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Application of Derivatives — CBSE Class 12 Mathematics Chapter Test

FREE CHAPTER TEST · CLASS XII · MATHEMATICS (041) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	40	19 (A 10 · B 3 · C 2 · D 2 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 19 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. In Section A, Questions 1 to 8 are multiple choice questions (MCQs) and Questions 9 and 10 are assertion-reason based questions of 1 mark each.
4. In Section B, Q11–13 are very short answer (VSA) type questions, carrying 2 marks each.
5. In Section C, Q14–15 are short answer (SA) type questions, carrying 3 marks each.
6. In Section D, Q16–17 are long answer (LA) type questions, carrying 5 marks each.
7. In Section E, Q18–19 are case study based questions, carrying 4 marks each, with sub-parts of the values of 1, 1 and 2 marks.
8. There is no overall choice. However, an internal choice has been provided in 1 question of Section B, 1 question of Section C, 1 question of Section D and in the 2-mark sub-part of each question of Section E.
9. Use of calculators is not allowed. log x denotes the natural logarithm of x.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Mathematics (041) Sample Question Paper 2026-27, released on 21 September 2026 at cbseacademic.nic.in, at half the length of the 80-mark board paper: 40 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Application of Derivatives · **Topics:** Rate of change of quantities · Increasing and decreasing functions · Maxima and minima: first derivative test · Second derivative test · Absolute maxima and minima · Applied (real-life) problems

SECTION A

This section comprises 10 questions of 1 mark each: 8 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. The radius of a circle is increasing at 0.5 cm/s. The rate at which its area is increasing when the radius is 4 cm is 1

(A) 2π cm²/s (B) 4π cm²/s

(C) 8π cm²/s (D) 16π cm²/s

2. The function $f(x) = x^3 - 3x$ is strictly decreasing on 1

(A) $(-\infty, -1)$ (B) $(1, \infty)$

(C) $(0, \infty)$ (D) $(-1, 1)$

3. The maximum value of $\sin x + \cos x$ is 1

(A) $\sqrt{2}$ (B) 2

(C) 1 (D) $1 + \sqrt{2}$

4. The maximum value of $f(x) = x\,e^{-x}$, $x \in \mathbb{R}$, is 1

(A) e (B) 1

(C) $\frac{1}{e}$ (D) 0

5. The function $f(x) = 2x^3 - 9x^2 + 12x + 1$ has a local maximum at 1

(A) $x = 2$ (B) $x = 0$

(C) $x = 1$ (D) $x = 3$

6. The volume of a cube is increasing at 12 cm³/s. The rate at which its edge is increasing when the edge is 4 cm is 1

(A) 0.25 cm/s (B) 2.5 cm/s

(C) 0.75 cm/s (D) 4 cm/s

7. The function $f(x) = \frac{\log x}{x}$, $x > 0$, is strictly increasing on 1

(A) (e, ∞) (B) $(0, \infty)$

(C) $(1, \infty)$ (D) $(0, e)$

8. The minimum value of $x + \frac{4}{x}$, $x > 0$, is 1

(A) 2 (B) 4

(C) 0 (D) there is no minimum

9. **Assertion (A):** The function $f(x) = x^3$ is strictly increasing on $\mathbb{R}$. 1

Reason (R): For $f(x) = x^3$, $f'(x) > 0$ for every real x.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

10. **Assertion (A):** Every local maximum value of a function is greater than every local minimum value of that function. 1

Reason (R): A function can have a local minimum value that is greater than one of its local maximum values.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

SECTION B

This section comprises 3 very short answer (VSA) type questions of 2 marks each.

11. Find the intervals in which the function $f(x) = x^2 - 4x + 6$ is strictly increasing or strictly decreasing. 2

12. (a) The radius of a spherical balloon is increasing at 2 cm/s. Find the rate at which its volume is increasing when the radius is 5 cm. 2

OR

(b) The total revenue (in rupees) from selling x units of a product is $R(x) = 2x^2 + 30x + 7$. Find the marginal revenue when $x = 6$.

13. Find the points of local maximum and local minimum, and the local maximum and minimum values, of $f(x) = x^3 - 6x^2 + 9x + 4$. 2

SECTION C

This section comprises 2 short answer (SA) type questions of 3 marks each.

14. (a) Find the intervals in which $f(x) = 2x^3 - 9x^2 - 24x + 5$ is strictly increasing or strictly decreasing. 3

OR

(b) Find the intervals of $[0, \frac{\pi}{2}]$ in which $f(x) = \sin x + \cos x$ is strictly increasing or strictly decreasing.

15. Find the absolute maximum and absolute minimum values of $f(x) = x^3 - 12x$ on the interval $[-3, 5]$. 3

SECTION D

This section comprises 2 long answer (LA) type questions of 5 marks each.

16. (a) An open box is to be made from a square sheet of metal of side 24 cm by cutting equal squares from the four corners and folding up the sides. Find the side of the square to be cut off so that the volume of the box is maximum, and find the maximum volume. 5

OR

(b) A wire 20 m long is cut into two pieces. One piece is bent into a square and the other into a circle. How should the wire be cut so that the combined area of the two figures is minimum?

