1. **(A)**. Using implicit differentiation, we obtain $6xdx + 10x^4y^{-3}dx - 6x^5y^{-4}dy + 10y^{-3}dy = -12x^{-4}\ln y\,dx + 4x^{-3}y^{-1}dy$. Evaluating, $6dx + 10dx - 6dy + 10dy = 4dy$. So, $\frac{dx}{dy} = 0$.

2. **(C)**. Taking the first derivative, we obtain $2x^3 - 5x^2 - 4x + 3 = (x+1)(2x-1)(x-3)$. So, $f(x)$ is increasing in the interval $\left(-1, \frac{1}{2}\right) \cup (3,\ \infty)$. Taking the second derivative, we obtain $6x^2 - 10x - 4 = 2(3x+1)(x-2)$. So, $f(x)$ is concave down in the interval $\left(-\frac{1}{3}, 2\right)$. Taking the union of these two intervals, we obtain $\left(-\frac{1}{3}, \frac{1}{2}\right)$. Therefore, $c - 4d = -\frac{1}{3} - 2 = -\frac{7}{3}$.

3. **(B)**. This limit is just equivalent to $\frac{1}{3}g'(x)$. Taking the derivative and using chain rule, we obtain $\frac{1}{3}\left(3x^2e^{x^3} - \frac{6}{x}\right) = x^2e^{x^3} - \frac{2}{x}$.

4. **(A)**. We can rewrite this limit as $\lim_{x\to 0^+} \frac{\ln x}{\frac{1}{x}}$. Then, using L'Hopital's rule, we take the derivative of the top and bottom to obtain $\lim_{x\to 0^+} \frac{1/x}{-1/x^2} = \lim_{x\to 0^+} -x = 0$.

5. **(B)**. Looking at the function $y = \sqrt[4]{x}$, the derivative is $y' = \frac{1}{4}x^{-\frac{3}{4}} = \frac{1}{4} \cdot \frac{1}{343}$. So, our approximation is $7 + 16 \cdot \frac{1}{4} \cdot \frac{1}{343} = 7 + \frac{4}{343}$. So, our answer is $4/343$.

6. **(C)**. If we draw lines of slope ± 3 through the points $(0,0)$ and $(1,1)$, we obtain a parallelogram with vertices $(0,0)$, $\left(\frac{1}{3}, -1\right)$,$\left(\frac{2}{3}, 2\right)$ $(\frac{2}{3}$, and $(1,1)$. Note that every point $(x, f(x))$ for $x \in (0,1)$ must be within this parallelogram by the Mean Value Theorem. We can construct functions arbitrarily close to the top or the bottom of the parallelogram. So, the desired $b - a$ is just the area of this parallelogram, which is $4/3$.

7. **(C)**. First, we'll start with the cone. Let the radius be r, so the height is $3 + \sqrt{9 - r^2}$. Then, the volume is $\frac{1}{3}\pi r^2(3 + \sqrt{9 - r^2})$. Taking the derivative and setting equal to zero gives $r = 2\sqrt{2}$. For the cylinder, let the radius again be r, so the height is $2\sqrt{9 - r^2}$. The volume is $2\pi r^2\sqrt{9 - r^2}$. Taking the derivative and setting equal to zero gives $r = \sqrt{6}$. So, the desired ratio is $\frac{4}{3}$.

8. **(B)**. We can write $V = \frac{1}{3}\pi r^2(3r) = \pi r^3$, so $dV = 3\pi r^2 dr$. Plugging in the given values, $4\pi = 3\pi(4)^2 dr$, so $dr = \frac{1}{12}$. Now, for the surface area, we have $A = \pi r^2$, so $dA = 2\pi r dr = 2\pi(4)\left(\frac{1}{12}\right) = \frac{2\pi}{3}$.

9. **(B)**. We first find $\frac{dy}{dx} = \frac{10t}{e^t} = \frac{10t}{e^t}$. Taking the derivative with respect to t, we obtain $\frac{10(e^t)-10t\ ^t}{(e^t)^2} \cdot \frac{dx}{dt} = e^t$, so our final answer is $\frac{10e^t(1-t)}{e^{3t}}$.

10. **(A)**. We can "rationalize the numerator": $\frac{Ax^2+10x-B^2x^2}{\sqrt{Ax^2+10x}+Bx}$. We must have that $A = B^2$, so we obtain $\lim_{n\to\infty} \frac{10x}{\sqrt{B^2x^2+10x}+Bx} = 5$. This implies that $\frac{10}{2B} = 5$, so $A = B = 1$.

