## Chapter 2 Multiple-Choice Review Exercises

**Directions**: These review exercises are multiple-choice questions based on the content in Chapter 2: Differentiation Rules.

**2.1**: Defining a Derivative
**2.2**: Differentiating Power, Exponential, and Sinusoidal Functions
**2.3**: Product Rule and Quotient Rule
**2.4**: Chain Rule
**2.5**: Implicit Differentiation and Differentiating Inverse Functions
**2.6**: Differentiating Logarithmic Functions
**2.7**: Related Rates
**2.8**: Linearization and Differentials
**2.9**: Hyperbolic Functions

For each question, select the best answer provided. To make the best use of these review exercises, follow these guidelines:

- Print out this document and work through the questions as if this paper were an exam.
- Do not use a calculator of any kind. All of these problems are designed to contain simple numbers.
- Try to spend no more than three minutes on each question. Work as quickly as possible without sacrificing accuracy.
- Do your figuring in the margins provided. If you encounter difficulties with a question, then move on and return to it later.
- After you complete all the questions, compare your responses to the answer key on the last page. Note any topics that require revision.

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## Differentiation Rules

**Number of Questions—50**

**NO CALCULATOR**

**1.** A tree's height as a function of time is modeled by $h(t)$, where $h(t)$ is measured in feet and $t$ is measured in years since the tree was planted. What is the best interpretation of the equation $h'(5) = 2$ ?

(A) When the tree is 2 years old, it is 5 feet tall.

(B) When the tree is 2 years old, it is growing at a rate of 2 feet per year.

(C) When the tree is 5 years old, it is 2 feet tall.

(D) When the tree is 5 years old, it is growing at a rate of 2 feet per year.

(E) When the tree is 5 years old, it is growing at a rate of 5 feet per year.

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**2.** If $y = \sin(2x+1)$, then $\dfrac{dy}{dx} =$

(A) $\cos(2x+1)$

(B) $-2\cos(2x+1)$

(C) $2\cos(2x+1)$

(D) $2\sin(2x+1)$

(E) $-2\sin(2x+1)$

**3.** $\dfrac{d}{dx}\left(\dfrac{2}{x^3}\right) =$

(A) $-\dfrac{8}{x^4}$ (B) $-\dfrac{6}{x^4}$ (C) $-\dfrac{6}{x^2}$ (D) $\dfrac{6}{x^2}$ (E) $\dfrac{6}{x^4}$

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**4.** If $f(x) = x^2 \ln x$, then $f'(x) =$

(A) $2$

(B) $x$

(C) $2x \ln x$

(D) $2x \ln x + 2$

(E) $2x \ln x + x$

**5.** $\dfrac{\mathrm{d}}{\mathrm{d}x}\left(\sec^2 x\right) =$

(A) $-2\sec^2 x \tan x$

(B) $-2\sec^2 x$

(C) $-2\sec x$

(D) $2\sec x$

(E) $2\sec^2 x \tan x$

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**6.** An equation of the line tangent to the graph of $f$ is $y+8=3(x-7)$. Which choice lists the correct properties of $f$ ?

(A) $f(-7)=-8$ and $f'(-7)=3$

(B) $f(-7)=8$ and $f'(-7)=3$

(C) $f(7)=-8$ and $f'(7)=-3$

(D) $f(7)=-8$ and $f'(7)=3$

(E) $f(7)=8$ and $f'(7)=3$

**7.** $\frac{\mathrm{d}}{\mathrm{d}x}\left(e^4\right)=$

(A) $0$ (B) $-e^4$ (C) $-4e^3$ (D) $4e^3$ (E) $e^4$

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**8.** $\dfrac{d}{dt}(\log_8 t)\Big|_{t=8} =$

(A) $\dfrac{1}{8\ln 8}$ (B) $\dfrac{1}{\ln 8}$ (C) $\dfrac{1}{\log_8 e}$ (D) $\dfrac{1}{8}$ (E) 1

