leq -1$, $0 < x \leq 2$
(ii) $-3 < y \leq 2$
(iii) $-2, 2$
(iv) $]-4, -1]$, $]0, 1]$
(v) $[1, 2]$
(vi) —
(vii) $]-2, -1]\cup]0, 2[$

(29) (i) $x > -4$
(ii) $y \geq -1$
(iii) 0
(iv) $]-3, -1]$, $[1, +\infty[$
(v) $]-4, -3]$, $]0, 1]$
(vi) —
(vii) $\{-1\}\cup]0, +\infty[$

(30) (i) $-2 < x \leq 3$
(ii) $-2 \leq y \leq 1$
(iii) 2
(iv) $[1, 3]$
(v) $]-2, -1]$
(vi) $[-1, 0]$, $]0, 1]$
(vii) $[-1, 0]$

Q3. (1) domain: $\mathbb{R}$, range: $[0, +\infty[$
(2) domain: $\mathbb{R}$, range: $\mathbb{R}$
(3) domain: $\mathbb{R} \setminus \{0\}$, range: $\mathbb{R} \setminus \{0\}$
(4) domain: $[0, +\infty[$, range: $[0, +\infty[$
(5) domain: $\mathbb{R}$, range: $\mathbb{R}$
(6) domain: $\mathbb{R}$, range: $[0, +\infty[$

Q4. (1) $-\frac{5}{2}$ (2) 3 (3) $\frac{1}{3}$ (4) ± 3 (5) $\frac{1}{2}$ (6) $-3, 1$ (7) $-\frac{3\pi}{2}$ (8) $-\frac{1}{3}$ (9) -5.5 (10) ± 2 (11) $-3, 1$ (12) — (13) $-2\sqrt{3}$ (14) 4.5 (15) 2 (16) 1 (17) $\frac{1}{2}, \frac{7}{2}$ (18) 9

Q5. (1) domain: $\mathbb{R}$, range: $\mathbb{R}$
(2) domain: $]-\infty, 3]$, range: $[0, +\infty[$
(3) domain: $\mathbb{R} \setminus \{1\}$, range: $\mathbb{R} \setminus \{3\}$
(4) domain: $\mathbb{R}$, range: $[-4, +\infty[$
(5) domain: $\mathbb{R}$, range: $[-2, +\infty[$
(6) domain: $\mathbb{R}$, range: $\mathbb{R}$
(7) domain: $[-\frac{1}{3}, +\infty[$, range: $[0, +\infty[$
(8) domain: $\mathbb{R} \setminus \{-4\}$, range: $\mathbb{R} \setminus \{-2\}$
(9) domain: $\mathbb{R}$, range: $[-9, +\infty[$
(10) domain: $\mathbb{R}$, range: $[3, +\infty[$
(11) domain: $\mathbb{R}$, range: $\mathbb{R}$
(12) domain: $[0, +\infty[$, range: $[-3, +\infty[$
(13) domain: $\mathbb{R}$, range: $[0, +\infty[$
(14) domain: $\mathbb{R}$, range: $]-\infty, 3]$
(15) domain: $[0, \frac{1}{4}[\cup]\frac{1}{4}, +\infty[$, range: $]-\infty, 4[\cup [7, +\infty[$

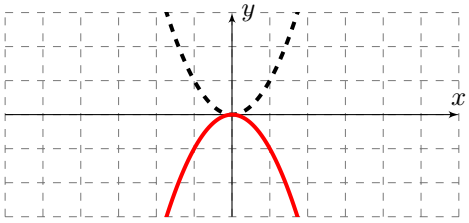
Q6. (1) 1 (2) 3 (3) 3.5 (4) -40 (5) 16 (6) 0 (7) 5π (8) 5 (9) -3 (10) $-\frac{11}{9}$ (11) $\frac{13}{9}$ (12) 4.2 (13) 18 (14) $2\sqrt{6} - 3$ (15) -16 (16) -27 (17) $\frac{2}{3}$ (18) $-\frac{1}{3}$

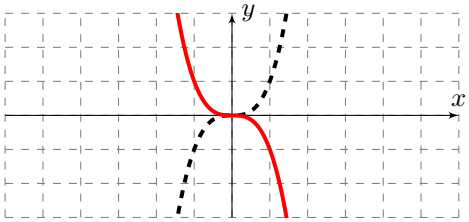
Q7. (1) $f(-x) = -2x + 5$
(2) $f(-x) = \sqrt{3 + x}$
(3) $f(-x) = 3 - \frac{2}{x+1}$
(4) $f(-x) = 9 - x^2$
(5) $f(-x) = (2x + 1)^2$
(6) $f(-x) = |1 - x| - 2$
(7) $f(-x) = -\frac{2}{3}x + \pi$
(8) $f(-x) = \sqrt{1 - 3x}$
(9) $f(-x) = \frac{3}{x-4} - 2$
(10) $f(-x) = x^2 - 4$
(11) $f(-x) = (1 - x)^2 - 4$
(12) $f(-x) = 3 + |4 + 2x|$
(13) $f(-x) = -\sqrt{3}x + 6$
(14) $f(-x) = \sqrt{-2x} - 3$
(15) $f(-x) = -x^3 - 8$
(16) $f(-x) = -(x + 1)^3$
(17) $f(-x) = 3 - |2x + 4|$
(18) $f(-x) = \frac{\sqrt{-x}-3}{2\sqrt{-x}-1}$

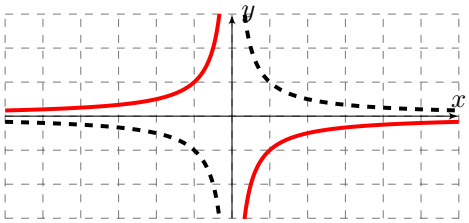
Q8. (1) O (2) N (3) O (4) E (5) E (6) N (7) O (8) O (9) N (10) E (11) N (12) E (13) E (14) O (15) E (16) N (17) E (18) N

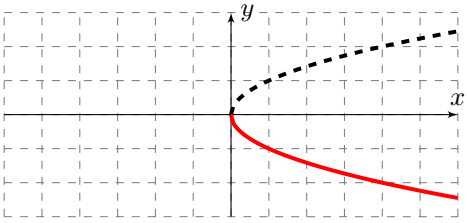
4.2 Transformations of graphs of functions

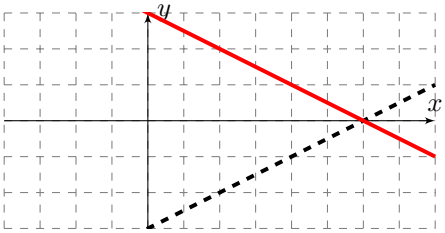
Q9. Graphs of $y = f(x)$ (black, dashed) and $y = -f(x)$ (red, solid)

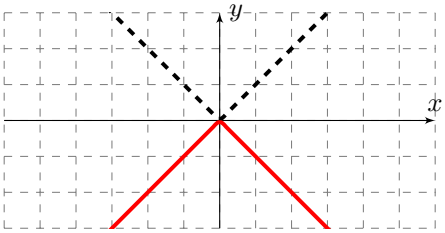
(1)


(2)


(3)


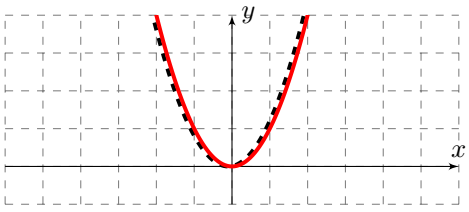
(4)


(5)


