1) **B** – $\log_3 3x = 3 \rightarrow 3^3 = 27 \rightarrow 3x = 27 \rightarrow x = 9$.

2) **C** – $\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$ is one of the definitions of e.

3) **A** – $e^{i\theta} = \cos\theta + i\sin\theta$

4) **A** – The PageRank Score works on a logarithmic (base 10) scale. Therefore, a difference of k in the PageRank between two pages means the page with the higher score receives 10 times more visits than the other page. Thus, in this case, the difference of $3k$ in PageRank means legendsonly.com receives $10^3 = 1000$ times more visits than penguinsonly.com. So, the answer is $16500 \times 1000 = 16{,}500{,}000$.

5) **B** – $\sqrt{1406-\sqrt{1406-\sqrt{1406}}}\ldots = x \rightarrow \sqrt{1406-x} = x \rightarrow 1406 - x = x^2 \rightarrow x^2 + x - 1406 \rightarrow (x+38)(x-37)$ →The answer must be positive, so $x = 37$.

6) **D** – Convert all the logs to base 10, giving: $\frac{\log 2+\log 4+\log 6+\log 8+\log 12+\log 2}{\log 48} = \frac{\log 110{,}592}{\log 48} = 3$.

7) **D** – $\frac{x^2\left(y^{\frac{1}{2}}\right)^3 z^5}{x^{-5}y^{\frac{-1}{2}}\left(z^{10}\right)^{\frac{1}{2}}} = x^7y^2$

8) **C** – $\begin{vmatrix} 2 & 3 & 2 \\ 2 & 3 & 1 \\ 4 & 9 & 1 \end{vmatrix} = 6 \rightarrow \log_{\sqrt{6}} 6 = x \rightarrow x = 2$

9) **B** – The x-coordinate of the maximum is found with the formula $\frac{-b}{2a}$ given quadratic equation $ax^2 + bx + c$. So, $\frac{-b}{2a} = \frac{-9}{-4}$. Plug it into $v(t)$ to get $\frac{49}{8}$.

10) **B** – $v(t)$ factors as $-(2t-1)(t-4)$, so its roots are $\frac{1}{2}$ and 4. She reaches maximum velocity at $t = \frac{9}{4}$, so she has been running for $\frac{7}{4}$, or 1.75, seconds.

11) **E** – Make the substitution $\log x = y$. Equation now is $-17y + y^2 + 74 = 2 \rightarrow y^2 - 17y + 72 \rightarrow (y-8)(y-9) \rightarrow y = 8, 9 \rightarrow \log x = 10^8, \log x = 10^9 \rightarrow 10^9 + 10^8 = 1100000000$.

12) **B** – By inspection, the solutions to the equation should be in the form 4001^a, where a is any value. Plugging in 4001^a for x, you get $\sqrt[3]{4001} \cdot 4001^{a^2} = 4001^{8a} \rightarrow 4001^{a^2+\frac{1}{3}} = 4001^{8a} \rightarrow a^2 + \frac{1}{3} = 8a \rightarrow a^2 - 8a + \frac{1}{3} = 0$. The variable a can take on multiple values, and the product of the solutions to this equation will be the sum of the values a as a power of 4001, so the answer is 4001^8.

13) **B** – $\log_2(\log_3(\log_7(\log_{15} C))) = 13 \rightarrow \log_3(\log_7(\log_{15} C)) = 2^{13} \rightarrow \log_7(\log_{15} C))) = 3^{2^{13}} \rightarrow \log_{15} C = 7^{3^{2^{13}}} \rightarrow C = 15^{7^{3^{2^{13}}}}$. Since the prime factorization of $15 = 3 * 5$, the answer is 2.

14) **A** – $\sin(2x) = 2\sin(x)\cos(x) \rightarrow \sin(x) = \frac{e^{ix} - e^{-ix}}{2i}, \cos(x) = \frac{e^{ix} + e^{-ix}}{2}$ in Euler's form. Therefore, $\sin(2x) = 2 * \frac{e^{ix} - e^{-ix}}{2i} * \frac{e^{ix} + e^{-ix}}{2} = \frac{e^{2ix} - e^{-2ix}}{2i}$.

15) **A** - The only real solutions are 2 and 4 (this can be seen graphically), so the sum of the solutions is 6.

16) **B** - $\frac{\log 625}{\log 11} \cdot \frac{\log 243}{\log 7} \cdot \frac{\log 14641}{\log 5} \cdot \frac{\log 16807}{\log 3} = \frac{\log 625}{\log 5} \cdot \frac{\log 243}{\log 3} \cdot \frac{\log 14641}{\log 11} \cdot \frac{\log 16807}{\log 7} = 4 \cdot 5 \cdot 4 \cdot 5 = 400$.

