Year 11 Mathematics Advanced

Topic: Introduction to Differentiation (4 of 6)
Review Questions: Rates of Change and Motion
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

Rates of change

1. Rates of change from a model

Motion in a straight line

2. Velocity and displacement
3. At rest, changing direction and distance travelled

Rates of change

1. Rates of change from a model

Q1 Sydney Grammar 2022 Trial Q6 · **1 mark**

A ghost gum tree was planted in 2010. The height of the tree H, in metres, is a function of the tree's age, in years, after planting. Which of the following is the correct interpretation of $H'(4) = 3.2$?

(A) Between 2010 and 2014, the height increased at a rate of 3.2 m per year.

(B) Between 2010 and 2014, the height increased by 3.2 m.

(C) At the start of 2014, the height was increasing at a rate of 3.2 m per year.

(D) At the start of 2014, the height was 3.2 m.

Q2 Fort St 2021 Prelim Q5(ai) · **1 mark**

A dragster is a car that races in a straight line. Its displacement d over 400 m is modelled by the equation $d(t) = t^2 + 3t - 2$, where time t in seconds is $0 \leq t \leq 20$. The difference quotient is given by

$$\frac{d(t+h) - d(t)}{h}.$$

What is the meaning of the difference quotient in this context?

Q3 Killara 2021 Prelim Q23(b) · **2 marks**

A petrol tank holds 35 000 litres of petrol. Petrol is draining from the tank and the volume of petrol remaining in the petrol tank after t minutes is given by $V = 35\,000\left(1 - \frac{t}{30}\right)^2$, where V is measured in litres. Find the instantaneous rate of flow at $t = 15$.

Q4 Hornsby Girls 2021 Prelim Q4 · **1 mark**

If the volume of water, V litres, in a tank after t minutes, is given by $V = 600t - t^3$, then after five minutes:

(A) The volume of water is decreasing at a rate of 525 litres per minute.

(B) The volume of water is increasing at a rate of 525 litres per minute.

(C) The volume of water is decreasing at a rate of 2 875 litres per minute.

(D) The volume of water is increasing at a rate of 2 875 litres per minute.

Q5 St George Girls 2023 Prelim Q25(b) · **2 marks**

The displacement x metres of a particle moving along the y-axis at a time t seconds is given by $x = 12+4t-t^2$. Find the average velocity of the particle in the first 3 seconds.

Q6 Pymble 2022 Prelim Q27(c) · **2 marks**

A swimming pool is to be emptied for maintenance. The quantity of water, Q litres, remaining in the pool at a time t minutes after it starts to drain, is given by $Q(t) = 2000(25-t)^2$, $t \geq 0$. At what time does the rate of flow of water from the pool reach 20 000 L/minute?

Q7 North Sydney Girls 2023 Prelim Q22 · **2 marks**

While writing this exam, the teacher accidentally knocked over and spilt their coffee onto their rug creating a stain. The area (in cm^2) of the coffee stain after time t seconds is given by the equation $A = 12 - \dfrac{12}{2t+1}$. Find the instantaneous rate of change in the area of the coffee stain after 5 seconds.

Q8 Killara 2024 Prelim Q29(d) · **3 marks**

Water is leaking from the bottom of a tank. It is given that V is the volume of water in litres remaining in the tank after t minutes and $0 \leq t \leq 25$, where $V(t) = 500\left(1 - \dfrac{1}{25}t\right)^3$. The initial rate of water leaking from the tank is 60 L/min. Hence, calculate the time at which water is leaking at half the initial rate, correct to the nearest whole number.

Motion in a straight line

2. Velocity and displacement

Q9 Killara 2021 Prelim Q20(b) · 1 mark

The displacement in metres of a particle travelling in a straight line is given by $x = 4t^2 - 12t$, where t is the time taken in seconds. Find the velocity (v) of the particle as a function of time.

Q10 Pymble 2022 Prelim Q26(c) · 1 mark

A particle is moving in a straight line. At time t seconds its displacement, in metres, from a fixed point O on the line is given by $x = t^2 - 2t$. What is the velocity of the particle at the time it has returned to its starting position?

Q11 St George Girls 2021 Prelim Q5(ai) · 1 mark

A particle is moving along the x-axis. Its displacement x centimetres at time t seconds is given by $x = 4 + 12t^2 - t^3$ for $t \geq 0$. What is the initial displacement of the particle?

Q12 International Grammar 2021 Prelim Q23(a) · 1 mark

The displacement from the origin (x metres) of a particle travelling in a straight line at a time (t seconds) is given by $x = 3t^4 - 16t^3 + 18t^2$, where $t \geq 0$. Find the velocity of the particle after 2 seconds.