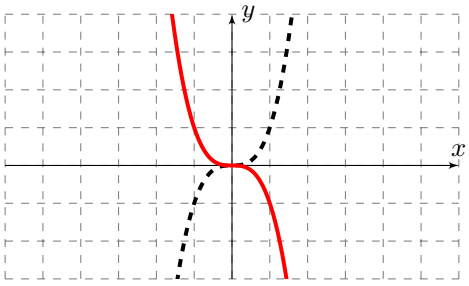
(6)


Q10. Graphs of $y = f(x)$ (black, dashed) and $y = f(-x)$ (red, solid)

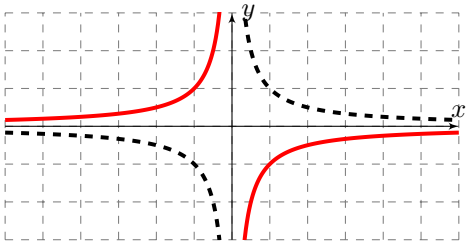
(1)



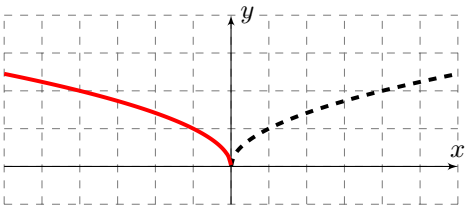
(2)



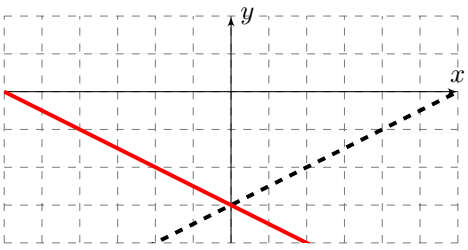
(3)



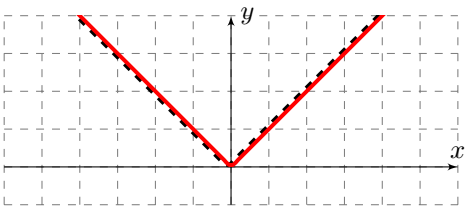
(4)



(5)

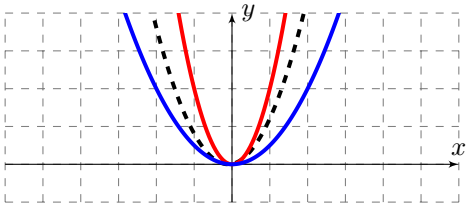


(6)

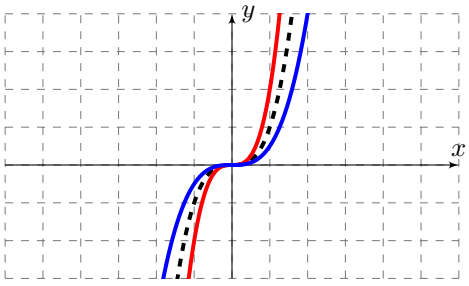


Q11. Graphs of $y = f(x)$ (black, dashed), $y = 2f(x)$ (red, solid) and $y = \frac{1}{2}f(x)$ (blue, solid)

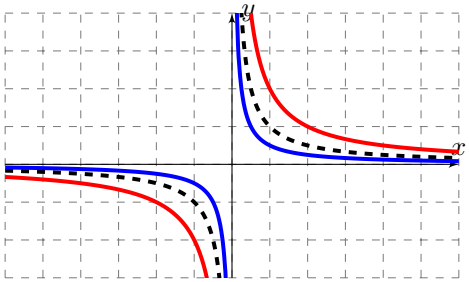
(1)



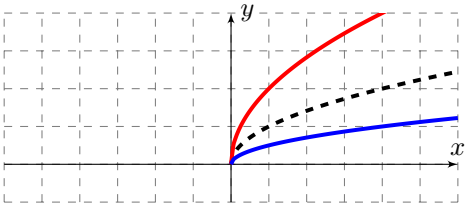
(2)



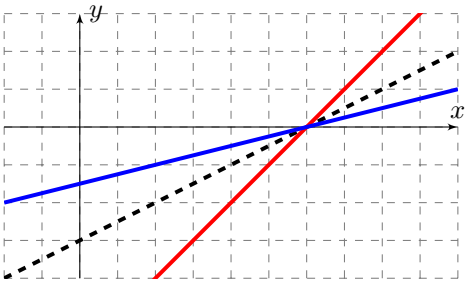
(3)



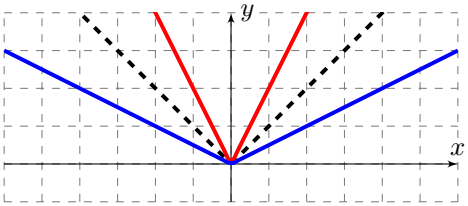
(4)



(5)

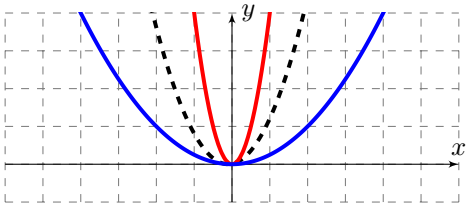


(6)

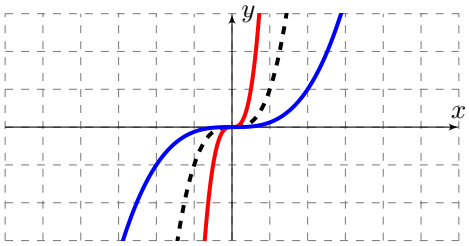


Q12. Graphs of $y = f(x)$ (black, dashed), $y = f(2x)$ (red, solid) and $y = f(\frac{1}{2}x)$ (blue, solid)

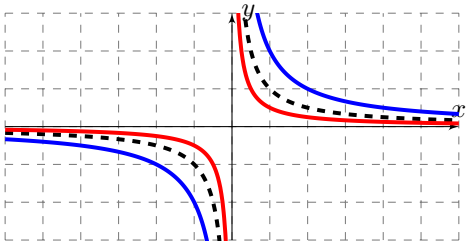
(1)



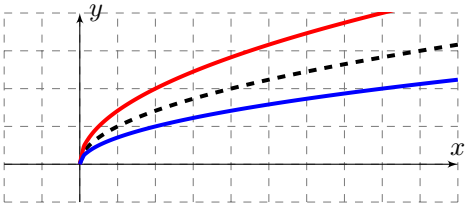
(2)



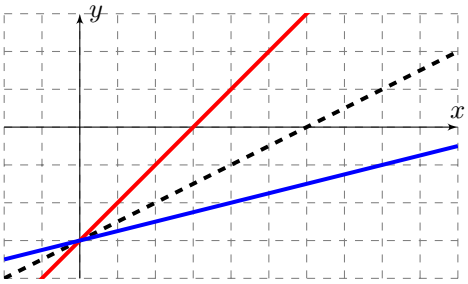
(3)



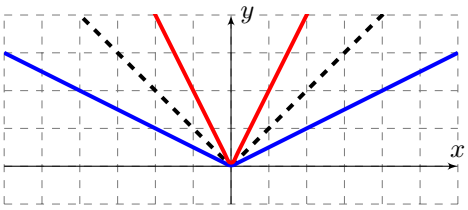
(4)



(5)

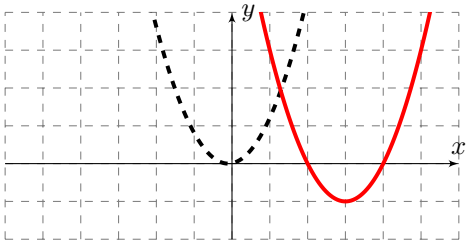


(6)



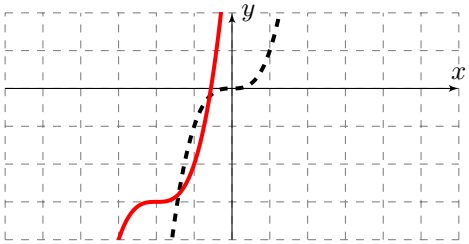
Q13. Graphs of $y = f(x)$ (black, dashed) and $y = g(x)$ (red, solid).

