Solving Exponential Equations Practice

1. Solve.

a) $2^x = 16$
b) $3^x = 27$
c) $2^x = 128$
d) $5^x = 125$
e) $4^y = 256$
f) $729 = 9^z$
g) $(-3)^x = -27$
h) $(-2)^x = -32$
i) $(-5)^a = 25$
j) $81 = (-3)^x$
k) $-2^x = -16$
l) $-4^y = -64$
m) $-5^x = -625$
n) $(-1)^x = 1$
o) $(-1)^m = -1$

2. Solve.

a) $7^{w-2} = 49$
b) $3^{x+4} = 27$
c) $2^{1-x} = 128$
d) $4^{3k} = 64$
e) $5^{3x-1} = 25$
f) $-81 = -3^{2x+8}$
g) $4^{x-1} = 1$
h) $3^{2-2x} = 1$
i) $(-1)^{2x} = 1$

3. Solve and check.

a) $6^{x+3} = 6^{2x}$
b) $2^{x+3} = 2^{2x-1}$
c) $3^{2y+3} = 3^{y+5}$
d) $2^{4x-7} = 2^{2x+1}$
e) $7^{5d-1} = 7^{2d+5}$
f) $3^{b-5} = 3^{2b-3}$

4. Solve.

a) $16^{2x} = 8^{3x}$
b) $4^t = 8^{t+1}$
c) $27^{x-1} = 9^{2x}$
d) $25^{2-c} = 125^{2c-4}$
e) $16^{2p+1} = 8^{3p+1}$
f) $(-8)^{1-2x} = (-32)^{1-x}$

5. Solve and check.

a) $2^{x+5} = 4^{x+2}$
b) $2^x = 4^{x-1}$
c) $9^{2q-6} = 3^{q+6}$
d) $4^x = 8^{x+1}$
e) $27^{y-1} = 9^{2y-4}$
f) $8^{x+3} = 16^{2x+1}$

6. Solve and check.

a) $5^{4-x} = \frac{1}{5}$
b) $10^{y-2} = \frac{1}{10\,000}$
c) $6^{3x-7} = \frac{1}{6}$
d) $3^{3x-1} = \frac{1}{81}$
e) $5^{2n+1} = \frac{1}{125}$
f) $\frac{1}{256} = 2^{2-5w}$

7. Solve and check.

a) $4^x = 8$
b) $64^z = 16$
c) $(-8)^y = -2$
d) $9^{-x} = 3$
e) $2^{9x} = \frac{1}{8}$
f) $9^{6x} = \frac{1}{27}$
g) $2^x = 16^4$
h) $2^{-2g} = 32$
i) $9^{2s+1} = 27$

8. Solve and check.

a) $9^{x+1} = 27^{2x}$
b) $16^y = 64^{2y-1}$
c) $36^{t-2} = 216^{-2t}$
d) $8^{2x-1} = 16^{x-1}$
e) $25^{1-3x} = 125^{-x}$
f) $16^{3+k} = 32^{1-2k}$

9. Solve and check.

a) $5 = 25^{\frac{x}{2}}$
b) $8 = 2^{\frac{x}{3}}$
c) $9^{\frac{y}{5}} = 27$
d) $\frac{1}{2} = 2^{\frac{a}{3}}$
e) $4^{\frac{x}{4}} = \frac{1}{8}$
f) $\left(\frac{3}{2}\right)^{\frac{m}{2}} = \frac{4}{9}$

10. Solve.

a) $3(5^{x+1}) = 15$
b) $2(3^{y-2}) = 18$
c) $5(4^x) = 10$
d) $2(4^{v+1}) = 1$
e) $2 = 6(3^{4f-2})$
f) $27(3^{3x+1}) = 3$

11. Solve and check.

a) $2^{x+2} - 2^x = 48$
b) $4^{x+3} + 4^x = 260$
c) $2^{a+5} + 2^a = 1056$
d) $6^{x+1} + 6^{x+2} = 7$
e) $3^{x+3} - 3^{x+1} = 648$
f) $10^{z+4} + 10^{z+3} = 11$
g) $2^{x+2} - 2^{x+5} = -7$
h) $3^{m+1} + 3^{m+2} - 972 = 0$
i) $5^{n+2} - 5^{n+3} = -2500$

19. Solve.

a) $\frac{27^x}{9^{2x-1}} = 3^{x+4}$ b) $27^x(9^{2x-1}) = 3^{x+4}$ c) $27^{x+1} = \left(\frac{1}{9}\right)^{2x-5}$

20. Solve.

a) $2^{x^2+2x} = 2^{x+6}$ b) $3^{x^2-2x} = 3^{x-2}$ c) $2^{2x^2-3x} = 2^{x^2-2x+12}$

22. Solve and check.

a) $\frac{2^{2x+1}}{2^{x-3}} = 4$ b) $\frac{9^{x+4}}{27^{x-1}} = 81$ c) $\frac{8^{x+2}}{4^{x+3}} = 16^{x-3}$

