



Key features of graphs

IB Mathematics: Applications and Interpretation SL

50 questions • Read, find and interpret • Syllabus 2.4

Learning goal	Find key features and explain what their coordinates mean.
Syllabus link	AI SL 2.4: intercepts, zeros, extrema, symmetry, vertices, asymptotes and intersections.
Structure	15 short responses; 15 extended responses; 20 original IB-style questions.
Technology	A GDC is allowed throughout; GDC marks tasks requiring it. TI-Nspire CX reminders are included.

How to use this worksheet

Work in your exercise book. Show your calculator setup and key results. Give exact values when clear; otherwise use **3 significant figures**, unless told differently. Include units in context questions. A **point** needs (x, y) ; a **value** needs one number. No differentiation is needed.

Suggested first session: Questions 1–10, 16–17, 21–22 and 31. Return to the remaining questions over several sessions.

1 Short response

Questions 1–15

1. Match each term to its meaning.

Term	Meaning
A. x -intercept	1. A point where a graph meets the y -axis.
B. y -intercept	2. A point shared by two graphs.
C. Intersection	3. A point where a graph meets the x -axis.

2. A graph has a minimum point at $(3, -5)$.

- (a) Write down the minimum **value**.
(b) Write down the value of x at which this minimum occurs.

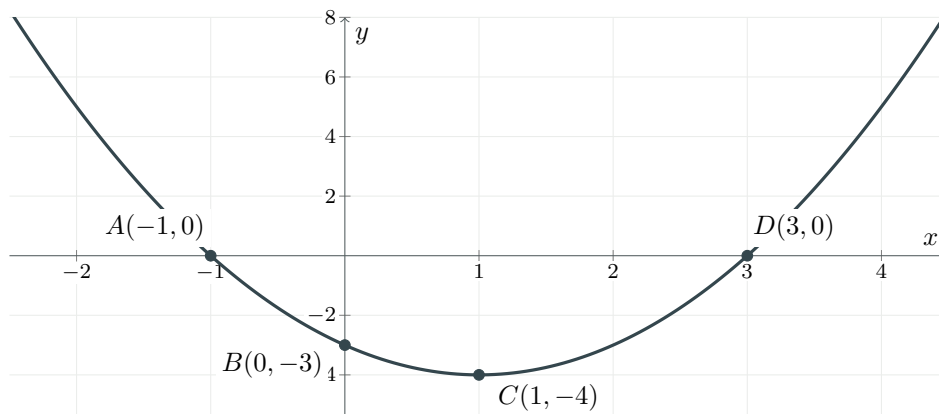
3. A graph meets the x -axis at $(-2, 0)$ and $(5, 0)$. Write down the two solutions of $f(x) = 0$.



1 Short response: read the graph

Questions 4–9

Use the graph of $y = f(x)$ below for Questions 4–9. It is a parabola and continues upwards on both sides beyond the displayed window.



4. Write down the coordinates of both x -intercepts.

At an x -intercept, the output y is zero.

5. Write down the zeros of f .

A zero is an x -value. It is also called a root of $f(x) = 0$.

6. Write down the y -intercept and the value of $f(0)$.

7. Write down (a) the vertex and (b) the minimum value of f .

8. State the equation of the vertical line of symmetry.

Your answer should start with $x =$.

9. The point $(-2, 5)$ lies on this parabola. Use symmetry to find the other point on the parabola with $y = 5$.

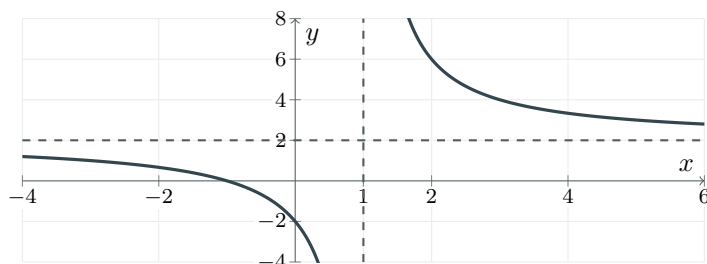


1 Short response: recognise the feature

Questions 10–15

10. A downward-opening parabola has vertex $(2, 9)$. State its maximum value and its line of symmetry.

11. The dashed lines are asymptotes of the graph shown. Write down the equation of (a) its vertical asymptote and (b) its horizontal asymptote.