17) **C** - $\lim_{x \to 3} \frac{\sqrt{x} - \sqrt{3}}{x-3} = \lim_{x \to 3} \frac{(\sqrt{x} - \sqrt{3})(\sqrt{x} + \sqrt{3})}{(x-3)(\sqrt{x} + \sqrt{3})} = \lim_{x \to 3} \frac{1}{(\sqrt{x} + \sqrt{3})} = \frac{1}{2\sqrt{3}} = \frac{\sqrt{3}}{6}$

18) **E** - $f(x) = \sqrt{\frac{\cos^2(x) - \sin^2(x)}{1 - \tan^2(x)}} = \sqrt{\frac{\cos(2x)}{1 - \tan^2(x)}}$. Plugging in $\frac{3\pi}{8}$ for x, we get $\frac{\sqrt{2 - \sqrt{2}}}{2}$.

19) **D**–For $f(x)$ to be defined, we should have $-1 \leq \log_2(\frac{x^2}{2}) \leq 1 \rightarrow \frac{1}{2} \leq \frac{x^2}{2} \leq 2 \rightarrow$

$1 \leq x^2 \leq 4 \rightarrow [-2,1] \cup [1,2]$

20) **A**–The range of the function is just the range of $\sin^{-1} x$, which is $[\frac{-\pi}{2}, \frac{\pi}{2}]$.

21) **C** – Let $\log_2 a = \log_3 b = \log_6 c = \log_7(a+b+c) = x \rightarrow 2^x = a, 3^x = b, 6^x =$ $c, 7^x = a+b+c \rightarrow 2^x + 3^x + 6^x = 7^x \rightarrow (\frac{2}{7})^x + (\frac{3}{7})^x + (\frac{6}{7})^x = 1 \rightarrow x = 2 \rightarrow$ $\log_{4\cdot 9\cdot 36} 6 = \frac{1}{4}$

22) **C**–The domain of $\frac{1}{\log(1-x)}$ is (-∞, 0) or (0,1) and the domain of $\sqrt{x+2}$ is [-2, ∞). The intersection of these is $[-2,0) \cup (0,1)$.

23) **B** - $\log_3(x-5) - \log_{27}(79x-185) \rightarrow \frac{\log(x-3)}{\log 3} - \frac{\log(79x-1\quad)}{3\log} \rightarrow$ $\frac{3\log(x-3)-\log(79x-185)}{3\log 3} \rightarrow 3\log(x-3) - \log(79x-185) = 0 \rightarrow \frac{(x-3)^3}{79x-185} = 1 \rightarrow x^3 -$ $15x^2 - 4x + 60 = 0 \rightarrow (x-2)(x+2)(x-15) \rightarrow x = 15$. *X* cannot equal 2 or -2 because then the log(x-3) will be undefined.

24) **B** – The hypotenuse of the triangle is e^x, and the side opposite the angle is2 ln x. Thus, the side adjacent to the angle is$\sqrt{e^{2x} - 4(\ln x)^2}$. The tangent of an angle is opposite over adjacent, so you get $\frac{2\ln x}{\sqrt{e^{2x}-4(\ln x)^2}}$.

25) **A** - $y = 2^{x(x-1)} \rightarrow x^2 - x - \log_2 y = 0$. Using the quadratic formula, you get $\frac{1\pm\sqrt{1+4\log_2 y}}{2}$. $f(x) \geq 1$, so $x = \frac{1}{2}\left(1 + \sqrt{1+4\log_2 y}\right) \rightarrow f^{-1}(x) = \frac{1}{2}\left(1 + \sqrt{1+4\log_2 y}\right)$.

26) **D** - $f(x) = \log(x + \sqrt{x^2+1})$. $f(-x) = \log(-x + \sqrt{x^2+1}) = \log\frac{-x^2+x^2+1}{x+\sqrt{x^2+1}} =$ $-\log\left(x + \sqrt{x^2+1}\right) = -f(x) \rightarrow f(-x) = -f(x)$, so, the function is odd.

27) **E** – Plugging in $\frac{\pi}{2}$ for $f'(x)$ gives us -1. So, using point-slope form for the equation of the line, we get $y-1=-1\left(x-\frac{\pi}{2}\right) \rightarrow y=-x+1+\frac{\pi}{2} \rightarrow$ y-intercept is $1+\frac{\pi}{2}$.

28) **C** - $x\log_x 10 = x \cdot \frac{\log 10}{\log x} = \frac{x}{\log x}$. So going back to the original equation, and dividing both sides by $\log x$, we have $\frac{2x}{\log x} = 1 - \frac{\ln x}{\log x} = 1 - \frac{\log x}{\log e} \cdot \frac{1}{\log x} = 1 - \frac{\log 10}{\log e} = 1 - \ln 10$. Therefore, $\frac{x}{\log x} = \frac{1}{2}\left(1 + \ln\frac{1}{10}\right)$, and $\frac{a}{b} = 5$.

29) **C** – The measured amplitude of the earthquake is the amplitude of $150\sin x + 360\cos x$, which is $\sqrt{150^2+360^2} = 390$. So, $magnitude = \log\frac{A}{A_0} \rightarrow \log\frac{390}{1.95} = \log 200 = \log 2 + \log 100 = \log(2) + 2 = 2.301$

30) **D** – The domain of $1-x$ is all reals except 1; the domain of $\sqrt{4-x^2}$ is [-2,2]; the domain of $\ln x$ is (1, ∞); and the domain of the sine function is all reals. The intersection of all these is (-2,1).