

Applications of Derivatives: math test solutions, College – download the PDF

Test solutions with the detailed point scale. Add up your points and spot what to review.

Suggested time: 45 minutes. Out of 20 points. Calculator allowed only when the problem says so.

1 Monotonicity and extrema

/ 4 pts

- (a) $f'(x) = 6x^2 - 6x - 12 = 6(x - 2)(x + 1)$, so $x = -1$ and $x = 2$. (1 pt)
- (b) $f' > 0$ on $(-\infty, -1)$ and $(2, \infty)$: increasing; $f' < 0$ on $(-1, 2)$: decreasing. (1.5 pts)
- (c) Local maximum $f(-1) = -2 - 3 + 12 + 4 = 11$; local minimum $f(2) = 16 - 12 - 24 + 4 = -16$. (1.5 pts)

2 Concavity

/ 3 pts

- (a) $f''(x) = 12x - 6$: concave down for $x < \frac{1}{2}$, concave up for $x > \frac{1}{2}$. (1 pt)
- (b) $f(\frac{1}{2}) = \frac{2}{8} - \frac{3}{4} - 6 + 4 = -2.5$: the inflection point is $(0.5, -2.5)$. (1 pt)
- (c) $f''(-1) = -18 < 0$: maximum; $f''(2) = 18 > 0$: minimum. (1 pt)

3 Mean Value Theorem

/ 3 pts

f is continuous on $[1, 9]$ and differentiable on $(1, 9)$. (1 pt)

Average rate: $\frac{3-1}{9-1} = \frac{1}{4}$. (1 pt)

$f'(c) = \frac{1}{2\sqrt{c}} = \frac{1}{4}$ gives $\sqrt{c} = 2$, so $c = 4 \in (1, 9)$. (1 pt)

4 Two pens

/ 4 pts

(a) The fencing is $2L + 3w = 240$, so $L = 120 - 1.5w$. (1 pt)

(b) $A(w) = w(120 - 1.5w)$ for $w \in (0$

Then $L = 60$ m and $A = 2400 \text{ m}^2$; A is 0 at both ends, so this is the maximum. (1.5 pts)

5 Oil spill

/ 3 pts

$A = \pi r^2$, so $\frac{dA}{dt} = 2\pi r \frac{dr}{dt}$. (1 pt)

$\frac{dA}{dt} = 2\pi(15)(0.5) = 15\pi \text{ ft}^2/\text{min}$. (1 pt)

$15\pi \approx 47.12 \text{ ft}^2/\text{min}$. (1 pt)

6 Limits and linearization

/ 3 pts

(a) The form is $\frac{0}{0}$. By L'Hôpital: $\frac{3e^{3x}}{2\cos 2x} \rightarrow \frac{3}{2}$. (1.5 pts)

(b) $f(0) = 0$, $f'(0) = 1$, so $L(x) = x$ and $\ln 1.05 \approx 0.05$ (the exact value is about 0.0488). (1.5 pts)



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