# Review Problems – Math115 Midterm Exam
# (Midterm covers Sec 2.1-4.1)

**Midterm Exam, Tuesday, March 13, 5:45 - 7:45pm.**

The midterm exam will consist of 10 *True or False* problems and 20 *Multiple-Choice* problems. The practice problems below are intended to be representative of what might appear on the exam.

## True or False Problems

**1**. T F If $f(x)$ is not defined at $x = a$, then $\lim_{x \to a} f(x)$ does not exist.

**2**. T F If $f(1) > 0$ and $f(3) < 0$, then there is a number $c$ between 1 and 3 such that $f(c) = 0$.

**3**. T F If both $\lim_{x \to a^-} f(x)$ and $\lim_{x \to a^+} f(x)$ exist, then $\lim_{x \to a} f(x)$ exists.

**4**. T F If $\lim_{x \to a} f(x)$ exists, then both $\lim_{x \to a^-} f(x)$ and $\lim_{x \to a^+} f(x)$ exist.

**5**. T F If $\lim_{x \to a} f(x)$ and $\lim_{x \to a} g(x)$ exist, then $\lim_{x \to a}(f(x)g(x))$ exists.

**6**. T F If $\lim_{x \to a} f(x)$ and $\lim_{x \to a} g(x)$ exist, then $\lim_{x \to a} \dfrac{f(x)}{g(x)}$ exists.

**7**. T F If $\lim_{x \to a} f(x) = 0$ and $\lim_{x \to a} g(x) = 0$, then $\lim_{x \to a} \dfrac{f(x)}{g(x)}$ DNE.

**8**. T F If $\lim_{x \to a} f(x) = L \neq 0$ and $\lim_{x \to a} g(x) = 0$, then $\lim_{x \to a} \dfrac{f(x)}{g(x)}$ does not exist.

**9**. T F If $\lim_{x \to a}(f(x)g(x))$ does not exist, then at least one of the limits $\lim_{x \to a} f(x)$ and $\lim_{x \to a} g(x)$ does not exist.

**10**. T F If $\lim_{x \to a} \dfrac{f(x)}{g(x)}$ does not exist, then at least one of the limits $\lim_{x \to a} f(x)$ and $\lim_{x \to a} g(x)$ does not exist.

**11**. T F If $\lim_{x \to a} f(x)$ exists, then $f$ is continuous at $x = a$.

**12**. T F If $f(x)$ is continuous at $x = a$, then $\lim_{x \to a} f(x)$ exists.

**13**. T F If $f(x)$ is continuous at $x = x_0$, then $f(x)$ has a derivative at $x = x_0$.

**14**. T F If $f(x)$ is differentiable at $x = x_0$, then $f(x)$ is continuous at $x = x_0$.

**15**. T F If $f(x)$ and $g(x)$ are continuous, then $f(x)g(x)$ is continuous.

**16**. T F If $f(x)$ and $g(x)$ are continuous, then $\dfrac{f(x)}{g(x)}$ is continuous.

**17**. T F If $f(x)$ and $g(x)$ are differentiable, then $f(x)g(x)$ is differentiable.

**18**. T F If $f(x)$ and $g(x)$ are differentiable, then $\dfrac{f(x)}{g(x)}$ is differentiable.

**19**. T F If $f$ is differentiable at $x = a$, then $\lim_{x \to a} f(x)$ exists.

**20**. T F If $f$ and $g$ are differentiable, then $\dfrac{d}{dx}(f(x)g(x)) = \dfrac{d}{dx}f(x)\dfrac{d}{dx}g(x)$.

## Multiple-Choice Problems

(DNE = Does not exist; NOTA = None of the above)

**1.** The domain of function $f(x) = \dfrac{x+3}{2x^2 - x - 3}$ is

(A) $(-\infty, +\infty)$ (B) $(-\infty, \frac{3}{2}) \cup (\frac{3}{2}, +\infty)$ (C) $(-\infty, -1) \cup (-1, +\infty)$

(D) $(-\infty, -1) \cup (-1, \frac{3}{2}) \cup (\frac{3}{2}, +\infty)$ (E) NOTA

**2.** The domain of function $f(x) = \dfrac{2x}{\sqrt{x^2 - 4}}$ is

(A) $(2, +\infty)$ (B) $(-\infty, -2)$ (C) $(-\infty, -2] \cup [2, +\infty)$ (D) $(-\infty, -2) \cup (2, +\infty)$ (E) NOTA

