1. A: The numerator and denominator both evaluate to 0 at 4, so we can use L'hopital's rule to get $\dfrac{3x^2}{1/2\sqrt{x}} = 6x^2\sqrt{x}$. When $x = 4$ this evaluates to 192.

   B: Multiplying and dividing by the conjugate, we get a numerator of $(x^2 - 46x + 2020) - (x^2 + 46x + 2021) = -92x - 1$ and a denominator of $\sqrt{x^2 - 46x + 2020} + \sqrt{x^2 + 46x + 2021}$. However, as x tends to infinity, both of the roots on the bottom tend to x as the lower order terms vanish, resulting in $2x$ on the bottom and $-92x$ on the top (asymptotically). These divide to give -46

   C: Numerator and denominator both evaluate to 0 at $x = 0$, so we can use L'hopital's again. The derivative of the numerator is $\frac{3}{2}\sqrt{x+4} + e^x \to 4$ while the derivative of the denominator is just 1, so the limit is 4

   D: This is equivalent to the limit of $\ln\left(\left(\dfrac{x^3 + 9x^2 + 27x + 27}{x^3}\right)^x\right)$. The numerator of the fraction is equivalent to $(x+3)^3$, so the fraction can be rewritten as $(1 + 3/x)^3$. Taking out the logarithm, we have $\ln(\lim_{x\to\infty}(1 + 3/x)^{3x}) = \ln(e^9) = 9$

   FINAL: $\boxed{159}$

2. A: Let $m = y/x$. Then we are looking for a locus of m values for which $m = \ln(1/m) = -\ln(m)$. However, sketching the graphs $y = m$ and $y = -\ln(m)$ (a different y than before) shows that they should only intersect at one point in the first quadrant, as $-\ln(m)$ decreases monotonically from infinity to negative infinity with $m > 0$ and m increases monotonically from 0 to infinity with $m > 0$. Thus, there is exactly one value of m, or y/x, that satisfies the equation, which we will denote as λ (as it cannot be found analytically). Then $y/x = \lambda$, so $y = \lambda x$ and our graph is equivalent to a line of slope λ passing through the origin. Thus, the slope of the normal line at any point, including $x = 21$, is $-1/\lambda$

   B: Sketching these lines we see they form a trapezoid with bases at $x = 1$ and $x = 21$. The length of one base is $y(1) = \lambda$ and the length of the other base is $y(21) = 21\lambda$. Also, the height is just $21 - 1 = 20$. Thus, the area of the trapezoid is $(1/2)(22\lambda)(20) = 220\lambda$

   FINAL: $\boxed{-220}$

3. A: The formula for a step of Newton's method is $x_{i+1} = x_i - f(x_i)/f'(x_i)$, which in this case simplifies to $x_{i+1} = x_i - (x_i/2) = x_i/2$. Thus if $x_0 = 80$, $x_1 = 40$, $x_2 = 20$, and so on. The actual root is 0 of course, so we want the

least n such that $80/2^n < 1/100 \to 2^n > 8000$. $2^{13} = 8192 > 8000$, so the answer for this part is $n = 13$.

B: The formula for a step of Euler's method is $f(x_{i+1}) = f(x_i) + (x_{i+1} - x_i)f'(x_i)$, which in this case simplifies to $f(x_{i+1}) = f(x_i) + (1)(2x_i)$ (where the step length is 1 because we are trying to reach n in n steps). Since we start out with $f(x_0) = 0$, $f(x_1) = 0 + 2(0) = 0$, $f(x_2) = 0 + 2(1) = 2$, $f(x_3) = 2 + 2(2) = 6$, and so on, adding $2i$ for each i less than n. Thus the approximation of $f(x_n)$ is $2\sum_{i=0}^{n-1} i = (n-1)(n) = n^2 - n$. Then the absolute error is n, so the percent error is $n/n^2 = 1/n$. For this to be less than 1%, we must have $1/n < 0.01$, so $n > 100$ and the least integer value of n is 101.

C: We know that the actual value of the integral is n^3. The approximated value is $1(1/2)(f(0) + (2\sum_{i=1}^{i=n-1} f(i)) + f(n))$ by the formula for trapezoidal sum. Then plugging in $f(i) = 3i^2$ we get $(3/2)(0 + 2(1^2 + 2^2 + \cdots + (n-1)^2) + n^2) = (3/2)(\frac{(n-1)(n)(2n-1)}{3} + n^2) = (3/2)\left(\frac{2n^3+n}{3}\right) = \frac{2n^3+n}{2} = n^3 + n/2$. Then the absolute error is $n^3 + n/2 - n^3 = n/2$, so the percent error is $(n/2)/n^3 = 1/(2n^2)$. For percent error less than 1%, we must have $\frac{1}{2n^2} < 0.01$ so $2n^2 > 100$ and the least integer n is 8.

