

# Answers

## Worksheet 11A (page 11.1)

1. (a) Translating 2 units upwards  
 (b) Translating 13 units to the left  
 (c) Translating 2 units to the right and 3 units downwards
2. (a)  $g(x) = f(x) + 5$   
 (b)  $g(x) = f(x + 6)$   
 (c)  $g(x) = f(x - 4) - 1$

3.

$f(x)$	$g(x)$	Transformation
$x^2$	$(x + 5)^2$	Translating 5 units to the left
$x + 8$	$x + 10$	Translating 2 units upwards
$x^3$	$(x - 2)^3 - 5$	Translating 2 units to the right and 5 units downwards
$\log(2x + 5) + 4$	$\log(2x + 5)$	Translating 4 units downwards
$\tan(x - 45)^\circ$	$\tan x^\circ$	Translating 45 units to the left
$3^{x+1} - 4$	$3^{x-1} + 4$	Translating 2 units to the right and 8 units upwards
$\frac{3}{x-2}$	$\frac{3}{x+4}$	Translating 6 units to the left
$5x^4$	$5(x-3)^4 + 1$	Translating 3 units to the right and 1 unit upwards
$\sqrt[3]{x+5} + 1$	$\sqrt[3]{x+8} - 3$	Translating 3 units to the left and 4 units downwards

## Worksheet 11B (page 11.3)

1. (a) Reflecting along the  $x$ -axis  
 (b) Reflecting along the  $y$ -axis  
 (c) Reflecting along the  $y$ -axis and then reflecting along the  $x$ -axis

2. (a)  $g(x) = -f(x)$   
 (b)  $g(x) = f(-x)$   
 (c)  $g(x) = -f(-x)$

3.

$f(x)$	$g(x)$	Transformation
$x^2 - 5$	$-x^2 + 5$	Reflecting along the $x$ -axis
$x^4 + 2x + 3$	$x^4 - 2x + 3$	Reflecting along the $y$ -axis
$2x^3 - 3x^2 - 5$	$2x^3 + 3x^2 + 5$	Reflecting along the $y$ -axis and then reflecting along the $x$ -axis
$\log \frac{x}{2x-1}$	$\log \frac{2x-1}{x}$	Reflecting along the $x$ -axis
$-2 \tan x^\circ + 3$	$2 \tan x^\circ + 3$	Reflecting along the $y$ -axis
$-6^x - 1$	$(\frac{1}{6})^x + 1$	Reflecting along the $y$ -axis and then reflecting along the $x$ -axis
$2(x+5)^2 + 7$	$2(x-5)^2 + 7$	Reflecting along the $y$ -axis
$-\frac{4}{x-5}$	$-\frac{4}{x+5}$	Reflecting along the $y$ -axis and then reflecting along the $x$ -axis
$\frac{1}{8^x} + 5$	$-2^{-3x} - 5$	Reflecting along the $x$ -axis

## Worksheet 11C (page 11.5)

1. (a) Enlarging 2 times along the  $x$ -axis  
 (b) Contracting  $\frac{1}{3}$  time along the  $y$ -axis  
 (c) Enlarging 2 times along the  $y$ -axis and contracting  $\frac{1}{4}$  time along the  $x$ -axis
2. (a)  $g(x) = \frac{1}{3}f(x)$   
 (b)  $g(x) = f(\frac{x}{6})$   
 (c)  $g(x) = 4f(4x)$

$f(x)$	$g(x)$	Transformation
$x^2 - 4$	$8x^2 - 32$	Enlarging 8 times along the y-axis
$x^3 + 3$	$27x^3 + 3$	Contracting $\frac{1}{3}$ time along the x-axis
$\log x$	$\frac{1}{3}\log 3x$	Contracting $\frac{1}{3}$ time along the y-axis and contracting $\frac{1}{3}$ time along the x-axis
$\frac{1}{4}\sin 4x^\circ$	$\sin 4x^\circ$	Enlarging 4 times along the y-axis
$2^{\frac{x}{2}} - 1$	$2^{2x} - 1$	Contracting $\frac{1}{4}$ time along the x-axis
$2(3x - 2)^3$	$5(x - 2)^3$	Enlarging $\frac{5}{2}$ times along the y-axis and enlarging 3 times along the x-axis
$3\cos 2x$	$7\cos 2x$	Enlarging $\frac{7}{3}$ times along the y-axis
$\sqrt{4x - 1}$	$\frac{1}{2}\sqrt{\frac{x}{3} - 1}$	Contracting $\frac{1}{2}$ time along the y-axis and enlarging 12 times along the x-axis
$x^2 - x + 1$	$16x^2 - 4x + 1$	Contracting $\frac{1}{4}$ time along the x-axis