**3.** Let $f(x) = \dfrac{1}{x^2}$ and $g(x) = 3x + 5$. Then, $(g \circ f)(x)$ is

(A) $\dfrac{1}{(3x+5)^2}$ (B) $\dfrac{3}{x^2} + 5$ (C) $\dfrac{1}{x^2}$ (D) $3x + 5$ (E) NOTA

**4.** Let $f(x) = x^2 + 1$ and $g(x) = \dfrac{1}{\sqrt{x}}$. Then, $f(g(2))$ is

(A) $\dfrac{1}{1+\sqrt{2}}$ (B) $\dfrac{1}{\sqrt{5}}$ (C) $\dfrac{2}{3}$ (D) $\dfrac{3}{2}$ (E) NOTA

**5.** $\lim_{x \to 2} \dfrac{x^2 - 9}{x - 3} =$ (A) 1 (B) DNE (C) 6 (D) 5 (E) NOTA

**6.** $\lim_{x \to 3} \dfrac{x^2 - 9}{x - 3} =$ (A) 1 (B) DNE (C) 6 (D) 5 (E) NOTA

**7.** $\lim\limits_{x\to 0} \dfrac{\sqrt{1+x}-1}{x} =$ (A) $\dfrac{1}{2}$ (B) DNE (C) $0$ (D) $-1$ (E) NOTA

**8.** $\lim\limits_{x\to \infty} \dfrac{3x^2+2x+4}{2x^2-3x+1} =$ (A) $4$ (B) $\frac{3}{2}$ (C) DNE (D) $0$ (E) NOTA

**9.** $\lim\limits_{x\to -\infty} \dfrac{x^2+3}{x+1} =$ (A) $1$ (B) $0$ (C) $2$ (D) $3$ (E) NOTA

**10.** $\lim\limits_{x\to -\infty} \dfrac{10x^{99}+3\pi+4x^{27}}{x^{27}+17x+2x^{99}} =$ (A) $2$ (B) $3$ (C) $4$ (D) $5$ (E) NOTA

**11.** Let $f(x) = \begin{cases} \sqrt{3x+7} & \text{for } x < 3, \\ 10-2x & \text{for } x > 3. \end{cases}$

(A) The domain of $f$ is $(-\infty, +\infty)$ (B) $\lim\limits_{x\to 3} f(x)$ exists (C) $f(x)$ is continuous at $x=3$.

(D) $f(x)$ is differentiable at $x=3$. (E) NOTA

**12.** Let $f(x) = \begin{cases} \sqrt{3x+7} & \text{for } x < 3, \\ 10-2x & \text{for } x \geq 3. \end{cases}$

(A) $f$ is not defined at $x=3$. (B) $\lim\limits_{x\to 3} f(x)$ DNE. (C) $f(x)$ is continuous at $x=3$.

(D) $f(x)$ is differentiable at $x=3$. (E) NOTA

**13.** Let $f(x) = x^2 - 4x$. When simplified, the difference quotient $\dfrac{f(x+h)-f(x)}{h}$ becomes

(A) $2x+h-4$ (B) $2$ (C) $0$ (D) $2x-4$ (E) NOTA

**14.** Let $f(x) = \dfrac{1}{x}$. When simplified, the difference quotient $\dfrac{f(x+h)-f(x)}{h}$ becomes

(A) $1$ (B) $\dfrac{-1}{x(x+h)}$ (C) $\dfrac{1}{h^2}$ (D) $0$ (E) NOTA

**15.** If we correctly calculate the derivative of $f(x) = x^2+17$ directly from the definition of derivative, which of the following will appear in our calculations?

