# Unit 9 · AP Review Cheat Sheet

**Unit 9 focus:** limits, derivatives and their applications

## 1 LIMITS AND CONTINUITY

| Topic | Key idea |
|---|---|
| 0/0 | factor, rationalize or L'Hôpital |
| Continuity | f(a) = limit |
| IVT | continuous → hits every value between |

## 2 DERIVATIVE RULES

| Rule | Formula |
|---|---|
| Power | $nx^{n-1}$ |
| Product | $f\prime g + fg\prime$ |
| Quotient | $\frac{f\prime g - fg\prime}{g^2}$ |
| Chain | $f\prime(g(x))g\prime(x)$ |

## 3 MIXED DERIVATIVE

Chain inside product.

**Example:** $y = xe^{2x}$
**Product:** $e^{2x} + x \cdot 2e^{2x}$

**Answer:** $e^{2x}(1 + 2x)$

## 4 WHAT F′ AND F″ TELL YOU

| Sign | f |
|---|---|
| f′ > 0 | increasing |
| f′ changes + → − | relative max |
| f″ > 0 | concave up |
| f″ changes sign | inflection point |

## 5 TANGENT LINE APPROXIMATION

$L(x) = f(a) + f\prime(a)(x - a)$

**Example:** f(2) = 5, f′(2) = −3. Estimate f(2.1).
**Compute:** 5 − 3(0.1)

**Answer: 4.7**

## 6 QUICK REMINDERS & COMMON MISTAKES

**✓ Do remember**

- Justify with calculus language ("because f′ changes from + to −").
- Units on every answer in context.
- Three decimal places on the AP exam.

**✘ Common mistakes**

- "The graph goes up": "f′(x) > 0 on …"
- Rounding mid-problem: store full values
- Leaving out + C: always include it

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**More practice:** integrals, FTC and free-response tips

## 1 INTEGRAL TOOLKIT

| Integral | Result |
|---|---|
| $\int x^n\,dx$ | $\frac{x^{n+1}}{n+1}+C$ |
| $\int \frac{1}{x}\,dx$ | $\ln\lvert x\rvert+C$ |
| $\int e^{kx}\,dx$ | $\frac{1}{k}e^{kx}+C$ |
| u-substitution | inside function u |

## 2 DEFINITE INTEGRAL

Antiderivative, top minus bottom.

**Example:** $\int_0^2 (3x^2-2x)\,dx$
**Evaluate:** $(8-4)-0$

**Answer: 4**

## 3 FTC AND ACCUMULATION

| Idea | Formula |
|---|---|
| FTC 1 | $\frac{d}{dx}\int_a^x f(t)\,dt = f(x)$ |
| Net change | $F(b)=F(a)+\int_a^b F'$ |
| Average value | $\frac{1}{b-a}\int_a^b f$ |

## 4 AREA AND VOLUME

| Find | Integral |
|---|---|
| Area | $\int(\text{top}-\text{bottom})\,dx$ |
| Washer | $\pi\int(R^2-r^2)\,dx$ |
| Cross sections | $\int A(x)\,dx$ |

## 5 PARTICLE MOTION FRQ

Displacement = ∫v. Position = initial + ∫v.

**Example:** v(t) = 2t − 4, s(0) = 3. Find s(5).
**Integrate:** $\int_0^5 (2t-4)\,dt = 25-20$

**Answer: s(5) = 8**

## 6 FREE-RESPONSE CHECKLIST

- Show the setup: write the integral or derivative.
- Name the theorem (IVT, MVT, EVT, FTC) and check its conditions.
- Give units and interpret in context.
- Answer every part, even if an earlier part is wrong.