FINAL: $\boxed{122}$

4. A: Velocity of X is $x'(t) = 12t^2 - 28$ and speed is magnitude of velocity or $|12t^2 - 28|$. We have to test 3 points for maximums - the two endpoints of the interval, and the local minimum of the velocity (which may become a maximum when the absolute value is taken). The local minimum is clearly at $t = 0$, because this is the vertex. Testing we get $|x'(-1)| = 16, |x'(0)| = 28$, and $|x'(2)| = 20$, so the maximum speed is 28.

B: It's tempting to simply take the difference between the two positions, but we must remember that particle Y might switch directions. To find where it switches directions, we check where the velocity changes signs. $y'(t) = 4t^3 - 28t = 4t(t^2 - 7)$, so velocity changes signs at $t = 0$ and $t = \pm\sqrt{7}$. The only one of those roots within the interval is $t = \sqrt{7}$, so we take $|y(\sqrt{7}) - y(1)| + |y(3) - y(\sqrt{7})| = |-24 - (12)| + |(-20) - (-24)| = 36 + 4 = 40$.

C: Let $L = \sqrt{x^2 + y^2}$ be the distance between the two points. Then to minimize L we want to find the points where its derivative switches from positive to negative on the interval. $L'(t) = \frac{x(t)x'(t) + y(t)y'(t)}{L}$, and since L is always positive only the numerator matters. Plugging in $x(t)$ and $y(t)$ the numerator becomes $(4t^3 - 28t)(12t^2 - 28) + (t^4 - 14t^2 + 25)(4t^3 - 28t) = (4t^3 - 28t)(t^4 - 2t^2 - 3) = 4t(t^2 - 7)(t^2 - 3)(t^2 + 1)$. Thus the roots are $t = 0, \pm\sqrt{3}, \pm\sqrt{7}$. Tracking the sign of the derivative, we see it is positive between $-\sqrt{7}$ and $-\sqrt{3}$, negative between $-\sqrt{3}$ and 0, positive between 0 and $\sqrt{3}$, and negative between $\sqrt{3}$ and $\sqrt{7}$. This implies that the only possible candidates for maxima are $t = \pm\sqrt{3}$. Trying both we get $y(t) = -8$ and $x(t) = \pm 16\sqrt{3}$. Thus, both give the same maximum L of $8\sqrt{13}$.

FINAL: $\boxed{900}$

5. A: Horizontal asymptote occurs when $f'(x) = 0$ and thus $f(x)$ is constant as x goes to infinity or negative infinity. Since the right-hand side simplifies to $(f(x)+4)(2-3x)$, the value of $y = f(x)$ for which $f'(x) = 0$ is just $y = -4$. (This same answer can be found by using separation of variables and then finding the limit as x goes to infinity).

   B: Since $g(x)$ is a quartic, anything past $g^{(4)}(x)$ will be 0, so we just add derivatives from 0 to 4. Let $g(x) = x^4 + ax^3 + bx^2 + cx + d$ (we know that the leading coefficient is 1 because it must be the same as in the summation). Then $g'(x) = 4x^3 + 3ax^2 + 2bx + c$, $g''(x) = 12x^2 + 6ax + 2b$, $g'''(x) = 24x + 6a$, and $g''''(x) = 24$. The coefficient of x^3 in the summation should thus be $a + 4 = 0$, so $a = -4$. The coefficient of x^2 should be $b + 3a + 12 = 0$, so $b = 0$. The coefficient of x should be $c + 2b + 6a + 24 = 16$, so $c = 16$. The constant term should be $d + c + 2b + 6a + 24 = 0$, so $d = -16$. Altogether this gives $g(x) = x^4 - 4x^3 + 16x - 16$. Testing roots and using synthetic division, this simplifies to $(x-2)^3(x+2)$, so the only distinct roots are 2 and -2, and their product is -4.