### Build-up Exercise 11A (page 11.7)

- Translating 6 units to the left
- Translating 2 units downwards
- Translating 3 units to the right and 1 unit upwards
- Translating 6 units to the left and 14 units upwards
- $y = -x^2 + 4$
- $y = -(x + 5)^2$
- Translating 6 units downwards
- Translating 4 units to the right
- $y = 4(x - 3)^4 + 6$
- $y = 4(x + 7)^4 - 3$
- Translating 5 units to the right and 3 units downwards
- Translating 1 unit to the left and 1 unit upwards

- Translating 3 units to the right and 11 units downwards
- Translating 3 units to the left and 9 units downwards
- Translating 3 units to the left
- Translating 3 units downwards
- Translating 6 units to the left and 4 units upwards
- Translating 2 units to the right and 4 units downwards
- (a) (i) Translating 5 units to the right and 3 units downwards  
(ii) Translating 3 units to the right and 11 units downwards  
(b) Translating 2 units to the left and 8 units downwards  
(c)  $g(x) = f(x - 5) - 3$ ,  $h(x) = f(x - 3) - 11$
- (a) (i) Translating 5 units to the right and 3 units downwards  
(ii) Translating 1 unit to the left and 5 units downwards  
(b) Translating 6 units to the left and 2 units downwards  
(c)  $g(x) = -(x - 2)^2 - 1$ ,  $h(x) = -(x + 4)^2 - 3$
- (a) Translating 1 unit to the left  
(b) Translating 3 units upwards  
(c) Translating 2 units to the right and 4 units upwards  
(d) Translating  $\frac{1}{2}$  unit to the left and 2 units downwards
- (a) Translating 60 units to the left  
(b) Translating 2 units downwards  
(c) Translating 90 units to the left and 1 unit downwards  
(d) Translating 30 units to the right and 1.4 units upwards
- (a) Translating 1 unit to the left and  $\frac{1}{2}$  unit upwards
- (a)  $y = (x - 3)^2 - 7$   
(b) Translating 3 units to the right and 7 units downwards
- (a) Translating 6 units to the right and 12 units downwards  
(b)  $g(x) = (x - 4)^2 - 9$   
(c) (0, 7)
- (a) (i) x-coordinate of Q = -3, k = -6  
(ii) 4  
(b)  $f(x) = -x^2 + 10x - 21$   
(c) A(3, 0), B(7, 0)
- (a)  $f(x) = x^2(x + 3)$ ,  $g(x) = (x + 1)(x - 2)^2$   
(b) (i) Translating 2 units to the right
- (b) Translating 3 units upwards
- (a) Translating 1 unit to the right and 4 units upwards  
(c) -0.6

**Build-up Exercise 11B** (page 11.14)

30. Reflecting along the  $x$ -axis
31. Reflecting along the  $y$ -axis
32. Reflecting along the  $x$ -axis
33. Reflecting along the  $y$ -axis and then reflecting along the  $x$ -axis
34. Reflecting along the  $x$ -axis / reflecting along the  $y$ -axis
35. Reflecting along the  $y$ -axis and then reflecting along the  $x$ -axis
36. (a)  $y = -\frac{4}{x^2} - 1$   
 (b)  $y = -\tan 2x^\circ - 4x$   
 (c)  $y = \log x - 2$
37. (a)  $y = \frac{1}{6^{x+1}} + \frac{8}{x}$   
 (b)  $y = -x \cos 2x^\circ - 1$   
 (c)  $y = -x^3 - 2x^2 - 3x - 4$
38. (a)  $y = -\sqrt{1-x} + 2$   
 (b)  $y = -x^2 - 3x - 5$   
 (c)  $y = -(x+2)^3 - 6$
39. (a) Reflecting along the  $x$ -axis  
 (b) Reflecting along the  $y$ -axis and then reflecting along the  $x$ -axis
40. (a) Reflecting along the  $x$ -axis  
 (b) Reflecting along the  $y$ -axis and then translating 2 units downwards
41. (a) Reflecting along the  $x$ -axis and then translating 3 units to the left  
 (b) Reflecting along the  $y$ -axis and then translating 2 units upwards
42. (a) Reflecting along the  $x$ -axis and then translating 1 unit to the left  
 (b) Reflecting along the  $y$ -axis and then reflecting along the  $x$ -axis
46. (a) Reflecting along the  $x$ -axis and then translating 1 unit to the right
47. (a)  $g(x) = -(1+x)(2-x)(4-x)$   
 (b)  $h(x) = -(x-1)(x+2)(x+4)$
48. (b)  $x$ -intercepts =  $-4, -3, -1, 1$ ,  $y$ -intercept =  $-2$
49. (b) Coordinates of vertex =  $(3, 4)$ ,  $x$ -intercepts =  $1, 5$ ,  $y$ -intercept =  $-5$

