## Transformations of graphs

1. Let $f(x)=\sqrt{x}$. Write the formula of a function $g$ whose graph is a result of the transformation listed below, applied to the graph of $f$. You may sketch the graphs of $f$ and $g$ to confirm your results. Also, note down in which cases the results are the same.
2. Translation 3 units leftwards, followed by translation 2 units rightwards.
3. Translation 2 units rightwards, followed by translation 3 units leftwards.
4. Translation 3 units upwards, followed by translation 2 units downwards.
5. Translation 2 units downwards, followed by translation 3 units upwards.
6. Translation 3 units rightwards, followed by translation 2 units upwards.
7. Translation 2 units upwards, followed by translation 3 units rightwards.
8. Translation 3 units leftwards, followed by reflection about the $X$-axis.
9. Reflection about the $X$-axis, followed by translation 3 units leftwards.
10. Translation 3 units rightwards, followed by reflection about the $Y$-axis.
11. Reflection about the $Y$-axis, followed by translation 3 units rightwards.
12. Translation 3 units upwards, followed by reflection about the $X$-axis.
13. Reflection about the $X$-axis, followed by translation 3 units upwards.
14. Translation 3 units downwards, followed by reflection about the $Y$-axis.
15. Reflection about the $Y$-axis, followed by translation 3 units downwards.
16. Translation 3 units leftwards, followed by enlargement of factor 2 from the $X$-axis.
17. Enlargement of factor 2 from the $X$-axis, followed by translation 3 units leftwards.
18. Translation 3 units rightwards, followed by enlargement of factor 2 from the $Y$-axis.
19. Enlargement of factor 2 from the $Y$-axis, followed by translation 3 units rightwards.
20. Translation 3 units upwards, followed by enlargement of factor 2 from the $X$-axis.
21. Enlargement of factor 2 from the $X$-axis, followed by translation 3 units upwards.
22. Translation 3 units downwards, followed by enlargement of factor 2 from the $Y$-axis.
23. Enlargement of factor 2 from the $Y$-axis, followed by translation 3 units downwards.
24. Reflection about the $X$-axis, followed by reflection about the $X$-axis.
25. Reflection about the $Y$-axis, followed by reflection about the $Y$-axis.
26. Reflection about the $X$-axis, followed by reflection about the $Y$-axis.
27. Reflection about the $Y$-axis, followed by reflection about the $X$-axis.
28. Reflection about the $X$-axis, followed by enlargement of factor 0.5 from the $X$-axis.
29. Enlargement of factor 0.5 from the $X$-axis, followed by reflection about the $X$-axis.
30. Reflection about the $X$-axis, followed by enlargement of factor 0.5 from the $Y$-axis.
31. Enlargement of factor 0.5 from the $Y$-axis, followed by reflection about the $X$-axis.
32. Reflection about the $Y$-axis, followed by enlargement of factor 0.5 from the $X$-axis.
33. Enlargement of factor 0.5 from the $X$-axis, followed by reflection about the $Y$-axis.
34. Reflection about the $Y$-axis, followed by enlargement of factor 0.5 from the $Y$-axis.
35. Enlargement of factor 0.5 from the $Y$-axis, followed by reflection about the $Y$-axis.
36. Enlargement of factor 0.5 from the $X$-axis, followed by enlargement of factor 4 from the $X$-axis.
37. Enlargement of factor 4 from the $X$-axis, followed by enlargement of factor 0.5 from the $X$-axis.
38. Enlargement of factor 0.5 from the $X$-axis, followed by enlargement of factor 4 from the $Y$-axis.
39. Enlargement of factor 4 from the $Y$-axis, followed by enlargement of factor 0.5 from the $X$-axis.
40. Enlargement of factor 0.5 from the $Y$-axis, followed by enlargement of factor 4 from the $Y$-axis.
41. Enlargement of factor 4 from the $Y$-axis, followed by enlargement of factor 0.5 from the $Y$-axis.
42. Solve task 1 for $f(x)=x^{3}-3 x+2$ and the following transformations.
43. Translation 1 unit leftwards, followed by translation 4 units rightwards.
44. Translation 4 units rightwards, followed by translation 1 unit leftwards.
45. Translation 1 unit upwards, followed by translation 4 units downwards.
46. Translation 4 units downwards, followed by translation 1 unit upwards.
47. Translation 1 unit rightwards, followed by translation 4 units upwards.
48. Translation 4 units upwards, followed by translation 1 unit rightwards.
49. Translation 1 unit leftwards, followed by reflection about the $X$-axis.
50. Reflection about the $X$-axis, followed by translation 1 unit leftwards.
51. Translation 1 unit rightwards, followed by reflection about the $Y$-axis.
52. Reflection about the $Y$-axis, followed by translation 1 unit rightwards.
53. Translation 1 unit upwards, followed by reflection about the $X$-axis.
54. Reflection about the $X$-axis, followed by translation 1 unit upwards.
55. Translation 1 unit downwards, followed by reflection about the $Y$-axis.
56. Reflection about the $Y$-axis, followed by translation 1 unit downwards.
57. Translation 1 unit leftwards, followed by enlargement of factor 3 from the $X$-axis.
58. Enlargement of factor 3 from the $X$-axis, followed by translation 1 unit leftwards.
59. Translation 1 unit rightwards, followed by enlargement of factor 3 from the $Y$-axis.