Section 1.3, pp. 23–25

1. a) 4 **b)** 3 **c)** 7 **d)** 3 **e)** 4 **f)** 3 **g)** 3 **h)** 5 **i)** 2 **j)** 4 **k)** 4 **l)** 3 **m)** 4 **n)** x any even integer **o)** m any odd integer **2. a)** 4 **b)** -1 **c)** -6 **d)** 1 **e)** 1 **f)** -2 **g)** 1 **h)** 1 **i)** all values of x **3. a)** 3 **b)** 4 **c)** 2 **d)** 4 **e)** 2 **f)** -2 **4. a)** 0 **b)** -3 **c)** -3 **d)** 2 **e)** 1 **f)** -2 **5. a)** 1 **b)** 2 **c)** 6 **d)** -3 **e)** 5 **f)** 1 **6. a)** 5 **b)** -2 **c)** 2 **d)** -1 **e)** -2 **f)** 2 **7. a)** $\frac{3}{2}$ **b)** $\frac{2}{3}$ **c)** $\frac{1}{3}$ **d)** $-\frac{1}{2}$ **e)** $-\frac{1}{3}$ **f)** $-\frac{1}{4}$ **g)** 16 **h)** $-\frac{5}{2}$ **i)** $\frac{1}{4}$ **8. a)** $\frac{1}{2}$ **b)** $\frac{3}{4}$ **c)** $\frac{1}{2}$ **d)** $-\frac{1}{2}$ **e)** $\frac{2}{3}$ **f)** $-\frac{1}{2}$ **9. a)** 1 **b)** 9 **c)** $\frac{15}{2}$ **d)** -3 **e)** -6 **f)** -4 **10. a)** 0 **b)** 4 **c)** $\frac{1}{2}$ **d)** $-\frac{3}{2}$ **e)** $\frac{1}{4}$ **f)** -1 **11. a)** 4 **b)** 1 **c)** 5 **d)** -1 **e)** 3 **f)** -3 **g)** -2 **h)** 4 **i)** 2 **12.** The equation is true for all values of **b)** 84 years **c)** 140 years **15. a)** $\frac{1}{8}$ **b)** 26 days **16. a)** 2 m **b)** 11% **17. a)** 5 h **b)** 20.4 years **c)** 30 s **18.** 59.6 h **19. a)** -1 **b)** 1 **c)** 1 **20. a)** 2, -3 **b)** 1, 2 **c)** 4, -3 **21.** 16 days **22. a)** -2 **b)** 7 **c)** 4 **23.** $x = -17$, $y = 2$

Aeman

FULL SOLUTIONS

Solving Exponential Equations Practice.

1. a.) (same bases method)

$2^x = 16$

$2^x = 2^4$

ignore bases

$\therefore x = 4$

OR

(Using logarithms)

$2^x = 16$

$\log_2(16) = x$

$\log_2(2^4) = x$

$\therefore 4 = x$

b.) $3^x = 27$

$3^x = 3^3$

$\therefore x = 3$

c.) $2^x = 128$

$2^x = 2^7$

$\therefore x = 7$

d.) $5^x = 125$

$5^x = 5^3$

$\therefore x = 3$

e.) $4^y = 256$

$4^y = 4^4$

$\therefore y = 4$

f) $729 = 9^z$

$9^3 = 9^z$

$\therefore 3 = z$

g) $(-3)^x = -27$

$(-3)^x = (-3)^3$

$\therefore x = 3$

h.) $(-2)^x = -32$

$(-2)^x = (-2)^5$

$\therefore x = 5$

i) $(-5)^a = 25$

$(-5)^a = (-5)^2$

$\therefore a = 2$

j.) $81 = (-3)^x$

$3^4 = (-3)^x$

$\therefore 4 = x$

k.) $-2^x = -16$

$-2^x = -2^4$

$\therefore x = 4$

l.) $-4^y = -64$

$-4^y = -4^3$

$\therefore y = 3$

m.) $-5^x = -625$

$-5^x = -5^4$

$\therefore x = 4$

n.) $(-1)^x = 1$

Trials $(-1)^x \neq (-1)^1$

$(-1)^x = (-1)^2$

$\therefore x =$ any even integer

o.) $(-1)^m = -1$

$(-1)^m = (-1)^1$

$(-1)^m \neq (-1)^2$

$\therefore m =$ any odd integer

2 a.) (same bases method)

$7^{w-2} = 49$

$7^{w-2} = 7^2$

ignore bases

$w - 2 = 2$ (+2 +2)

$\therefore w = 4$

OR

(rearrange for x to appear once)

$7^{w-2} = 49$

$7^w \cdot 7^{-2} = 7^2$

$\frac{7^w \cdot 7^{-2}}{7^{-2}} = 7^2 \cdot 7^2$

$7^w = 7^{2+2}$

$7^w = 7^4$

$\log_7(7^4) = w$

$\therefore 4 = w$

OR

Aeman

(take the logarithm of both sides)