   C: $V = \frac{4}{3}\pi r^3$ and $A = 4\pi r^2$, so we have $\frac{dV}{dt} = -kA \to 4\pi r^2 \frac{dr}{dt} = -k(4\pi r^2)$ and thus $r'(t) = -k$ for some positive constant k. Integrating, or just recognizing this is linear, gives $r(t) = r_0 - kt$ for some original radius r_0. Then $V(t) = \frac{4}{3}\pi(r_0 - kt)^3$. To have $V(3)/V(0) = 1/8$, we must have $(r_0 - 3k)^3/(r_0)^3 = 1/8$. This simplifies to $1 - 3k/r_0 = 1/2$, so $k = r_0/6$. Then for the volume to be 0 we must have $r_0 - kt = 0 \to t = 6$. Discounting the time that has already been taken, it takes 3 additional minutes for the rest of the snowball to melt.

   FINAL: $\boxed{192}$

6. C: Sketching a coordinate plane with $x = d$ and $y = f$, we see that the sample space is a rectangle of width 9 ($1 < x < 10$) and height 8 ($0 < y < 8$). Rearranging the inequality we see that it is just a parabola: $y > -x^2 + 14x - 40 = -(x-7)^2 + 9$. The parabola is downward-sloping and crosses the sample space at $(4,0)$, $(6,8)$, $(8,8)$, and $(10,0)$. To find the probability that y is below the parabola, we must find the area bounded under the parabola and within the rectangle. This can be found as $\int_4^6 -x^2 + 14x - 40dx + \int_6^8 8dx + \int_8^{10} -x^2 + 14x - 40dx = 28/3 + 16 + 28/3 = \dfrac{104}{3}$. Then we divide this by the total area of the rectangle, $(9)(9) = 72$, to get $13/27$. But this is the probability that y is below the parabola, when we are actually looking for the probability that it is above, so we take the complement

to get 14/27.

D: Use the same trick of converting to coordinates, with Alex's number being x, Vishnav's being y, and Akash's being z. The sample space is a unit cube with one vertex at the origin (sides of $0 < x < 1$, $0 < y < 1$, $0 < z < 1$). We are looking for the probability that the inequality $x^2 + 4y^2 + 4z^2 < 4$. Dividing by 4 we get $\frac{x^2}{4} + \frac{y^2}{1} + \frac{z^2}{1} > 1$, the equation for an ellipsoid with x-axis of $2(2) = 4$, y-axis of $2(1) = 2$, and z-axis of $2(1) = 2$. Sketching it out, we see that this ellipsoid must be the figure formed when an ellipse with horizontal axis 4 and vertical axis 2 is revolved around the x-axis. Thus, to find the volume of the region enclosed in a cube with $0 < x < 1$, we integrate. The ellipse that is being revolved has equation $x^2/4 + y^2/1 = 1$, so $y = \sqrt{1 - x^2/4}$. Then by disc method, the volume is $\pi \int_0^1 1 - x^2/4dx = \frac{11}{12}\pi$. But this is the volume of the entire ellipsoid in $0 < x < 1$, and we are only looking for the portion with positive y and z, so we must divide by 4 to get $\frac{11}{48}\pi$. Then to get the probability we divide by the volume of the unit cube, which is just 1, and our answer is $\frac{11}{48}\pi$.

FINAL: $\boxed{42 + 22\pi}$

7. A: Let Josh's location along the x-axis be $j(t)$, Nihar's location along the y-axis be $n(t)$, and Rayyan's location along the z-axis be $r(t)$. Same naming conventions as previous, with $j(t) = 10t$, $n(t) = 20t$, and $r(t) = 30t$ along the z-axis. Then we have the three points $(10t, 0, 0)$, $(0, 20t, 0)$, and $(0, 0, 30t)$. We can find the area of the triangle with these vertices by considering vectors. The vector from Josh to Nihar is $< -10t, 20t, 0 >$ and the vector from Josh to Rayyan is $< -10t, 0, 30t >$. It is well-known that the area of a triangle with two vector sides is equal to half the magnitude of the vector cross-product. We can easily evaluate this cross-product as $< 600t^2, 300t^2, 200t^2 >$. Then the magnitude is $\sqrt{360000t^4 + 90000t^4 + 40000t^4} = t^2\sqrt{490000} = 700t^2$ and the area is $A(t) = 350t^2$. Thus $A'(t) = 700t$ so $A'(3) = 2100$.

B: $h = d = 2r$ so $V(t) = \frac{1}{3}\pi r(t)^2 h(t) = \frac{2}{3}\pi r(t)^3$. Then $V'(t) = 2\pi r(t)^2 r'(t) = 30$ and thus $r'(t) = 15/(\pi r(t)^2)$. If $h(t) = 10$ then $r(t) = 5$, so $r'(t) = 3/(5\pi)$ and thus $h'(t) = \dfrac{6}{5\pi}$.