(1)



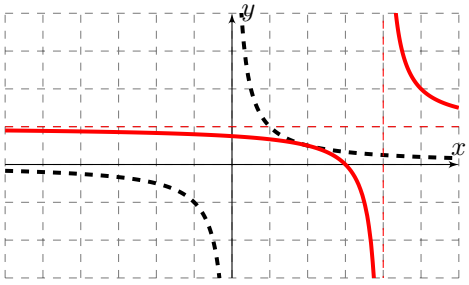
$g(x) = (x-3)^2 - 1$
$x \in \mathbb{R}$, $y \geq -1$

(2)



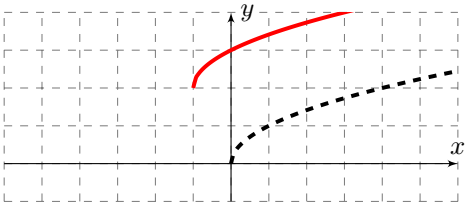
$g(x) = (x+2)^3 - 3$
$x, y \in \mathbb{R}$

(3)



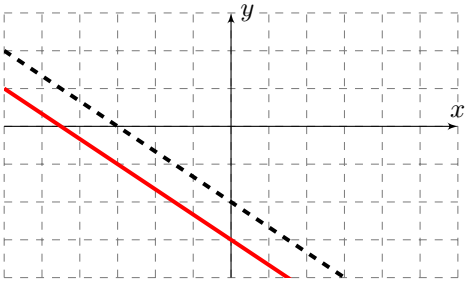
$g(x) = \frac{1}{x-4} + 1$
$x \in \mathbb{R} \setminus \{4\}$, $y \in \mathbb{R} \setminus \{1\}$

(4)



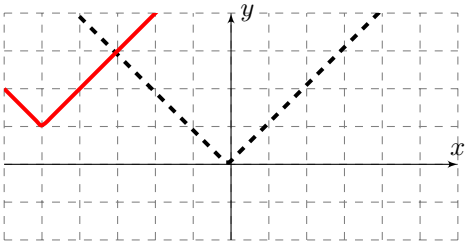
$g(x) = \sqrt{x+1} + 2$
$x \geq -1$, $y \geq 2$

(5)



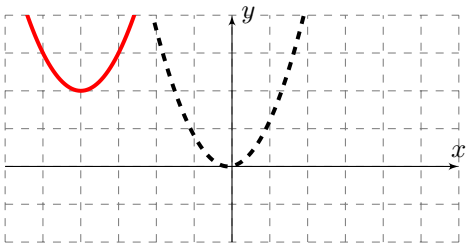
$g(x) = -\frac{2}{3}x - 3$
$x, y \in \mathbb{R}$

(6)



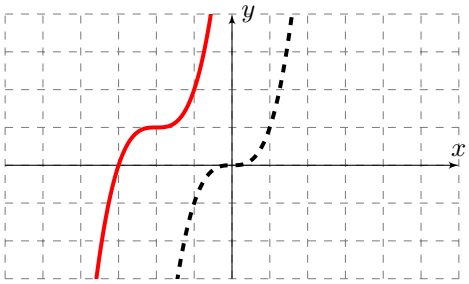
$g(x) = |x+5| + 1$
$x \in \mathbb{R}$, $y \geq 1$

(7)



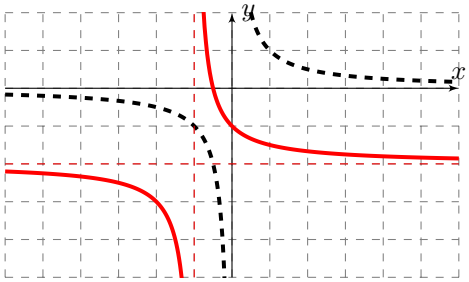
$g(x) = (x+4)^2 + 2$
$x \in \mathbb{R}$, $y \geq 2$

(8)



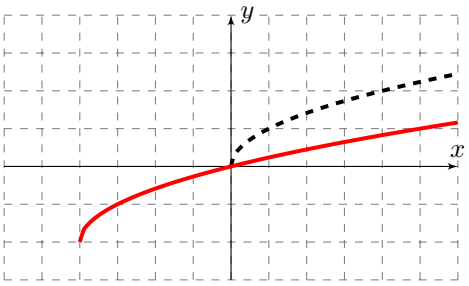
$g(x) = (x+2)^3 + 1$
$x, y \in \mathbb{R}$

(9)



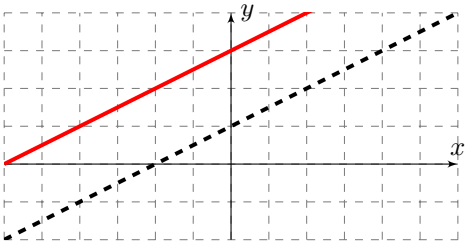
$g(x) = \frac{1}{x+1} - 2$
$x \in \mathbb{R} \setminus \{-1\}$, $x \in \mathbb{R} \setminus \{-2\}$

(10)



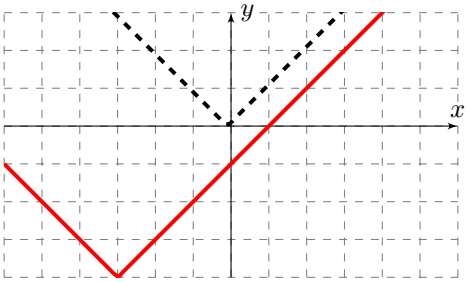
$g(x) = \sqrt{x+4} - 2$
$x \geq -4$, $y \geq -2$

(11)



$g(x) = \frac{1}{2}x + 3$
$x, y \in \mathbb{R}$

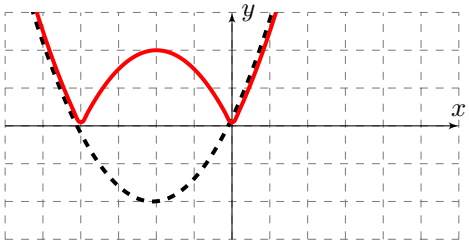
(12)



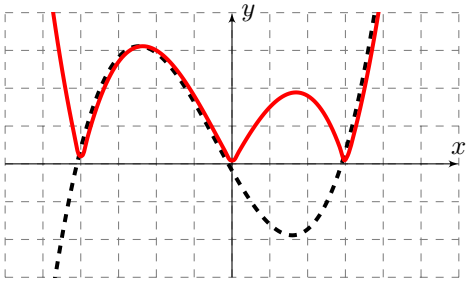
$g(x) = |x+3| - 4$
$x \in \mathbb{R}$, $y \geq -4$

Q14. $y = f(x)$ (black, dashed), $y = |f(x)|$ (red, solid)

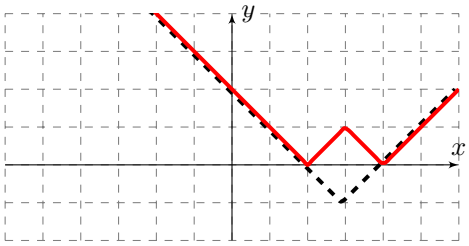
(1)



