IB DP MATHEMATICS

AA Topic 2 · Functions

TOPICAL WORKSHEET

2.1 Function Basics · 2.2 Quadratic Functions
2.3 Transformations of Graphs · 2.4 Rational Functions

Standard and Higher Level · Syllabus 2025

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Original exam-style questions written for the IB Diploma Programme Mathematics course (first assessment 2025)

Section A — Multiple Choice (15 marks)

Circle the letter of the best answer to each question. Each question is worth 1 mark.

1. A relation is a function if **[1]**

A every element of the range maps to exactly one element of the domain

B every element of the domain maps to exactly one element of the range

C every element of the domain maps to at least two elements of the range

D the relation is symmetric about the y-axis

2. The domain of $f(x) = \sqrt{(x-1)}$ is **[1]**

A $x \in \mathbb{R}$

B $x \geq 1$

C $x \geq 0$

D $x \leq 1$

3. If $f(x) = 2x + 3$ and $g(x) = x^2$, the composite function $(f \circ g)(2)$ is **[1]**

A 7

B 11

C 16

D 25

4. The inverse function $f^{-1}(x)$ of a one-to-one function $f(x)$ is best described as **[1]**

A the function multiplied by -1

B the function reflected in the x-axis

C the function that reverses the effect of $f(x)$, obtained by reflecting $y = f(x)$ in the line $y = x$

D the function $f(x)$ shifted one unit to the right

5. A quadratic function written in vertex form is given by **[1]**

A $y = ax^2 + bx + c$

B $y = a(x-h)^2 + k$, with vertex (h, k)