(a) $\lim\limits_{h\to 0} x^2+h$ (b) $\lim\limits_{x\to 0} x^2+h$ (c) $\lim\limits_{h\to 0} 2x+h$ (d) $\lim\limits_{x\to 0} 2x+h$ (e) $\lim\limits_{h\to 0} x+h$ (f) $\lim\limits_{x\to 0} x+h$

**16.** Let $y = x^{17}$. The definition of $\dfrac{dy}{dx}$ is:

(A) $\lim\limits_{h\to 0} \dfrac{x^{17}}{h}$ (B) $\lim\limits_{x\to 0} \dfrac{x^{17}}{h}$ (C) $\lim\limits_{h\to 0} \dfrac{(x+h)^{17}}{h}$ (D) $\lim\limits_{x\to 0} \dfrac{(x+h)^{17}}{h}$

(E) $\lim\limits_{h\to 0} \dfrac{(x+h)^{17}-x^{17}}{h}$ (f) $\lim\limits_{x\to 0} \dfrac{(x+h)^{17}-x^{17}}{h}$

**17.** The slope of the tangent line to the graph $y = ax^{1/3}$ (where $a$ is a non-zero constant) at the point $x = 0$ is:

(a) $a$ (b) $\frac{-2a}{3}$ (c) $\frac{a}{3}$ (d) 0 (e) there is a vertical tangent line (f) there is no tangent line

**18.** The equation of the tangent line to the graph of $y = ax^3$ (where $a$ is a constant) at the point $(1, a)$ is:

(a) $y = ax$ (b) $y = ax - 2a$ (c) $y = ax - 2a + 2$ (d) $y = 3ax$ (e) $y = 3ax - 2a$ (f) $y = 3ax - 2a + 2$

**19.** Let $C(x)$ denote the cost function to produce $x$ units and $p(x)$ denote the unit price at which $x$ units will sell. What is the profit function in terms of $C(x)$ and $p(x)$?

(A) $x(p(x) - C(x))$ (B) $p(x) - xC(x)$ (C) $p(x) + xC(x)$ (D) $xp(x) - C(x)$ (E) NOTA

**20.** Using the notation of Problem **19**, what is the marginal profit in terms $C(x)$ and $p(x)$?

(A) $p'(x) - C'(x)$ (B) $p'(x) + xp(x) - C(x)$ (C) $x(p(x) - C(x))$

(D) $p(x) + xp'(x) - C'(x)$ (E) NOTA

**21.** Let $C$ be the cost function for a manufacturing process. Which of the following best estimates the difference between the total cost of producing 500 items and the total cost of producing 501 items?

(A) $C(500)$ (B) $C'(500)$ (C) $\frac{C(500)}{500}$ (D) $\frac{C'(500)}{500}$ (E) $\frac{500C'(500) - C(500)}{250,000}$

**22.** Given the demand equation $p = 18 - 2x$ and the supply equation $p = 2x + 10$, where $p$ is the unit price and $x$ represents the quantity, find the equilibrium quantity and the equilibrium price.

(A) $x = 2$ and $p = 14$ (B) $x = 3$ and $p = 16$ (C) $x = 4$ and $p = 18$ (D) $x = 18$ and $p = 4$ (E) NOTA

**23.** Given the demand function $p = d(x) = -0.01x^2 - 0.1x + 10$ and the supply function $p = s(x) = 0.01x^2 + 0.2x + 5$, where $p$ is the unit price and $x$ represents the quantity, find the equilibrium quantity and the equilibrium price.

(A) $x = 5$ and $p = 6.25$ (B) $x = 10$ and $p = 8$ (C) $x = 15$ and $p = 10.25$

(D) $x = 20$ and $p = 13$ (E) NOTA

**24.** It is known that $\lim_{x\to 2^+} f(x) = 3$, $\lim_{x\to 2^-} f(x) = 3$, and $f(2) = 1$. Which of the following statements is False ?

(A) $f(x)$ is discontinuous at $x = 2$. (B) The graph of $f(x)$ is broken at $x = 2$.

(C) $\lim_{x\to 2} f(x)$ exists. (D) $f(x)$ is differentiable at $x = 2$. (E) $f(x)$ is defined at $x = 2$.

**25.** It is known that $f(x)$ is continuous on $(-\infty, \infty)$ and $f(-1) = -2,\ f(0) = 2$, and $f(2) = 4$. Which of the following statements is True ?

(A) $f(x)$ must have a zero in (-1,0).  (B) $f(x)$ must have a zero in (-2,-1).

(C) $f(x)$ must have a zero in (2,4).  (D) $f(x)$ must have a zero in (0,2).  (E) NOTA is true.

