1. **B**. Each time the derivative is taken, the first term is multiplied by its exponent and the exponent has 1 subtracted from it, giving $(21!)x$. Using the Chain Rule on the second piece gives $(2)^{20}e^{2x}$. The first time the derivative is taken of $\ln x$, it results in $\frac{1}{x}$. Then the Power Rule is used repeatedly, causing the exponent in the denominator to increase each time, the signs in front to alternate, and the coefficients to multiply, to $(-1)^{19}\frac{18!}{x^{19}}$.

2. **A**. Rationalize the numerator: $\lim_{x\to 7}\frac{x+2-9}{(x-7)\sqrt{x+2}+3}$. The factors of $x-7$ cancel: $\lim_{x\to 7}\frac{1}{\sqrt{x+2}+3}=\frac{1}{6}$.

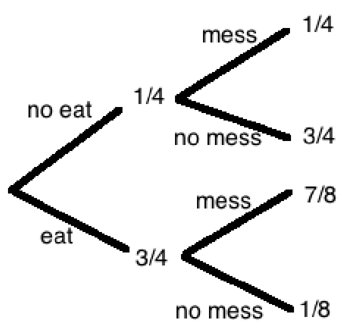
3. **D**. Divide through by 3 to get $x^2+y^2-8x+6y=75$. Use implicit differentiation: $2x+2y\left(\frac{dy}{dx}\right)-8+6\left(\frac{dy}{dx}\right)=0$, and solve for $\left(\frac{dy}{dx}\right)$ to get $\frac{dy}{dx}=\frac{4-x}{y+3}$. When $x=10$, $y=5$ or $y=-11$. Plugging in $(10,5)$, $\frac{dy}{dx}=\frac{4-10}{5+3}=-\frac{3}{4}$. Plugging in $(10,-11)$, $\frac{dy}{dx}=\frac{4-10}{-11+3}=\frac{3}{4}$. Their sum is 0.

4. **B**. The derivative is $h'(x)=-a\sin x+b\sec^2 x+c\sec x\tan x-d\csc^2 x+e\cos x-f\csc x\cot x$. Plugging in $\frac{\pi}{4}$: $a\left(\frac{\sqrt{2}}{2}\right)+b(2)+c(\sqrt{2})-d(2)+e\left(\frac{\sqrt{2}}{2}\right)-f(\sqrt{2})$. Group the like terms together: $(e-a)\left(\frac{\sqrt{2}}{2}\right)+(b-d)(2)+(c-f)(\sqrt{2})$, then substitute in the given information: $(4)\left(\frac{\sqrt{2}}{2}\right)+(-3)(2)+(2)(\sqrt{2})=4\sqrt{2}-6$.

5. **D**. Plug in 2 for x in each part, set equal: $16a+10=4b-6$. Take the derivative of each part, plug in 2 for x, set equal: $32a+5=4b-3$. Solve using elimination: $b=6$.

6. **B**. Use u-substitution, with $u=\ln x$ and $du=\frac{1}{x}dx$. $\int u\,\mathrm{d}u=\frac{1}{2}u^2=\frac{1}{2}(\ln x)^2|_1^e=\frac{1}{2}((\ln e)^2-(\ln 1)^2)=\frac{1}{2}(1-0)=\frac{1}{2}$.

7. **D**. Find the zeros of the polynomial: $x=1, x=5$. The value of the polynomial is negative on the interval $(1,5)$, so integrate both pieces separately. $\int_0^1 3x^2-18x+15\,\mathrm{d}x-\int_1^5 3x^2-18x+15\,\mathrm{d}x=x^3-9x^2+15x|_0^1-(x^3-9x^2+15x)|_1^5=(1-9+15-0)-[(125-225+75)-(1-9+15)]=7-(-32)=39$.



8. **C**. Create a tree diagram:
The formula for conditional probability is $P(A|B)=\frac{P(A\cap B)}{P(B)}$. Let A be that Mrs. Funk had to clean up a mess, and B be that the dog ate something bad for her. $P(A\cap B)=\left(\frac{3}{4}\right)\left(\frac{7}{8}\right)=\frac{21}{32}$. $P(B)=\left(\frac{3}{4}\right)\left(\frac{7}{8}\right)+\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)=\frac{21}{32}+\frac{1}{16}=\frac{23}{32}$. Therefore, $P(A|B)=\frac{\frac{21}{32}}{\frac{23}{32}}=\frac{21}{23}$.

9. **A**. Use partial fraction decomposition: $\frac{A}{x}+\frac{B}{x-1}+\frac{C}{x+1}=\frac{x^2-2}{x^3-x}\to A(x^2-1)+B(x^2-x)+C(x^2+x)=x^2-2$. Set up equations with coefficients equal to each other: $A+B+C=1$ from the x^2 terms, $-B+C=0$ from the x

terms, $-A = -2$ from the constant terms: $A = 2$, $B = -\frac{1}{2}$, $C = -\frac{1}{2}$. Now integrate $\int \left(\frac{2}{x} - \frac{\frac{1}{2}}{x+1} - \frac{\frac{1}{2}}{x-1} \right) \mathrm{d}x =$ $2 \ln x - \frac{1}{2} \ln(x+1) - \frac{1}{2} \ln(x-1) + C = \ln \frac{x^2}{\sqrt{x^2-1}} + C$.