**9.** Given that $f$ is differentiable at $a$, which of the following must be true?

I. $f$ is continuous at $a$.

II. The graph of $y = f(x)$ does not contain a vertical tangent or sharp turn at $x = a$.

III. $\lim\limits_{x\to a} \dfrac{f(x)-f(a)}{x-a}$ exists.

(A) I only

(B) I and II only

(C) I and III only

(D) II and III only

(E) I, II, and III

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**10.** If $g(x) = \sqrt{\sin 3x}$, then $g'\left(\frac{\pi}{6}\right)$ is

(A) $-1$ (B) $0$ (C) $1$ (D) $\frac{\pi}{2}$ (E) undefined

**11.** Which function is *not* differentiable over the set of all real numbers?

(A) $|x+3|$

(B) $6$

(C) $\cos 2x$

(D) $5+\sinh x$

(E) $x^4 - 2x^3 + 6$

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**12.** What is an equation of the line tangent to the graph of $y = e^{2x}$ at $x = 2$ ?

(A) $y - e^4 = e^4(x-2)$

(B) $y - e^4 = 2e^4(x-2)$

(C) $y - e^4 = 2e^4(x+2)$

(D) $y + e^4 = e^4(x-2)$

(E) $y + e^4 = 2e^4(x+2)$

**13.** It is known that $f(-1) = -3$ and $f'(-1) = 6$. If $a(x) = x^2 f(x)$, then $a'(-1) =$

(A) $-15$ (B) $-12$ (C) $-6$ (D) $6$ (E) $12$

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**14.** The line $y = 4x + 8$ is parallel to the line tangent to the graph $y = x^2 - 4x - 4$ when

(A) $x = -3$ (B) $x = -2$ (C) $x = 2$ (D) $x = 4$ (E) $x = 5$

**15.** For the curve $2x^2 + 3xy - y = 5$, $\frac{dy}{dx} =$

(A) $\frac{3y - 4x}{1 - 3x}$ (B) $\frac{4x + 3y}{3x}$ (C) $\frac{4x - 3y}{1 - 3x}$ (D) $\frac{4x + 3y}{1 - 3x}$ (E) $\frac{4x + 3y}{1 + 3x}$

**16.** The slope of the line normal to the graph of $y = \sqrt{x}$ at $x = 9$ is

(A) $-6$ (B) $-\frac{1}{6}$ (C) $-\frac{1}{3}$ (D) $\frac{1}{6}$ (E) $6$

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**17.** If $y = \dfrac{1}{t^2+4}$, then $dy =$

(A) $\dfrac{-2t}{t^2+4}\,dt$

(B) $\dfrac{-2t}{(t^2+4)^2}\,dt$

(C) $\dfrac{1}{t^2+4}\,dt$

(D) $\dfrac{2t}{t^2+4}\,dt$

(E) $\dfrac{2t}{(t^2+4)^2}\,dt$

**18.** $\sinh(\ln 2) =$

(A) $\dfrac{1}{4}$ (B) $\dfrac{3}{4}$ (C) $\dfrac{5}{4}$ (D) $1$ (E) $2$

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**19.** If $y = \sin^6 5x$, then $\dfrac{dy}{dx} =$

(A) $6\sin^5 5x$

(B) $6\sin^5 5x \cos 5x$

(C) $30\sin^5 5x$

(D) $30\sin^5 5x \cos 5x$

(E) $30\sin^6 5x \cos 5x$

**20.** A linearization of $\sqrt{x}$ centered at $x = 1$ approximates $\sqrt{1.4}$ to be

(A) 0.6 (B) 0.8 (C) 1 (D) 1.2 (E) 1.4

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**21.** If $v(x) = x^2\sqrt{x}\sin x$, then $v'(x) =$

(A) $\frac{5}{2}x\sqrt{x}\cos x$

(B) $2x\sqrt{x}\cos x$

(C) $-\frac{5}{2}x\sqrt{x}\sin x - x^2\sqrt{x}\cos x$

(D) $\frac{5}{2}x\sqrt{x}\sin x - x^2\sqrt{x}\cos x$

(E) $\frac{5}{2}x\sqrt{x}\sin x + x^2\sqrt{x}\cos x$

**22.** A cube's side lengths are all 1 inch. By using differentials, how much does the cube's volume (in cubic inches) *decrease* when its side lengths are all shrunk to 0.9 inch?