**26.** A ball is thrown straight up into the air so that its height (in feet) after $t$ seconds is given by $s(t) = -16t^2 + 64t$. The average velocity of the ball over the interval [1, 1.05] is

(A) $49.56$ ft/sec (B) $1.56$ ft/sec (C) $31.2$ ft/sec (D) $48$ ft/sec (E) NOTA

**27.** For the distance function $s(t)$ given in the above problem, the velocity of the ball at time $t = 1$ is

(A) 50 ft/sec  (B) 2 ft/sec  (C) 32 ft/sec  (D) 48 ft/sec  (E) NOTA

**28.** An equation of the tangent line to the curve $y = x^3 - 2x + 5$ at the point (-2, 1) is

(A) $y + 1 = (2x^2 - 2)(x + 2)$  (B) $y - 1 = (2x^2 - 2)(x + 2)$  (C) $y = \dfrac{-x}{2}$

(D) $y = 5x + 11$  (E) $y = 10x + 21$

**29.** Find an equation of the tangent line of the graph of $y = x(x + 1)^5$ at the point $x = 1$.

(A) $y - 32 = (x + 1)^4(6x + 1)$  (B) $y + 32 = (x + 1)^4(6x + 1)$  (C) $y = 112x - 80$

(D) $y = 112x + 80$  (E) NOTA

**30.** For $f(x) = \sqrt{2 + \sqrt{x}}$, evaluate $f'(4)$.  (A) $\frac{1}{64}$  (B) $\frac{1}{16}$  (C) $\frac{1}{4}$  (D) $\frac{1}{2}$  (E) NOTA

**31.** Let $f(x) = |x|$. Then,

(A) $f$ is not defined at $x = 0$  (B) $f$ has no limit at $x = 0$

(C) $f$ is not continuous at $x = 0$  (D) $f$ has no derivative at $x = 0$  (E) NOTA

**32.** An equation of the tangent line to the curve $y = (x^2 + x + 1)(x^3 - 2x + 2)$ at the point (1, 3) is

(A) $y = 2x + 1$  (B) $y = 3x$  (C) $y = 6x - 3$  (D) $y = 7x - 4$  (E) NOTA

**33.** Suppose that $F(x) = f(x^2+1)$ and $f'(2) = 3$. $F'(1) =$  (A) 3  (B) 4  (C) 5  (D) 6  (E) NOTA

**34.** Suppose $h = f \circ g$. Find $h'(0)$ given that $f'(0) = 6,\ f'(5) = -2,\ g(0) = 5$ and $g'(0) = 3$.

(A) $-6$  (B) 18  (C) $-10$  (D) 30  (E) NOTA

**35.** Find $\dfrac{dy}{dx}$ in terms of $x$ and $y$ when $x$ and $y$ are related by the equation $x^2y - y^3 = 2$.

(A) $\dfrac{xy}{3y^2+x^2}$ (B) $\dfrac{x}{x-3y}$ (C) $\dfrac{2xy}{3y^2-x^2}$ (D) $\dfrac{x^2+y^2}{2x+y}$ (E) NOTA

**36.** Find $\dfrac{dy}{dx}$ at point $(2, \sqrt{5})$ when $x$ and $y$ are related by the equation $2x^2 - y^2 = 3$.

(A) $\dfrac{4}{\sqrt{5}}$ (B) $\dfrac{2\sqrt{5}}{5}$ (C) $\sqrt{5}$ (D) 2 (E) NOTA

**37.** Find $\dfrac{dy}{dx}$ when $x$ and $y$ are related by the equation $x^2 + y^2 + 2x^2y^2 = 10$.

(A) $-\dfrac{x(1+2y^2)}{y(1+2x^2)}$ (B) $-\dfrac{y(1+2x^2)}{x(1+2y^2)}$ (C) $-\dfrac{x(1+2x^2)}{y(1+2y^2)}$ (D) $-\dfrac{x}{y}$ (E) NOTA

**38.** Find an equation of the tangent line to the graph defined by $x^3 + y^4 = 9$ at the point $(2, 1)$.

(a) $y = 7x + 9$ (b) $y = 3x + 7$ (c) $y = -3x + 9$ (d) $y = -3x + 7$ (e) $y = -7x + 9$

**39.** The second derivative of function $f(x) = (x^2 + 1)^5$ is

(A) $20(x^2+1)^3$ (B) $10x(x^2+1)^4$ (C) $10(x^2+1)^3(9x^2+1)$ (D) $10(x^2+1)^3(7x^2+4)$ (E) NOTA

**40.** The third derivative of $f(x) = \frac{1}{x}$ is (A) $\frac{-1}{x^2}$ (B) $\frac{-2}{x^3}$ (C) $\frac{2}{x^3}$ (D) $\frac{1}{x^2}$ (E) $\frac{-6}{x^4}$

**41.** The distance $s$ (in feet) covered by a car $t$ seconds after starting from rest is given by $s = -t^3 + 8t^2 + 20t$. Find the car's acceleration at time $t$.

