Year 11 Mathematics Advanced

Topic: Introduction to Differentiation (3 of 6)
Review Questions: Tangents, Normals and Angle of Inclination
Term 3, 2026

How to use this review set

These are real past-paper questions, grouped by question pattern. The grey label on each question shows where it is from and its marks.

- The questions are grouped by the pattern that keeps coming up in exams, a few of each in a row, running from the plainer patterns into the harder ones near the end. Work through them and you will meet every type an exam can throw at you.
- This set **is your diagnostic**. Working through it shows you exactly which patterns are solid and which need work. Attempt every question properly in your own book, and go back to your notes to help you work through tough questions if needed.
- Every question you get wrong, need help with or struggle with goes in your **Mistakes Log**, which you should be working on daily to get you exam-ready.

Contents

Tangents, normals and angle of inclination

1. Equations of tangents and normals
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4. Angle of inclination ($\tan\theta = m$)

Tangents, normals and angle of inclination

1. Equations of tangents and normals

Q1 Sydney Grammar 2021 Prelim Q3 · **1 mark**

What is the value of the gradient of the tangent to the curve $y = 3x^2 + 2x$ at the point $(1, 5)$?

(A) 1

(B) 4

(C) 6

(D) 8

Q2 Loreto Kirribilli 2022 Prelim Q14 · **2 marks**

Find the gradient of the curve $y = \dfrac{1}{x^2}$ at the point $\left(\dfrac{1}{2}, 4\right)$.

Q3 Gosford 2023 Prelim Q26(a) · **2 marks**

Let $y = 3x - x^2$. Show that the gradient of the tangent at $x = 3$ is equal to -3.

Q4 Sydney Grammar 2023 Prelim Q11(a) · **3 marks**

Find the equation of the normal to the curve $y = 2\sqrt{x}$, at the point on the curve where $x = 9$.

Q5 North Sydney Girls 2021 Prelim Q1(bi) · **3 marks**

Find the equation of the normal to the curve $y = (2x + 1)^4$ at the point where $x = -1$. Leave your answer in general form.

Q6 Knox 2022 Prelim Q12(b) · **3 marks**

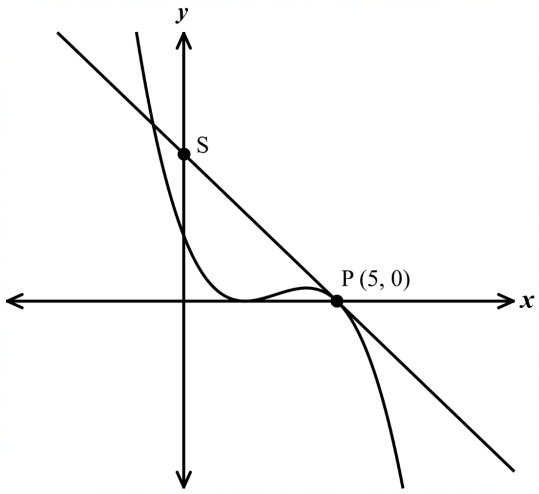
Find the equation of the normal to the curve $y = 3 - 4x^2 - x^3$, at the point where $x = -1$. Leave your final answer in general form.

Q7 Killara 2023 Prelim Q31(a) · **3 marks**

Consider the following function:

$$f(x) = \frac{1}{5}(x-2)^2(5-x).$$

Point $P(5,0)$ is on the graph of $f(x)$. Find the equation of the tangent to the graph $f(x)$ at $P(5,0)$.

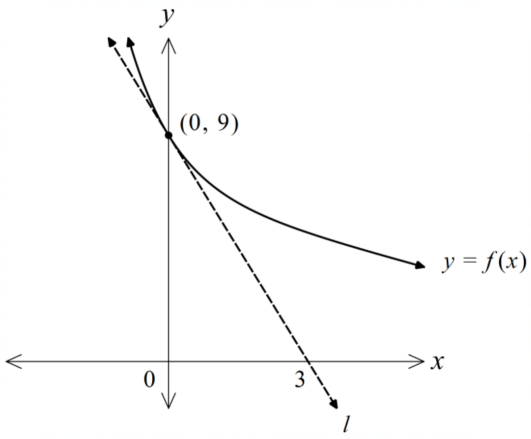


Q8 Baulkham Hills 2024 Prelim Q17 · **3 marks**

Find the equation of the tangent to the curve $y = 8x^3 - 6x^2 + x - 1$ at the point where $x = 1$.

Q9 Killara 2022 Prelim Q36 · **2 marks**

The graph below shows a function $y = f(x)$, and its tangent at the point $(0, 9)$ represented by line l.



Given a new function $g(x) = \sqrt{f(x)}$, find the value of $g'(0)$.

