4 **(a)** Express $1-6x-x^2$ in the form $a-(x+b)^2$, where a and b are constants. [3]

(b) The graph of $y=x^2$ is transformed to the graph of $y=1-6x-x^2$ by a reflection followed by a translation of $\begin{pmatrix} m \\ n \end{pmatrix}$. Give details of the reflection and determine the values of m and n. [3]

6 Functions f and g are defined by

$$\mathrm{f}(x) = (x+3)^2 - 12 \quad \text{for } x \geqslant 0,$$

$$\mathrm{g}(x) = 2x - 5 \quad \text{for } x \in \mathbb{R}.$$

(a) State the range of f. [1]

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(b) Find an expression for $\mathrm{f}^{-1}(x)$. [2]

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(c) Solve the equation $\mathrm{gf}(x) = 69$. [4]

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3 **(a)** The graph of $y = \mathrm{f}(x)$ is transformed to the graph of $y = \mathrm{f}(3x) + 2$.

Describe fully the two transformations which have been combined to give the resulting graph. [3]

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(b) A different graph has equation $y = \mathrm{g}(x)$. This graph is stretched by scale factor 3 in the y-direction and then reflected in the y-axis.

Write down the equation of the transformed graph in terms of the function g. [2]

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9 The function f is defined by $f(x) = \frac{4}{(3x-6)^2} + \frac{1}{(3x-6)^3}$ for $x > 2$.

(a) Find an expression for $f'(x)$ and hence determine whether f is an increasing function, a decreasing function or neither. [4]

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(b) State whether f^{-1} exists. Give a reason for your answer. [1]

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The function g is defined by $g(x) = 4x - 3$ for $x > a$.

(c) Find the range of g in terms of the constant a. [1]

(d) Find the set of values of a for which the composite function fg exists. [2]

10 The functions f and g are defined by

$$\mathrm{f}(x) = \sqrt{x} \qquad \text{for } x \geqslant 0,$$

$$\mathrm{g}(x) = 3\sqrt{x+2} - 5 \qquad \text{for } x \geqslant -2.$$

(a) Describe fully a sequence of transformations which transforms the graph of $y = \mathrm{f}(x)$ to the graph of $y = \mathrm{g}(x)$. You should make clear the order in which the transformations are applied. [5]

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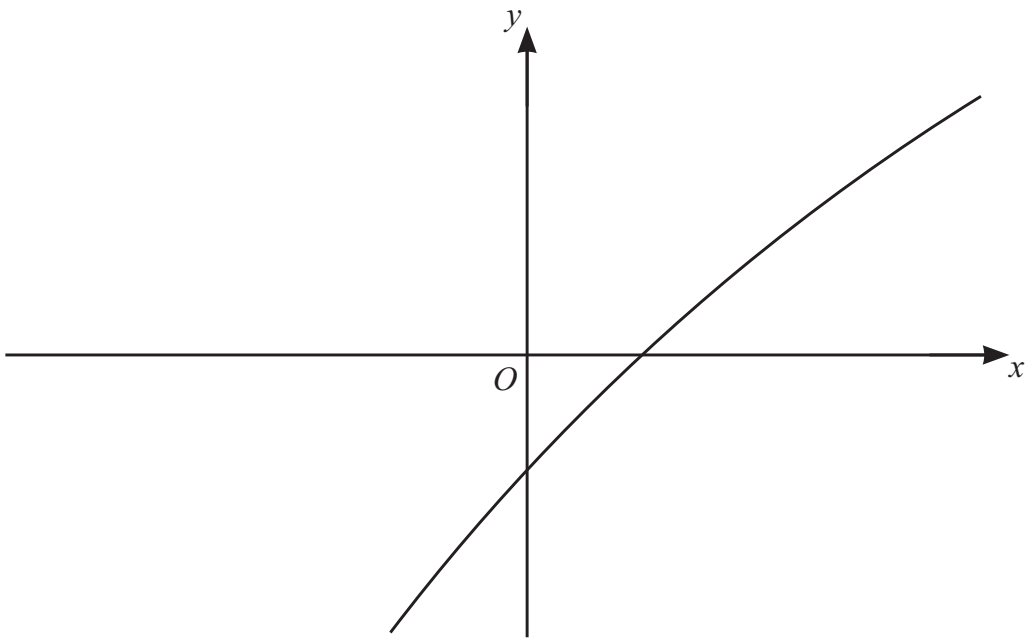

The diagram shows the graph of $y = \mathrm{g}(x)$.