12. Consider $g(x) = \frac{5}{x+2} + 3$.

- (a) Which value of x makes the denominator zero?
- (b) State the vertical asymptote.

13. A function has the values below. The outputs continue approaching the same number as x increases. Suggest the equation of its horizontal asymptote.

x	10	100	1000
$f(x)$	4.6	4.06	4.006

14. The graphs of $y = f(x)$ and $y = g(x)$ meet only at $(4, 7)$. State (a) the solution of $f(x) = g(x)$ and (b) the common output.

15. Choose a TI-Nspire tool for each task: **Zero, Minimum, Maximum, Intersection.**

- (a) Find the bottom of a U-shaped graph.
- (b) Find where two graphs meet.
- (c) Find an x -intercept.
- (d) Find the top of an upside-down U-shaped graph.



2 Extended response

Questions 16–30

TI-Nspire CX: a short reminder

Enter the function on a **Graphs** page. Set a suitable window using **Menu** → **Window/Zoom** → **Window Settings**. Then use **Menu** → **Analyze Graph** → **Zero, Minimum, Maximum** or **Intersection**. Select the relevant graph(s) when prompted, then choose a left and a right bound around **one** feature. Repeat for other features. For the y -intercept, evaluate the function at $x = 0$.

16. **GDC** Let $f(x) = x^2 - 4x - 1$.

Suggested window: $x \in [-2, 6]$, $y \in [-7, 12]$.

- (a) Use **Minimum** to find the vertex.
- (b) State the minimum value and the line of symmetry.
- (c) Use **Zero** twice to find both zeros.
- (d) Find $f(0)$ and write the y -intercept as a point.

17. **GDC** Let $g(x) = -x^2 - 2x + 8$.

Suggested window: $x \in [-5, 3]$, $y \in [-4, 11]$.

- (a) Find the maximum point.
- (b) Find both x -intercepts.
- (c) State the line of symmetry. Check that your two zeros lie the same distance from it.

18. **GDC** Let $f(x) = (x + 1)^2 + 2$.

- (a) Find the minimum point.
- (b) Explain why $f(x) = 0$ has no real solutions.
- (c) Add the line $y = 6$. Find both solutions of $f(x) = 6$.

19. **GDC** Let $f(x) = (x - 3)^2$.

- (a) Find the minimum point.
- (b) How many distinct zeros are there?
- (c) Does the graph cross the x -axis or just touch it?

20. **GDC** Let $f(x) = x^3 - 3x + 1$.

Suggested window: $x \in [-3, 3]$, $y \in [-5, 5]$.

- (a) Find the local maximum and local minimum points.
- (b) Find all three zeros.
- (c) The function is defined for all real x . Does it have a greatest value? Explain briefly.

“Local” means higher or lower than the nearby points; it need not be highest or lowest overall.



2 Extended response: intersections

Questions 21–25

At an intersection, the graphs have the **same x and the same y** . To solve $f(x) = g(x)$, graph both sides and find every intersection in the required domain. The solutions are the **x -coordinates**.

21. **GDC** Let $f(x) = 2x + 1$ and $g(x) = 10 - x$.

- (a) Enter the functions as $f1(x)$ and $f2(x)$. Find their intersection.
- (b) Hence solve $2x + 1 = 10 - x$.
- (c) Substitute your x -value into both expressions to check the common output.

22. **GDC** Let $f(x) = x^2 - 2$ and $g(x) = x$.

- (a) Find both intersection points.
- (b) Write down both solutions of $x^2 - 2 = x$.

After finding the first intersection, use a new pair of bounds around the second.

23. **GDC** Let $f(x) = -x^2 + 4x + 2$.

- (a) To solve $f(x) = 5$, which horizontal line should you add?
- (b) Find both intersection points.
- (c) Write down both solutions of $f(x) = 5$.

24. **GDC** Let $f(x) = 2^x$ and $g(x) = 5 - x$, for $0 \leq x \leq 4$.

- (a) Find the point of intersection to 3 significant figures.
- (b) Hence solve $2^x = 5 - x$ on this domain.
- (c) Compare $f(0)$ with $g(0)$, and $f(4)$ with $g(4)$. Describe how their order changes.

Suggested window: $x \in [0, 4]$, $y \in [0, 17]$.

25. **GDC** A student uses **nSolve** on $x^2 - 3x - 4 = 0$ and obtains $x = 4$.