C $y = a(x-p)(x-q)$

D $y = mx + c$

6. For a quadratic $ax^2+bx+c = 0$, the discriminant is given by **[1]**

A $\Delta = b^2 - 4ac$

B $\Delta = b^2 + 4ac$

C $\Delta = \sqrt{(b^2-4ac)}$

D $\Delta = 4ac - b^2$

7. If the discriminant of a quadratic equation is positive ($\Delta > 0$), the equation has **[1]**

A no real roots

B exactly one repeated real root

C two distinct real roots

D infinitely many real roots

8. The roots of $x^2 - 5x + 6 = 0$ are **[1]**

A $x = 1, 6$

B $x = -2, -3$

C $x = 2, 3$

D $x = -1, -6$

9. The graph of $y = f(x) + k$, for a positive constant k, is the graph of $y = f(x)$ **[1]**

A translated k units to the right

B translated k units upward

C stretched vertically by a factor of k

D reflected in the x-axis

10. The graph of $y = f(x-k)$, for a positive constant k, is the graph of $y = f(x)$ **[1]**

A translated k units to the left

B translated k units to the right

C translated k units upward

D reflected in the y-axis

11. The graph of $y = -f(x)$ is obtained from $y = f(x)$ by **[1]**

A a reflection in the y-axis

B a reflection in the x-axis

C a horizontal stretch

D a translation upward

12. The graph of $y = af(x)$, for a constant $a > 1$, is the graph of $y = f(x)$ **[1]**

A stretched vertically by a scale factor of a

B stretched horizontally by a scale factor of a

C translated a units upward

D compressed vertically by a scale factor of a

13. The vertical asymptote of $y = 1 \div (x-3)$ is **[1]**

A $x = 0$

B $x = -3$

C $x = 3$

D $y = 3$

14. The horizontal asymptote of $y = 1 \div (x - 3) + 2$ is **[1]**

A $y = 0$

B $y = 2$

C $y = 3$

D $x = 2$

15. The domain of $y = 1 \div (x+5)$ is **[1]**

A all real x

B $x \neq 5$

C $x \neq -5$

D $x \geq -5$

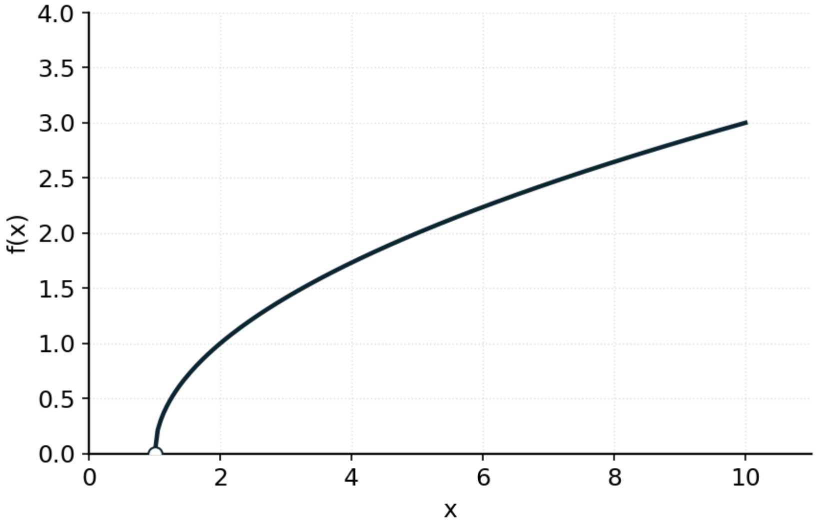
Section B — Structured Questions (65 marks)

Answer all questions in the space provided. Working must be shown for full marks.

2.1 Function Basics

Question 1 [7 marks]

The graph shows the function f(x) = √(x−1) (computed).



The function f(x) = √(x−1) (computed).

(a) Using the graph, state the domain and range of f(x). **[2]**

(b) Calculate f(5), and confirm it agrees with the graph. **[2]**

(c) Find the value of x for which f(x) = 3. **[3]**

Question 2 [6 marks]

Composite and inverse functions combine or reverse the effect of individual functions.

(a) Given f(x) = 2x + 3, state the value of f(0) and explain what this represents on the graph of y = f(x). **[2]**

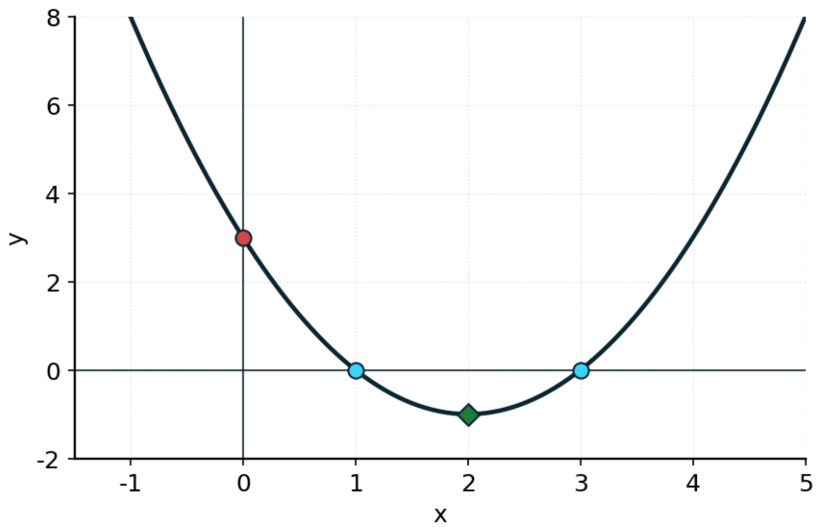
(b) Given f(x) = 2x + 3 and g(x) = x^2, find (f∘g)(2). **[2]**

(c) Find the inverse function, $f^{-1}(x)$, of f(x) = 2x + 3. **[2]**

2.2 Quadratic Functions

Question 3 [7 marks]

The graph shows the quadratic function y = $x^2 - 4x + 3$ (computed).



y = $x^2 - 4x + 3$ (computed), with roots, y-intercept, and vertex marked.