(A) 0.1 (B) 0.2 (C) 0.3 (D) 0.5 (E) 0.6

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**23.** If $y = \sin^{-1}\left(x^2+4\right)$, then $\dfrac{\mathrm{d}y}{\mathrm{d}x} =$

(A) $\dfrac{-1}{\sqrt{1-(x^2+4)^2}}$

(B) $\dfrac{1}{\sqrt{1-(x^2+4)^2}}$

(C) $\dfrac{-2x}{\sqrt{1-(x^2+4)^2}}$

(D) $\dfrac{2x}{\sqrt{1-(x^2+4)^2}}$

(E) $\dfrac{2x}{\sqrt{1+(x^2+4)^2}}$

**24.** $\displaystyle\lim_{h\to 0}\frac{\ln(1+h)}{h}$ is

(A) $-1$ (B) $0$ (C) $1$ (D) $e$ (E) nonexistent

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**25.** If $y = \tan^{-1} 3x$, then $y'' =$

(A) $\dfrac{-54x}{\sqrt{1-9x^2}}$ (B) $\dfrac{-54x}{9x^2-1}$ (C) $\dfrac{-54x}{(1-9x^2)^2}$ (D) $\dfrac{-54x}{(1+9x^2)^2}$ (E) $\dfrac{54x}{(1+9x^2)^2}$

**26.** If $f$ and $g$ are inverse functions of each other, with $f(2) = 4$ and $f'(2) = 7$, then $g'(4) =$

(A) $-\dfrac{1}{7}$ (B) $\dfrac{1}{7}$ (C) $\dfrac{1}{4}$ (D) 4 (E) 7

**27.** If $y = 8^x$, then $y' =$

(A) $8^x$ (B) $8^x \ln 8$ (C) $8^x \log_8 e$ (D) $e^x \ln 8$ (E) $e^x \log_8 e$

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**28.** $\dfrac{\mathrm{d}}{\mathrm{d}x}\ln\left(x^2+4x-8\right)=$

(A) $\dfrac{1}{2x+4}$

(B) $\dfrac{1}{x^2+4x-8}$

(C) $\dfrac{-2x-4}{x^2+4x-8}$

(D) $\dfrac{2x+4}{x^2+4x-8}$

(E) $\dfrac{2x+4}{\ln(x^2+4x-8)}$

**29.** The range of $4\operatorname{sech}2x+5$ is

(A) $(0,4]$ (B) $(0,5]$ (C) $(4,5]$ (D) $(4,9]$ (E) $(5,9]$

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**30.** If $f(x) = \cos x$, then $f^{(66)}(x) =$

(A) $-\cos x$ (B) $-\sin x$ (C) $\cos x$ (D) $\sin x$ (E) $\tan x$

**31.** If $e^{2x} - \sin y = y^2$, then $\dfrac{\mathrm{d}y}{\mathrm{d}x} =$

(A) $\dfrac{e^{2x}}{2y + \cos y}$

(B) $\dfrac{e^{2x}}{2y - \cos y}$

(C) $\dfrac{2e^{2x}}{2y - \cos y}$

(D) $\dfrac{2e^{2x}}{\cos y - 2y}$

(E) $\dfrac{2e^{2x}}{2y + \cos y}$

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**32.** $\displaystyle\lim_{x\to\pi/3} \frac{\frac{1}{2}-\cos x}{x-\frac{\pi}{3}}$ is

(A) $-\dfrac{\sqrt{3}}{2}$ (B) $-\dfrac{1}{2}$ (C) $\dfrac{1}{2}$ (D) $\dfrac{\sqrt{3}}{2}$ (E) nonexistent