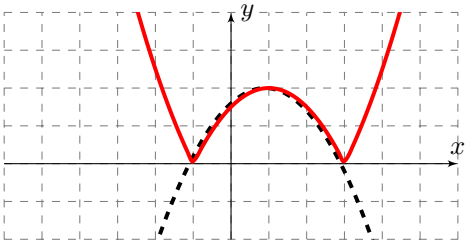
(2)



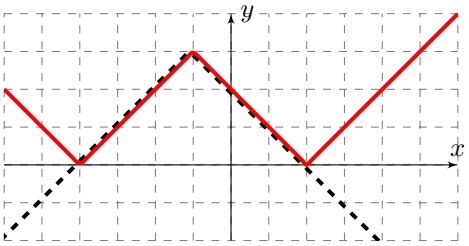
(3)



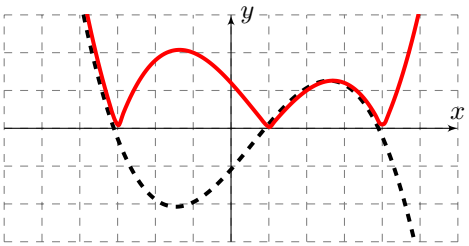
(4)



(5)

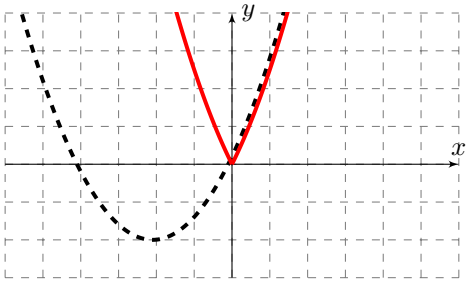


(6)

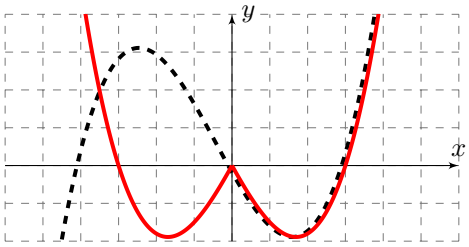


Q15. graph of $y = f(x)$ (dashed, black) and of $y = f(|x|)$ (solid, red)

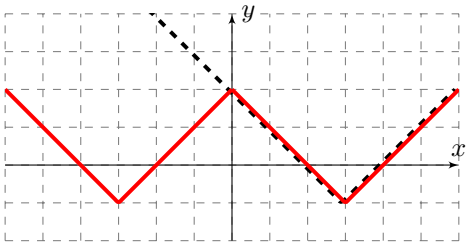
(1)



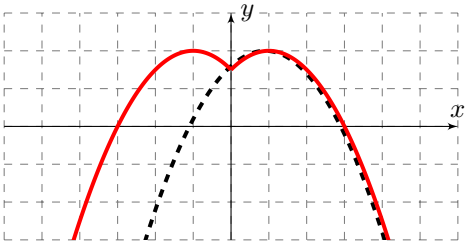
(2)



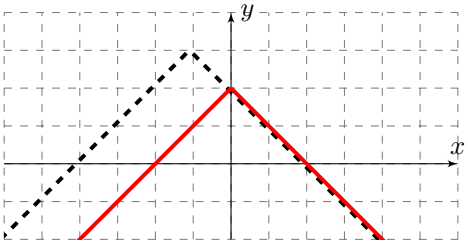
(3)



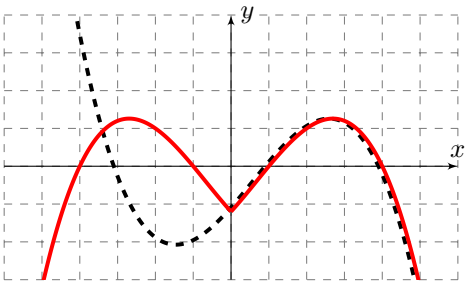
(4)



(5)



(6)



Q16. (1) (i) $y = x^2$

(ii) translation by $\begin{pmatrix} 3 \\ 1 \end{pmatrix}$

(iii) $y = (x-3)^2 + 1$

(2) (i) $y = x^2$

(ii) translation by $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$

(iii) $y = (x-2)^2 - 4$

(3) (i) $y = x^2$

(ii) translation by $\begin{pmatrix} -1 \\ -4 \end{pmatrix}$

(iii) $y = (x+1)^2 - 4$

(4) (i) $y = x^3$

(ii) translation by $\begin{pmatrix} 4 \\ 1 \end{pmatrix}$

(iii) $y = (x-4)^3 + 1$

(5) (i) $y = x^3$

(ii) translation by $\begin{pmatrix} -5 \\ 1 \end{pmatrix}$

(iii) $y = (x+5)^3 + 1$

(6) (i) $y = x^3$

(ii) reflection in x-axis or in y-axis

(iii) $y = -x^3$

(7) (i) $y = x^3$

(ii) reflection in x-axis or in y-axis

followed by translation by $\begin{pmatrix} -5 \\ 1 \end{pmatrix}$

(iii) $y = -(x+5)^3 + 1$

(8) (i) $y = \sqrt{x}$

(ii) translation by $\begin{pmatrix} -5 \\ -2 \end{pmatrix}$

(iii) $y = \sqrt{x+5} - 2$

(9) (i) $y = \sqrt{x}$

(ii) reflection in y-axis

(iii) $y = \sqrt{-x}$

(10) (i) $y = \sqrt{x}$

(ii) reflection in y-axis

followed by translation by $\begin{pmatrix} 0 \\ -3 \end{pmatrix}$

(iii) $y = \sqrt{-x} - 3$

(11) (i) $y = |x|$

(ii) translation by $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$

(iii) $y = |x-2| - 3$

(12) (i) $y = |x|$

(ii) reflection in x axis

followed by translation by $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$

(iii) $y = -|x-2| + 1$

(13) (i) $y = \sqrt{x}$

(ii) translation by $\begin{pmatrix} -2 \\ -2 \end{pmatrix}$

(iii) $y = \sqrt{x+2} - 2$

(14) (i) $y = \sqrt{x}$

(ii) reflection in y-axis

followed by translation by $\begin{pmatrix} 2 \\ -2 \end{pmatrix}$

or translation by $\begin{pmatrix}-2\\-2\end{pmatrix}$
followed by reflection in y-axis

(iii) $y = \sqrt{-x+2} - 2$

(15) (i) $y = \sqrt{x}$
(ii) reflection in x-axis followed by shift 4 left and 1 up
(iii) $y = -\sqrt{x+4} + 1$

(16) (i) $y = \frac{1}{x}$
(ii) reflection in x-axis or in y-axis
(iii) $y = -\frac{1}{x}$

(17) (i) $y = \frac{1}{x}$
(ii) translation 2 right
(iii) $y = \frac{1}{x-2}$

(18) (i) $y = \frac{1}{x}$
(ii) translation by $\begin{pmatrix}-2\\-1\end{pmatrix}$
(iii) $y = \frac{1}{x+2} - 1$

(19) (i) $y = \frac{1}{x}$
(ii) reflection in x-axis or in y-axis
followed by translation by $\begin{pmatrix}-2\\-1\end{pmatrix}$
(iii) $y = -\frac{1}{x+2} - 1$

(20) (i) $y = \frac{1}{x}$
(ii) reflection in x-axis or in y-axis
followed by translation by $\begin{pmatrix}1\\2\end{pmatrix}$
(iii) $y = -\frac{1}{x-1} + 2$

(21) (i) $y = x^2$
(ii) vertical stretch by -2
followed by translation by $\begin{pmatrix}3\\3\end{pmatrix}$
(iii) $y = -2(x-3)^2 + 3$