- (a) Graph $y = x^2 - 3x - 4$ and find all its zeros.
- (b) Explain why giving only $x = 4$ is incomplete.
- (c) Why is graphing a useful check before accepting a single numerical answer?

One answer may not be all the answers. A single **nSolve** result does not show that there is only one solution. Use it as a complete solution method only when you have established that there is just one solution in the required domain; otherwise inspect the graph and find each solution.



2 Extended response: asymptotes and domains

Questions 26–30

A **vertical asymptote** is a line $x = a$ beside which the graph rises or falls without bound. A **horizontal asymptote** is a line $y = b$ that the graph approaches far to the left or right. For the fractions used here, a zero denominator locates the vertical asymptote. Write **line equations**, not just numbers.

26. **GDC** Let $f(x) = 1 + \frac{6}{x-2}$.

- (a) Complete the table. Write “undefined” where appropriate.

x	1.9	1.99	2	2.01	2.1
$f(x)$					

- (b) State the vertical asymptote.
(c) Graph the function and evaluate $f(100)$ and $f(1000)$. Suggest the horizontal asymptote.

27. **GDC** Let $g(x) = 2 - \frac{4}{x+1}$. Enter the denominator in brackets: 2-4/(x+1).

- (a) Find the vertical and horizontal asymptotes.
(b) Find the x - and y -intercepts.
(c) Check the y -intercept by substituting $x = 0$.

Suggested window: $x \in [-6, 6]$, $y \in [-6, 8]$.

28. **GDC** Let $h(x) = 3 + 5(0.6)^x$, for $x \geq 0$.

- (a) Find the y -intercept.
(b) Evaluate $h(5)$ and $h(10)$. Suggest the horizontal asymptote.
(c) Find the solution of $h(x) = 4$.

29. **GDC** Let $f(x) = 10 - (x-1)^2$, for $-1 \leq x \leq 4$.

- (a) Find the maximum point.
(b) Calculate the two endpoint values, $f(-1)$ and $f(4)$.
(c) State the minimum value **on this domain** and where it occurs.

For a restricted domain, check the endpoints as well as the turning points.

30. **GDC** Two hire companies charge $C(t) = 12 + 4t$ and $D(t) = 24 + 2t$ euros for t hours, where $0 \leq t \leq 12$.

- (a) Find the intersection of the two cost graphs.
(b) Explain both coordinates in this context.
(c) Which company is cheaper for 8 hours? Show both costs.



3 IB exam-style practice

Questions 31–50

Original AI SL Paper 1-style questions. A GDC is allowed throughout. Marks are shown in square brackets. Show key working, including graph equations and coordinates.

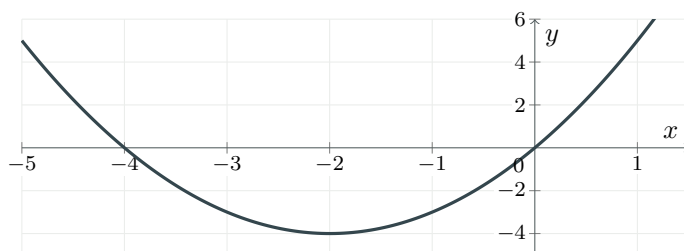
31. GDC Consider $f(x) = x^2 - 6x + 5$. [6 marks]

- (a) Write down the y -intercept. [1]
- (b) Find both zeros of f . [2]
- (c) Find the coordinates of the vertex. [2]
- (d) State the equation of the line of symmetry. [1]

32. GDC Consider $g(x) = 12 - 3x^2$. [5 marks]

- (a) Write down the maximum value of g . [1]
- (b) Find the zeros of g . [2]
- (c) Write down the y -intercept. [1]
- (d) State the axis about which the graph is symmetric. [1]

33. Part of the graph of a quadratic function $y = f(x)$ is shown. [5 marks]



- (a) Write down the number of distinct zeros. [1]
- (b) Write down the coordinates of the minimum point. [2]
- (c) Solve $f(x) = 0$. [2]

34. GDC A ball's height is modelled by $h(t) = -t^2 + 8t + 1$, where h is in metres and $0 \leq t \leq 8$ seconds. [6 marks]

- (a) Find the initial height. [1]
- (b) Find the maximum height and the time at which it occurs. [3]
- (c) Find both times when the height is 13 metres. [2]



3 IB exam-style practice

Questions 35–38

35. **GDC** Let $f(x) = x^3 - 6x^2 + 9x + 2$, for $0 \leq x \leq 4$. [7 marks]