10. **B**. The equation for horizontal distance traveled is $x(t) = 49t \cos(30°)$ and for vertical distance is $y(t) = 49t \sin(30°) - 4.9t^2$. First find the time when the cannonball hits the ground: $0 = 4.9t(10 \sin(30°) - t) \to t = 10 \left(\frac{1}{2} \right) = 5$. Then plug in 5 for t in the horizontal distance: $x = 49(5) \left(\frac{\sqrt{3}}{2} \right) = \frac{245\sqrt{3}}{2}$.

11. **D**. Since we are concerned with the adjacent side and the hypotenuse, set up the equation $\cos\theta = \frac{7}{h}$. Use implicit differentiation: $-\sin\theta \left(\frac{d\theta}{dt} \right) = \frac{-7}{h^2} \left(\frac{dh}{dt} \right)$. If the hypotenuse is 25 inches, use Pythagorean theorem to find that the side opposite θ is 24 inches. Therefore, $\sin\theta = \frac{24}{25}$. Substitute into the equation: $\left(-\frac{24}{25} \right) \left(\frac{d\theta}{dt} \right) = \frac{-7}{25^2}(2) \to$ $\frac{d\theta}{dt} = \frac{7}{300}$ radians per second.

12. **B**. Differentiate: $p'(t) = 30x^4 - 60x^2 - 90$. Set equal to zero and solve for x to find that the only real solutions are $x = \pm\sqrt{3}$. Their product is -3. They must be maximums or minimums because neither of them satisfies the equation $p"(t) = 0$.

13. **B**. Newton's method states that $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$. $f'(x) = 3x^2 + 8x$. Therefore, $x_1 = -1 - \frac{1}{-5} = \frac{-4}{5}$ and $x_2 = -\frac{4}{5} - \frac{\frac{6}{125}}{\frac{-112}{25}} = -\frac{227}{280}$.

14. **E**. $f(x) = x^2 - x^3$ and $f'(x) = 2x - 3x^2$. Set the derivative equal to zero and solve for x: $x = \frac{2}{3}$ or $x = 0$. Since zero will not provide a maximum, $\frac{2}{3}$ is our answer.

15. **A**. Let x equal the width of the rectangle, which will be the radius of our cylinder. Since the perimeter must equal 12, the height is $6-x$. The volume of the cylinder is $V = \pi x^2(6-x)$. Differentiate to get $V' = \pi(12x-3x^2) = 0 \to x = 4$. The dimensions to maximize the volume of the cylinder are 4 inches by 2 inches.

16. **A**. Use synthetic division to divide the polynomials: $\int \left(x^2 + 2x + 4 + \frac{8}{x-2} \right) \mathrm{d}x = \frac{1}{3}x^3 + x^2 + 4x + 8 \ln|x-2| + C$.

17. **D**. Since $\int_{10}^{3} f(x)\,\mathrm{d}x = 7$, $\int_{3}^{10} f(x)\,\mathrm{d}x = -7$. $\int_{1}^{3} f(x)\,\mathrm{d}x + \int_{3}^{10} f(x)\,\mathrm{d}x = \int_{1}^{10} f(x)\,\mathrm{d}x \to \int_{1}^{3} f(x)\,\mathrm{d}x - 7 = 4 \to$ $\int_{1}^{3} f(x)\,\mathrm{d}x = 11$.

18. **B**. Find $f(5)$ and $f'(5)$: $f(5) = \sqrt{(5)^4 - 16(5)^2} = \sqrt{225} = 15$, $f'(x) = \frac{2x^3 - 16x}{\sqrt{x^4 - 16x^2}}$, $f'(5) = \frac{250 - 80}{(15)} = \frac{170}{15} = \frac{34}{3}$. Since we are finding the line normal to the graph, use the perpendicular slope. The line has slope $-\frac{3}{34}$ and passes through the point $(5, 15)$, therefore the line is $y - 15 = -\frac{3}{34}(x-5)$.

19. **C**. Solve for y: $\pm y = \sqrt{x^2 - 9}$, and use only the positive portion since the graph is in the first quadrant only. To find the volume: $\pi \int_{3}^{5} \left(\sqrt{x^2 - 9} \right)^2 \mathrm{d}x = \pi \left(\frac{1}{3}x^3 - 9x \right) |_3^5 = \pi \left(\frac{125}{3} - 9(5) - \left(\frac{27}{3} - 9(3) \right) \right) = \pi \left(-\frac{10}{3} - (-18) \right) =$ $\frac{44\pi}{3}$.