(a) Using the graph, state the roots (x-intercepts) and the y-intercept of the function. **[2]**

(b) By completing the square, write $x^2 - 4x + 3$ in vertex form, and state the coordinates of the vertex. **[2]**

(c) State the equation of the axis of symmetry of this quadratic. **[3]**

Question 4 [6 marks]

The quadratic formula and the discriminant allow the roots of any quadratic equation to be found or classified.

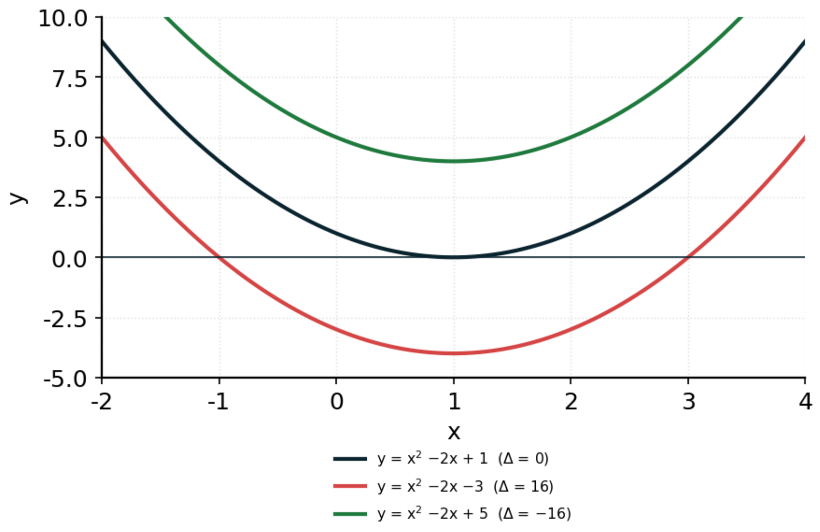
(a) State the quadratic formula for solving $ax^2+bx+c = 0$. **[2]**

(b) State the discriminant formula, and state what a negative discriminant tells us about the roots of the equation. **[2]**

(c) Calculate the discriminant of $2x^2+3x-5 = 0$, and state how many real roots this equation has. **[2]**

Question 5 [7 marks]

The graph shows three quadratic functions, each with a different discriminant (computed).



Three quadratics with discriminants Δ = 0, 16, and −16 respectively (computed).

(a) Using the graph, identify which curve touches the x-axis at exactly one point, which crosses it at two points, and which does not meet the x-axis at all. Relate each case to the sign of the discriminant. **[2]**

(b) Verify by calculation that the discriminant of $y = x^2 - 2x + 1$ is zero. **[2]**

(c) Calculate the discriminant of $y = x^2 - 2x + 5$, and confirm this is consistent with the graph. **[3]**

2.3 Transformations of Graphs

Question 6 [6 marks]

Transformations allow the graph of a known function $y = f(x)$ to be used to sketch related functions.

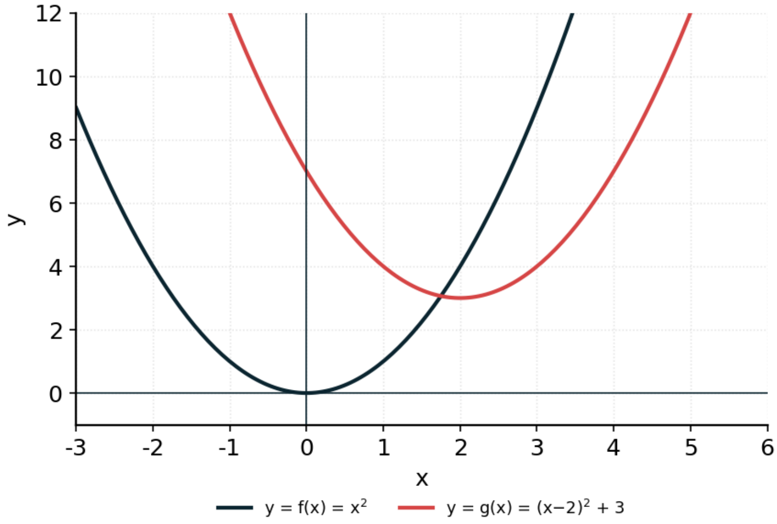
(a) Describe the transformation applied to $y = f(x)$ to obtain $y = f(x) + k$ and $y = f(x - k)$, for a positive constant k. **[2]**

