Exponential Equations:

1. $5^x = 125 \Rightarrow 5^x = 5^3 \Rightarrow x = 3$

2. $6^{2x} = 36 \Rightarrow 6^{2x} = 6^2 \Rightarrow 2x = 2 \Rightarrow x = 1$

3. $3^x = 243 \Rightarrow 3^x = 3^5 \Rightarrow x = 5$

4. $2^{3x} = 64 \Rightarrow 2^{3x} = 2^6 \Rightarrow 3x = 6 \Rightarrow x = 2$

5. $2^x = \frac{1}{16} \Rightarrow 2^x = \frac{1}{2^4} \Rightarrow 2^x = 2^{-4} \Rightarrow x = -4$

6. $3^x = \frac{1}{27} \Rightarrow 3^x = \frac{1}{3^3} \Rightarrow 3^x = 3^{-3} \Rightarrow x = -3$

7. $5^x = \frac{1}{625} \Rightarrow 5^x = \frac{1}{5^4} \Rightarrow 5^x = 5^{-4} \Rightarrow x = -4$

8. $2^{-x} = 128 \Rightarrow 2^{-x} = 2^7 \Rightarrow -x = 7 \Rightarrow x = -7$

9. $3^{2x} = 81 \Rightarrow 3^{2x} = 3^4 \Rightarrow 2x = 4 \Rightarrow x = 2$

10. $6^{3x} = 36^{x+1} \Rightarrow 6^{3x} = \left(6^2\right)^{x+1} \Rightarrow 6^{3x} = 6^{2x+2} \Rightarrow 3x = 2x + 2 \Rightarrow x = 2$

11. $8^{4+3x} = \frac{1}{4} \Rightarrow \left(2^3\right)^{4+3x} = \frac{1}{2^2} \Rightarrow \left(2^3\right)^{4+3x} = 2^{-2} \Rightarrow 2^{12+9x} = 2^{-2} \Rightarrow 12 + 9x = -2 \Rightarrow x = -\frac{14}{9}$

12. $5^{-x^2} = \frac{1}{25} \Rightarrow 5^{-x^2} = \frac{1}{5^2} \Rightarrow 5^{-x^2} = 5^{-2} \Rightarrow -x^2 = -2 \Rightarrow x^2 = 2 \Rightarrow x = \pm\sqrt{2}$

13. $9^{2-d^2} = \frac{1}{3} \Rightarrow \left(3^2\right)^{2-d^2} = 3^{-1} \Rightarrow 3^{4-2d^2} = 3^{-1} \Rightarrow 4 - 2d^2 = -1 \Rightarrow d^2 = \frac{5}{2} \Rightarrow d = \pm\sqrt{\frac{5}{2}} = \pm\frac{\sqrt{10}}{2}$

14. $25^{-2x} = 5^{6x-3} \Rightarrow \left(5^2\right)^{-2x} = 5^{6x-3} \Rightarrow 5^{-4x} = 5^{6x-3} \Rightarrow -4x = 6x - 3 \Rightarrow -10x = -3 \Rightarrow x = \frac{3}{10}$

15. $2^{n+1} = 4^{1-2n} \Rightarrow 2^{n+1} = \left(2^2\right)^{1-2n} \Rightarrow 2^{n+1} = 2^{2-4n} \Rightarrow n + 1 = 2 - 4n \Rightarrow 5n = 1 \Rightarrow n = \frac{1}{5}$

16. $3^x = 9^{x+1} \Rightarrow 3^x = \left(3^2\right)^{x+1} \Rightarrow 3^x = 3^{2x+2} \Rightarrow x = 2x + 2 \Rightarrow -x = 2 \Rightarrow x = -2$

17. $64^{x-4} = \left(\frac{1}{2}\right)^{2x} = \left(2^6\right)^{x-4} = \left(2^{-1}\right)^{2x} \Rightarrow 2^{6x-24} = 2^{-2x} \Rightarrow 6x-24 = -2x \Rightarrow 8x = 24 \Rightarrow x = 3$

18. $\left(\frac{1}{2}\right)^{y+1} = 4^{3y-4} \Rightarrow \left(2^{-1}\right)^{y+1} = \left(2^2\right)^{3y-4} \Rightarrow 2^{-y-1} = 2^{6y-8} \Rightarrow -y-1 = 6y-8 \Rightarrow -7y = -7 \Rightarrow y = 1$

19. $3^x\left(3^{x+1}\right) = 9 \Rightarrow 3^x\left(3^{x+1}\right) = 3^2 \Rightarrow 3^{2x+1} = 3^2 \Rightarrow 2x+1 = 2 \Rightarrow 2x = 1 \Rightarrow x = \frac{1}{2}$