20. **B**. $\frac{dy}{dt} = 1$, $\frac{dx}{dt} = 2x - 3$. Therefore $\frac{dy}{dx} = \frac{1}{2x-3}$. To find the second derivative, use the chain rule: $\dfrac{\frac{d}{dt}\left(\frac{dy}{dx}\right)}{\frac{dx}{dt}}$.
Therefore, $\frac{d^2y}{dx^2} = \dfrac{\frac{-2}{(2t-3)^2}}{2t-3}$. Evaluate at $t = 2$: $\frac{-2}{(2(2)-3)^3} = -2$.

21. **B**. $f'(x) = \frac{1}{2}\cos\left(\frac{x}{2}\right)$. Set equal to 0 and solve for x: $\cos\left(\frac{x}{2}\right) = 0 \to \frac{x}{2} = \frac{\pi}{2}, \frac{3\pi}{2} \to x = \pi, 3\pi$. However, only π is on the specified interval, so the sum of all solutions is π.

22. **C**. First, note that the height and radius of the full tank are proportional to the height and radius of the partially full tank, so find an expression for the radius: $\frac{2}{6} = \frac{r}{h} \to r = \frac{h}{3}$. Then substitute into the volume formula for a cone: $V = \frac{1}{3\pi}r^2h = \frac{1}{27}\pi h^3$. Differentiate: $\frac{dV}{dt} = \frac{1}{27}\pi(3)(h^2)\left(\frac{dh}{dt}\right)$, then substitute in the known values: $\frac{dV}{dt} = \frac{1}{9}\pi(2)^2(0.2) = \frac{4\pi}{45}$.

23. **D**. $\int_0^a \sin x \, dx = -\cos x|_0^a = -\cos a + \cos 0 = 1 + \frac{\sqrt{2}}{2}$. There are two angles that satisfy this equation, $\frac{3\pi}{4}$ and $\frac{5\pi}{4}$. The sum of these is 2π.

24. **D**. To convert Cartesian coordinates to polar coordinates, $r = \sqrt{x^2+y^2} = \sqrt{(\sqrt{3})^2 + (-1)^2} = \pm 2$. If $r = 2$: $\tan^{-1}\frac{-1}{\sqrt{3}} = -\frac{\pi}{6}$. This angle is coterminal to $\frac{11\pi}{6}$. If $r = -2$, then the radius extends in the negative direction and rotates $-\frac{\pi}{6}$, providing $\theta = \frac{5\pi}{6}$. Therefore $(-2, \frac{11\pi}{6}, 3)$ is not a possible representation of the point.

25. **A**. If a plane is perpendicular to a vector, then the components of the vector become the coefficients on the variables in the plane equation. $8x + 2y + 3z = d$, plug in the x, y, and z-coordinates of the point to find d: $8(7) + 2(12) + 3(-5) = d \to d = 65$.

26. **B**. Find the eigenvalues of the matrix: $\begin{vmatrix} 3-\lambda & 2 \\ 1 & 4-\lambda \end{vmatrix} = 0$, $\lambda^2 - 7\lambda + 10 = 0$, $(\lambda-5)(\lambda-2) = 0$, $\lambda = 5, 2$. To find the eigenvectors: $\begin{bmatrix} 3 & 2 \\ 1 & 4 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \lambda \begin{bmatrix} x \\ y \end{bmatrix}$. Use $\lambda = 5$ to find the system of equations $3x + 2y = 5x$, $x + 4y = 5y$. Both equations reduce to $x = y$, so that any vector with x- and y-components being equal is an eigenvector of this matrix.

27. **A**. Let S=sum of the infinite series. List out the first several terms: $S = \frac{2}{9} + \frac{4}{27} + \frac{6}{81} + \frac{8}{243}$.... Multiply the series by $\frac{1}{3}$: $\frac{S}{3} = \frac{2}{27} + \frac{4}{81} + \frac{6}{243} + \frac{8}{729}$.... Then subtract the two sums to get $\frac{2S}{3} = \frac{2}{9} + \frac{2}{27} + \frac{2}{81} + \frac{2}{243}$.... This is an infinite geometric series with first term $\frac{2}{9}$ and common ratio $\frac{2}{3}$. $\frac{2S}{3} = \dfrac{\frac{2}{9}}{1 - \frac{2}{3}} = \frac{1}{3}$. Solve for S to find that $S = \frac{1}{2}$.

28. **C**. In an odd function, $B(-x) = -B(x)$. Therefore, $\frac{B(B(B(-3)))}{3B(1) - 2B(3) - B(5)} = \frac{B(B(-5))}{3(2) - 2(5) - (1)} = \frac{B(-1)}{6 - 10 - 1} = \frac{-2}{-5} = \frac{2}{5}$.

29. **B**. Separate the differential equation: $4y^3\,dy = e^{2x}\,dx$. Integrate both sides to get $y^4 = \frac{1}{2}e^{2x} + C$. Since $y(0) = 1$, $(1)^4 = \frac{1}{2}e^0 + C \to C = \frac{1}{2}$.

30. **B**. Use the product rule: $f'(x) = \sin x(-\sin x) + \cos x(\cos x)$. This simplifies to $\cos 2x$. $\cos 2\left(\frac{\pi}{4}\right) = 0$.