17. Find the points of local maxima and minima of $f(x) = \sin x + \sqrt{3}\cos x$, $0 < x < 2\pi$, and the local maximum and minimum values, using the second derivative test. 5

SECTION E

This section comprises 2 case study based questions of 4 marks each, with sub-parts of 1, 1 and 2 marks.

18. Water is being poured at the rate of 5 cm^3/s into a conical vessel held with its vertex downwards. The cone has base radius 5 cm and height 10 cm. When the depth of water is h cm, the radius of the water surface is r cm.

(i) Find the relation between r and h. [1]

(ii) Express the volume V of water in terms of h. [1]

(iii) Find the rate at which the water level is rising when the depth is 4 cm. [2]

OR

(iii) Find the rate at which the area of the water surface is increasing when the depth is 4 cm. [2]

19. A small company finds that its weekly profit P (in thousands of rupees) from making and selling x hundred units of a product is $P(x) = -2x^2 + 48x - 100$.

(i) Find $P'(x)$. [1]

(ii) Find the number of units at which $P'(x) = 0$. [1]

(iii) Find the maximum weekly profit, verifying by the second derivative test that it is a maximum. [2]

OR

(iii) Find the interval of x ($x > 0$) on which the profit is increasing. [2]

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
(B)	(D)	(A)	(C)	(C)	(A)	(D)	(B)	(C)	(D)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (B). $dA/dt = 2\pi r\, dr/dt = 2\pi(4)(0.5) = 4\pi$ cm²/s.

Q2. Answer (D). $f'(x) = 3x^2 - 3 = 3(x - 1)(x + 1) < 0$ for $-1 < x < 1$.

Q3. Answer (A). $\sin x + \cos x = \sqrt{2}\sin(x + \pi/4)$, whose maximum is $\sqrt{2}$ (at $x = \pi/4$).

Q4. Answer (C). $f'(x) = e^{-x}(1 - x) = 0$ at $x = 1$, a maximum (f' changes from + to −); $f(1) = 1/e$.

Q5. Answer (C). $f'(x) = 6(x - 1)(x - 2)$; $f''(x) = 12x - 18$ is −6 at $x = 1$ (maximum) and +6 at $x = 2$ (minimum).

Q6. Answer (A). $dV/dt = 3a^2\, da/dt$: $12 = 48\, da/dt$, so $da/dt = 0.25$ cm/s.

Q7. Answer (D). $f'(x) = (1 - \log x)/x^2 > 0$ when $\log x < 1$, i.e. $0 < x < e$.

Q8. Answer (B). $f'(x) = 1 - 4/x^2 = 0$ at $x = 2$; $f''(2) = 8/8 = 1 > 0$; $f(2) = 2 + 2 = 4$.

Q9. Answer (C). $x_1 < x_2 \Rightarrow x_1^3 < x_2^3$, so A is true. R is false: $f'(0) = 0$ (a strictly increasing function can have $f' = 0$ at isolated points). Answer (C).

Q10. Answer (D). For $f(x) = x + 1/x$, the local maximum value is −2 (at $x = -1$) and the local minimum value is 2 (at $x = 1$): A is false, R is true. Answer (D).

Q11. (2 marks) Answer: decreasing on $(-\infty, 2)$, increasing on $(2, \infty)$.
$f'(x) = 2x - 4 = 2(x - 2)$. [1]
$f'(x) < 0$ for $x < 2$ and $f'(x) > 0$ for $x > 2$: f is strictly decreasing on $(-\infty, 2)$ and strictly increasing on $(2, \infty)$. [1]

Q12. (2 marks) Answer: (a) 200π cm³/s; (b) ₹ 54.
(a) $V = (4/3)\pi r^3$, so $dV/dt = 4\pi r^2\, dr/dt$. [1] At $r = 5$: $dV/dt = 4\pi(25)(2) = 200\pi$ cm³/s. [1]
OR (b) Marginal revenue $= R'(x) = 4x + 30$. [1] At $x = 6$: $R'(6) = 24 + 30 =$ ₹ 54. [1]

Q13. (2 marks) Answer: local max 8 at $x = 1$; local min 4 at $x = 3$.
$f'(x) = 3x^2 - 12x + 9 = 3(x - 1)(x - 3) = 0$ at $x = 1, 3$; $f''(x) = 6x - 12$. [1]
$f''(1) = -6 < 0$: local maximum at $x = 1$, value $f(1) = 8$. $f''(3) = 6 > 0$: local minimum at $x = 3$, value $f(3) = 4$. [1]