(22) (i) $y = x^2$
(ii) vertical stretch by $\frac{1}{2}$
followed by translation by $\begin{pmatrix}-1\\-2\end{pmatrix}$
(iii) $y = \frac{1}{2}(x+1)^2 - 2$

(23) (i) $y = |x|$
(ii) vertical stretch by $-\frac{2}{3}$
followed by translation by $\begin{pmatrix}3\\2\end{pmatrix}$
(iii) $y = -\frac{2}{3}|x-3| + 2$

(24) (i) $y = x^3$
(ii) vertical stretch by $-\frac{1}{4}$
followed by translation by $\begin{pmatrix}-3\\2\end{pmatrix}$
(iii) $y = -\frac{1}{4}(x+3)^3 + 2$

(25) (i) $y = \sqrt{x}$
(ii) horizontal dilation by $-\frac{1}{2}$
followed by translation 2 down
(iii) $y = \sqrt{-2x} - 2$

(26) (i) $y = \sqrt{x}$
(ii) vertical stretch by 2
followed by translation by $\begin{pmatrix}-1\\-3\end{pmatrix}$
(iii) $y = 2\sqrt{x+1} - 3$

(27) (i) $y = \sqrt{x}$
(ii) reflection in x-axis followed by horizontal stretch by 2
and translation 3 up
(iii) $y = -\sqrt{\frac{x}{2}} + 3$

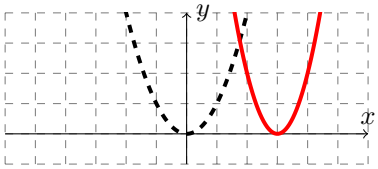
(28) (i) $y = \frac{1}{x}$
(ii) vertical / horizontal dilation by $\frac{1}{2}$
followed by translation 1 down
(iii) $y = \frac{1}{2x} - 1$

(29) (i) $y = \frac{1}{x}$
(ii) vertical / horizontal stretch by -2
followed by shift 2 right 1 up
(iii) $y = \frac{-2}{x-2} + 1$

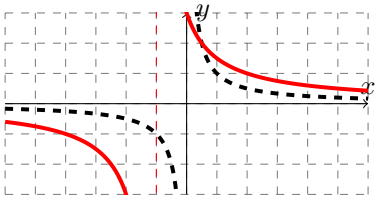
(30) (i) $y = x^2$
(ii) shift 3 right and 4 down followed by reflection of the part below x-axis in the axis
(iii) $y = |(x-3)^2 - 4|$

Q17. Graphs of $y = f(x)$ (black, dashed) and $y = g(x)$ (red, dotted).

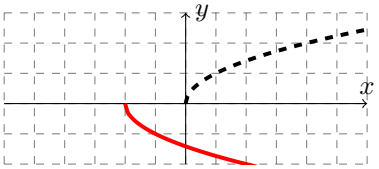
(1) vertical stretch by 2, translation 3 right



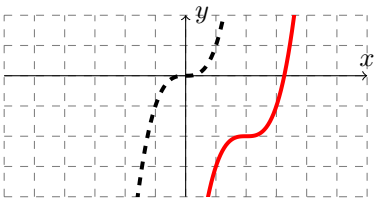
(2) vertical stretch by 3, translation 1 left



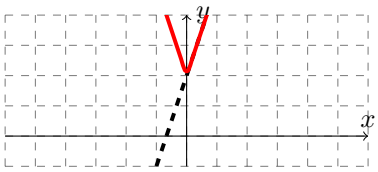
(3) reflection in x-axis, translation 2 left



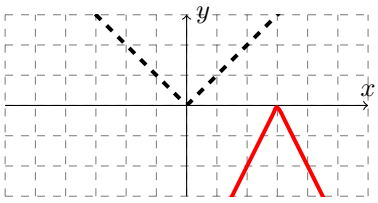
(4) translation 2 right, 2 down



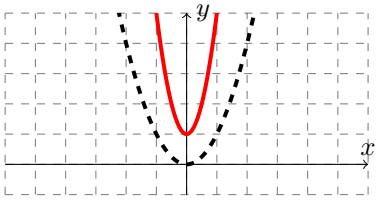
(5) reflection in y axis of the part for $x > 0$



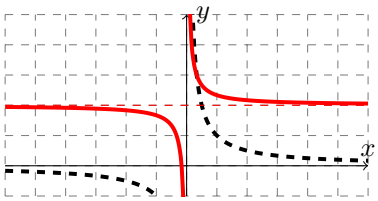
(6) vertical stretch by -2, translation 3 right



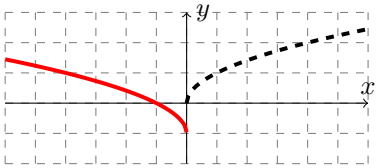
(7) horizontal dilation by $\frac{1}{2}$, translation 1 up



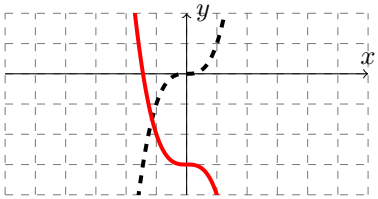
(8) horizontal dilation by $\frac{1}{3}$, translation 2 up



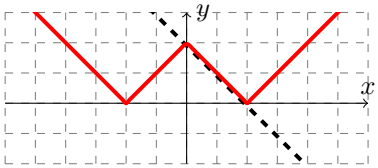
(9) reflection in y-axis, translation 1 down



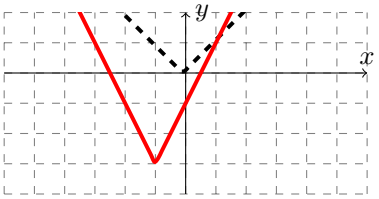
(10) reflection in x/y-axis followed by translation 3 down



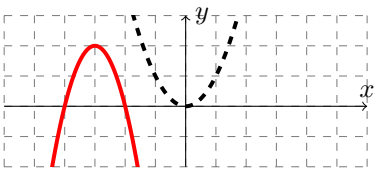
(11) reflection in y-axis of the part $x > 0$ followed by reflection in x-axis of the part $y < 0$



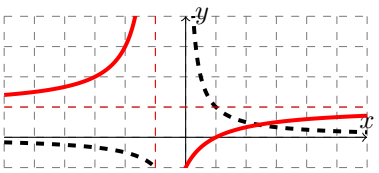
(12) vertical stretch by 2 followed by translation 1 left, 3 down



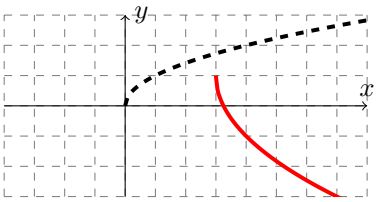
(13) vertical stretch by -2 followed by translation 3 left, 2 up



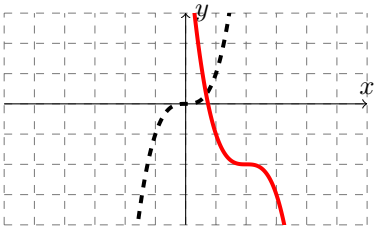
(14) vertical dilation by -2 followed by translation 1 left, 1 up



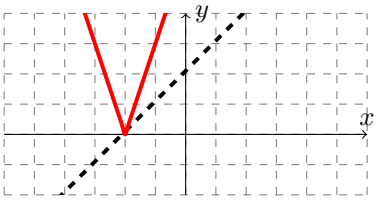
(15) vertical dilation by -2 followed by translation 3 right 1 up



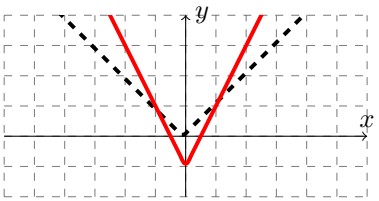
(16) reflection in x-axis followed by translation 2 right 2 down