- (a) Find the coordinates of the local maximum point. [2]
- (b) Find the coordinates of the local minimum point. [2]
- (c) Find all solutions of $f(x) = 4$ on the given domain. [3]

36. **GDC** Let $g(x) = x^2 + 2x + 3$. [5 marks]

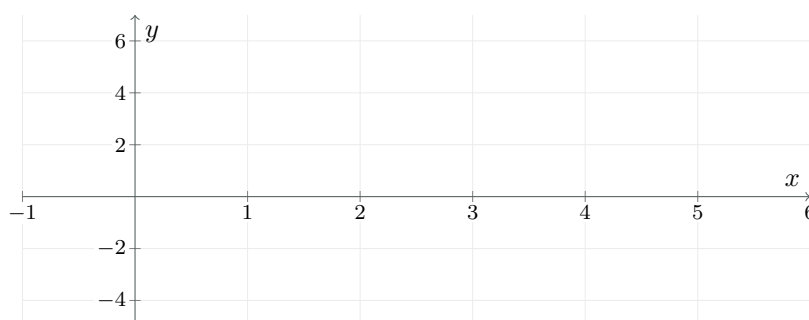
- (a) Find the coordinates of the vertex. [2]
- (b) Explain why g has no real zeros. [1]
- (c) Solve $g(x) = 5$. [2]

37. **GDC** The functions f and g are defined by $f(x) = 3x - 2$ and $g(x) = 14 - x$. [4 marks]

- (a) Find the coordinates of their point of intersection. [2]
- (b) Hence solve $3x - 2 = 14 - x$. [1]
- (c) Write down the common value of f and g at this point. [1]

38. **GDC** Let $f(x) = x^2 - 4x + 1$ and $g(x) = x - 3$. [8 marks]

- (a) Sketch both graphs on the axes below. Label each graph and show both intersections. [3]
- (b) Find the coordinates of both points of intersection. [4]
- (c) Hence write down the solutions of $x^2 - 4x + 1 = x - 3$. [1]



Before moving on: Have you found every intersection? Does the question ask for x -values, y -values or full coordinate pairs?



3 IB exam-style practice

Questions 39–42

39. GDC The water depths in two containers are modelled by $H(t) = 14 - 0.8t$ and $J(t) = 2 + 0.4t$, in centimetres, for $0 \leq t \leq 15$ minutes. [7 marks]

- (a) Find the initial depth in each container. [2]
 - (b) Find when the depths are equal, and state this depth. [3]
 - (c) Determine which container has the greater depth after 12 minutes. Show your calculations. [2]
-

40. GDC The cost, in euros, of hiring a bicycle for t hours is $A(t) = 5 + 3t$ with company A and $B(t) = 11 + 1.5t$ with company B, for $0 \leq t \leq 10$. [7 marks]

- (a) Calculate the cost with each company for 2 hours. [2]
 - (b) Find the hire duration for which the costs are equal, and state the common cost. [3]
 - (c) Determine the cheaper company for 7 hours. Show your calculations. [2]
-

41. GDC Let $f(x) = \frac{8}{x-1} - 2$. [5 marks]

- (a) State the equation of the vertical asymptote. [1]
 - (b) State the equation of the horizontal asymptote. [1]
 - (c) Find the y -intercept. [1]
 - (d) Find the zero of f . [2]
-

42. GDC Let $g(x) = 3 + \frac{12}{x+2}$. [5 marks]

- (a) State the equations of both asymptotes. [2]
- (b) Find the y -intercept. [1]
- (c) Solve $g(x) = 5$. [2]



3 IB exam-style practice

Questions 43–46

43. **GDC** The temperature of a drink is modelled by $T(t) = 18 + 62(0.85)^t$, where T is in $^{\circ}\text{C}$ and $t \geq 0$ is in minutes. [5 marks]

- (a) Find the initial temperature. [1]
- (b) State the horizontal asymptote and interpret it in this context. [2]
- (c) Find when the temperature reaches 35°C . [2]

44. **GDC** A concentration is modelled by $C(t) = 2 + 18(0.75)^t$, in mg/L, where $t \geq 0$ is in hours. [5 marks]