Q14. (3 marks) Answer: (a) increasing on $(-\infty, -1) \cup (4, \infty)$, decreasing on $(-1, 4)$; (b) increasing on $[0, \pi/4]$, decreasing on $[\pi/4, \pi/2]$.
(a) $f'(x) = 6x^2 - 18x - 24 = 6(x - 4)(x + 1)$. [1] $f' = 0$ at $x = -1$ and $x = 4$. [½] $f' > 0$ on $(-\infty, -1)$ and $(4, \infty)$; $f' < 0$ on $(-1, 4)$. [1] So f is strictly increasing on $(-\infty, -1) \cup (4, \infty)$ and strictly decreasing on $(-1, 4)$. [½]
OR (b) $f'(x) = \cos x - \sin x$. [1] On $(0, \pi/4)$, $\cos x > \sin x$, so $f' > 0$ and f is strictly increasing on $[0, \pi/4]$. [1] On $(\pi/4, \pi/2)$, $\sin x > \cos x$, so $f' < 0$ and f is strictly decreasing on $[\pi/4, \pi/2]$. [1]

Q15. (3 marks) Answer: max 65 at $x = 5$; min −16 at $x = 2$.
$f'(x) = 3x^2 - 12 = 0$ at $x = \pm 2$, both in $[-3, 5]$. [1]
$f(-3) = -27 + 36 = 9$, $f(-2) = -8 + 24 = 16$, $f(2) = 8 - 24 = -16$, $f(5) = 125 - 60 = 65$. [1]
Absolute maximum 65 (at $x = 5$); absolute minimum −16 (at $x = 2$). [1]

Q16. (5 marks) Answer: (a) 4 cm; 1024 cm³; (b) square $80/(\pi + 4)$ m, circle $20\pi/(\pi + 4)$ m.
(a) If squares of side x are cut, $V = x(24 - 2x)^2$, $0 < x < 12$. [1] $V' = (24 - 2x)^2 - 4x(24 - 2x) = (24 - 2x)(24 - 6x)$. [1] $V' = 0$ at $x = 4$ ($x = 12$ gives no box). [1] $V'' = 24x - 192$ (from $V = 4x^3 - 96x^2 + 576x$, $V'' = 24x - 192$), $V''(4) = -96 < 0$: maximum. [1] Cut squares of side 4 cm; maximum volume $= 4 \times 16^2 = 1024$ cm³. [1]
OR (b) Let x m make the square (side $x/4$) and $20 - x$ the circle (radius $(20 - x)/2\pi$). Total area $A = x^2/16 + (20 - x)^2/(4\pi)$. [1½] $A' = x/8 - (20 - x)/(2\pi) = 0 \Rightarrow \pi x = 4(20 - x) \Rightarrow x = 80/(\pi + 4)$. [1½] $A'' = 1/8 + 1/(2\pi) > 0$: minimum. [1] The square uses $80/(\pi + 4)$ m and the circle $20\pi/(\pi + 4)$ m of wire. [1]

Q17. (5 marks) Answer: local max 2 at $\pi/6$; local min -2 at $7\pi/6$.
$f'(x) = \cos x - \sqrt{3} \sin x = 0 \Rightarrow \tan x = 1/\sqrt{3} \Rightarrow x = \pi/6$ or $7\pi/6$. [2]
$f''(x) = -\sin x - \sqrt{3} \cos x = -f(x)$. [1]
$f(\pi/6) = 1/2 + 3/2 = 2$, so $f''(\pi/6) = -2 < 0$: local maximum at $x = \pi/6$, value 2. [1]
$f(7\pi/6) = -1/2 - 3/2 = -2$, so $f''(7\pi/6) = 2 > 0$: local minimum at $x = 7\pi/6$, value -2. [1]

Q18. (4 marks) Answer: (i) $r = h/2$; (ii) $\pi h^3/12$; (iii) $5/(4\pi)$ cm/s, or $5/2$ cm²/s.
(i) By similar triangles $r/h = 5/10$, so $r = h/2$. [1]
(ii) $V = (1/3)\pi r^2 h = \pi h^3/12$. [1]
(iii)(a) $dV/dt = (\pi h^2/4)\, dh/dt$. [1] At $h = 4$: $5 = 4\pi\, dh/dt$, so $dh/dt = 5/(4\pi)$ cm/s. [1]
OR (iii)(b) Surface area $S = \pi r^2 = \pi h^2/4$, $dS/dt = (\pi h/2)\, dh/dt$. [1] At $h = 4$: $dS/dt = 2\pi \times 5/(4\pi) = 5/2$ cm²/s. [1]

Q19. (4 marks) Answer: (i) $-4x + 48$; (ii) 12; (iii) ₹ 1,88,000, or $0 < x < 12$.
(i) $P'(x) = -4x + 48$. [1]
(ii) $-4x + 48 = 0 \Rightarrow x = 12$, i.e. 1200 units. [1]
(iii)(a) $P''(x) = -4 < 0$, so $x = 12$ gives a maximum. [1] $P(12) = -288 + 576 - 100 = 188$: ₹ 1,88,000 per week. [1]
OR (iii)(b) $P'(x) > 0$ when $x < 12$. [1] Profit increases for $0 < x < 12$ (up to 1200 units). [1]

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