C: Let the distance from the shadow's tip to Tanvi be a and the distance from Tanvi to the streetlight be b. By similar triangles, $6/a = 15/(a + b)$, so we can simplify to get $a = 2b/3$. Assume the streetlight is at $x = 0$. So if Tanvi's position is $x = b(t)$, then the tip of her shadow is at $x = b(t) + a(t) = \frac{5}{3}b(t)$. Thus the speed of the shadow's tip is $\frac{5}{3}b'(t) = 25/3$.

FINAL: $\boxed{210\pi}$

8. A: Using integration by parts $\int \ln(x)dx = x\ln(x) - \int \frac{1}{x}(x)dx = x\ln(x) - x$. The upper bound evaluates to -1. The lower bound evaluates to $\lim_{x\to 0} x\ln(x) = \lim_{x\to 0} \frac{\ln(x)}{1/x}$. In this limit both the numerator and denominator go to infinity, so we can use L'hopital's. The derivative of the numerator is $1/x$ and the derivative of the denominator if $-1/x^2$, so the overall limit becomes $\lim_{x\to 0} -x = 0$. Thus the definite integral is $-1 - 0 = -1$.

   B: $\int x^{-1/2}dx = 2\sqrt{x}$. The upper bound evaluates to $2\sqrt{3}$ and the lower bound to $\lim_{x\to 0} 2\sqrt{x} = 0$. So the definite integral is $2\sqrt{3} - 0 = 2\sqrt{3}$

   C: This is just the limit Riemann Sum equivalent of $\int_0^{e-1} \ln(x+1)dx$. Using the same IBP as in part A, we get $(x+1)\ln(x+1) - (x+1)$. Upper bound evaluates to $e - e = 0$. Lower bound evaluates to $0 - 1 = -1$. Definite integral is then $0 - (-1) = 1$.

   D: First we factor an n^2 out of the denominator to get $\frac{1}{n}\sum_{i=1}^{3n} \sqrt{1 + 2\sqrt{i/n} + (i/n)}$, which is clearly the limit Riemann Sum equivalent of $\int_0^3 \sqrt{x + 2\sqrt{x} + 1}dx$. Looking carefully, the expression in the radical is actually equivalent to $(\sqrt{x}+1)^2$, so we get $\int \sqrt{x} + 1dx = \frac{2}{3}x^{3/2} + x$. Upper bound evaluates to $2\sqrt{3} + 3$ and lower evaluates to 0, so this part is just $2\sqrt{3} + 3$.

   FINAL: $\boxed{3}$

9. A: This forms a circle, but the circumference can be found more easily with the polar arc length formula. $L = \int \sqrt{r^2 + (\frac{dr}{d\theta})^2}d\theta = \int_0^{\pi} \sqrt{(6\cos\theta - 3\sin\theta)^2 + (-6\sin\theta - 3\cos\theta)^2}d\theta = \int_0^{\pi} \sqrt{36+9}d\theta = 3\pi\sqrt{5}$.

   B: This forms a frustum, but the surface area can be found more easily by using the revolution surface area formula: $A = 2\pi\int y\sqrt{1 + (\frac{dy}{dx})^2}dx = 2\pi\int_1^4 (2x+6)\sqrt{1+2^2}dx = 2\pi\sqrt{5}\int_1^4 2x + 6dx = 2\pi\sqrt{5}(4^2 + 6(4) - 1^2 - 6(1)) = 66\pi\sqrt{5}$.

   C: This is just a figure with a semicircle base and cross-sections perpendicular to the diameter that are 30-60-90 triangles. Let the semicircle be centered at the origin. For any x, $y = \sqrt{r^2 - x^2} = \sqrt{12 - x^2}$. Then the other leg of the 30-60-90 triangle has length $y/\sqrt{3}$, so the area is $\frac{y^2}{2\sqrt{3}} = \frac{12-x^2}{2\sqrt{3}}$. To find the volume we integrate along all x values and add up all the areas of these triangles: $\frac{1}{2\sqrt{3}}\int_{-2\sqrt{3}}^{2\sqrt{3}} 12 - x^2dx = \frac{1}{2\sqrt{3}}(12x - \frac{1}{3}x^3) \to 16$.