(b) Describe the transformation applied to $y = f(x)$ to obtain $y = -f(x)$, and to obtain $y = f(-x)$. **[2]**

(c) Describe the transformation applied to $y = f(x)$ to obtain $y = af(x)$, for a constant $0 < a < 1$. **[2]**

Question 7 [7 marks]

The graph shows $f(x) = x^2$ and $g(x) = (x-2)^2+3$ (computed).



$f(x) = x^2$ and $g(x) = (x-2)^2+3$ (computed).

(a) Using the graph, describe the single transformation that maps $y = f(x)$ onto $y = g(x)$. **[2]**

(b) State the translation vector describing this transformation. **[2]**

(c) Using function notation, express $g(x)$ in terms of $f(x)$, and hence confirm this matches the given formula $g(x) = (x-2)^2+3$. **[3]**

Question 8 [6 marks]

Let $f(x) = x^2 - 4x$.

(a) Find expressions for $-f(x)$ and $f(-x)$, and state the transformation each represents. **[2]**

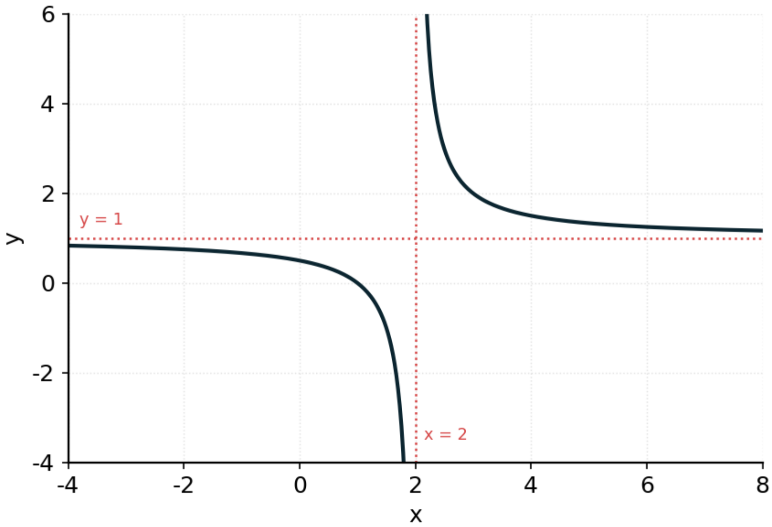
(b) Calculate $f(1)$. **[2]**

(c) Let $g(x) = 2f(x)$. Calculate $g(1)$. **[2]**

2.4 Rational Functions

Question 9 [7 marks]

The graph shows the rational function y = 1÷(x−2) + 1 (computed).



y = 1÷(x−2) + 1 (computed), showing its two asymptotes.

(a) Using the graph, state the equations of the vertical and horizontal asymptotes. **[2]**

(b) Using the function, explain algebraically why x = 2 is a vertical asymptote. **[2]**

(c) Find the exact y-intercept and x-intercept of the function algebraically. **[3]**

Question 10 [6 marks]

Rational functions of the form y = 1÷(x−a) + b have asymptotes determined directly by the constants a and b.

(a) State the general rule for finding the vertical and horizontal asymptotes of y = 1÷(x−a) + b. **[2]**

(b) State the equations of the asymptotes of $y = 1 \div (x+3) - 2$. **[2]**

(c) State the domain of $y = 1 \div (x+3) - 2$. **[2]**