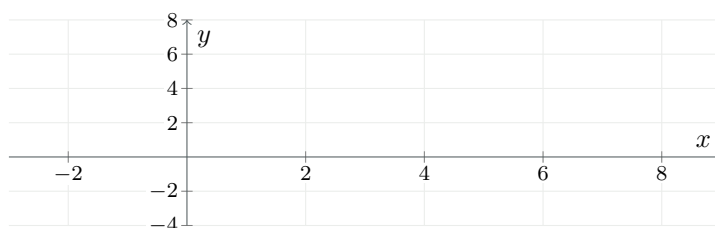
- (a) Find the initial concentration. [1]
- (b) Find when the concentration reaches 8 mg/L. [2]
- (c) State the horizontal asymptote. [1]
- (d) Can the concentration reach 1 mg/L according to this model? Give a reason. [1]

45. **GDC** Let $f(x) = \frac{4}{x}$ and $g(x) = x + 1$. [6 marks]

- (a) Find both points of intersection to 3 significant figures. [4]
- (b) Hence solve $\frac{4}{x} = x + 1$. [1]
- (c) Explain why $x = 0$ is excluded from the domain of f . [1]

46. **GDC** Let $h(x) = 2 + \frac{6}{x-3}$. [6 marks]

- (a) State the equations of the vertical and horizontal asymptotes. [2]
- (b) Find the y -intercept. [1]
- (c) Sketch the graph on the axes below. Include both branches, dashed asymptotes and the intercept found in part (b). [3]





3 IB exam-style practice

Questions 47–50

47. **GDC** The volume of water in a tank is modelled by $V(t) = -2t^2 + 20t + 40$, in litres, for $0 \leq t \leq 10$ minutes. [6 marks]

- (a) Find the initial volume. [1]
- (b) Find the maximum volume and when it occurs. [3]
- (c) Find both times when the volume is 72 litres. [2]

48. **GDC** Let $f(x) = x^3 - 4x$, for $-3 \leq x \leq 3$. [8 marks]

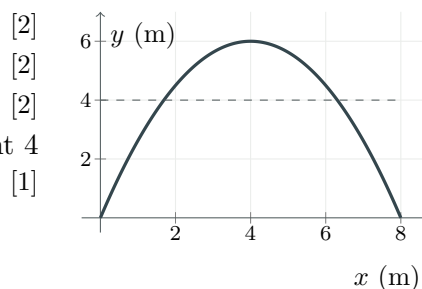
- (a) Find the local maximum and local minimum points. [4]
- (b) Find all solutions of $f(x) = 2$ on the given domain. [3]
- (c) Explain why a single **nSolve** result is not enough here. [1]

49. **GDC** Let $g(x) = 9 - (x - 2)^2$, for $-1 \leq x \leq 6$. [6 marks]

- (a) Find the maximum point on this domain. [2]
- (b) Find the minimum value and the x -value where it occurs. [2]
- (c) Find the zeros on this domain. [2]

50. **GDC** An arch is modelled by $y = 6 - 0.375(x - 4)^2$, for $0 \leq x \leq 8$. Both coordinates are measured in metres. [7 marks]

- (a) Find the highest point. [2]
- (b) Find the ground-level intercepts. [2]
- (c) Find both x -values at height 4 m. [2]
- (d) Hence find the horizontal width of the arch at height 4 m. [1]





Answer key and solution outlines

Section 1

Check the meaning as well as the number. Numerical graph results are rounded to 3 significant figures where needed.

1 Short response: Questions 1–15

1. A–3; B–1; C–2. An intercept is where the graph meets an axis; an intersection is shared by two graphs.
2. (a) The minimum value is -5 (the y -coordinate). (b) It occurs when $x = 3$.
3. $x = -2$ or $x = 5$. At each point, the output is zero.
4. $(-1, 0)$ and $(3, 0)$.
5. -1 and 3 . Zeros are inputs, so coordinate pairs are not needed.
6. The y -intercept is $(0, -3)$ and $f(0) = -3$.
7. (a) Vertex $(1, -4)$. (b) Minimum value -4 .
8. $x = 1$. This vertical line passes through the vertex.
9. $(4, 5)$. The input -2 is 3 units left of $x = 1$, so its mirror is 3 units right: $x = 1 + 3 = 4$. The output stays 5.
10. Maximum value 9; line of symmetry $x = 2$.
11. (a) $x = 1$. (b) $y = 2$.
12. (a) $x + 2 = 0$ gives $x = -2$. (b) The vertical asymptote is $x = -2$.
13. $y = 4$. The outputs approach 4 as x increases. The table suggests this behaviour; a few values alone would not prove it for an unknown function.
14. (a) $x = 4$. (b) The common output is 7: $f(4) = g(4) = 7$.
15. (a) Minimum. (b) Intersection. (c) Zero. (d) Maximum.

