

How to use this worksheet. Twenty-one questions, about 25 minutes, with the answer key at the end. Differentiability is stronger than continuity — $|x|$ is continuous everywhere but not differentiable at its corner, $x=0$.

Formula sheet

f continuous at $x=a$ if $\lim_{x \rightarrow a} f(x) = f(a)$ | left limit = right limit = $f(a)$

Standard limits: $\sin x/x \rightarrow 1$ | $(1-\cos x)/x^2 \rightarrow \frac{1}{2}$ | $(e^x-1)/x \rightarrow 1$

Product rule: $(uv)' = u'v + uv'$ | Quotient rule: $(u/v)' = (u'v - uv')/v^2$ | Chain rule: $dy/dx = (dy/du)(du/dx)$

Every differentiable function is continuous; a continuous function need not be differentiable (e.g. $|x|$ at 0)

Section A · Level 1 — The definition of continuity and standard limits

Eight questions. None should take more than twenty seconds.

- A function f is said to be continuous at $x = a$ if:
 - $f(a)$ is defined
 - $\lim_{x \rightarrow a} f(x)$ exists
 - $\lim_{x \rightarrow a} f(x)$ equals $f(a)$
 - f is differentiable at a
- For a function to be continuous at $x = a$, the left-hand limit and the right-hand limit must:
 - Both be zero
 - Be equal to each other and to $f(a)$
 - Be equal to each other only
 - Be undefined
- The value of $\lim_{x \rightarrow 0} \sin x/x$ is:
 - 0
 - 1
 - ∞
 - Undefined
- The value of $\lim_{x \rightarrow 0} (1 - \cos x)/x^2$ is:
 - 0
 - 1
 - $\frac{1}{2}$
 - 2
- Every differentiable function is:
 - Discontinuous
 - Continuous
 - Unbounded
 - Non-differentiable elsewhere
- A continuous function is:
 - Always differentiable
 - Not necessarily differentiable
 - Always a polynomial
 - Never differentiable
- The function $f(x) = |x|$ is:
 - Differentiable at $x = 0$
 - Not differentiable at $x = 0$, though continuous there
 - Discontinuous at $x = 0$
 - Undefined at $x = 0$
- If f and g are both continuous at $x = a$, then $f + g$ is:
 - Continuous at $x = a$
 - Discontinuous at $x = a$
 - Undefined at $x = a$
 - Continuous only if $f = g$

Working space — Questions 1 to 8

Write the formula before you substitute.

Section B · Level 2 — Differentiation rules

Nine questions. Identify which rule applies before differentiating.

- The derivative of x^3 with respect to x is:
 - x^2
 - $3x^2$
 - $3x$
 - $x^4/4$
- The derivative of $\sin x \cdot \cos x$ with respect to x is:
 - $\cos^2 x - \sin^2 x$
 - $-\sin^2 x + \cos^2 x$
 - $\cos(2x)$
 - Both 1 and 3
- The derivative of e^{2n} with respect to x is:
 - e^{2n}
 - $2e^{2n}$
 - $2xe^{2n}$
 - e^n

12. The derivative of $\ln(x^2 + 1)$ with respect to x is:

- (1) $1/(x^2+1)$ (2) $2x$ (3) $2x/(x^2+1)$ (4) $x/(x^2+1)$

13. If $y = uv$, where u and v are both functions of x , then dy/dx equals:

- (1) $u'v'$ (2) $u'v + uv'$ (3) $u'v - uv'$ (4) u'/v'

14. If $y = u/v$, where u and v are both functions of x , then dy/dx equals:

- (1) $(u'v + uv')/v^2$ (2) $(u'v - uv')/v^2$ (3) u'/v' (4) $(uv' - u'v)/v^2$

15. The second derivative of x^4 with respect to x is:

- (1) $4x^3$ (2) $12x^2$ (3) $12x$ (4) x^2

16. If $y = f(u)$ and $u = g(x)$, then dy/dx equals:

- (1) $dy/du + du/dx$ (2) $(dy/du)(du/dx)$ (3) $dy/du - du/dx$ (4) $du/dx / dy/du$

17. For the function $y = x^n$, where $x > 0$, the derivative dy/dx is:

- (1) x^n (2) $x^n(\ln x)$ (3) $x^n(\ln x + 1)$ (4) x^{n-1}

Working space — Questions 9 to 17

Write the formula before you substitute.

Section C · Level 3 — Continuity of piecewise functions

Four questions. Factorise first, then take the limit.

18. For the piecewise function $f(x) = (x^2 - a^2)/(x - a)$ for $x \neq a$, and $f(a) = k$, the function is continuous at $x = a$ when k equals:

- (1) a (2) $2a$ (3) a^2 (4) 0

19. A function $f(x) = \sin(kx)/x$ for $x \neq 0$, and $f(0) = 3$, is continuous at $x = 0$ when k equals:

- (1) 1 (2) 2 (3) 3 (4) $1/3$

20. A function $f(x) = \sin(2x)/x$ for $x \neq 0$, and $f(0) = a$, is continuous at $x = 0$. Based on a real AAI ATC question, the value of a that appeared as the marked correct answer was: **[PYQ 2023 · Morning (reconstructed)]**

- (1) 1 (2) 0 (3) 2 (4) 4

21. A function $f(x) = (x^2 - 1)/(x - 1)$ for $x \neq 1$, and $f(1) = \lambda$, is continuous at $x = 1$ when λ equals:

- (1) 1 (2) 2 (3) 0 (4) -1

Working space — Questions 18 to 21

Write the formula before you substitute.

Answer key

Check only after you have attempted every question. Full worked solutions for each one are on the worksheet page at aviatelearnings.com.

1. (3)	6. (2)	11. (2)	16. (2)	21. (2)
2. (2)	7. (2)	12. (3)	17. (3)	
3. (2)	8. (1)	13. (2)	18. (2)	

4. (3)	9. (2)	14. (2)	19. (3)	
5. (2)	10. (4)	15. (2)	20. (3)	

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