1. Find the derivative of each function. Do not simplify.

(a) \( f(x) = \frac{2}{\sqrt{x}} - 7x^3 - 10 \)

(b) \( f(x) = \frac{1 - 2x}{3x^2 + x} \)

(c) \( f(x) = xe^{5x} \)

2. Find an equation of the line tangent to the curve \( y = x \ln x \) at the point \((e, e)\).
3. Use the graph of $y = f(x)$ below to estimate each limit if it exists. If the limit does not exist, write “DNE”.

(a) $\lim_{x \to 10} f(x) = \underline{\phantom{0}}$

(b) $\lim_{x \to 20^{-}} f(x) = \underline{\phantom{0}}$

(c) $\lim_{x \to 20^{+}} f(x) = \underline{\phantom{0}}$

(d) $\lim_{x \to 20} f(x) = \underline{\phantom{0}}$

4. Find each limit, if it exits. If the limit does not exist, write “DNE”.

(a) $\lim_{x \to 3} \frac{2x^2 - 18}{x^2 + x - 12} = \underline{\phantom{0}}$

(b) $\lim_{x \to \infty} \frac{4 - x^2}{3x^2 + 9x - 30} = \underline{\phantom{0}}$
5. Match each description below to one of the graphs.

(a) \( f'(x) > 0 \) and \( f''(x) < 0 \) on \((-\infty, 0)\), \( f'(x) > 0 \) and \( f''(x) > 0 \) on \((0, \infty)\)

(b) \( f'(x) > 0 \) and \( f''(x) > 0 \) on \((-\infty, 0)\), \( f'(x) < 0 \) and \( f''(x) > 0 \) on \((0, \infty)\)

(c) \( f'(x) > 0 \) and \( f''(x) < 0 \) on \((-\infty, 0)\), \( f'(x) < 0 \) and \( f''(x) < 0 \) on \((0, \infty)\)

(d) \( f'(x) < 0 \) and \( f''(x) < 0 \) on \((-\infty, 0)\), \( f'(x) < 0 \) and \( f''(x) > 0 \) on \((0, \infty)\)

6. A company is marketing a new refrigerator. It determines that in order to sell \( x \) refrigerators, the price per refrigerator must be

\[
p = 200 - 0.2x.
\]

It also determines that the total cost of producing \( x \) refrigerators is given by

\[
C(x) = 1000 + 80x + 0.3x^2.
\]

How many refrigerators must the company produce and sell in order to maximize profit? (Recall that the total revenue is \( R(x) = px \).)
7. Let \( f(x) = \frac{x^3 + 3x^2 - 9x}{20} \).

(a) Find the interval(s) on which \( f(x) \) is increasing.

(b) Find all points where relative maxima and minima occur.

(c) Find the interval(s) on which \( f(x) \) is concave up.

(d) Find all points of inflection.

(e) Sketch on the given axes the graph of \( y = f(x) \). Mark the \( x \)- and \( y \)-intercepts. Plot additional points as needed.
8. Compute each integral.

(a) \int \left(x^2 - 5 + \frac{3}{x}\right) \, dx

(b) \int_0^1 xe^{-x^2} \, dx

(c) \int x^2 \sqrt{5 + 2x^3} \, dx

(d) \int (x - 1) \ln x \, dx \quad \text{(Use integration by parts.)}
9. A company determines that its marginal revenue, in dollars, from the sale of $x$ units of a product is given by

$$R'(x) = \frac{2000}{\sqrt{x + 1}}$$

Find the increase in revenue when $x$ increases from 7 to 26.

10. Let $D(x) = (x - 2)^2 + 6$ be the price, in dollars per unit, that consumers are willing to pay for $x$ units of a product. Let $S(x) = x^2 + x$ be the price, in dollars per unit, that producers are willing to accept for $x$ units.

(a) Find the equilibrium point.

(b) Compute the consumer surplus at the equilibrium point, i.e. the area of the shaded region.
11. Given \( f(x, y) = \frac{1}{2} \ln(x^2 + y^2) + \frac{3y}{x} - 9x \), find:

(a) \( f_y \)

(b) \( f_{yx} \)

12. Let

\[ f(x, y) = -x^3 - 3y^2 + 6xy + 5. \]

The critical points for this function are \((0, 0)\) and \((2, 2)\). Classify each critical point as a relative maximum, a relative minimum, or a saddle point.
13. Use the method of Lagrange multipliers to find the minimum value of the function

\[ f(x, y) = 2y^2 - 6x^2 \]

subject to the constraint

\[ 2x + y = 4. \]