$\log_7[7^{w-2} = 49]$

$\log_7(7^{w-2}) = \log_7(49)$

$w-2 = \log_7(7^2)$

$w-2 = 2$

$+2 \quad +2$

$\therefore w = 4$

3 a.) $6^{x+3} = 6^{2x}$

$x+3 = 2x$

$-x \quad -x$

$\therefore 3 = x$

Check

$6^{(3)+3} = 6^{(2)(3)}$

$6^6 = 6^6$

$\therefore LS = RS$ ✓

b.) $2^{x+3} = 2^{2x-1}$

$x+3 = 2x-1$

$-x \quad +1 \quad -x \quad +1$

$\therefore 4 = x$

Check

$2^{(4)+3} = 2^{2(4)-1}$

$2^7 = 2^7$

$LS = RS$ ✓

b.) $3^{x+4} = 27$

$3^{x+4} = 3^3$

$-4 \quad -4$

$x+4 = 3$

$\therefore x = -1$

c.) $2^{1-x} = 128$

$2^{1-x} = 2^7$

$+x-7 \quad +x-7$

$1-x = 7$

$\therefore -6 = x$

c.) $3^{2y+3} = 3^{y+5}$

$2y+3 = y+5$

$-y \quad -3 \quad -y \quad -3$

$\therefore y = 2$

Check

$3^{(2)(2)+3} = 3^{2+5}$

$3^7 = 3^7$

$\therefore LS = RS$ ✓

d.) $2^{4x-7} = 2^{2x+1}$

$-2x+7 \quad -2x+7$

$4x-7 = 2x+1$

$\frac{2x}{2} = \frac{8}{2}$

$\therefore x = 4$

Check

$2^{4(4)-7} = 2^{2(4)+1}$

$2^9 = 2^9$

$\therefore LS = RS$ ✓

d.) $4^{3k} = 64$

$4^{3k} = 4^3$

$\frac{3k}{3} = \frac{3}{3}$

$\therefore k = 1$

e.) $5^{3x-1} = 25$

$5^{3x-1} = 5^2$

$3x-1 = 2$

$+1 \quad +1$

$\frac{3k}{3} = \frac{3}{3}$

$\therefore k = 1$

e.) $7^{5d-1} = 7^{2d+5}$

$-2d+1 \quad -2d+1$

$5d-1 = 2d+5$

$\frac{3d}{3} = \frac{6}{3}$

$\therefore d = 2$

Check

$7^{5(2)-1} = 7^{2(5)+5}$

$7^9 = 7^9$

$\therefore LS = RS$ ✓

f.) $3^{6-5} = 3^{2b-3}$

$-6 \quad +2 \quad -6 \quad +3$

$b-5 = 2b-3$

$-2 = b$

Check

$3^{(-2)-5} = 3^{2(-2)-3}$

$3^{-7} = 3^{-7}$

$\therefore LS = RS$ ✓

f.) $-81 = -3^{2x+8}$

$-3^4 = -3^{2x+8}$

$-8 \quad -8$

$4 = 2x+8$

$-4 = 2x$

$\frac{-4}{2} = \frac{2x}{2}$

$\therefore -2 = x$

g.) $4^{x-1} = 1$

$4^{x-1} = 4^0$

$+1 \quad +1$

$x-1 = 0$

$x = 1$

i) $(-1)^{2x} = 1$

$\therefore x \in \mathbb{R}$ since any value multiplied by 2 and give an even integer exponent.

↳ Example(s):