50. (a)  $y = -(x-2)^2 + 2$   
 (b) Reflecting along the  $x$ -axis, and then translating 2 units to the right and 2 units upwards
51. (a) (i)  $y = -(x+6)^2 + 2$   
 (ii)  $y = -(x+6)^2 + 2$   
 (b) Yes

**Build-up Exercise 11C** (page 11.20)

52. (a)  $y = 54x^2 + 36x - 2$   
 (b)  $y = \frac{3}{4}x^2 + \frac{3}{2}x - \frac{1}{4}$
53. (a)  $y = 10 \log \frac{x}{2}$   
 (b)  $y = 5 \log \frac{x}{5}$
54. (a) Enlarging 2 times along the  $x$ -axis  
 (b) Enlarging  $\frac{5}{4}$  times along the  $y$ -axis
55. (a) Contracting  $\frac{1}{2}$  time along the  $y$ -axis  
 (b) Contracting  $\frac{3}{4}$  time along the  $x$ -axis
56. (a)  $y = \frac{8}{3}x^3 - 8x^2 + 36x - 72$   
 (b)  $y = \frac{9}{16}x^3 - \frac{3}{4}x^2 + \frac{3}{2}x - \frac{4}{3}$
57. (a) Contracting  $\frac{1}{3}$  time along the  $y$ -axis and contracting  $\frac{2}{7}$  time along the  $x$ -axis  
 (b) Enlarging  $\frac{5}{2}$  times along the  $y$ -axis and enlarging 6 times along the  $x$ -axis
58. (a) Contracting  $\frac{1}{5}$  time along the  $y$ -axis and enlarging 2 times along the  $x$ -axis  
 (b) Contracting  $\frac{1}{2}$  time along the  $y$ -axis and contracting  $\frac{1}{4}$  time along the  $x$ -axis
59. (a)  $\frac{1}{2}$   
 (b) Contracting  $\frac{1}{2}$  time along the  $y$ -axis
63. (a) Contracting  $\frac{2}{3}$  time along the  $y$ -axis and enlarging 2 times along the  $x$ -axis  
 (b)  $g(x) = 2 \cos \frac{x^\circ}{2} - 2 \sin \frac{x^\circ}{2}$

64. (a) Enlarging 2 times along the  $x$ -axis and then translating 10 units upwards  
(b) Enlarging 2 times along the  $y$ -axis and then translating 3 units to the left  
(c) Contracting  $\frac{1}{2}$  time along the  $y$ -axis and then reflecting along the  $x$ -axis
65. (a) Enlarging 2 times along the  $y$ -axis and enlarging 2 times along the  $x$ -axis, and then reflecting along the  $x$ -axis  
(b)  $a = -2, b = \frac{1}{2}$
66. (a)  $y = 2(x + 3)^2 - 8$   
(b) Enlarging 2 times along the  $y$ -axis, and then translating 3 units to the left and 8 units downwards
67. (a)  $h(x) = -4\left(\frac{x}{2} - 1\right)^2 - 1$   
(b) Translating 2 units to the left and 1 unit upwards
68. (a) Enlarging 3 times along the  $y$ -axis and contracting  $\frac{1}{2}$  time along the  $x$ -axis, and then translating 1 unit upwards  
(c) Maximum value = 4, minimum value = -2, period = 180