(A) $-t^3 + 8t^2 + 20t$ (B) $-3t^2 + 16t + 20$ (C) $-6t + 16$ (D) $-6t + 36$ (E) NOTA

**42.** The differential of function $f(x) = 1000$ is (A) 1000 (B) $1000dx$ (C) 0 (D) $dx$ (E) NOTA

**43.** Use differentials to estimate the change in $\sqrt{x^2+5}$ when $x$ increases from 2 to 2.123.

(A) 0.083 (B) 0.082 (C) 0.081 (D) 0.080 (E) NOTA

**44.** A diver springs from a board over a swimming pool. The height in feet above the water level of the diver $t$ seconds after leaving the board is given by $h(t) = 4 + 12t - 16t^2$. With what velocity does the diver hit the water?

(A) $-4ft/sec$ (B) $-32ft/sec$ (C) $-12ft/sec$ (D) $-20ft/sec$ (E) $-2.5ft/sec$

Problems **45** through **46** are about the function $f(x) = x^3 - 3a^2x$ where $a > 0$.

**45.** Where is $f$ increasing?

(a) exactly when $x > a$ (b) exactly when $x < a$ (c) exactly when $x > -a$

(d) exactly when $x < -a$ (e) exactly when $-a < x < a$

(f) exactly when either $x < -a$ or $x > a$ (g) $f$ is always increasing (h) $f$ is never increasing

**46.** Where does $f$ have a relative maximum?

(a) $x = -a$ (b) $x = -\sqrt{a}$ (c) $x = 0$ (d) $x = \sqrt{a}$ (e) $x = a$

(f) there is no relative maximum

**47.** If $3x + y^2 - xy = 0$, what is $\frac{dy}{dx}$?

(a) $2y - x$ (b) $y - 3$ (c) $\frac{y-3}{2y-x}$ (d) $\frac{2y-x}{y-3}$

**48.** Let $f(x) = \sqrt{x}$. What's the differential $df$ when $x = 9$ and $dx = 0.1$?

(a) $\frac{1}{6}$ (b) $\frac{1}{9}$ (c) $\frac{1}{10}$ (d) $\frac{1}{30}$ (e) $\frac{1}{60}$ (f) $\frac{1}{90}$

Questions **49** through **52** are about the following function:

$$f(x) = \begin{cases} x & \text{if } x < -1 \\ x^2 & \text{if } -1 \le x < 2 \\ x+2 & \text{if } 2 \le x \le 5 \\ 2x & \text{if } 5 < x \end{cases}$$

**49.** What is $\lim_{x \to (-1)^-} f(x)$? (a) -2 (b) -1 (c) 0 (d) 1 (e) 2 (f) DNE

**50.** What is $\lim_{x \to (-1)^+} f(x)$? (a) -2 (b) -1 (c) 0 (d) 1 (e) 2 (f) DNE

**51.** How many points of discontinuity does $f$ have? (a) 0 (b) 1 (c) 2 (d) 3

**52.** Which of the following is true?

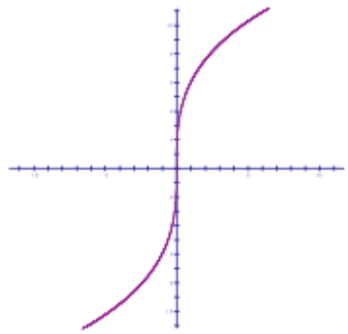
(a) the function is not defined at $x = 2$

(b) the function is defined but not continuous at $x = 2$

(c) the function is continuous but has no derivative at $x = 2$

(d) the function is continuous and has a derivative at $x = 2$

Questions **53** and **54** are about the function $g(x)$ with the following graph.