$(-1)^{2(1)} = 1 \quad (-1)^{2(5)} = 1$

$(-1)^2 = 1 \quad (-1)^{10} = 1$

$1 = 1$ ✓ $\quad 1 = 1$ ✓

↳ And so forth

h.) $3^{2-2x} = 1$

$3^{2-2x} = 3^0$

$-2 \quad -2$

$2-2x = 0$

$\frac{-2x}{-2} = \frac{-2}{-2}$

$\therefore x = 1$

4 a.) $16^{2x} = 8^{3x}$

$2^{4(2x)} = 2^{3(3x)}$

$4(2x) = 3(3x)$

$-8x \quad 8x = 9x \quad -8x$

$\therefore 0 = x$

b.) $4^{t} = 8^{t+1}$

$2^{2(t)} = 2^{3(t+1)}$

$2t = 3(t+1)$

$-2t \quad -3 \quad -2t \quad -3$

$2t = 3t + 3$

$\therefore -3 = t$

c.) $27^{x-1} = 9^{2x}$

$3^{3(x-1)} = 3^{2(2x)}$

$3(x-1) = 2(2x)$

$3x - 3 = 4x$ $\quad -3x \quad -3x$

$\therefore -3 = x$

d.) $25^{2-6} = 125^{2t-4}$

$5^{2(2-6)} = 5^{3(2t-4)}$

$2(2-t) = 3(2t-4)$

$4 - 2t = 6t - 12$ $\quad +12 \quad +2t \quad +2t \quad +12$

$\frac{16}{2} = \frac{8t}{8}$

$\therefore 2 = t$

e.) $16^{2p+1} = 8^{3p+1}$

$2^{4(2p+1)} = 2^{3(3p+1)}$

$4(2p+1) = 3(3p+1)$

$8p + 4 = 9p + 3$ $\quad -8p \quad -3 \quad -8p \quad -3$

$\therefore 1 = p$

f.) $(-8)^{1-2x} = (-32)^{1-x}$

$(-2^3)^{(-2x)} = (-2^5)^{1-x}$

$3(1-2x) = 5(1-x)$

$3 - 6x = 5 - 5x$ $\quad -5 \quad +6x \quad -5 \quad +6x$

$\therefore -2 = x$

5. a.) $2^{x+5} = 4^{x+2}$

$2^{x+5} = 2^{2(x+2)}$

$x + 5 = 2(x+2)$

$x + 5 = 2x + 4$ $\quad -x \quad -4 \quad -x \quad -4$

$\therefore 1 = x$

check

$2^{(1)+5} = 4^{1+2}$

$2^6 = 4^3$

$2^6 = (2^2)^3$

$2^6 = 2^6$

$\therefore LS = RS$ ✓

b.) $2^x = 4^{x-1}$

$2^x = 2^{2(x-1)}$

$x = 2(x-1)$

$x = 2x - 2$ $\quad +2 \quad -x \quad -x \quad +2$

$\therefore 2 = x$

check

$2^{(2)} = 4^{(2)-1}$

$2^2 = 4^1$

$4 = 4$

$\therefore LS = RS$ ✓

e.) $27^{y-1} = 9^{2y-4}$

$3^{3(y-1)} = 3^{2(2y-4)}$

$3(y-1) = 2(2y-4)$

$3y - 3 = 4y - 8$ $\quad -3y \quad +8 \quad -3y \quad +8$

$\therefore 5 = y$

check

$27^{(5)-1} = 9^{2(5)-4}$

$27^4 = 9^6$

$3^{3(4)} = 3^{2(6)}$

$3^{12} = 3^{12}$

$\therefore LS = RS$ ✓

c.) $9^{2q-6} = 3^{q+6}$

$3^{2(2q-6)} = 3^{q+6}$

$2(2q-6) = q+6$

$4q - 12 = q + 6$ $\quad -q \quad +12 \quad -q \quad +12$

$\frac{3q}{3} = \frac{18}{3}$

$\therefore q = 6$

check

$9^{2(6)-6} = 3^{(6+6)}$

$9^6 = 3^{12}$

$3^{2 \cdot 6} = 3^{12}$

$\therefore 3^{12} = 3^{12}$

$\therefore LS = RS$ ✓

d.) $4^x = 8^{x+1}$

$2^{2(x)} = 2^{3(x+1)}$

$2(x) = 3(x+1)$

$2x = 3x + 3$ $\quad -2x \quad -2x \quad -3$

$-3 = x$

check

$4^{(-3)} = 8^{(-3)+1}$

$4^{-3} = 8^{-2}$

$2^{2(-3)} = 2^{(3)(-2)}$

$2^{-6} = 2^{-6}$

$\therefore LS = RS$ ✓

f.) $8^{x+3} = 16^{2x+1}$

$2^{3(x+3)} = 2^{4(2x+1)}$

$3(x+3) = 4(2x+1)$

$3x + 9 = 8x + 4$ $\quad -3x \quad -4 \quad -3x \quad -4$

$\frac{5}{5} = \frac{5x}{5}$

$\therefore 1 = x$

check

$8^{(1)+3} = 16^{2(1)+1}$

$8^4 = 16^3$

$2^{3(4)} = 2^{4(3)}$

$2^{12} = 2^{12}$

$\therefore LS = RS$ ✓

Anthony

6 a.) $5^{4-x} = \frac{1}{5}$

$5^{4-x} = 5^{-1}$

$4 - x = -1$

$^{+1}\quad\ ^{+x}\quad\ \ ^{+x+1}$

$\therefore 5 = x$

Check

$5^{4-5} = \frac{1}{5}$

$5^{-1} = 5^{-1}$

$\therefore LS = RS$ ✓

b.) $10^{y-2} = \frac{1}{10\,000}$

$10^{y-2} = \frac{1}{10^4}$

$10^{y-2} = 10^{-4}$

$y - 2 = -4$

$^{+2}\quad\ ^{+2}$

$y = -2$

Check

$10^{(-2)-2} = \frac{1}{10\,000}$

$10^{-4} = \frac{1}{10\,000}$

$\frac{1}{10000} = \frac{1}{10000}$

$\therefore LS = RS$ ✓

c.) $6^{3x-7} = \frac{1}{6}$

$6^{3x-7} = 6^{-1}$

$3x - 7 = -1$

$^{+7}\quad\ ^{+7}$

$\frac{3x}{3} = \frac{6}{3}$

$x = 2$

Check

$6^{3(2)-7} = \frac{1}{6}$

$6^{-1} = \frac{1}{6}$

$\frac{1}{6} = \frac{1}{6}$

$\therefore LS = RS$ ✓

d.) $3^{3x-1} = \frac{1}{81}$

$3^{3x-1} = \frac{1}{3^4}$

$3^{3x-1} = 3^{-4}$

$3x - 1 = -4$

$^{+1}\quad\ ^{+1}$

$\frac{3x}{3} = \frac{-3}{3}$

$x = -1$

Check

$3^{3(-1)-1} = \frac{1}{81}$