   D: Consider two circles of radius 2, one centered at $(-1,0)$ and the other at $(1,0)$. Since the spherical situation is axially symmetric, we can obtain the volume of intersection by simply revolving the area of intersection about the x-axis. Thus we integrate from 0 to 1 using disk method, and double our answer due to symmetry. At each x value from 0 to 1, the distance from the center at $(-1,0)$ is $x+1$, so the corresponding y value is $y=\sqrt{r^2-(x+1)^2}=\sqrt{4-(x+1)^2}$. Then we have $2\pi\int_0^1 y^2dx = 2\pi\int_0^1(4-(x+1)^2)dx = 2\pi(4x-\frac{1}{3}(x+1)^3) = \dfrac{10\pi}{3}$

FINAL: $\boxed{20\pi}$

10. A: In the limit, this series can be compared to $\sum_{n=1}^{\infty}\frac{1}{\sqrt{n}}$. The latter series diverges because it is a power series with $p<1$, so therefore the former must diverge.

B: We use the ratio test: $a_{n+1}=\dfrac{(2n+2)!}{((n+1)!)^2 6^{n+1}}$, so the ratio $\lim_{n\to\infty}\frac{a_{n+1}}{a_n}=\lim_{n\to\infty}\dfrac{(2n+2)(2n+1)}{6(n+1)^2}=4/6<1$. Thus, the series converges.

C: We use the ratio test: $\lim_{n\to\infty}|\frac{a_{n+1}}{a_n}|=x^3$, so the series will only converge if $|x|<1$. Therefore the radius of convergence is 1.

$A+B+C=2+3+1=6$. $\zeta(6)=\frac{1}{1^6}+\frac{1}{2^6}+\frac{1}{3^6}+\ldots$ while $\eta(6)=\frac{1}{1^6}-\frac{1}{2^6}+\frac{1}{3^6}+\ldots$. If we can subtract just the even terms from $\zeta(s)$ we can get $\eta(s)$. Fortunately, we can isolate the even terms by multiplying $\zeta_2(6)=\frac{1}{2^6}\zeta(6)=\frac{1}{2^6}+\frac{1}{4^6}+\ldots$. Then $\zeta(6)-2\zeta_2(6)=\frac{31}{32}\zeta(6)=\eta(6)$, so the ratio is $\boxed{\dfrac{31}{32}}$.

11. We have six conditions on $x(t)$ and $y(t)$: $x(0)=4$, $y(0)=0$, $x'(0)=0$, $y'(0)=v_0$, $x''(t)=-4x$, and $y''(t)=-4y$. This type of differential equation is quite common and it is well-known that it results in a sinusoidal oscillation about an equilibrium, of the sort $x(t)=\sin(t)$. But to make sure the other initial conditions are satisfied, we must modify the function with phase shift, amplitude, and period to get $x(t)=4\cos(2t)$. Similarly, we find that $y(t)=0.5v_0\sin(2t)$. Differentiating these two functions shows that they indeed satisfy all the necessary conditions.

A: We find the shape of the path using the normal trick for solving parametric trig equations. $x/4=\cos(2t)$ and $y/(0.5v_0)=\sin(2t)$, so $\frac{x^2}{16}+\frac{y^2}{0.25v_0^2}=1$. This is only a circle when $0.25v_0^2=16$, so $|v_0|=8$.

B: The two differential equations are completely separate, so since we are only looking at the x-coordinate we only have to consider $x(t)=4\cos(2t)$. $x(t)=0$ when $t=\frac{\pi}{4}+n\pi$ for integer n. Since $\pi\approx 3.14$, $31.4\approx 10\pi$ and thus $28.26\approx 9\pi$. There should be 2 roots within every interval of π, for a total of 18 up to 9π. There should be one additional root for $9\pi+\pi/4\approx 28.26+0.78<30$. But $9\pi+3\pi/4$ would not be less than 30 so it is not a root. Thus there are 19 crossings.

C: Using the equations of motion, found earlier, $x(\pi/6)=2$, $x'(\pi/6)=-4\sqrt{3}$, $y(\pi/6)=3\sqrt{3}$, $y'(\pi/6)=6$. Since velocities are constant after this point, the time it takes to reach the y-axis is $t = \frac{\Delta x}{v} = \frac{2}{4\sqrt{3}} = \frac{\sqrt{3}}{6}$. Then the change in y-value is $\Delta y = v_y t = \sqrt{3}$. The y-coordinate at crossing is $y(\pi/6) + \Delta y = 4\sqrt{3}$.