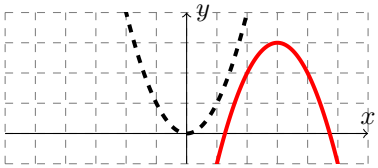
(17) reflection in x-axis of the part $y < 0$ followed by vertical stretch by 2



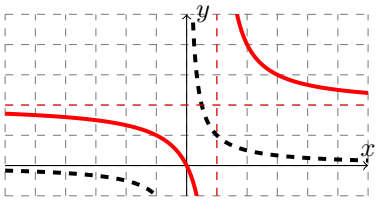
(18) horizontal dilation by $\frac{1}{2}$, translation 1 down



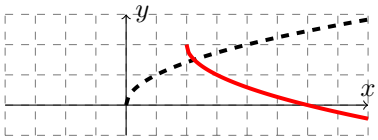
(19) reflection in x-axis followed by translation 3 right, 3 up



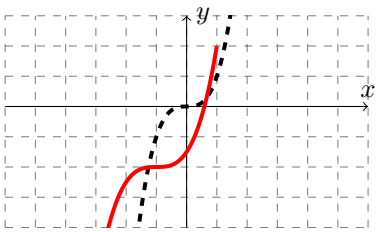
(20) vertical stretch by 2 followed by translation 1 right, 2 up



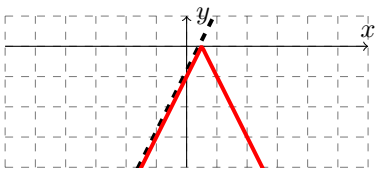
(21) reflection in x-axis followed by translation 2 right 2 up



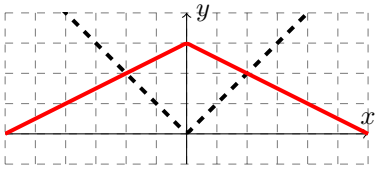
(22) vertical dilation by $\frac{1}{2}$ followed by translation 1 left 2 down



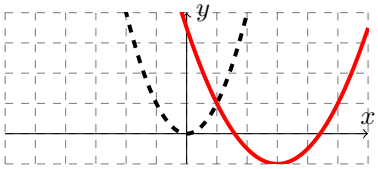
(23) reflection in x-axis of the part $y < 0$ followed by reflection in x-axis



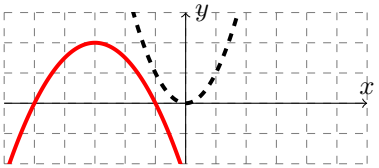
(24) reflection in x-axis and horizontal dilation by 2 followed by translation 3 up



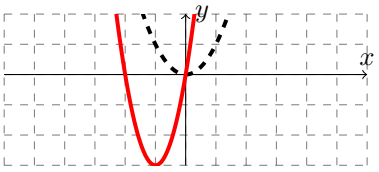
(25) vertical dilation by $\frac{1}{2}$ followed by translation 3 right, 1 down



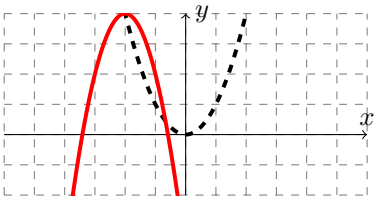
(26) vertical dilation by $-\frac{1}{2}$ followed by translation 3 left, 2 up



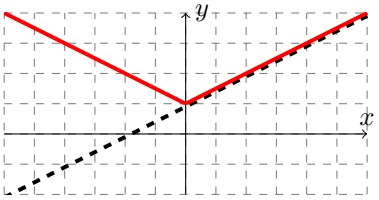
(27) vertical dilation by 3 followed by translation 1 left, 3 down



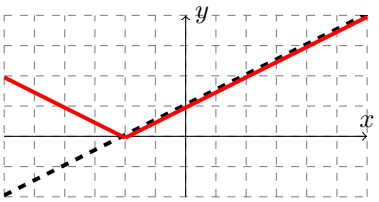
(28) vertical dilation by -2 followed by translation 2 left, 4 up



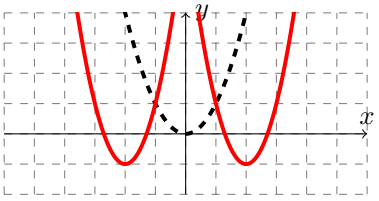
(29) reflection of the part left of y-axis in the axis



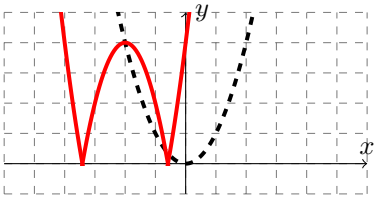
(30) reflection of the part below x-axis in the axis



(31) vertical stretch by 2, then shift 2 right and 1 down and reflection of the part right of y-axis in the axis

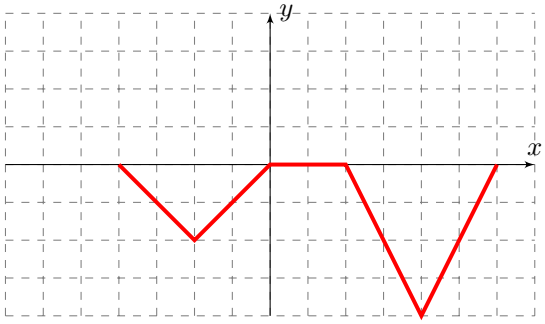


(32) vertical stretch by 2, then shift by $\begin{pmatrix} -2 \\ -4 \end{pmatrix}$ and reflection of the part below x-axis in the axis

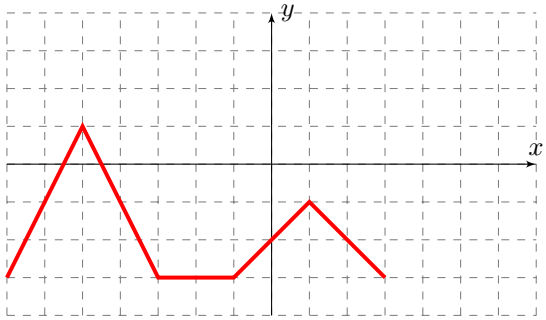


Q18. (1) $A' = (4, 4)$,
(2) $A' = (-3, 2)$,
(3) $A' = (-1.5, 3)$,
(4) $A' = (-3, -4)$,
(5) $A' = (2, 7)$,
(6) $A' = (-8, -5)$.