20. $27^{-x} = 81^{3x+1} \Rightarrow \left(3^3\right)^{-x} = \left(3^4\right)^{3x+1} \Rightarrow 3^{-3x} = 3^{12x+4} \Rightarrow -3x = 12x+4 \Rightarrow -15x = 4 \Rightarrow x = -\frac{4}{15}$

21. $8\left(2^{x-1}\right) = 64 \Rightarrow 2^3\left(2^{x-1}\right) = 2^6 \Rightarrow 2^{x+2} = 2^6 \Rightarrow x+2 = 6 \Rightarrow x = 4$

22. $125^{x+1} = 25^{3x-1} \Rightarrow \left(5^3\right)^{x+1} = \left(5^2\right)^{3x-1} \Rightarrow 5^{3x+3} = 5^{6x-2} \Rightarrow 3x+3 = 6x-2 \Rightarrow -3x = -5 \Rightarrow x = \frac{5}{3}$

23. $\frac{1}{9} = 27^{2x} \Rightarrow \frac{1}{3^2} = \left(3^3\right)^{2x} \Rightarrow 3^{-2} = 3^{6x} \Rightarrow -2 = 6x \Rightarrow x = -\frac{2}{6} = -\frac{1}{3}$

24. $\frac{1}{4} = 64^{2x-1} \Rightarrow \frac{1}{2^2} = \left(2^6\right)^{2x-1} \Rightarrow 2^{-2} = 2^{12x-6} \Rightarrow -2 = 12x-6 \Rightarrow 4 = 12x \Rightarrow x = \frac{4}{12} = \frac{1}{3}$

25. $\left(\frac{3}{4}\right)^{2x} = \frac{64}{27} \Rightarrow \left(\frac{3}{4}\right)^{2x} = \left(\frac{4^3}{3^3}\right) \Rightarrow \left(\frac{3}{4}\right)^{2x} = \left(\frac{3^{-3}}{4^{-3}}\right) \Rightarrow \left(\frac{3}{4}\right)^{2x} = \left(\frac{3}{4}\right)^{-3} \Rightarrow 2x = -3 \Rightarrow x = -\frac{3}{2}$

26. $\left(\frac{2}{5}\right)^{2x} = \frac{125}{8} \Rightarrow \left(\frac{2}{5}\right)^{2x} = \frac{5^3}{2^3} \Rightarrow \left(\frac{2}{5}\right)^{2x} = \left(\frac{2^{-3}}{5^{-3}}\right) \Rightarrow \left(\frac{2}{5}\right)^{2x} = \left(\frac{2}{5}\right)^{-3} \Rightarrow 2x = -3 \Rightarrow x = -\frac{3}{2}$

27. $\left(\frac{3}{7}\right)^{x} = \frac{49}{9} \Rightarrow \left(\frac{3}{7}\right)^{x} = \frac{7^2}{3^2} \Rightarrow \left(\frac{3}{7}\right)^{x} = \left(\frac{3^{-2}}{7^{-2}}\right) \Rightarrow \left(\frac{3}{7}\right)^{x} = \left(\frac{3}{7}\right)^{-2} \Rightarrow x = -2$

28. $\frac{2^{x-1}}{2^{3-4x}} = 16 \Rightarrow \frac{2^{x-1}}{2^{3-4x}} = 2^4 \Rightarrow 2^{(x-1)-(3-4x)} = 2^4 \Rightarrow 2^{x-1-3+4x} = 2^4 \Rightarrow 2^{5x-4} = 2^4 \Rightarrow 5x-4=4 \Rightarrow x = \frac{8}{5}$

29. $\frac{3^{1-x}}{3^x} = 9^{5x} \Rightarrow \frac{3^{1-x}}{3^x} = \left(3^3\right)^{5x} \Rightarrow 3^{(1-x)-x} = 3^{15x} \Rightarrow 3^{1-x-x} = 3^{15x} \Rightarrow 3^{1-2x} = 3^{15x} \Rightarrow 1-2x = 15x \Rightarrow x = \frac{1}{17}$

30. $\frac{4^{2x}}{2^{x-3}} = 1 \Rightarrow \frac{\left(2^2\right)^{2x}}{2^{x-3}} = 2^0 \Rightarrow \frac{2^{4x}}{2^{x-3}} = 2^0 \Rightarrow 2^{4x-(x-3)} = 2^0 \Rightarrow 2^{4x-x+3} = 2^0 \Rightarrow$
$2^{3x+3} = 2^0 \Rightarrow 3x+3=0 \Rightarrow x = -1$