$3^{-4} = \frac{1}{81}$

$\frac{1}{81} = \frac{1}{81}$

$\therefore LS = RS$ ✓

e.) $5^{2n+1} = \frac{1}{125}$

$5^{2n+1} = \frac{1}{5^3}$

$5^{2n+1} = 5^{-3}$

$2n + 1 = -3$

$^{-1}\quad\ ^{-1}$

$\frac{2n}{2} = \frac{-4}{2}$

$n = -2$

Check

$5^{2(-2)+1} = \frac{1}{125}$

$5^{-3} = \frac{1}{125}$

$\frac{1}{125} = \frac{1}{125}$

$\therefore LS = RS$ ✓

f.) $\frac{1}{256} = 2^{2-5w}$

$\frac{1}{2^8} = 2^{2-5w}$

$2^{-8} = 2^{2-5w}$

$^{-2}\quad\ ^{-2}$

$-8 = 2 - 5w$

$\frac{-10}{-5} = \frac{-5w}{-5}$

$\therefore 2 = w$

Check

$\frac{1}{256} = 2^{2-5(2)}$

$\frac{1}{256} = 2^{-8}$

$\frac{1}{256} = \frac{1}{256}$

$\therefore LS = RS$ ✓

7a.) $4^x = 8$

$2^{2x} = 2^3$

$\frac{2x}{2} = \frac{3}{2}$

$\therefore x = \frac{3}{2}$

Check

$4^{(\frac{3}{2})} = 8$

$2^{2(\frac{3}{2})} = 8$

$2^3 = 8$

$8 = 8$

$\therefore LS = RS$ ✓

b.) $64^z = 16$

$4^{3(z)} = 4^2$

$3(z) = 2$

$\frac{3(z)}{3} = \frac{2}{3}$

$\therefore z = \frac{2}{3}$

Check

$64^{(\frac{2}{3})} = 16$

$4^{3(\frac{2}{3})} = 16$

$4^2 = 16$

$16 = 16$

$\therefore LS = RS$ ✓

c.) $(-8)^y = -2$

$(-2^3)^y = -2$

$\frac{3(y)}{3} = \frac{1}{3}$

$y = \frac{1}{3}$

Check

$(-8)^{(\frac{1}{3})} = -2$

$(-2^3)^{\frac{1}{3}} = -2$

$\therefore -2 = -2$

$LS = RS$ ✓

d.) $9^{-x} = 3$

$3^{2(-x)} = 3$

$2(-x) = 1$

$\frac{-2x}{-2} = \frac{1}{-2}$

$\therefore x = \frac{1}{-2}$

Check

$9^{-(\frac{1}{2})} = 3$

$3^{2(\frac{-1}{2})} = 3$

$3^{-1} = 3$

$\therefore LS = RS$ ✓

e.) $2^{9x} = \frac{1}{8}$

$2^{9x} = \frac{8}{8}^{-1}$

$2^{9x} = 2^{3(-1)}$

$9x = 3(-1)$

$\frac{9x}{9} = \frac{-3}{9}$

$\therefore x = -\frac{1}{3}$

Check

$2^{9(-\frac{1}{3})} = \frac{1}{8}$

$2^{-3} = \frac{1}{8}$

$\frac{1}{8} = \frac{1}{8}$

$\therefore LS = RS$ ✓

f.) $9^{6x} = \frac{1}{27}$

$3^{2(6x)} = 27^{-1}$

$3^{2(6x)} = 3^{3(-1)}$

$2(6x) = 3(-1)$

$\frac{12x}{12} = \frac{-3}{12}$

$\therefore x = -\frac{1}{4}$

Check

$9^{6(-\frac{1}{4})} = \frac{1}{27}$

$9^{-\frac{3}{2}} = \frac{1}{27}$

$3^{2(-\frac{3}{2})} = \frac{1}{27}$

$3^{-3} = \frac{1}{27}$

$\frac{1}{27} = \frac{1}{27}$

$\therefore LS = RS$ ✓

c.) $36^{t-2} = 216^{-2t}$

$6^{2(t-2)} = 6^{3(-2t)}$

$2(t-2) = 3(-2t)$

$2t - 4 = -6t$ (−2t, −2t)

$\frac{-4}{-8} = \frac{-8t}{-8}$

$\therefore \frac{1}{2} = t$

Check

$36^{\frac{1}{2}-\frac{2}{1}\cdot\frac{2}{2}} = 216^{-2(\frac{1}{2})}$

$36^{-\frac{3}{2}} = 216^{-1}$

$6^{2(-\frac{3}{2})} = 6^{3(-1)}$

$6^{-3} = 6^{-3}$

$\therefore LS = RS$ ✓

d.) $8^{2x-1} = 16^{x-1}$

$2^{3(2x-1)} = 2^{4(x-1)}$

$3(2x-1) = 4(x-1)$

$6x - 3 = 4x - 4$ (−4x, +3, −4x, +3)

$\frac{2x}{2} = \frac{-1}{2}$

$\therefore x = -\frac{1}{2}$

Check

$8^{2(-\frac{1}{2})-1} = 16^{(-\frac{1}{2})-\frac{1}{2}}$

$8^{-1-1} = 16^{-\frac{3}{2}}$

$8^{-2} = 2^{4(-\frac{3}{2})}$

$2^{3(-2)} = 2^{-6}$

$2^{-6} = 2^{-6}$

$\therefore LS = RS$ ✓

g.) $2^x = 16^4$

$2^x = 2^{4(4)}$

$x = 4(4)$

$\therefore x = 16$

Check

$2^{(16)} = 16^4$

$2^{16} = 2^{4(4)}$

$2^{16} = 2^{16}$

$\therefore LS = RS$ ✓

h.) $2^{-2g} = 32$

$2^{-2g} = 2^5$

$\frac{-2g}{-2} = \frac{5}{-2}$

$\therefore g = 5/-2$

Check

$2^{-2(\frac{5}{-2})} = 32$

$2^5 = 2^5$

$\therefore LS = RS$ ✓

e.) $25^{1-3x} = 125^{-x}$

$5^{2(1-3x)} = 5^{3(-x)}$

$2(1-3x) = 3(-x)$

$2 - 6x + 6x = -3x + 6x$

$\frac{2}{3} = \frac{3x}{3}$

$\therefore \frac{2}{3} = x$

Check

$25^{1-3(\frac{2}{3})} = 125^{-(\frac{2}{3})}$

$25^{1-2} = 5^{3(-\frac{2}{3})}$

$25^{-1} = 5^{-2}$

$5^{2(-1)} = 5^{-2}$

$5^{-2} = 5^{-2}$

$\therefore LS = RS$ ✓

f.) $16^{3+k} = 32^{1-2k}$

$2^{4(3+k)} = 2^{5(1-2k)}$

$4(3+k) = 5(1-2k)$

$12 + 4k = 5 - 10k$ (−5, −4k, −5, −4k)