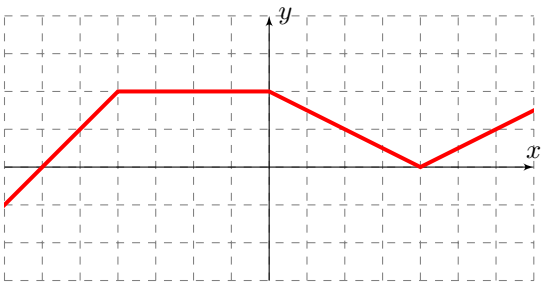
Q19. (i) (1) $y = f(-x) - 2$



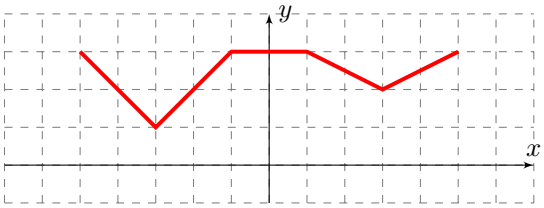
(2) $y = -f(x + 1) - 1$



(3) $y = f(\frac{x}{2})$



(4) $y = \frac{1}{2}f(x - 1) + 2$



(ii) (1) $y = -f(x) - 1$
(2) $y = f(2x) - 1$
(3) $y = \frac{1}{2}f(-2x)$

4.3 Equations and inequalities

Q20. (1) $-1, \frac{1}{3}$
(2) $-1, 2$
(3) $-\frac{7}{4}, \frac{3}{4}$
(4) $-\frac{8}{3}, \frac{4}{3}$
(5) 2
(6) -1
(7) 11
(8) $\frac{4}{3}$
(9) -1
(10) 1
(11) 3
(12) $\frac{1}{2}$

Q21. (i) $-2, 2$
(ii) $0, 4$

Q22. (i) -3
(ii) -5

Q23. (i) $\frac{1}{2}$
(ii) $\frac{7}{2}$

Q24. (i) 9
(ii) 4.5

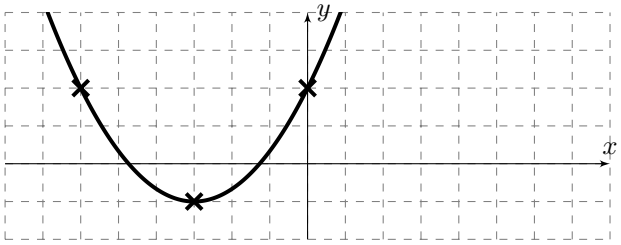
Q25. (1) 0: —
(2) 1: -1.31
(3) 2: $-1, 1.54$
(4) 1: 0.0605
(5) 3: $-0.0644, 3.17, 4.89$
(6) 1: 2.21
(7) 1: -1.52
(8) 3: $-0.481, 1.31, 3.17$
(9) 2: $-1.15, 1.15$
(10) 2: $-1.22, 0.549$
(11) 2: $0.780, 5.55$
(12) 2: $-5.24, -0.764$

Q26. (1) $x \leq -0.861$ or $0.746 \leq x \leq 3.11$
(2) $-4.59 < x < -0.887$ or $x > 1.47$
(3) $-0.535 \leq x \leq 0.444$ or $x \geq 3.69$
(4) $-1.65 < x < 1.27$ or $2 < x < 2.38$
(5) $-0.618 < x < 0$ or $1.62 < x \leq 2$
(6) $0 \leq x \leq 1$
(7) $-1.88 \leq x < -1$ or $0.347 \leq x \leq 1.53$
(8) $-2 \leq x \leq -1.41$ or $-1 < x \leq 1.41$
(9) $-3 < x \leq -2$ or $-1.41 \leq x < -1$ or $1.41 \leq x < 3$
(10) $-0.562 < x < 1$ or $3.56 < x \leq 4$
(11) $1 \leq x \leq 3.56$
(12) $-2.41 < x < -0.305$
(13) $0.918 \leq x \leq 2.66$

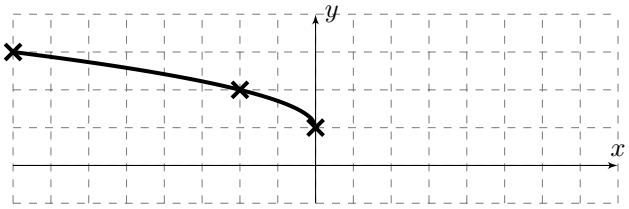
4.4 Chapter review

non-calculator questions

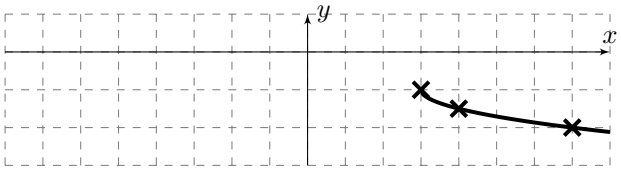
Q1. (1) vertical dilation by $\frac{1}{3}$
followed by
shift 3 left and 1 down



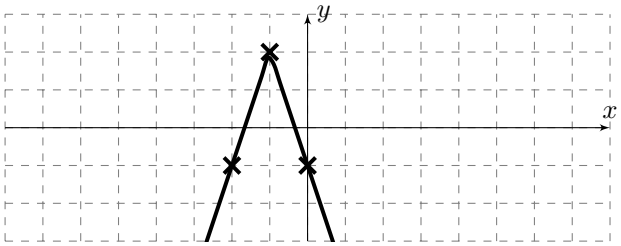
(2) horizontal dilation by -2
followed by
shift 1 up



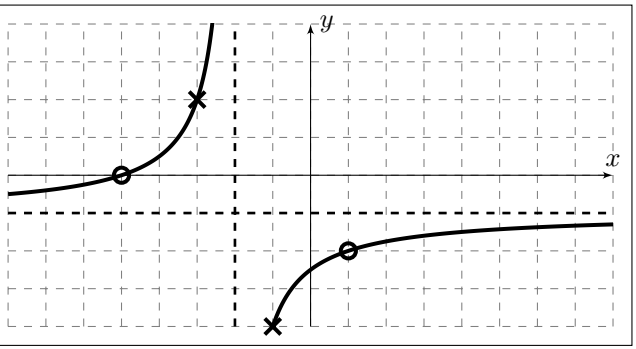
(3) vertical dilation by $-\frac{1}{2}$
followed by
shift 3 right and 1 down



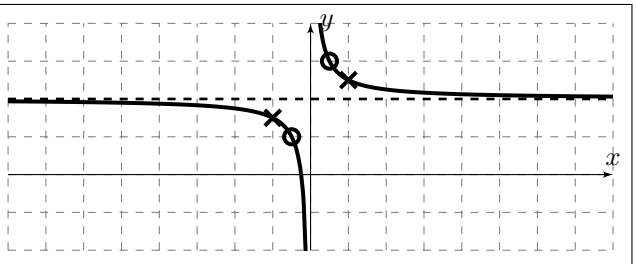
(4) vertical dilation by -3
followed by
shift 1 left and 2 up



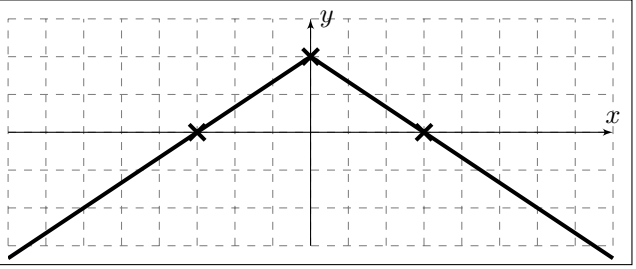
(5) vertical (or horizontal) dilation by -3
followed by
shift 2 left and 1 down



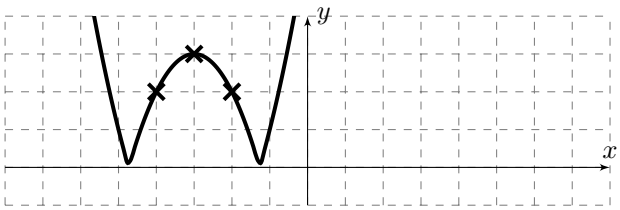
(6) vertical (or horizontal) dilation by $-\frac{1}{2}$
followed by
shift 2 up



(7) reflection of the part right of y-axis in the axis



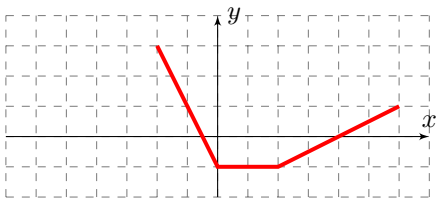
(8) shift 3 left and 3 down
followed by
reflection of the part below the x-axis in th axis