**53.** In the region shown, which statement is true?

(a) There is a derivative at every point.

(b) There is a point where there is a tangent line but no derivative.

(c) There is a point where there is no tangent line.

**54.** In the region shown, which of the following statements is true?

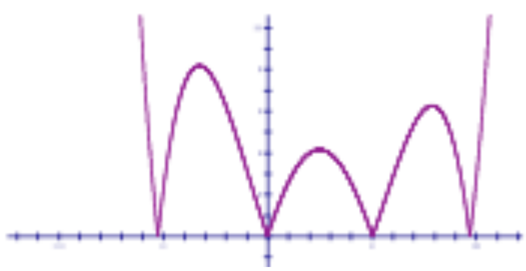
(a) if $x \neq 0$ then $g'(x) < 0$

(b) if $x \neq 0$ then $g'(x) > 0$

(c) if $x < 0$ then $g'(x) < 0$ and if $x > 0$ then $g'(x) > 0$

(d) if $x < 0$ then $g'(x) > 0$ and if $x > 0$ then $g'(x) < 0$

**55.** Consider the graph of the function below in the region shown.



Which statement is true?

(a) Every point has a derivative

(b) There is exactly one point with no derivative

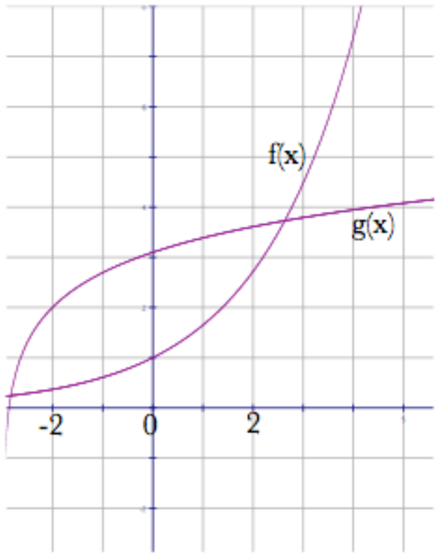
(c) There are exactly two points with no derivative

(d) There are exactly three points with no derivative

(e) There are exactly four points with no derivative

(f) There are exactly five points with no derivative

Question **56** is about the following two functions:




**56.** Which of the following statements is true?

(a) $g'(2) > f'(2)$

(b) $g'(2) = f'(2)$

(c) $g'(2) < f'(2)$

Problems **57 - 59** are about the following situation: An art gallery has found that the price of a print from a famous painting is described by the formula $p = A - x^2$ where $p$ is the price people are willing to pay, $x$ is the number of prints produced from the original, and $A$ is a positive constant depending on the reputation of the artist (i.e., a famous artist will have a high $A$ value).

**57.** What is the revenue when $x$ reprints are made from the same original and all of them are sold?

(A) $A - x^2$ (B) $Ax - x^2$ (C) $Ax - x^3$ (D) more information is needed

**58.** When is the revenue maximized?

(a) when $x = \sqrt{\frac{A}{2}}$ (b) when $x = \frac{A}{3}$ (c) when $x = \sqrt{\frac{A}{3}}$

(d) there isn't enough information to decide (e) the revenue is never maximized.

**59.** Use differentials to find the approximate difference in price when the number of prints produced is 102 compared to 100 (assume all are sold). [Do *not* calculate the exact answer. The exact answer will be marked incorrect.]

(a) \$400 more (b) \$400 less (c) \$402 more (d) \$402 less (e) \$404 more (f) \$404 less

(g) more information is needed to decide

**60.** A new toy is catching on gradually, showing a steady growth in sales, so that $t$ years after being put on the market $x = \sqrt{t}$ thousand are sold. The price $p = \sqrt{100 - x^2}, 1 \leq x$. When $p = 5$, what's $t$?

(a) 0 (b) 10 (c) 25 (d) 50 (e) 75 (f) 90 (g) 100

Problems **61** and **62** are about the following situation: A truck's gas pedal is stuck and the truck is rolling down the highway so that at time $t$ its distance from the starting point is $t^2$ miles, where $t$ is in hours.