FINAL: $\boxed{108\sqrt{3}}$

12. Given the x-coordinate of P_i, we want a formula for the x-coordinate of P_{i-1}. Let the x-coordinate of point P_i be a_i, and assume it is positive (since the function is odd, answer should be the same if it is negative). The derivative at $x = a_i$ is $3a_i^2$, so the tangent line equation is $y - a_i^3 = 3a_i^2(x - a_i)$. Then to find the other intersection point, we plug in $y = x^3$: $x^3 - a_i^3 = 3a_i^2(x - a_i)$, so assuming $x - a_i \neq 0$ then we can divide on both sides to get $x^2 + a_i x + a_i^2 = 3a_i^2 \to x^2 + a_i x - 2a_i^2 = (x + 2a_i)(x - a_i) = 0$. Thus P_{i-1} has x-coordinate $-2a_i$, and by the same logic, P_{i+1} has x-coordinate $-\frac{1}{2}a_i$. From this we can find a simple explicit formula: $a_i = (-\frac{1}{2})^i a_0$.

    For all $i > 0$, A_i is the area bound by the line connecting (a_i, a_i^3) and $(-2a_i, -8a_i^3)$, and the curve $y = x^3$. We also know by sketching concavity that the tangent line will always fall below the curve if $a_i > 0$. Thus $A_i = \int_{-2a_i}^{a_i} x^3 - (a_i^3 + 3a_i^2(x - a_i))dx = \int_{-2a_i}^{a_i} x^3 - 3a_i^2 x + 2a_i^3 dx = \frac{1}{4}(a_i^4 - 16a_i^4) - \frac{3}{2}a_i^2(a_i^2 - 4a_i^2) + 2a_i^3(a_i - (-2a_i)) = -\frac{15}{4}a_i^4 + \frac{9}{2}a_i^4 + 6a_i^4 = \frac{27}{4}a_i^4$. Since $A_i = \frac{27}{4}a_i^4$ and $a_i = (-\frac{1}{2})^i a_0$, $A_i = (\frac{1}{16})^i(\frac{27}{4})a_0^4$. Thus the sum of the A_i is a geometric series with initial term $\frac{27}{64}a_0^4$ and common ratio $\frac{1}{16}$, for a total sum of $\frac{9}{20}a_0^4$. Plugging in $a_0 = 2\sqrt{5}$, the answer is $\boxed{180}$.

13. B: $x^3 + 6x^2 + 12x + 18 = (x+2)^3 + 10$, so $\int x^3 + 6x^2 + 12x + 18 dx = \frac{1}{4}(x+2)^4 + 10x$. The upper bound evaluates to $\frac{100^4}{4} + 980 = 25000980$, and the lower bound evaluates to 4, so in total it is 25000976. The sum of the digits is 29.

    C: Factoring out the 30, integrand simplifies to $(1 - \cos^2(x))^2(\sin x)$, so we can use the u-sub $u = \cos(x)$ to get $\int_0^1 (1 - u^2)^2 du = \int_0^1 u^4 - 2u^2 + 1 du = \frac{1}{5} - \frac{2}{3} + 1 = \frac{8}{15}$. Then we factor back in the 30 to get 16.

    $A - D = -\int_0^\pi e^x \cos x - e^x \sin x dx$. But the integrand is just the derivative of $e^x \cos x$, so it all evaluates to $1 + e^\pi$.

    FINAL: $\boxed{46 + e^\pi}$

14. A: Taking the derivative we get $\dfrac{5(\log_2 x)^4}{x \ln 2} - \sin\left(\dfrac{\pi}{x-4}\right)\dfrac{-1}{(x-4)^2}$. Then plug in $x = 5$ to get $\dfrac{(\log_2 5)^4}{\ln 2}$

    B: By fundamental theorem of calculus, $g'(x) = 3x^2(\cos(x) + \sin(x))$ so $g'(\pi) = -3\pi^2$

    C: $g''(x) = 6x(\cos x + \sin x) + 3x^2(\cos x - \sin x)$, so $g''(\pi) = -6\pi - 3\pi^2$

D: Let numerator be $n(x)$ and denominator be $d(x)$. When $2 < x < 4$, $x^2 - 6x + 8 < 0$, so $n(x)$ is equivalent to $-x^2 + 6x - 8$. $n(3) = 1$, $n'(3) = 0$, $d(3) = 10$, $d'(3) = 1$. By quotient rule, $h'(3) = -1/100$.

FINAL: $\boxed{106 + \ln(5)}$