Q13 Hornsby Girls 2022 Prelim Q21(c) · 2 marks

A particle is travelling in one dimension. Its displacement in metres at time t seconds is given by $x = t^3 - 6t^2 + 9t + 3$. The particle is at rest at times t_1 and t_2 (where $t_1 < t_2$). Complete the table of values below.

t	0	$t_1 =$ _____	$t_2 =$ _____
x			

Q14 Gosford 2024 Prelim Q23(c) · 3 marks

Gerry's displacement from home is modelled by the equation $x = -0.5t^2 + 2t + 6$, where x is measured in kilometres and t is measured in hours. Sketch the graph of velocity vs time for Gerry's journey for $0 \leq t \leq 6$.

Q15 Fort St 2022 Prelim Q12(biii) · **2 marks**

The displacement, x metres, of an object moving along a straight line over time, t seconds, is given by $x = (t^3 + 1)^4$. Show that the particle is never at the origin.

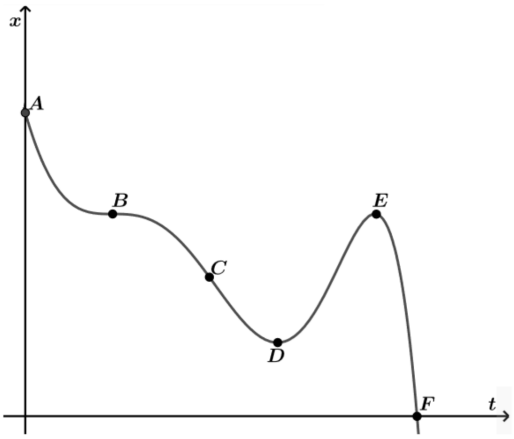
Q16 Penrith 2023 Prelim Q22(d) · **2 marks**

A particle is moving in a straight line. Its displacement, x m, from a fixed point, O, after t seconds is given by $x = 3t^2 - 6t$, where $t \geq 0$. Is the particle speeding up or slowing down when $t = 0.5$ seconds? Explain how you determined this.

3. At rest, changing direction and distance travelled

Q17 Hurlstone 2021 Prelim Q12 · **1 mark**

For the displacement graph below, at which of the points will the particle be at rest?



(A) B, C, D and E only

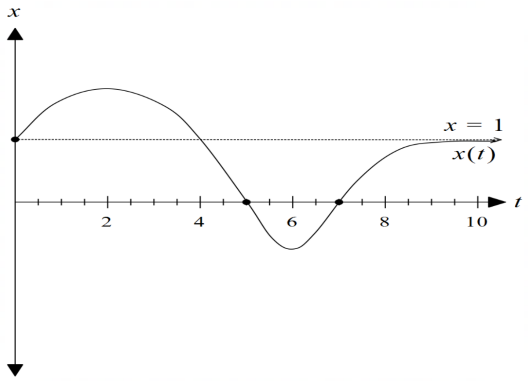
(B) A and F only

(C) D and E only

(D) B, D and E only

Q18 Manly 2022 Prelim Q29(a) · **1 mark**

A particle is moving along the x-axis, and its displacement from the origin is given by $x(t)$, where t is the time in seconds. $x(t)$ has a horizontal asymptote along the line $x = 1$. The graph of $x(t)$ is shown below. When is the particle at rest?



Q19 St George Girls 2022 Prelim Q29(a) · **2 marks**

A particle moves from rest at a point A in a straight line, so that t seconds after leaving A its displacement, x metres, is given by $x = 16t^2 - 2t^4$. Find what time the particle next comes to rest.

Q20 Gosford 2023 Prelim Q20(b) · **1 mark**

A particle moves in a straight line described by the function $x(t) = -t^2 + 5t + 6$. When does the particle change directions?

Q21 Moriah 2021 Prelim Q27(b) · **2 marks**

The displacement from the origin (x metres) of a particle travelling in a straight line at a time (t seconds) is given by $x = 3t^4 - 16t^3 + 18t^2$, where $t \geq 0$. It can be shown that the velocity $\dfrac{dx}{dt} = 0$ at time $t = 1$ second. Find any other time(s) when the particle is stationary.

Q22 Hornsby Girls 2021 Prelim Q19 · **3 marks**

A particle moves in a straight line so that its displacement $x(t)$ from a fixed point on the line at time $t \geq 0$ is given by $x(t) = 6 + 8t - 4\sqrt{t^2 + 16}$. Show that the particle never comes to rest.