Useful distinctions

Zero/root: an x -value. Intercept or vertex: a point (x, y) .

Maximum/minimum value: a y -value. Asymptote: a line equation.



Answer key and solution outlines

Section 2

2 Extended response: Questions 16–23

16. Graph $y = x^2 - 4x - 1$. (a) Minimum gives $(2, -5)$. (b) The minimum value is -5 and the symmetry line is $x = 2$. (c) Zero, once on each side of the vertex, gives $x \approx -0.236$ and $x \approx 4.24$. (d) $f(0) = 0^2 - 4(0) - 1 = -1$, so the y -intercept is $(0, -1)$.

17. Graph $y = -x^2 - 2x + 8$. (a) Maximum gives $(-1, 9)$. (b) Zero gives $(-4, 0)$ and $(2, 0)$. (c) The symmetry line is $x = -1$; both zeros are 3 units from this line.

18. (a) Minimum gives $(-1, 2)$. (b) Even the lowest output is $2 > 0$, so the graph never meets the x -axis. (c) Graph $y = (x + 1)^2 + 2$ and $y = 6$: intersections $(-3, 6)$ and $(1, 6)$, giving $x = -3$ or $x = 1$.

19. (a) Minimum gives $(3, 0)$. (b) One distinct zero: $x = 3$. (c) The graph touches the axis and turns upwards. The outputs on both sides are positive.

20. (a) Maximum and Minimum give $(-1, 3)$ and $(1, -1)$ respectively. (b) Applying Zero in three separate intervals gives $x \approx -1.88, 0.347, 1.53$. (c) No. The right-hand branch rises without bound; the local maximum is only higher than nearby points.

21. (a) Graph $y = 2x + 1$ and $y = 10 - x$. Intersection gives $(3, 7)$. (b) Hence $x = 3$. (c) $2(3) + 1 = 7$ and $10 - 3 = 7$, so both expressions have the same output.

22. (a) Graph $y = x^2 - 2$ and $y = x$. The intersections are $(-1, -1)$ and $(2, 2)$. (b) The solutions are the x -coordinates: $x = -1$ or $x = 2$.

23. (a) Add $y = 5$. (b) Its intersections with $y = -x^2 + 4x + 2$ are $(1, 5)$ and $(3, 5)$. (c) Hence $x = 1$ or $x = 3$.



Answer key and solution outlines

Section 2 continued

2 Extended response: Questions 24–30

24. (a) Graph $y = 2^x$ and $y = 5 - x$ on $[0, 4]$. Intersection gives $(1.7156207\dots, 3.2843792\dots) \approx (1.72, 3.28)$. (b) $x \approx 1.72$. (c) $f(0) = 1 < 5 = g(0)$, but $f(4) = 16 > 1 = g(4)$. The rising exponential starts below the falling line and finishes above it.

25. (a) Graph $y = x^2 - 3x - 4$. Zero gives $x = -1$ and $x = 4$. (b) The answer $x = 4$ misses the other root, $x = -1$. (c) Graphing helps reveal multiple solutions so that each can be located separately. Check the full required domain, not just a small screen window.

26. (a) Substitute each input into $1 + 6/(x - 2)$:

x	1.9	1.99	2	2.01	2.1
$f(x)$	-59	-599	undefined	601	61

(b) The denominator is zero at $x = 2$ and nearby outputs grow in magnitude: vertical asymptote $x = 2$. (c) $f(100) = 1.061224\dots$ and $f(1000) = 1.006012\dots$. The fraction approaches zero for large x , so the horizontal asymptote is $y = 1$.

27. (a) The graph has asymptotes $x = -1$ and $y = 2$. (b) Zero gives $(1, 0)$; the y -intercept is $(0, -2)$. (c) $g(0) = 2 - 4/(0 + 1) = -2$.

28. (a) $h(0) = 3 + 5(0.6)^0 = 8$, giving $(0, 8)$. (b) $h(5) = 3.3888 \approx 3.39$ and $h(10) = 3.030233\dots \approx 3.03$. Horizontal asymptote: $y = 3$. (c) Graph $y = 3 + 5(0.6)^x$ and $y = 4$; Intersection gives $x = 3.150660\dots \approx 3.15$.