$\frac{7}{-14} = \frac{-14k}{-14}$

$\therefore -\frac{1}{2} = k$

Check

$16^{\frac{2\cdot3}{2\cdot1}+(-\frac{1}{2})} = 32^{1-2(\frac{1}{2})}$

$16^{\frac{5}{2}} = 32^2$

$2^{4(\frac{5}{2})} = 2^{5(2)}$

$2^{10} = 2^{10}$

$\therefore LS = RS$ ✓ Hilary

i.) $9^{2s+1} = 27$

$3^{2(2s+1)} = 3^3$

$2(2s+1) = 3$

$4s + 2 - 2 = 3 - 2$

$\frac{4s}{4} = \frac{1}{4}$

$\therefore s = \frac{1}{4}$

Check

$9^{2(\frac{1}{4})+1} = 27$

$9^{\frac{1}{2}+\frac{1}{1}\cdot\frac{2}{2}} = 27$ 8

$3^{2(\frac{3}{2})} = 27$

$3^3 = 27$

$27 = 27$

$\therefore LS = RS$ ✓

a.) $9^{x+1} = 27^{2x}$

$3^{2(x+1)} = 3^{3(2x)}$

$2(x+1) = 3(2x)$

$2x + 2 - 2x = 6x - 2x$

$\frac{2}{4} = \frac{4x}{4}$

$\therefore \frac{1}{2} = x$

Check

$9^{\frac{1}{2}+\frac{1}{1}\cdot\frac{2}{2}} = 27^{2(\frac{1}{2})}$

$3^{2(\frac{3}{2})} = 27$

$3^3 = 3^3$

$\therefore LS = RS$ ✓

b.) $16^y = 64^{2y-1}$

$4^{2(y)} = 4^{3(2y-1)}$

$2(y) = 3(2y-1)$

$2y - 2y + 3 = 6y - 2y + 3$ (−2y, +3)

$\frac{3}{4} = \frac{4y}{4}$

$\therefore \frac{3}{4} = y$

Check

$16^{(\frac{3}{4})} = 64^{2(\frac{3}{4})-1}$

$2^{4(\frac{3}{4})} = 2^{6(\frac{3}{2}-\frac{1}{1}\cdot\frac{2}{2})}$

$2^3 = 2^{6(\frac{1}{2})}$

$2^3 = 2^3$

$\therefore LS = RS$ ✓

9. a.) $5 = 25^{\frac{x}{2}}$

$5 = 5^{2(\frac{x}{2})}$

$5 = 5^{x}$

$\therefore 1 = x$

Check

$5 = 25^{\frac{(1)}{2}}$

$5 = 5^{2(\frac{1}{2})}$

$5 = 5$

$\therefore LS = RS$ ✓

b.) $8 = 2^{\frac{x}{3}}$

$2^3 = 2^{\frac{x}{3}}$

$3 \cdot 3 = \frac{x}{3} \cdot 3$

$\therefore 9 = x$

Check

$8 = 2^{\frac{9}{3}}$

$2^3 = 2^3$

$\therefore LS = RS$ ✓

c.) $9^{\frac{y}{5}} = 27$

$3^{2(\frac{y}{5})} = 3^3$

$2(\frac{y}{5}) = 3$

$5 \cdot \frac{2y}{5} = 3 \cdot 5$

$\frac{2y}{2} = \frac{15}{2}$

$\therefore y = \frac{15}{2}$

Check

$9^{\frac{(15)}{2}{5}} = 27$

$9^{\frac{15}{2} \cdot \frac{1}{5}} = 27$

$9^{\frac{3}{2}} = 27$

$3^{2(\frac{3}{2})} = 3^3$

$3^3 = 3^3$

$\therefore LS = RS$ ☺

d.) $\frac{1}{2} = 2^{\frac{a}{3}}$

$2^{-1} = 2^{\frac{a}{3}}$

$3 \cdot -1 = \frac{a}{3} \cdot 3$

$\therefore -3 = a$

Check

$\frac{1}{2} = 2^{\frac{-3}{3}}$

$\frac{1}{2} = 2^{-1}$

$2^{-1} = 2^{-1}$

$\therefore LS = RS$ ✓

e.) $4^{\frac{x}{4}} = \frac{1}{8}$

$2^{2(\frac{x}{4})} = 8^{-1}$

$2^{2(\frac{x}{4})} = 2^{3(-1)}$

$2(\frac{x}{4}) = 3(-1)$

$2 \cdot \frac{x}{2} = -3 \cdot 2$

$\therefore x = -6$

Check

$4^{\frac{(-6)}{4}} = \frac{1}{8}$

$4^{-\frac{3}{2}} = \frac{1}{8}$

$2^{2(\frac{-3}{2})} = \frac{1}{8}$

$\therefore 2^{-3} = \frac{1}{8} \rightarrow \frac{1}{8} = \frac{1}{8} \therefore LS = RS$ ✓