(b) On the diagram sketch the graph of $y = \mathrm{g}^{-1}(x)$ together with any relevant mirror line. [2]

(c) Find an expression for $g^{-1}(x)$. [2]

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(d) State the range of g^{-1}. [1]

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The function h is defined by

$$h(x) = x - 2 \qquad \text{for } x \geqslant 0.$$

(e) Find the value of $g^{-1}h(4)$. [1]

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(f) Explain why the composite function hg^{-1} cannot be formed. [1]

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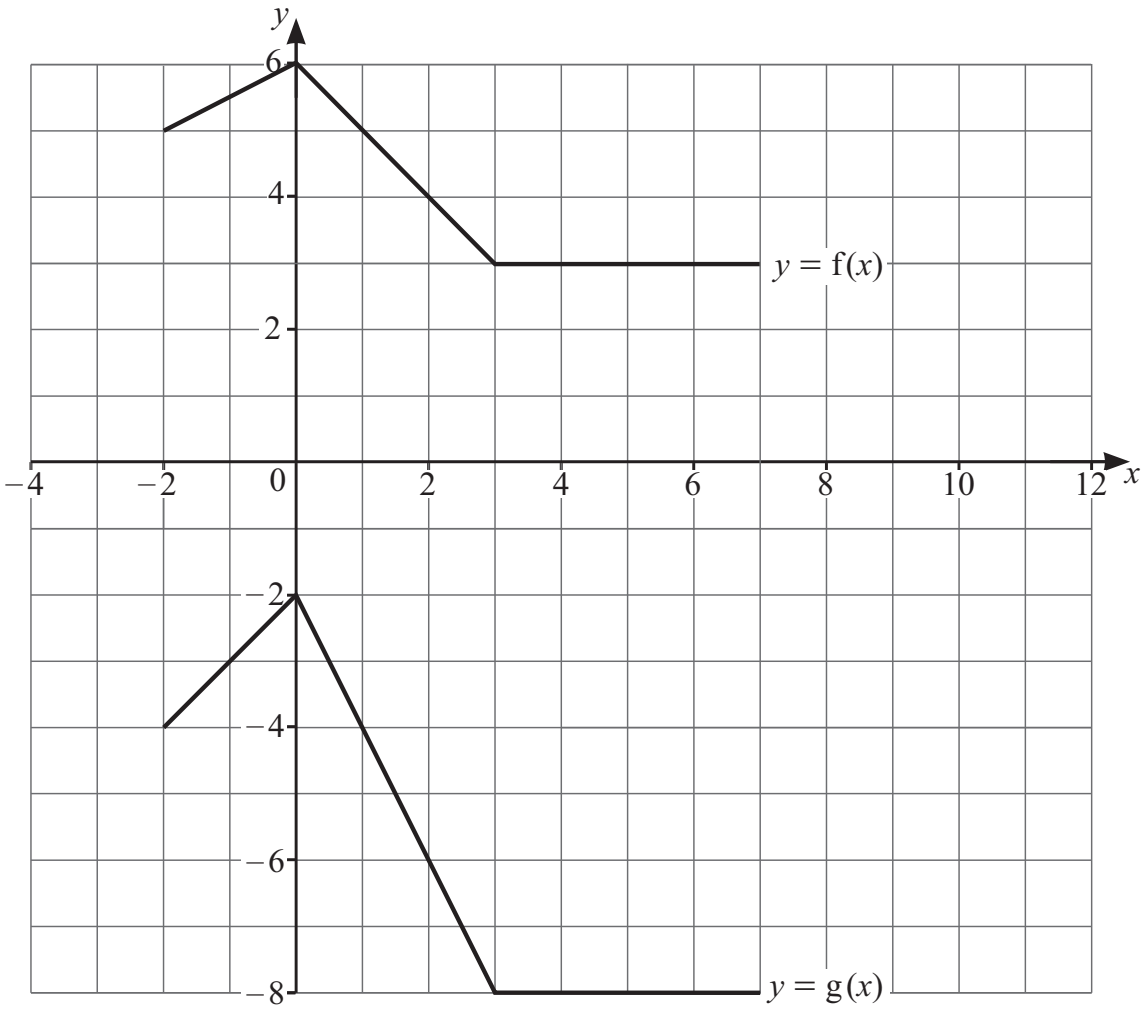
Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.

1



The diagram shows the graphs with equations $y = \mathrm{f}(x)$ and $y = \mathrm{g}(x)$.

Describe fully a sequence of two transformations which transforms the graph of $y = \mathrm{f}(x)$ to the graph of $y = \mathrm{g}(x)$. Make clear the order in which the transformations should be applied. [4]

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11 **(a)** Express x^2+4x+2 in the form $(x+a)^2+b$, where a and b are integers. [2]

The functions f and g are defined as follows.

$$\text{f}(x) = x^2+4x+2 \qquad \text{for } x \leqslant -2$$

$$\text{g}(x) = -x-4 \qquad \text{for } x \geqslant -2$$

(b) **(i)** Find an expression for $\text{f}^{-1}(x)$. [3]

(ii) Find an expression for $(\mathrm{gf})^{-1}(x)$. [4]

Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.