

For full credit show all of your work (legibly!), unless otherwise specified. Answers may include all arithmetic operations, trigonometric functions, inverse trigonometric functions, and natural logarithms. Algebraic simplification of answers is unnecessary.

1. **(8 points)** Estimate the following values using appropriate linear approximations.

(a) **(4 points)** $\sqrt{25.07}$.

(b) **(4 points)** $(0.993)^5$.

2. **(15 points)** A prison guard using a spotlight has located an escaped prisoner 50 meters north and 120 meters east of their current position. The prisoner is running eastwards at 3 meters per second.

(a) **(9 points)** How quickly is the prisoner moving away from the guard?

(b) **(6 points)** How quickly should the guard be turning the spotlight to keep it trained on the fugitive?

1	/	8
2	/	15
3	/	12
4	/	14
5	/	10
6	/	12
7	/	8
8	/	21
9	/	(6)
Σ	/	100

3. (12 points) Find $\frac{d}{dx} \frac{e^{\arctan x}}{\csc x}$.

4. (14 points) The *cisoid of Diocles* is a curve satisfying the equation $x(x^2 + y^2) = 4y^2$.

(a) (10 points) Find a formula for $\frac{dy}{dx}$ on this curve.

(b) (4 points) Find the equation of the tangent line to the curve at $(2, -2)$.

5. **(10 points)** Find an equation of the tangent line to the curve $y = \frac{x^2+4}{x^2+2x}$ at $(2, 1)$.

6. **(12 points)** Calculate $\frac{d}{dx} \frac{(x^3+2x)(e^x+\sin x)}{\ln x+7}$.

7. **(8 points)** Find the maximum and minimum values of the function $f(x) = x^3 - 3x^2 - 7$ on the interval $[-2, 1]$.

8. **(21 points)** Answer the following derivative-related questions.

(a) **(7 points)** If $f(q) = (\operatorname{arcsec} q)(\cos q + 8 \ln q)$, find $f'(q)$.

(b) **(7 points)** Find $\frac{d}{dt} \cot(e^{\arcsin t})$.

(c) **(7 points)** Compute $\frac{d}{ds} \left(s^5 - \frac{\sqrt{s}}{e^{7s}} \right)$.

9. **(6 point bonus)** Currently Yvette is 10 miles north of the Library of Babel, walking south at 3mph, while Zachary is 1 mile east of the Library, walking east at 5mph. How soon will it be the case that the distance between them is (if only momentarily) unchanging? Do your work on the back of this sheet.