**61.** How fast is the truck moving when $t = 3$?

(a) 1 mile per hour (b) 2 miles per hour (c) 3 miles per hour

(d) 6 miles per hour (e) 9 miles per hour

**62.** Which of the following is true?

(a) Its acceleration is increasing (b) Its acceleration is decreasing

(c) Its acceleration is constant

(d) Sometimes its acceleration is increasing and sometimes it is decreasing

(e) there is not enough information to decide whether (a) through (d) are true or false

Problems **63** through **66** are about the following situation: Michael and Angela have a business selling postcards with scenes of Kansas prairies. Their camera, computer, printer, and paper cutter cost them \$2500. Their supplies (e.g., paper, ink cartridges, gas for the car) cost them \$0.50 per postcard. Each postcard sells for \$1. Since they sell over the internet, they make exactly as many as they sell. Let $x$ designate the number of postcards they sell.

**63.** What is their cost in dollars? (a) 2500 (b) $\frac{x}{2}$ (c) $2500 + \frac{x}{2}$ (d) $\frac{2500}{x}$ (e) $\frac{2500 + \frac{x}{2}}{x}$

**64.** What is their profit in dollars? (a) 2500 (b) $\frac{x}{2}$ (c) $-2500 + \frac{x}{2}$ (d) $\frac{2500}{x}$ (e) $x - \frac{2500}{x}$

**65.** What is their marginal profit? (a) 0 (b) \$0.10 (c) \$0.25 (d) \$0.50 (e) \$0.75 (f) \$1 (g) it varies according to how much they sell

**66.** How many postcards must they sell to break even?

(a) 5000 (b) 12,500 (c) 25,000 (d) 50,000 (e) 100,000

Problems **67** through **70** are about the following situation: Wiley E. Coyote, in his eagerness to catch the Roadrunner, jumps straight up in the air from the edge of a cliff so that when he comes down he falls off the cliff. The cliff is 40 feet off the ground. His height $t$ seconds after he jumps is $s = -16t^2 + 12t + 40$.

**67.** When does he hit the ground? [Hint: $-16t^2 + 12t + 40 = (4t - 8)(-4t - 5)$.]

(a) when $t = 0$ (b) when $t = 5/4$ (c) when $t = 2$ (d) when $t = 4$ (e) when $t = 5$

**68.** What's his velocity when $t = 2$?

(a) about - 10 feet per second (b) about - 20 feet per second (c) about - 30 feet per second

(d) about - 40 feet per second (e) about - 50 feet per second

**69.** While he's in the air, when does his velocity equal 0?

(a) when $t = 0$ (b) when $t = \frac{1}{8}$ (c) when $t = \frac{3}{8}$ (d) when $t = \frac{1}{2}$

(e) he's always moving, so his velocity never equals 0

**70.** Let $a(t)$ be his acceleration. Which of the following is true?

(a) his acceleration is increasing (b) his acceleration is decreasing

(c) his acceleration is sometimes increasing and sometimes decreasing

(d) his acceleration is constant

**71.** A cubic block of ice is melting at an unnaturally controlled rate. Its volume is changing at the constant rate of -75 cubic cm per minute. When the length of each of its sides is 5 cm, how fast is this length changing?

(a) 0 cm per minute (b) - 1 cm per minute (c) - 5 cm per minute

(d) -25 cm per minute (e) -75 cm per minute

**72.** A ladder 17 feet long is standing straight up against the side of a house. The base of the ladder is pulled away from the side of the house at the rate of 2 feet per second and the top of the ladder is moving down the wall of the house. How fast is the top of the ladder moving after 4 seconds?

a) 4 ft/sec (b) 2 ft/sec (c) $\frac{3}{2}$ ft/sec (d) $\frac{16}{15}$ ft/sec (e) $\frac{8}{15}$ ft/sec

**73.** A flood lamp is installed on a vertical wall 96 feet from the ground. A six foot tall woman is walking towards the wall at the rate of 30 feet per second. How fast is the tip of her shadow moving when she is 50 feet from the wall?

a) 30 ft/sec (b) 32 ft/sec (c) 56 ft/sec (d) 60 ft/sec (e) 96 ft/sec

**74.** An ant is moving on a blackboard along the $x-$axis so that its position at time $t$ is $x(t) = t^2 - t^3$, where $0 \leq t \leq 10$. What is the ant's acceleration when $t = 3$?

(a) - 21 (b) -18 (c) -16 (d) -3 (e) 3