29. (a) Maximum gives $(1, 10)$. (b) $f(-1) = 10 - (-2)^2 = 6$ and $f(4) = 10 - 3^2 = 1$. (c) Comparing the turning-point output and both endpoint outputs, the minimum value is 1, at $x = 4$.

30. (a) Graph $y = 12 + 4x$ and $y = 24 + 2x$. Intersection gives $(6, 36)$. (b) Both companies charge €36 for 6 hours. (c) $C(8) = 12 + 4(8) = 44$; $D(8) = 24 + 2(8) = 40$. Company D is cheaper by €4.

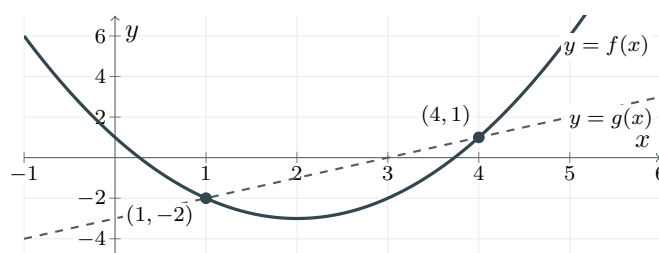


Answer key and solution outlines

Section 3

3 IB exam-style practice: Questions 31–40

31. (a) $f(0) = 5 \Rightarrow (0, 5)$. (b) Zero gives $x = 1, 5$. (c) Minimum gives $(3, -4)$. (d) $x = 3$.
32. (a) Maximum value 12. (b) Zero gives $x = -2, 2$. (c) $g(0) = 12 \Rightarrow (0, 12)$. (d) The y -axis (the line $x = 0$).
33. (a) Two. (b) $(-2, -4)$. (c) $x = -4$ or $x = 0$. The second intercept is the origin.
34. (a) $h(0) = 1$ m. (b) Graph $y = -x^2 + 8x + 1$ on $[0, 8]$; Maximum gives $(4, 17)$: 17 m at 4 s. (c) Intersect with $y = 13$: $t = 2$ s and $t = 6$ s.
35. (a) Maximum gives $(1, 6)$. (b) Minimum gives $(3, 2)$. (c) Intersect $y = x^3 - 6x^2 + 9x + 2$ with $y = 4$ on $[0, 4]$: $x = 0.267949\dots, 2, 3.732050\dots$, so $x \approx 0.268, 2, 3.73$.
36. (a) Minimum gives $(-1, 2)$. (b) The minimum output is $2 > 0$, so no point lies on the x -axis. (c) Intersect $y = x^2 + 2x + 3$ with $y = 5$: $x = -2.732050\dots$ or $0.732050\dots$, hence $x \approx -2.73$ or 0.732 .
37. (a) Intersect $y = 3x - 2$ and $y = 14 - x$: $(4, 10)$. (b) $x = 4$. (c) The common output is 10.
38. (a) A suitable sketch is shown below. (b) Intersect $y = x^2 - 4x + 1$ and $y = x - 3$: $(1, -2)$ and $(4, 1)$. (c) Hence $x = 1$ or $x = 4$.



39. (a) $H(0) = 14$ cm and $J(0) = 2$ cm. (b) Intersect $y = 14 - 0.8x$ and $y = 2 + 0.4x$: $(10, 6)$. The depths are both 6 cm after 10 min. (c) $H(12) = 14 - 0.8(12) = 4.4$ cm and $J(12) = 2 + 0.4(12) = 6.8$ cm. Container J has the greater depth.
40. (a) $A(2) = 5 + 3(2) = 11$ euros; $B(2) = 11 + 1.5(2) = 14$ euros. (b) The cost graphs intersect at $(4, 17)$: both charge €17 for 4 hours. (c) $A(7) = 26$ euros and $B(7) = 21.50$ euros, so B is cheaper.



Answer key and solution outlines

Section 3 continued

3 IB exam-style practice: Questions 41–46

41. (a) $x = 1$ (the denominator is zero). (b) $y = -2$ (the fraction approaches zero far away). (c) $f(0) = 8/(-1) - 2 = -10$, so $(0, -10)$. (d) Zero gives $x = 5$; check: $8/(5 - 1) - 2 = 0$.

