1. Find the critical numbers of $f(x) = 3x^3 + 17x^2 - 8x$.

a) $x = 0$ and $-8$

b) $x = -4$ and $\frac{2}{9}$

c) $x = \frac{4}{9}$ and $3$

d) $x = -\frac{32}{9}$ and $17$

e) $x = \frac{2}{9}$ and $-8$

2. The graph of the second derivative $f''$ of a function $f$ is shown. Find the $x$-coordinates of the inflection points.

a) 6 and 9

b) 5 and 8

c) 3 and 6

d) 4 and 8

e) 3 and 9

3. Find the open interval in $(0, 2\pi)$ on which $f(x) = 3x + 10\cos x$ is concave upward.

a) $\left(0, \frac{\pi}{2}\right)$

b) $(\pi, 2\pi)$

c) $\left(\frac{3\pi}{2}, 2\pi\right)$

d) $\left(\frac{5\pi}{4}, \frac{7\pi}{4}\right)$

e) $\left(\frac{\pi}{2}, \frac{3\pi}{2}\right)$

4. Find $\lim_{x \to \infty} (\sqrt{x^2 + 7x} - \sqrt{x^2 + 11x})$.

a) 9

b) $-4$

c) $-2$

d) 18

e) $\sqrt{7} - \sqrt{11}$

5. Which one of the following statements is correct?

a) The graph of $y = 8x^2 - x^4$ is decreasing on $(-2, 0)$.

b) The graph of $y = 8x^2 - x^4$ is increasing on $(-\infty, \infty)$.

c) The graph of $y = 8x^2 - x^4$ is increasing on $(-\infty, 0)$.

d) The graph of $y = 8x^2 - x^4$ is decreasing on $(-2, 2)$.

e) The graph of $y = 8x^2 - x^4$ is decreasing on $(0, 2)$.

6. Find the sum of two positive numbers such that the product of the two numbers is 225 and the sum is a minimum.

a) 78

b) 50

c) 34

d) 30

e) 25

7. Find the absolute maximum value of $y = \sqrt{49 - x^2}$ on the interval $[-7, 7]$.

a) 7

b) 8

c) 0

d) 6

e) 14

8. Find the exact value(s) of the numbers $c$ that satisfy the conclusion of the Mean Value Theorem for the function $f(x) = x^3 - 5x$ for the interval $[-5, 5]$.

a) $\pm \frac{\sqrt{3}}{5}$

b) $\pm \frac{5\sqrt{3}}{3}$

c) $\frac{\sqrt{3}}{3}$

d) $\pm 3$

e) $\pm 5$

9. How many real roots does the equation $x^5 - 6x + c = 0$ have in the interval $[-1, 1]$?

a) no real roots

b) three real roots

c) at most one real root

d) two real roots

e) at least 5 real roots
10. Find \( \lim_{x \to \infty} \frac{\sqrt{x^2 + 8x}}{8x + 5} \).

a) 0  
b) \infty  
c) \frac{5}{8}  
d) \frac{1}{5}  
e) \frac{1}{8}

11. Find the slant asymptote of \( f(x) = \frac{x^4 + 4}{x^3} \).

a) \( y = x \)  
b) \( y = x^2 \)  
c) \( y = 1 \)  
d) \( y = x + 4 \)  
e) \( y = 4 \)

12. Find the point in the line \( y = 2x + 9 \) that is closest to the origin.

a) \( \left( -\frac{9}{2}, 0 \right) \)  
b) \( (-4, 1) \)  
c) \( (2, 13) \)  
d) \( \left( -\frac{18}{5}, 0 \right) \)  
e) \( \left( -\frac{18}{5}, \frac{9}{5} \right) \)

13. Suppose oil spills from a ruptured tanker and spreads in a circular pattern. If the radius of the oil spill increases at a constant rate of 1 m/s, how fast is the area of the spill increasing when the radius is 48 m?

a) \( 202\pi \text{ m}^2/\text{s} \)  
b) \( 101\pi \text{ m}^2/\text{s} \)  
c) \( 192\pi \text{ m}^2/\text{s} \)  
d) \( 96\pi \text{ m}^2/\text{s} \)  
e) \( 288\pi \text{ m}^2/\text{s} \)

14. A plane flying horizontally at an altitude of 1 mile and a speed of 450 mi/h passes directly over a radar station. Find the rate at which the distance from the plane to the station is increasing when it is 10 miles away from the station.

a) \( 50\sqrt{99} \text{ mi/h} \)  
b) \( 45\sqrt{99} \text{ mi/h} \)  
c) \( 50\sqrt{101} \text{ mi/h} \)  
d) 540 mi/h  
e) 517 mi/h

15. Find the linear approximation of the function \( g(x) = \sqrt{1 + x} \) at \( a = 0 \).

a) \( \sqrt{1 + x} \approx \frac{1}{7}x + 1 \)  
b) \( \sqrt{1 + x} \approx 7x - 1 \)  
c) \( \sqrt{1 + x} \approx 7x + 1 \)  
d) \( \sqrt{1 + x} \approx x + 7 \)  
e) \( \sqrt{1 + x} \approx \frac{1}{7}x - 1 \)

16. Find the differential of the function \( y = x^4 + 2x \).

a) \( dy = (4x^4 + 2)dx \)  
b) \( dy = (x^3 + 2)dx \)  
c) \( dy = (4x^3 + 2)dx \)  
d) \( dy = (4x - 2)dx \)  
e) \( dy = (x^4 + 2x)dx \)

17. The altitude of a triangle is increasing at a rate of 4 cm/min while the area of the triangle is increasing at a rate of 5 cm²/min. At what rate is the base of the triangle changing when the altitude is 2 cm and the area is 92 cm²?

18. Find the largest possible volume of the box with a square base and an open top whose total surface area is 1200 cm².