11. **(E)**. We can rearrange and use L'Hopital's: $\lim_{x\to-\infty} \frac{3x^2}{e^{-2x}} = \lim_{x\to-\infty} \frac{6x}{-2e^{-2x}} = \lim_{x\to-\infty} \frac{6}{4e^{-2x}} = 0$.

12. **(A)**. Let this limit be y. We have that $\ln y = \lim_{x\to\infty} \frac{\ln(2x^3+e^{-x})}{x^3} = 0$, so $y = 1$.

13. **(B)**. Note that $\sec\left(\arcsin\frac{3}{\sqrt{9+x^2}}\right) = \frac{\sqrt{9+x^2}}{x}$, so we have $f(x) = \arctan\left(\frac{\sqrt{9+x^2}}{x}\right)$. Thus, $f'(x) = \frac{1}{1+\frac{9+x^2}{x^2}} \cdot \frac{x\cdot\frac{x}{\sqrt{9+x^2}}-\sqrt{9+x^2}}{x^2} = \frac{x^2}{9+2x^2} \cdot -\frac{9}{x^2\sqrt{9+x^2}} = -\frac{9}{(9+2x^2)\sqrt{9+x^2}} = -\frac{1}{9\sqrt{2}}$.

14. **(A)**. We are looking for $\frac{1}{f'(g(3))} = \frac{1}{f'(0)} = \frac{1}{8}$, since we have $f'(x) = 5 + 3e^x$.

15. **(B)**. From the definition, we see that $|3x + 1 - 4| < \epsilon$ whenever $|x - 1| < \frac{\epsilon}{3}$. So, the largest choice of δ that would work is $\frac{\epsilon}{3} = 0.0005$.

16. **(C)**. The first limit is equal to zero, since sine is confined between -1 and 1 as x in the denominator goes to infinity. For the second limit, the numerator approaches $\frac{\pi}{2}$ as the denominator goes to infinity, so this limit is also equal to zero. The third limit goes to infinity, since the numerator grows much faster than the denominator. The fourth limit goes to zero since it is equal to $e^{-\infty} = 0$. The fifth limit does not exist.

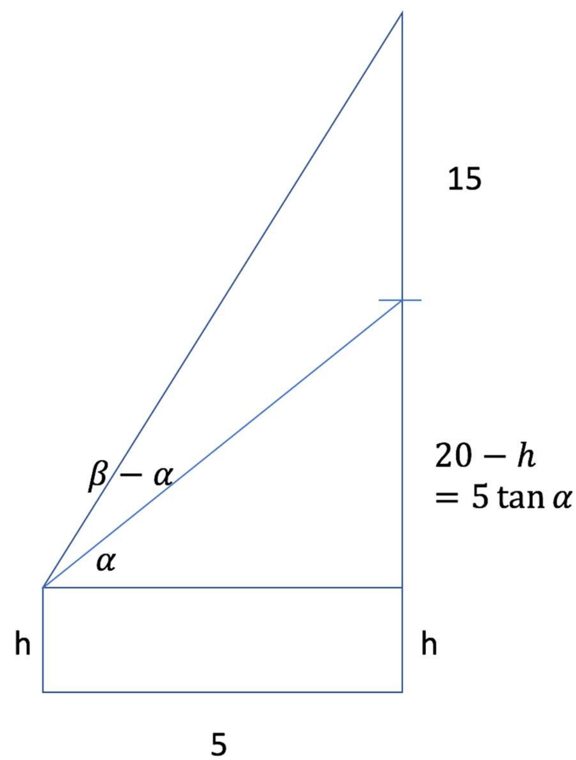
17. **(B)**. We have that $\frac{dx}{dy} \cdot \frac{1}{3}x^{-\frac{2}{3}} + \frac{1}{3}y^{-\frac{2}{3}} = 0$, so $\frac{dx}{dy} = -\left(\frac{x}{y}\right)^{\frac{2}{3}} = -4$. Taking the derivative once again, we have $\frac{d^2x}{dy^2} = -\frac{2}{3}\left(\frac{y}{x}\right)^{\frac{1}{3}} \cdot \frac{yx'-x}{y^2} = -\frac{2}{3} \cdot \frac{1}{2} \cdot (-12) = 4$.