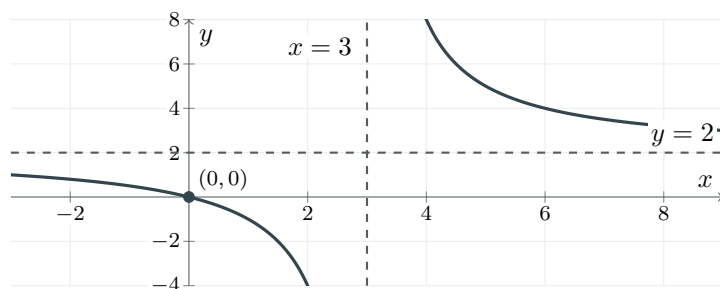
42. (a) $x = -2$ and $y = 3$. (b) $g(0) = 3 + 12/2 = 9$, so $(0, 9)$. (c) Intersect $y = 3 + 12/(x + 2)$ with $y = 5$: $x = 4$.

43. (a) $T(0) = 18 + 62 = 80^\circ\text{C}$. (b) $T = 18$: the temperature approaches 18°C as time increases, representing the surrounding temperature in this model. (c) Intersect $y = 18 + 62(0.85)^x$ with $y = 35$: $t \approx 7.96$ min.

44. (a) $C(0) = 2 + 18 = 20$ mg/L. (b) Intersect $y = 2 + 18(0.75)^x$ with $y = 8$: $t = 3.818841 \dots \approx 3.82$ h. (c) $C = 2$. (d) No. The term $18(0.75)^t$ is positive, so $C(t) > 2$ for every finite $t \geq 0$.

45. (a) Intersect $y = 4/x$ and $y = x + 1$ separately on the negative and positive sides: $(-2.561552 \dots, -1.561552 \dots)$ and $(1.561552 \dots, 2.561552 \dots)$. To 3 s.f.: $(-2.56, -1.56)$ and $(1.56, 2.56)$. (b) $x \approx -2.56$ or $x \approx 1.56$. (c) $4/0$ is undefined: division by zero is not allowed.

46. (a) $x = 3$ and $y = 2$. (b) $h(0) = 2 + 6/(-3) = 0$, so $(0, 0)$. (c) Both branches and asymptotes are shown below.





Answer key and solution outlines

Section 3 continued

3 IB exam-style practice: Questions 47–50

47. (a) $V(0) = 40$ L. (b) Graph $y = -2x^2 + 20x + 40$ on $[0, 10]$; Maximum gives $(5, 90)$: 90 L after 5 min. (c) Intersect this curve with $y = 72$: $t = 2$ min and $t = 8$ min.

48. (a) Graph $y = x^3 - 4x$ on $[-3, 3]$. Maximum gives $(-1.154700\dots, 3.079201\dots) \approx (-1.15, 3.08)$. Minimum gives $(1.154700\dots, -3.079201\dots) \approx (1.15, -3.08)$. (b) Add $y = 2$ and locate three intersections: $x = -1.675130\dots, -0.539188\dots, 2.214319\dots$. Thus $x \approx -1.68, -0.539, 2.21$. (c) There are three solutions; one numerical answer would miss two of them.

49. (a) Maximum gives $(2, 9)$. (b) Check both endpoints: $g(-1) = 9 - (-3)^2 = 0$ and $g(6) = 9 - 4^2 = -7$. The curve's lowest output on this domain is -7 , at $x = 6$. (c) The zeros are $x = -1$ and $x = 5$. The endpoint $x = -1$ is included.

50. (a) Maximum gives $(4, 6)$: the highest point is 6 m above the ground, at $x = 4$ m. (b) Zero gives $(0, 0)$ and $(8, 0)$. (c) Intersect $y = 6 - 0.375(x-4)^2$ with $y = 4$: $x = 1.690598\dots$ m and $x = 6.309401\dots$ m, or 1.69 m and 6.31 m to 3 s.f. (d) Width = $x_{\text{right}} - x_{\text{left}} = 6.309401\dots - 1.690598\dots = 4.618802\dots \approx 4.62$ m. Retain full calculator values until this final subtraction.

A final check

1. Did I use the full stated domain?
2. Did I find all solutions?
3. Did I give a point, a value or a line equation as requested?
4. Did I retain calculator precision and include the correct units?

Source alignment. IB Mathematics: applications and interpretation guide, SL 2.4 (p. 36); supplied AI SL Paper 1 questions used for wording and mark style only. All worksheet questions are original. Calculator menu guidance checked against Texas Instruments: finding minimum, maximum and zeros and the TI-Nspire graphing guide.