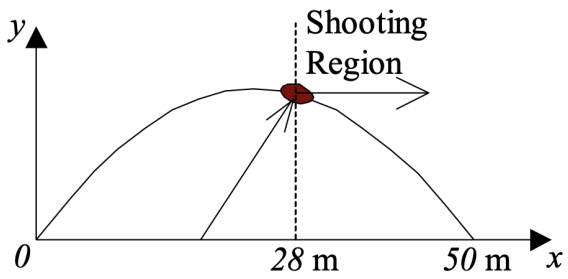
Q10 Knox 2023 Prelim Q35 · **3 marks**

In a rifle club, discs are projected and follow the path of the parabola with equation

$$y = -\frac{x^2}{25} + 2x.$$

The rules of competition include the following:

1. Competitors must only shoot at the disc when it is in the "shooting region", as shown in the figure below.
2. Competitors must shoot from a position no further than 23 m from the origin.
3. The number of points awarded for each shot is equal to the height of the disc when first struck by a bullet.
4. Bonus points are awarded if the disc is completely destroyed. (NB. To guarantee complete destruction, the direction of the bullet must be normal to the path of the disc.)
5. You may assume the direction of motion for the disc is always tangential to its parabolic path.



What advice about shooting position (relative to O) and shooting angle (relative to the x-axis) would you give a competitor wishing to achieve maximum points? Justify your answer with calculations.

2. Tangents from an external point

Q11 Hurlstone 2022 Trial Q11(d) · **2 marks**

The equation of a curve C is given by $y = x^2 + ax + b$, where a and b are constants. The tangent to C at $(0, 5)$ passes through $(5, 20)$. Find the values of a and b.

Q12 Sydney Grammar 2021 Prelim Q14(c) · **4 marks**

The line ℓ is the tangent to the curve $y = 1 - \dfrac{1}{x}$ at the point where $x = a$, where a is a constant.

(i) Show that ℓ has equation $x - a^2 y = 2a - a^2$.

(ii) If the line ℓ passes through the origin, find the value of a and hence the equation of ℓ.

Q13 Abbotsleigh 2024 Prelim Q26 · **4 marks**

(a) Show that the tangent to the curve $y = x^2 + 1$ at the point $P(a,\ a^2 + 1)$ has equation $2ax - y - a^2 + 1 = 0$.

(b) Find the coordinates of any points on the curve where the tangent to the curve passes through the origin.

Q14 Fort St 2022 Prelim Q9(b) · **3 marks**

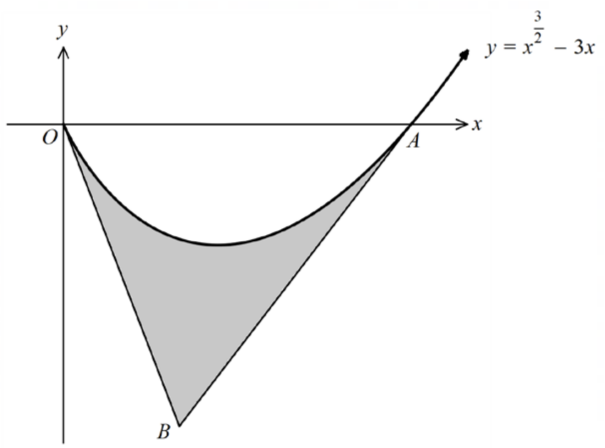
Find the equation of the tangents to the curve $y = x^2 - 4x$, at the points where the curve cuts the x-axis. Hence, what is the point of intersection of these tangents?

Q15 Shore 2023 Trial Q15 · **3 marks**

The tangent to the graph of $f(x) = x^3 + ax^2 + 1$ at $x = 1$ passes through the origin. Find the value of a.

Q16 North Sydney Girls 2022 Trial Q32(a) · **3 marks**

The graph of $y = x^{\frac{3}{2}} - 3x$ meets the x-axis at the origin O and at the point $A(9, 0)$. Tangents to the curve at O and A meet at the point B. Show that the coordinates of B are $(3, -9)$.



Q17 Glenwood 2023 Trial Q32 · **3 marks**

Two tangents can be drawn from the origin to the graph of the curve $y = x^2 + 3x + 5$. Find the equations of these tangents.

Q18 Girraween 2022 Trial Q33 · **4 marks**

By considering the equation of the tangent to $y = x^2 - 1$ at the point $(a, a^2 - 1)$, find the equations of the two tangents to $y = x^2 - 1$ which pass through $(3, -8)$.

3. Finding a point or parameter from a gradient condition

Q19 St George Girls 2022 Prelim Q14(b) · **2 marks**

A function is given by the formula $f(x) = 2x^2 - 32ax$ where a is a constant. Find the value of a given that $f'(4) = 0$.

Q20 St George Girls 2023 Prelim Q14 · **2 marks**

Given the function $y = 10x^3 - 4$, for what value(s) of x is $\dfrac{dy}{dx} = 10$?