f.) $\left(\frac{3}{2}\right)^{\frac{m}{2}} = \frac{4}{9}$ reciprocate

$\left(\frac{3}{2}\right)^{\frac{m}{2}} = \left(\frac{9}{4}\right)^{-1}$

$\left(\frac{3}{2}\right)^{\frac{m}{2}} = \left(\frac{3^2}{2^2}\right)^{-1}$

$\left(\frac{3}{2}\right)^{\frac{m}{2}} = \left(\frac{3}{2}\right)^{-1(2)}$

$2 \cdot \frac{m}{2} = -1(2) \cdot 2$

$\therefore m = -4$

Check

$\left(\frac{3}{2}\right)^{\frac{(-4)}{2}} = \frac{4}{9}$

$\left(\frac{2}{3}\right)^{\frac{4}{2}} = \frac{4}{9}$

$\left(\frac{2}{3}\right)^{2} = \frac{4}{9}$

$\frac{4}{9} = \frac{4}{9}$

$\therefore LS = RS$ ✓

10 a.) $\frac{3}{3}(5^{x+1}) = \frac{15}{3}$

$5^{x+1} = 5$

$x + 1 = 1$

$\therefore x = 0$

b.) $\frac{2}{2}(3^{y-2}) = \frac{18}{2}$

$3^{y-2} = 9$

$3^{y-2} = 3^2$

$y - 2 = 2$

$\therefore y = 4$

c.) $5(4^{v}) = 10$

$5(4^{x}) = 5(2)$

$5(2^{2(x)}) = 5(2)$

$\frac{2(x)}{2} = \frac{1}{2}$

$\therefore x = \frac{1}{2}$

d.) $\frac{2}{2}(4^{v+1}) = \frac{1}{2}$

$4^{v+1} = \frac{1}{2}$

$4^{v+1} = 2^{-1}$

$2^{2(v+1)} = 2^{-1}$

$2(v+1) = -1$

$2v + 2 = -1$

$2v = \frac{-3}{2}$

$\therefore v = \frac{-3}{2}$

e.) $\frac{2}{6} = \frac{6}{6}(3^{4f-2})$

$\frac{1}{3} = 3^{4f-2}$

$3^{-1} = 3^{4f-2}$

$-1 + 2 = 4f - 2$

$\frac{1}{4} = \frac{4f}{4}$

$\frac{1}{4} = f$

f.) $\frac{27}{27}(3^{3x+1}) = \frac{3}{27}$

$3^{3x+1} = \frac{1}{9}$

$3^{3x+1} = 9^{-1}$

$3^{3x+1} = 3^{2(-1)}$

$3x + 1 = 2(-1)$

$3x + 1 = -2$

$\frac{3x}{3} = \frac{-3}{3}$

$\therefore x = -1$

11 a.) $2^{x+2} - 2^x = 48$

* let $a = 2^x$ *

$2^{x+2} - a = 48$

$2^x \cdot 2^2 - a = 48$

$(a) \cdot 2^2 - a = 48$

$4a - a = 48$

$\frac{3a}{3} = \frac{48}{3}$

$a = 16$

plug back ↓

$2^x = 16$

$2^x = 2^4$

$\therefore x = 4$

(or can switch to log form for $2^x = 2^4$)

check

$2^{(4)+2} - 2^4 = 48$

$2^6 - 2^4 = 48$

$64 - 16 = 48$

$48 = 48$

$\therefore LS = RS$ ✓

b.) $4^{x+3} + 4^x = 260$

* let $a = 4^x$ *

$4^{x+3} + a = 260$

$4^x \cdot 4^3 + a = 260$

$a \cdot 64 + a = 260$

$64a + a = 260$

$\frac{65a}{65} + \frac{260}{65}$

$a = 4$

↓

$4^x = 4$

$\therefore x = 1$

check

$4^{(1)+3} + 4^1 = 260$

$4^4 + 4 = 260$

$256 + 4 = 260$

$260 = 260$

$\therefore LS = RS$ ✓

c.) $2^{a+5} + 2^a = 1056$

* let $x = 2^a$ *

$2^{a+5} + x = 1056$

$2^a \cdot 2^5 + x = 1056$

$x \cdot 2^5 + x = 1056$

$32x + x = 1056$

$\frac{33x}{33} = \frac{1056}{33}$

$\therefore x = 32$

↓

$2^a = 32$

$2^a = 2^5$

$\therefore a = 5$

check

$2^{(5)+5} + 2^{(5)} = 1056$

$2^{10} + 32 = 1056$

$1024 + 32 = 1056$

$1056 = 1056$

$\therefore LS = RS$ ✓

d.) $6^{x+1} + 6^{x+2} = 7$

* let $a = 6^x$ *

$6^x \cdot 6^1 + 6^x \cdot 6^2 = 7$

$a \cdot 6 + a \cdot 36 = 7$

$6a + 36 = 7$

$\frac{42a}{42} = \frac{7}{42}$

$a = \frac{7}{42}$

↓

$6^x = \frac{7}{42}$

$6^x = \frac{1}{6}$

$6^x = 6^{-1}$

$\therefore x = -1$

Check:

$6^{(-1)+1} + 6^{(-1)+2} = 7$

$6^0 + 6 = 7$

$1 + 6 = 7$

$7 = 7$

$\therefore LS = RS$ ✓

e.) $3^{x+3} - 3^{x+1} = 648$

* let $a = 3^x$ *

$3^x \cdot 3^3 - 3^x \cdot 3^1 = 648$

$a \cdot 27 - a \cdot 3 = 648$

$27a - 3a = 648$

$\frac{24a}{24} = \frac{648}{24}$

$a = 27$

↓

$3^x = 27$

$3^x = 3^3$

$\therefore x = 3$

check

$3^{(3)+3} - 3^{(3)+1} = 648$

$3^6 - 3^4 = 648$

$729 - 81 = 648$

$648 = 648$ → $\therefore LS = RS$ ✓

f.) $10^{z+4} + 10^{z+3} = 11$

* let $x = 10^z$ *

$10^z \cdot 10^4 + 10^z \cdot 10^3 = 11$

$x \cdot 10000 + x \cdot 1000 = 11$

$10000x + 1000x = 11$

$\frac{11000x}{11000} = \frac{11}{11000}$

$x = \frac{1}{1000}$

↓

$10^z = \frac{1}{1000}$

$10^z = 1000^{-1}$

$10^z = 10^{-1(3)}$

$\therefore z = -3$

check

$10^{(-3)+4} + 10^{(-3)+3} = 11$

$10^1 + 10^0 = 11$

$10 + 1 = 11$

$11 = 11$

$\therefore LS = RS$ ✓

g.) $2^{x+2} - 2^{x+5} = -7$

* let $a = 2^x$ *

$2^x \cdot 2^2 - 2^x \cdot 2^5 = -7$

$a \cdot 4 - a \cdot 32 = -7$

$4a - 32a = -7$

$\frac{-28a}{-28} = \frac{-7}{-28}$

$a = \frac{1}{4}$

$2^x = \frac{1}{4}$

$2^x = 4^{-1}$

$2^x = 2^{2(-1)}$

$\therefore x = -2$

Check

$2^{(-2+2)} - 2^{(-2)+5} = -7$

$2^0 - 2^3 = -7$

$1 - 8 = -7$

$-7 = -7$

$\therefore LS = RS$

h.) $3^{m+1} + 3^{m+2} - 972 = 0$

$+972 \quad +972$

* let $x = 3^m$ *

$3^{m+1} + 3^{m+2} = 972$

$3^m \cdot 3 + 3^m \cdot 3^2 = 972$

$x \cdot 3 + x \cdot 9 = 972$

$3x + 9x = 972$

$\frac{12x}{12} = \frac{972}{12}$

$x = 81$

$3^m = 81$

$3^m = 3^4$

$\therefore m = 4$

Check

$3^{(4)+1} + 3^{(4)+2} = 972$

$3^5 + 3^6 = 972$

$243 + 729 = 972$

$972 = 972$

$\therefore LS = RS$ ✓

i.) $5^{n+2} - 5^{n+3} = -2500$

* let $x = 5^n$ *

$5^n \cdot 5^2 - 5^n \cdot 5^3 = -2500$

$x \cdot 25 - x \cdot 125 = -2500$

$25x - 125x = -2500$

$\frac{-100x}{-100} = \frac{-2500}{-100}$

$x = 25$

$5^n = 25$

$5^n = 5^2$

$\therefore n = 2$

Check

$5^{(2)+2} - 5^{(2)+3} = -2500$

$5^4 - 5^5 = -2500$

$625 - 3125 = -2500$

$-2500 = -2500$

$\therefore LS = RS$ ✓

19. a.) $\frac{27^x}{9^{2x-1}} = 3^{x+4}$

$\frac{3^{3(x)}}{3^{2(2x-1)}} = 3^{x+4}$

$3(x) - 2(2x-1) = x+4$

$3x - 4x + 2 = x+4$

$-x \quad -2 \quad -x \quad -2$

$-x + 2 = x + 4$

$\frac{-2x}{-2} = \frac{2}{2}$

$\therefore x = -1$

b.) $27^x(9^{2x-1}) = 3^{x+4}$

$3^{3(x)}(3^{2(2x-1)}) = 3^{x+4}$

$3(x) + 2(2x-1) = x+4$

$3x + 4x - 2 = x + 4$

$-x \quad +2 \quad -x \quad +2$

$7x - 2 = x + 4$

$\frac{6x}{6} = \frac{6}{6}$

$\therefore x = 1$

c.) $27^{x+1} = \left(\frac{1}{9}\right)^{2x-5}$

$3^{3(x+1)} = 9^{-1(2x-5)}$

$3^{3(x+1)} = 3^{2(-1(2x-5))}$

$3(x+1) = -2(2x-5)$

$+4x \quad -3 \quad +4x \quad -3$

$3x + 3 = -4x + 10$

$\frac{7x}{7} = \frac{7}{7}$

$\therefore x = 1$

20. a.) $2^{x^2+2x} = 2^{x+6}$

$x^2+2x = x+6$

$x^2+x-6=0$

$(x+3)(x-2)=0$

$\therefore x=-3, 2$

b.) $3^{x^2-2x} = 3^{x-2}$

$x^2-2x = x-2$

$x^2-3x+2=0$

$(x-1)(x-2)=0$

$\therefore x=1, 2$

c.) $2^{2x^2-3x} = 2^{x^2-2x+12}$

$2x^2-3x = x^2-2x+12$

$0=-x^2+x+12$

$0=-(x^2-x-12)$

$0=-(x-4)(x+3)$

$-x+4=0$, $4=x$

$\therefore x=4, -3$

22 a.) $\frac{2^{2x+1}}{2^{x-3}} = 4$

$\frac{2^{2x+1}}{2^{x-3}} = 2^2$

$2x+1-(x-3)=2$

$2x+1-x+3=2$

$x+4=2$

$\therefore x=-2$

Check

$\frac{2^{2(-2)+1}}{2^{-2-3}} = 4$

$\frac{2^{-4+1}}{2^{-5}} = 4$

$\frac{2^{-3}}{2^{-5}} = 4$

$2^{-3--(5)} = 4$

$2^{-3+5} = 4$

$2^2 = 4$

$4=4$

$\therefore LS=RS$ ✓

b.) $\frac{9^{x+4}}{27^{x-1}} = 81$

$\frac{3^{2(x+4)}}{3^{3(x-1)}} = 3^4$

$2(x+4)-3(x-1)=4$

$2x+8-3x+3=4$

$-x+11=4$

$7=x$

Check

$\frac{9^{7+4}}{27^{7-1}} = 81$

$\frac{9^{11}}{27^6} = 81$

$\frac{3^{2(11)}}{3^{3(6)}} = 81$

$\frac{3^{22}}{3^{18}} = 81$

$3^{22-18} = 81$

$3^4 = 81$

$81=81$

$\therefore LS=RS$ ✓

c.) $\frac{8^{x+2}}{4^{x+3}} = 16^{x-3}$

$\frac{2^{3(x+2)}}{2^{2(x+3)}} = 2^{4(x-3)}$

$3(x+2)-2(x+3)=4(x-3)$

$3x+6-2x-6=4x-12$

$x = 4x-12$

$-x \quad -x$

$0=3x-12$

$+12 \quad +12$

$12=3x$

$\frac{12}{3} = \frac{3x}{3}$

$\therefore 4=x$

check

$\frac{8^{(4)+2}}{4^{(4)+3}} = 16^{(4)-3}$

$\frac{8^6}{4^7} = 16$

$\frac{2^{3(6)}}{2^{2(7)}} = 16$

$\frac{2^{18}}{2^{14}} = 16$

$2^{18-14} = 16$

$2^4 = 16$

$16=16$

$\therefore LS=RS$ ✓

Hilary