**33.** $\dfrac{\mathrm{d}}{\mathrm{d}x}\left(\dfrac{\tan x}{x^2}\right) =$

(A) $\dfrac{\sec^2 x}{2x}$

(B) $\dfrac{2x\tan x - x^2\sec^2 x}{x^2}$

(C) $\dfrac{2x\tan x - x^2\sec^2 x}{x^4}$

(D) $\dfrac{x^2\sec^2 x - 2x\tan x}{x^2}$

(E) $\dfrac{x^2\sec^2 x - 2x\tan x}{x^4}$

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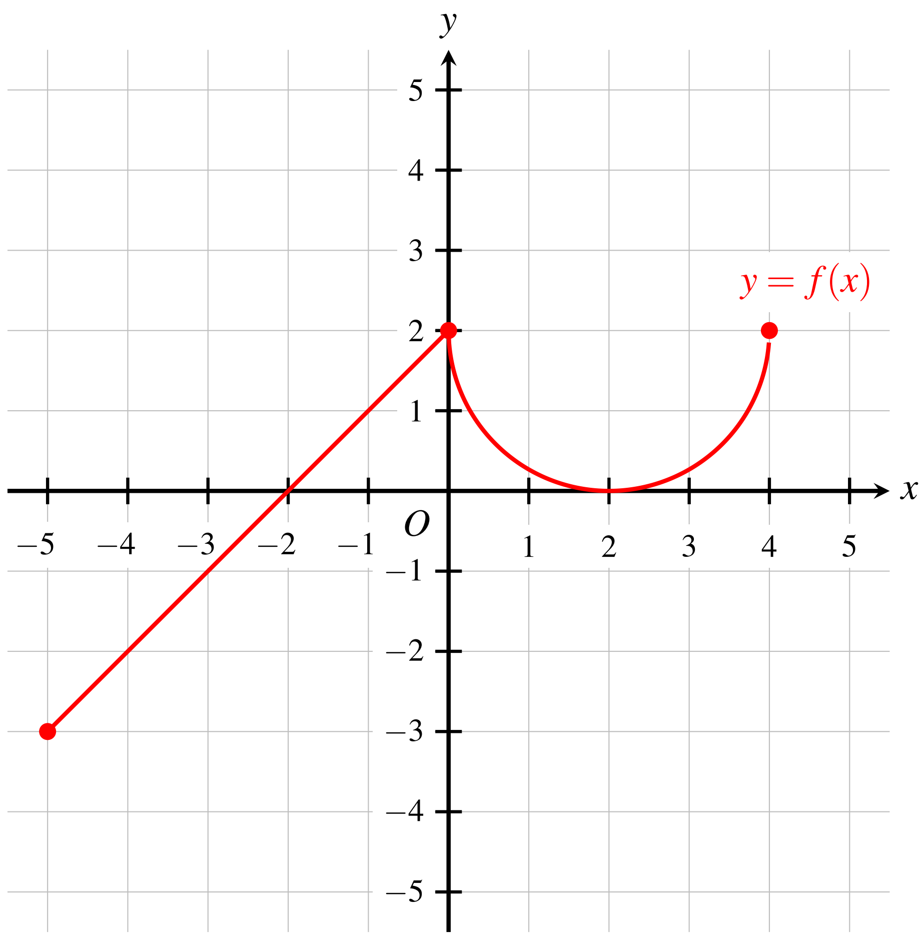
Questions 34–36 refer to the following graph.