Q21 Cherrybrook Tech 2022 Prelim Q21(a) · **2 marks**

A tangent is drawn to the parabola $y = x^2 - 4x$ at the point P. The tangent has a gradient of 6. Find the coordinates of P.

Q22 Sydney Girls 2020 Trial Q17 · **2 marks**

Find the x-values for the points on the graph of $f(x) = -x^3 + 6x^2$ at which the normal has slope $-\dfrac{1}{9}$.

Q23 Sydney Grammar 2021 Prelim Q11(bii) · **3 marks**

Consider the curve $y = (2x - 3)^3$, for which $\dfrac{dy}{dx} = 6(2x - 3)^2$. Hence, find all the points on the curve $y = (2x - 3)^3$ where the gradient of the tangent is equal to 24.

Q24 Killara 2022 Prelim Q18 · **3 marks**

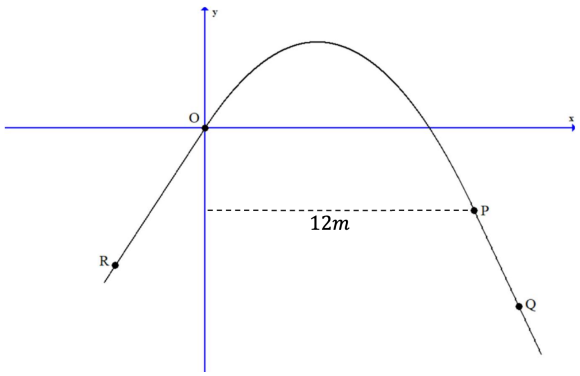
Consider the function $f(x) = \dfrac{a}{x} + 2x^2$ for some constant a. It is known that $f'(4) = 7$. Find the value of a.

Q25 Blacktown Boys 2022 Prelim Q21 · **3 marks**

The curve $y = ax^3 + bx$ passes through the point $(1, 7)$. The tangent at this point is parallel to the line $y = 3x - 8$. Find the values of a and b.

Q26 Gosford 2024 Prelim Q10 · **1 mark**

Luna Park is designing a new roller coaster, and the diagram below illustrates part of its design. The section RO is a straight line with $m = 2.5$ and the section PQ is a straight line with $m = -3.5$. The section OP is a parabola of the form $y = ax^2 + bx$. The horizontal distance from the y-axis to P is 12 m.



For the ride to be smooth, the straight-line sections must be tangents to the parabola at O and P. What are the values of a and b that make the ride smooth?

(A) $a = -0.0625$ and $b = 2.5$

(B) $a = -0.25$ and $b = 2.5$

(C) $a = -2.5$ and $b = -3.5$

(D) $a = -2$ and $b = 1$

4. Angle of inclination ($\tan\theta = m$)

Q27 Hurlstone 2021 Prelim Q13 · 1 mark

For the equation $y = 3x^2 - 4$, what is the angle of inclination of the tangent to the curve at the point where $x = 1$?

(A) $8°$

(B) $6°$

(C) $61°$

(D) $81°$

Q28 North Sydney Girls 2022 Prelim Q32(b) · 1 mark

Consider the function $f(x) = -\sqrt{x-4}$.

(a) Determine the equation of the normal to the curve at the point where $x = 8$. Write your answer in gradient-intercept form.

(b) Hence, find the angle of inclination of the normal with the positive x-axis. Give your answer to the nearest degree.

Q29 Hornsby Girls 2022 Prelim Q2 · 1 mark

The tangent to the curve $y = x^2$ at the point $(2, 4)$ makes the angle θ with the positive direction of the x-axis. What is the value of θ, correct to the nearest minute?

(A) $1°19'$

(B) $1°20'$

(C) $75°57'$

(D) $75°58'$

Q30 Hurlstone 2022 Prelim Q8 · **1 mark**

What is the angle of inclination to the positive x-axis, to the nearest degree, of the tangent to the curve $y = \frac{x^3}{6} + 2x$ at the point where $x = 1$?

(A) 65°

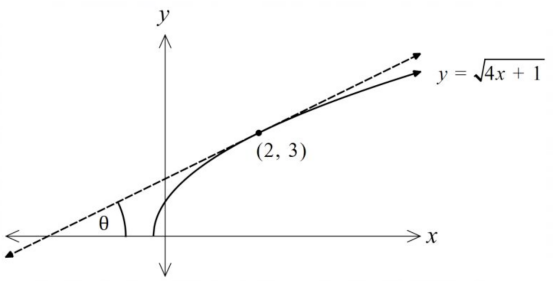
(B) 68°

(C) 79°

(D) 112°

Q31 Killara 2022 Prelim Q30 · **3 marks**

The function $y = \sqrt{4x + 1}$ has been graphed below. The dotted line shows the tangent to the curve at the point $(2, 3)$.



Find the angle the tangent line makes to the x-axis from the positive side (θ), correct to the nearest degree.