18. **(B)**. If we let $y = \sqrt{x + \sqrt{x + \sqrt{x + \cdots}}}$, we know that $y^2 - y - x = 0$, so $y = \frac{1+\sqrt{1+4x}}{2}$. As x approaches zero, then, y approaches 1.

19. **(B)**. The first derivative can be factored as $(2x + 3)(x - 2)^2$. So, there are no local maxima. Taking the derivative again gives $(3x + 1)(x - 2)$, giving two inflection points, the sum of which are $\frac{5}{3}$.

20. **(B)**. We have the following equation modeling movement: $w^2 + h^2 = 625$. Then, $2wdw + 2hdh = 0$. Plugging in, $2(20)dw + 2(15)(-5) = 0$, so $dw = 15/4$.

21. **(B)**. Let h be Edouard's height. Let α be the angle of elevation from the top of his head to the bottom of the screen, and let β be the angle of elevation from the top of his head to the top of the screen. Then, we know that $\tan\alpha = \frac{20-}{5}$ and $\tan\beta = \frac{35-h}{5}$. So, $\sec^2\alpha\, d\alpha = -\frac{dh}{5}$. We have that $d\alpha = -0.2$ and $dh = 10$, since one foot every 6 seconds is equivalent to ten feet per minute. Plugging in, $\sec^2\alpha\,(-0.2) = -2$, so $\sec^2\alpha = 10$. This means that $\tan\alpha = 3$. To find $\tan\beta$, look at the diagram below, so $\tan\beta = \frac{5\tan\alpha+15}{5} = 6$, so $\sec^2\beta = 37$. Then, $\sec^2\beta\, d\beta = -\frac{dh}{5} = -2$. Again, plugging in, we see that $d\beta = -\frac{2}{37}$.



22. **(C)**. We can write this as $\lim_{n\to\infty}\sum_{i=1}^{n}\frac{1/n}{\sqrt{1-\left(\frac{i}{n}\right)^2}}$. So, this is equivalent to $\int_0^1 \frac{1}{\sqrt{1-x^2}}dx$, which we can then evaluate: $\arcsin 1 - \arcsin 0 = \frac{\pi}{2}$.

23. **(C)**. Using the Fundamental Theorem of Calculus, this is equal to $9x^2 3x^3 \ln 3x^3 - 4x\ln 2x = 27\ln 3 - 4\ln 2$.

24. **(A)**. Only the exponential terms matter, so the limit is $\frac{1}{3}$.

25. **(C)**. We'll find the probability that none of the molecules were shared. For each molecule, there is a $\frac{10^{40}-1\ \ ^{20}}{10^{40}} = 1 - \frac{1}{10^{20}}$ probability it was not in Caesar's last breath. So, for all of the molecules, there is a $\left(1 - \frac{1}{10^{20}}\right)^{10^{20}} \approx e^{-1}$ probability that none of them were in Caesar's last breath. Thus, the complement of this probability is $1 - \frac{1}{e}$.

26. **(A)**. Note that $f'(x) = 3x^2 - 2x$. We begin the iterations: $x_1 = 1 - \frac{3}{1} = -2$. Next, $x_2 = -2 - \frac{-9}{16} = -\frac{23}{16}$.

27. **(D)**. Firstly, we evaluate $r = \sin\frac{\pi}{2} + 2\pi = 2\pi + 1$. Then, $\frac{dr}{d\theta} = \frac{1}{2}\cos\frac{\theta}{2} + 2 = 2$. So,

$$\frac{dy}{dx} = \frac{r\cos\theta + r'\sin\theta}{-r\sin\theta + r'\cos\theta} = \frac{(2\pi+1)(-1) + 2(0)}{2(-1)} = \pi + \frac{1}{2}$$

28. **(D)**. The partial derivative is $5x^2z - 3y^2z^2 = 90 - 48 = 42$.

29. **(A)**. We are still using $f(x,y,z) = 5x^2yz - y^3z^2$. So, taking the partial with respect to z gives $5x^2y - 2y^3z$. Then, taking the partial with respect to x gives $10xy$. Finally, taking the partial with respect to y gives $10x$.

30. **(A)**. We have $\pi(p,w) = p\sqrt{L} - wL$. Taking the partial derivative and setting equal to zero gives $\frac{p}{2\sqrt{L}} = w$, so $L = \frac{p^2}{4w^2}$.