60. Enlargement of factor 3 from the $Y$-axis, followed by translation 1 unit rightwards.
61. Translation 1 unit upwards, followed by enlargement of factor 3 from the $X$-axis.
62. Enlargement of factor 3 from the $X$-axis, followed by translation 1 unit upwards.
63. Translation 1 unit downwards, followed by enlargement of factor 3 from the $Y$-axis.
64. Enlargement of factor 3 from the $Y$-axis, followed by translation 1 unit downwards.
65. Reflection about the $X$-axis, followed by reflection about the $X$-axis.
66. Reflection about the $Y$-axis, followed by reflection about the $Y$-axis.
67. Reflection about the $X$-axis, followed by reflection about the $Y$-axis.
68. Reflection about the $Y$-axis, followed by reflection about the $X$-axis.
69. Reflection about the $X$-axis, followed by enlargement of factor 2.5 from the $X$-axis.
70. Enlargement of factor 2.5 from the $X$-axis, followed by reflection about the $X$-axis.
71. Reflection about the $X$-axis, followed by enlargement of factor 2.5 from the $Y$-axis.
72. Enlargement of factor 2.5 from the $Y$-axis, followed by reflection about the $X$-axis.
73. Reflection about the $Y$-axis, followed by enlargement of factor 2.5 from the $X$-axis.
74. Enlargement of factor 2.5 from the $X$-axis, followed by reflection about the $Y$-axis.
75. Reflection about the $Y$-axis, followed by enlargement of factor 2.5 from the $Y$-axis.
76. Enlargement of factor 2.5 from the $Y$-axis, followed by reflection about the $Y$-axis.
77. Enlargement of factor 0.4 from the $X$-axis, followed by enlargement of factor 2 from the $X$-axis.
78. Enlargement of factor 2 from the $X$-axis, followed by enlargement of factor 0.4 from the $X$-axis.
79. Enlargement of factor 0.4 from the $X$-axis, followed by enlargement of factor 2 from the $Y$-axis.
80. Enlargement of factor 2 from the $Y$-axis, followed by enlargement of factor 0.4 from the $X$-axis.
81. Enlargement of factor 0.4 from the $Y$-axis, followed by enlargement of factor 2 from the $Y$-axis.
82. Enlargement of factor 2 from the $Y$-axis, followed by enlargement of factor 0.4 from the $Y$-axis.
83. Solve task 1 for $f(x)=\sqrt{x}$ and the following transformations.
84. Translation 3 units rightwards, followed by translation 2 units upwards, then followed by reflection about the $X$-axis.
85. Translation 3 units rightwards, followed by reflection about the $X$-axis, then followed by translation 2 units upwards.
86. Translation 2 units upwards, followed by translation 3 units rightwards, then followed by reflection about the $X$-axis.
87. Translation 2 units upwards, followed by reflection about the $X$-axis, then followed by translation 3 units rightwards.
88. Reflection about the $X$-axis, followed by translation 3 units rightwards, then followed by translation 2 units upwards.
89. Reflection about the $X$-axis, followed by translation 2 units upwards, then followed by translation 3 units rightwards.
90. Reflection about the $Y$-axis, followed by enlargement of factor 2 from the $Y$-axis, then followed by translation 2 units downwards.
91. Reflection about the $Y$-axis, followed by translation 2 units downwards, then followed by enlargement of factor 2 from the $Y$-axis.
92. Translation 2 units downwards, followed by enlargement of factor 2 from the $Y$-axis, then followed by reflection about the $Y$-axis.
93. Translation 2 units leftwards, followed by enlargement of factor 0.5 from the $X$-axis, then followed by reflection about the $Y$-axis, then followed by translation 1 unit upwards.
94. Enlargement of factor 0.5 from the $X$-axis, followed by translation 2 units leftwards, then followed by translation 1 unit upwards, then followed by reflection about the $Y$-axis.
95. Translation 3 units leftwards, followed by enlargement of factor 0.5 from the $X$-axis, then followed by reflection about the $X$-axis, then followed by enlargement of factor 4 from the $Y$-axis, then followed by reflection about the $Y$-axis, then followed by translation 1 unit upwards.
96. Let $f(x)=\sqrt{x}$. For the formulas of $g$ given below state the transformations that, applied to the graph of $f$, give the graph of $g$. State, precisely, the order of these transformations.
97. $g(x)=\sqrt{0.5 x}+3$.
98. $g(x)=\sqrt{0.5 x-3}$.
99. $g(x)=\sqrt{3-x}$.
100. $g(x)=\sqrt{-x}+3$.
101. $g(x)=2 \sqrt{x}-3$.
102. $g(x)=2 \sqrt{x-3}$.
103. $g(x)=-\sqrt{x}-3$.
104. $g(x)=-\sqrt{x-3}$.
105. $g(x)=\sqrt{2 x+1}$.
106. $g(x)=\sqrt{2(x+1)}$.
107. $g(x)=-2 \sqrt{x}-2$.
108. $g(x)=-4 \sqrt{-2 x+3}+1$.
109. The graphs of $f$ are given below. Sketch the graphs of $|f(x)|, f(|x|),|f(|x|)|, f^{2}(x)$ and $\frac{1}{f(x)}$. Indicate clearly all characteristic points and the asymptotes.
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110. The graph of $f$ is given below. Sketch the graphs of
111. $g(x)=2 f(x)$,
112. $g(x)=f(1-x)$,
113. $g(x)=f(2 x)+1$,
114. $g(x)=-f(x+1)$,
115. $g(x)=f(|x|)+1$,
116. $g(x)=\left|f\left(\frac{1}{2} x\right)\right|$,
117. $g(x)=f(|x|-1)$,
118. $g(x)=|f(x)+3|$,
119. $g(x)=\frac{1}{f(x-1)}$,
120. $g(x)=\frac{2}{f(x)}+1$,
121. $g(x)=f^{2}(x)-1$,
122. $g(x)=(f(x)+1)^{2}$.

Indicate clearly all characteristic points and the asymptotes.


