Limits and Derivatives

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. $\lim_{x \to 3} (3x^2 + x + 3)$ equals:

(a) −33 **(b)** 34 **(c)** 27 **(d)** 33

2. $\lim_{x \to 4} (x^6 - 4096) \div (x - 4)$ equals:

(a) 4,096 **(b)** 24,576 **(c)** 6,144 **(d)** 5,120

3. $\lim_{x \to 0} (\sin 2x \div \sin 2x)$ equals:

(a) 2 **(b)** 3 **(c)** 0 **(d)** 1

4. The derivative of $4x^4 - 4x^3 - x^2 - 3x - 2$ is:

(a) $16x^3 - 12x^2 - 2x - 5$ **(b)** $16x^3 - 12x^2 - 2x - 3$
(c) $4x^3 - 4x^2 - x - 3$ **(d)** $20x^3 - 12x^2 - 2x - 3$

5. $\lim_{x \to 0} (\sin x)/x$ equals:

(a) it does not exist **(b)** 0
(c) 1 **(d)** ∞

6. If $f(x) = -4x^3 + 3x^2 + 4x + 4$, then $f'(1)$ is:

(a) 2 **(b)** 7 **(c)** −2 **(d)** −1

7. The derivative of $-3 \sin x - \cos x - x^5$ is:

(a) $-3 \cos x + \sin x - 5x^4$ **(b)** $3 \cos x + \sin x - 5x^4$
(c) $-3 \cos x - \sin x - 5x^4$ **(d)** $-3 \cos x + \sin x - x^4$

8. Assertion (A): The derivative of x^8 is x^7.
Reason (R): For any positive integer n, the derivative of x^n is nx^{n-1}.

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer 8 × 2 = 16 marks

9. Evaluate $\lim_{x \to 3} (x^2 - 5x + 6) \div (x - 3)$.

10. Evaluate $\lim_{x \to 3} (x^3 - 27) \div (x - 3)$.

11. Evaluate $\lim (x \to 0) (\sin 4x + 3x) \div x$.

12. Find the derivative of $5x^5 - 6x^4 + 4x^3 + 2x^2 - x$.

13. Find the derivative of $(-2x - 3)(x^2 + 1)$ using the product rule.

14. Find the derivative of $(-6x + 2) \div (3x + 2)$.

15. Find the derivative of $f(x) = 4x^2 + x + 8$ from first principles, and hence find $f'(3)$.

16. Differentiate $x^6 \cos x$.

Section C — Word problems — 4 × 4 = 16 marks

17. Evaluate: (a) $\lim (x \to 4) (x^6 - 4{,}096) \div (x - 4)$; (b) $\lim (x \to 0) (\sin 3x) \div (\sin 4x)$; (c) $\lim (x \to -1) (x^2 - 1) \div (x + 1)$.

18. $f(x) = -x + 1$ for $x < -3$ and $f(x) = 4x + 16$ for $x \geq -3$. Find the left-hand and right-hand limits at $x = -3$. Does $\lim (x \to -3) f(x)$ exist?

19. For $f(x) = -2x^3 + 1$, find $f'(x)$, $f'(3)$ and $f'(0)$. What is the slope of the tangent to the graph at $x = 3$?

20. Find the derivative of f(x) = 1 ÷ (x + 1) from first principles.

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Answer key

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Q	Answer	Working
1	**(d) 33**	substitute directly
2	**(c) 6,144**	$na^{n-1} = 6 \times 4^5$
3	**(d) 1**	use $\lim (\sin \theta)/\theta = 1$
4	**(b) $16x^3 - 12x^2 - 2x - 3$**	$d/dx\ x^n = nx^{n-1}$
5	**(c) 1**	x in radians
6	**(c) −2**	$f'(x) = -12x^2 + 6x + 4$
7	**(a) $-3 \cos x + \sin x - 5x^4$**	$(\sin x)' = \cos x$, $(\cos x)' = -\sin x$
8	**(d) A is false, but R is true.**	A is false: $d/dx\ x^n = nx^{n-1}$ with n = 8. R is true.
9	**1**	factorise: $(x - 3)(x - 2)$; cancel and put x = 3
10	**27**	$\lim (x^n - a^n)/(x - a) = na^{n-1} = 3 \times 3^2$
11	**7**	$\sin 4x \div x \to 4$; $3x \div x = 3$
12	**$25x^4 - 24x^3 + 12x^2 + 4x - 1$**	differentiate term by term
13	**$-6x^2 - 6x - 2$**	$u'v + uv' = -2(x^2 + 1) + (-2x - 3)(2x)$
14	**$-18 \div (3x + 2)^2$**	$(u'v - uv')/v^2 = [-6(3x + 2) - 3(-6x + 2)] \div (3x + 2)^2$
15	**$f'(x) = 8x + 1$; $f'(3) = 25$**	$[f(x + h) - f(x)] \div h = 8x + 1 + 4h \to 8x + 1$ as $h \to 0$
16	**$6x^5 \cos x - x^6 \sin x$**	product rule
17	**(a) 6,144; (b) 3/4; (c) −2**	(c): $x^2 - r^2 = (x - r)(x + r)$
18	**LHL = 4, RHL = 4; yes, the limit is 4**	put x = −3 in each expression
19	**$f'(x) = -6x^2$; $f'(3) = -54$; $f'(0) = 0$; the slope is −54**	—
20	**$f'(x) = -1 \div (x + 1)^2$**	$[1/(x + h + 1) - 1/(x + 1)] \div h = -1 \div [(x + h + 1)(x + 1)] \to -1/(x + 1)^2$

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