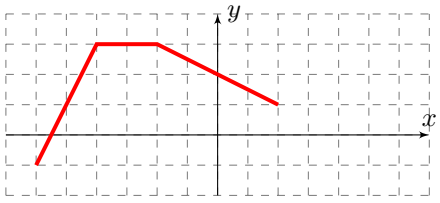
Q2. (1) $y = -2(x+3)^2 + 3$
(2) $y = \frac{-2}{x-1} - 1$
(3) $y = \frac{1}{2}(x-2)^3 + 1$
(4) $y = -\frac{2}{3}|x+3| + 2$
(5) $y = \sqrt{-2x} - 1$
(6) $y = ||x+3| - 2|$

Q3. (1) even (2) odd (3) neither

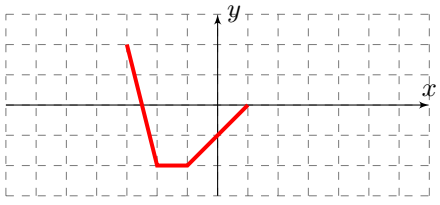
Q4. (i) (1)



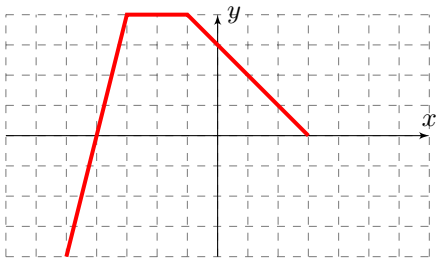
(2)



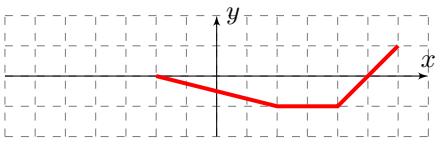
(3)



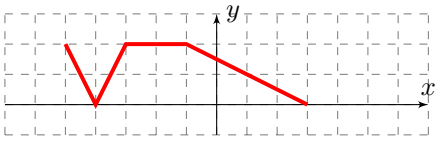
(4)



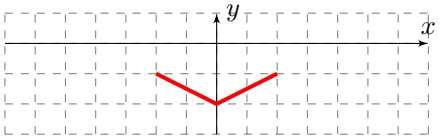
(5)



(6)



(7)



(ii) (1) $y = f(x-2) + 1$
(2) $y = -f(x+1) + 1$
(3) $y = -2f(x-1)$
(4) $y = \frac{1}{2}f(x) - 1$
(5) $y = |f(x) + 1|$
(6) $y = f(2x) + 1$
(7) $y = f(|x|)$

Q5. **DOMAIN**:
f_1: $x \le -\frac{3}{2}$
f_2: $x \in \mathbb{R}$
f_3: $x \in \mathbb{R}$
f_4: $x \in \mathbb{R}$
f_5: $x \in \mathbb{R}, x \neq -1$
f_6: $x \in \mathbb{R}$
f_7: $x > -3$
f_8: $x \le 3, x \neq -3$

RANGE:
f_1: $y \le 0$
f_2: $y \le 4$
f_3: $y \ge -1$
f_4: $y \ge -5$
f_5: $y \in \mathbb{R}, y \neq 3$
f_6: $y \le 2$

Q6.

function	(1)	(2)	(3)
domain	$[-5,-1[\cup]1,5]$	$]-5,4[$	$[-5,5]$
range	$[0,2]$	$]-4,2]$	$[-2,2]$
zeroes	$-4,4$	$-3,0,3$	$-4,0,4$
decreasing	$[-5,-4]$, $[2,4]$	$[-1,1]$	$[-5,-4]$, $[-2,2]$, $[4,5]$
increasing	$[-4,-2]$, $[4,5]$	$]-5,-1]$, $[1,4[$	$[-4,-2]$, $[2,4]$
constant	$[-2,-1[$, $]1,2]$	$\emptyset$	$\emptyset$
even	yes	no	no
odd	no	no	yes
one-to-one	no	no	no

calculator questions

Q7. (1) $(-3.59,-0.279)$, $(-0.549,-1.82)$, $(10.1,0.0986)$
(2) $(4.24,9.48)$, $(8.83,18.7)$
(3) $(-13.4,-0.590)$, $(0.561,20.1)$, $(15.3,-0.416)$
(4) $(-16.4,-6.82)$, $(0.382,0.159)$, $(16.0,6.66)$

Q8. (1) $x \in [-20,-3.59[\cup]-0.549,0[\cup]10.1,20]$ / $-20 \leq x < -3.59$ or $-0.549 < x < 0$ or $10.1 < x \leq 20$
(2) $x \in [-20,4.24[\cup]8.83,20]$ / $-20 \leq x < 4.24$ or $8.83 < x \leq 20$
(3) $x \in [-20,-13.4]\cup]0.5,0.561] \cup [15.3,20]$ / $-20 \leq x \leq -13.4$ or $0.5 < x \leq 0.561$ or $15.3 \leq x \leq 20$
(4) $x \in [-20,-16.4] \cup [0.382,16.0]$ / $-20 \leq x \leq -16.4$ or $0.382 \leq x \leq 20$
(answer can be given in any of the two forms shown above)

Chapter 5
Quadratics

5.1 Solving quadratic equations

Factorisation

Q1. (1) x^2+3x+2
(2) x^2+4x+3
(3) $x^2+7x+10$
(4) x^2-4x+3
(5) x^2-6x+8
(6) $x^2-13x+12$
(7) x^2+x-6
(8) x^2-x-6
(9) x^2+2x-8
(10) x^2-9
(11) x^2-x-12
(12) $x^2+4x-12$
(13) $x^2-2x-24$
(14) $x^2+5x-24$
(15) $x^2+4x-21$

Q2. (1) $2x^2+3x+1$
(2) $2x^2+9x+10$
(3) $2x^2-7x+3$
(4) $2x^2-5x+3$
(5) $2x^2-x-1$
(6) $3x^2+x-2$
(7) $3x^2-5x-2$
(8) $3x^2-x-2$
(9) $6x^2+13x-5$
(10) $6x^2-13x+5$
(11) $6x^2+7x-5$
(12) $15x^2-16x+4$
(13) $15x^2-17x-4$
(14) $15x^2+4x-4$
(15) $12x^2-25x+12$

Q3. (1) $(x)(x-2)$
(2) $(x+2)(x+1)$
(3) $(x+3)(x+2)$
(4) $(x+3)(x+1)$
(5) $(x+4)(x)$
(6) $(x+4)(x+1)$
(7) $(x+4)(x+2)$
(8) $(x+4)(x+3)$
(9) $(x+5)(x+1)$
(10) $(x+5)(x+2)$
(11) $(x+6)(x+2)$
(12) $(x+1)(x+12)$
(13) $(x-1)(x-3)$
(14) $(x-1)(x-2)$
(15) $(x-2)(x-3)$
(16) $(x-1)(x-6)$
(17) $(x-2)(x-4)$
(18) $(x-1)(x-8)$
(19) $(x-3)(x-4)$
(20) $(x-2)(x-6)$
(21) $(x-1)(x-12)$

Q4. (1) $(x+3)(x-2)$
(2) $(x+2)(x-3)$
(3) $(x+4)(x-2)$
(4) $(x+2)(x-4)$
(5) $(x+1)(x-8)$
(6) $(x+3)(x-3)$
(7) $(x+6)(x-1)$
(8) $(x+3)(x-4)$
(9) $(x+2)(x-6)$
(10) $(x+6)(x-2)$
(11) $(x+4)(x-3)$
(12) $(x+4)(x-6)$
(13) $(x+2)(x-12)$
(14) $(x+8)(x-3)$
(15) $(x+24)(x-1)$