**34.** At which value of $x$ is $f$ *not* differentiable?

(A) $-4$ (B) $-2$ (C) $0$ (D) $2$ (E) $3$

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**35.** $\lim_{x\to -5^+} \frac{f(x)+3}{x+5}$ is

(A) $-5$ (B) $-3$ (C) $1$ (D) $3$ (E) nonexistent

**36.** Let $h$ be a differentiable function such that $h(-2) = 2$ and $h'(-2) = 3$. If $p(x) = \frac{f(2x)}{3h(x)}$, then $p'(-2) =$

(A) $-\frac{5}{6}$ (B) $\frac{1}{6}$ (C) $\frac{2}{3}$ (D) $\frac{5}{6}$ (E) $\frac{5}{3}$

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**37.** A particle travels along the $x$-axis with time $t$ according to the function $x(t) = \ln(t+1)$. At $t = 2$, the particle's acceleration is

(A) $-\frac{1}{9}$ (B) $-\frac{1}{3}$ (C) $\frac{2}{27}$ (D) $\frac{1}{9}$ (E) $\frac{1}{3}$

**38.** $\lim\limits_{n\to\infty}\left(1+\frac{2}{n}\right)^n$ is

(A) $e^{-2}$ (B) $e^{-1}$ (C) $e$ (D) $e^2$ (E) nonexistent

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**39.** A circle's radius is increased from 10 to 10.1. By using differentials, the change in the circle's area is approximately

(A) $2\pi$ (B) $4\pi$ (C) $10\pi$ (D) $20\pi$ (E) $40\pi$

**40.** At which values of $x$ does $y = \frac{1}{3}x^3 + 2x^2 - 5x + 6$ have a horizontal tangent?

I. $x = -5$.

II. $x = -1$.

III. $x = 1$.

(A) I only

(B) III only

(C) I and III only

(D) II and III only

(E) I, II, and III

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**41.** $\dfrac{\mathrm{d}}{\mathrm{d}x}\left(\dfrac{\sin^2 x}{e^{4x}}\right) =$

(A) $\sin 2x - 4\sin^2 x$

(B) $\dfrac{\sin 2x + 4\sin^2 x}{e^{4x}}$

(C) $\dfrac{\sin 2x - 4\sin^2 x}{e^{4x}}$

(D) $\dfrac{\sin 2x + 4\sin^2 x}{e^{8x}}$

(E) $\dfrac{\sin 2x - 4\sin^2 x}{e^{8x}}$

**42.** $\dfrac{\mathrm{d}}{\mathrm{d}x}\tanh^{-1}(\cos x) =$

(A) $-\csc x$ (B) $-\sec x$ (C) $\cos x$ (D) $\csc x$ (E) $\sec x$

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**43.** For the curve $y^3 - y = x + 8$, $\dfrac{d^2y}{dx^2} =$

(A) $-\dfrac{6y}{(3y^2-1)^2}$

(B) $\dfrac{6y}{(3y^2-1)^2}$

(C) $-\dfrac{6y}{(3y^2-1)^3}$

(D) $\dfrac{6y}{(3y^2-1)^3}$

(E) $-\dfrac{6y}{(3y^2-1)^4}$

**44.** $\dfrac{d}{dx}\left(x^{\sec x}\right) =$

(A) $(\sec x)x^{\sec x - 1}$

(B) $(\sec x)x^{\sec x}$

(C) $(\sec x \tan x)\, x^{\sec x}$

(D) $\left(\dfrac{\sec x}{x} - \sec x \tan x \ln x\right) x^{\sec x}$

(E) $\left(\dfrac{\sec x}{x} + \sec x \tan x \ln x\right) x^{\sec x}$

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**45.** The curve $2x^3y + 16x^2y^2 + 1 = 0$ has a vertical tangent when

I. $x = -2$.

II. $x = 0$.

III. $x = 2$.

(A) I only

(B) II only

(C) I and III only

(D) II and III only

(E) I, II, and III

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**46.** If $y = \sin^4\left(\sqrt{x}\right)$, then $y' =$

(A) $4\sin^3\left(\sqrt{x}\right)$

(B) $4\sin^3\left(\sqrt{x}\right)\cos\left(\sqrt{x}\right)$

(C) $\dfrac{2\sin^3\left(\sqrt{x}\right)}{\sqrt{x}}$

(D) $\dfrac{2\sin^3\left(\sqrt{x}\right)\cos\left(\sqrt{x}\right)}{\sqrt{x}}$

(E) $\dfrac{2\cos^3\left(\sqrt{x}\right)\sin\left(\sqrt{x}\right)}{\sqrt{x}}$

**47.** $\dfrac{\mathrm{d}}{\mathrm{d}x}\left(x^4e^{2x}\sec x\right) =$

(A) $4x^3e^{2x}\sec x + x^4e^{2x}\sec x + x^4e^{2x}\sec x$

(B) $4x^3e^{2x}\sec x + 2x^4e^{2x}\sec x + x^4e^{2x}\sec x$

(C) $4x^3e^{2x}\sec x + x^4e^{2x}\sec x + x^4e^{2x}\sec x\tan x$

(D) $4x^3e^{2x}\sec x + 2x^4e^{2x}\sec x + x^4e^{2x}\sec x\tan x$

(E) $x^4e^{2x}\sec x + 2x^4e^{2x}\sec x + x^4e^{2x}\sec x$

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**48.** $\dfrac{d}{dx}\left(\dfrac{e^{\sin x}\tan x}{x^5\sin 5x}\right) =$

(A) $\dfrac{e^{2\sin x}\tan x + e^{\sin x}\tan x\sec^2 x - 5x^4e^{\sin x} - 5e^{\sin x}\cos 5x}{x^5\sin 5x}$

(B) $\dfrac{5x^4e^{\sin x} + 5e^{\sin x}\cos 5x - e^{2\sin x}\tan x - e^{\sin x}\tan x\sec^2 x}{x^5\sin 5x}$

(C) $\dfrac{xe^{\sin x}\sin x + xe^{\sin x}\sec^2 x - 5e^{\sin x}\tan x - 5xe^{\sin x}\tan x\cot 5x}{x^6\sin 5x}$

(D) $\dfrac{5e^{\sin x}\tan x + 5xe^{\sin x}\tan x\cot 5x - xe^{\sin x}\sin x - xe^{\sin x}\sec^2 x}{x^6\sin 5x}$

(E) $\dfrac{e^{2\sin x}\tan x + e^{\sin x}\tan x\sec^2 x - 5x^4e^{\sin x} - 5e^{\sin x}\cos 5x}{x^{10}\sin^2 5x}$

**49.** A projectile's height, in feet, above the ground as a function of time, in seconds, is given by the function $h(t) = -16t^2 - 64t + 80$. The projectile's speed, in feet per second, upon striking the ground is

(A) 32 (B) 64 (C) 96 (D) 128 (E) 192

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**50.** $\dfrac{d}{dx}\left(\dfrac{1}{\ln(\ln(\ln x))}\right) =$

(A) $\dfrac{-1}{\ln(\ln x)[\ln(\ln(\ln x))]^2}$

(B) $\dfrac{1}{x(\ln x)\ln(\ln x)\ln(\ln(\ln x))}$

(C) $\dfrac{-1}{x(\ln x)\ln(\ln x)\ln(\ln(\ln x))}$

(D) $\dfrac{1}{x(\ln x)\ln(\ln x)[\ln(\ln(\ln x))]^2}$

(E) $\dfrac{-1}{x(\ln x)\ln(\ln x)[\ln(\ln(\ln x))]^2}$

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*This marks the end of the review exercises. The following page contains the answers to all the questions.*

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**1.** D
**2.** C
**3.** B
**4.** E
**5.** E
**6.** D
**7.** A
**8.** A
**9.** E
**10.** B
**11.** A
**12.** B
**13.** E
**14.** D
**15.** D
**16.** A
**17.** B
**18.** B
**19.** D
**20.** D
**21.** E
**22.** C
**23.** D
**24.** C
**25.** D
**26.** B
**27.** B
**28.** D
**29.** E
**30.** A
**31.** E
**32.** B
**33.** E
**34.** C
**35.** C
**36.** D
**37.** A
**38.** D
**39.** A
**40.** C
**41.** C
**42.** A
**43.** C
**44.** E
**45.** C
**46.** D
**47.** D
**48.** C
**49.** C
**50.** E

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