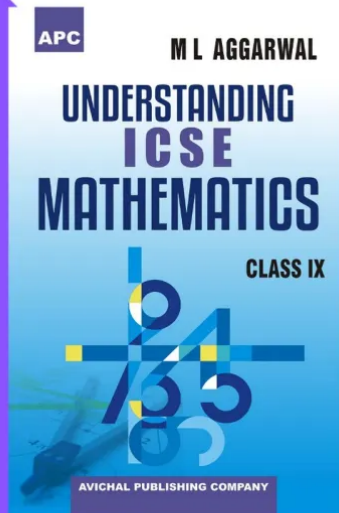


ML Aggarwal Solutions for Class 9 Maths

Chapter 9- Logarithms



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ML Agrawal Solutions

CLASS 9 MATHS

Chapter 9: Logarithms

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Chapter 9- Logarithms

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ML Aggarwal 9th Maths Chapter 9, Class 9 Maths Chapter 9 solutions

EXERCISE 9.1

1. Convert the following to logarithmic form:

(i) $5^2 = 25$

(ii) $a^5 = 64$

(iii) $7^x = 100$

(iv) $9^0 = 1$

(v) $6^1 = 6$

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

(vii) $10^{-2} = 0.01$

(viii) $(81)^{3/4} = 27$

Solution:

(i) $5^2 = 25$

Let us apply log, we get

$$\text{Log}_5 25 = 2$$

(ii) $a^5 = 64$

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Let us apply log, we get

$$\text{Log}_a 64 = 5$$

(iii) $7^x = 100$

Let us apply log, we get

$$\text{Log}_7 100 = x$$

(iv) $9^0 = 1$

Let us apply log, we get

$$\text{Log}_9 1 = 0$$

(v) $6^1 = 6$

Let us apply log, we get

$$\text{Log}_6 6 = 1$$

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

Let us apply log, we get

$$\text{Log}_3 1/9 = -2$$

(vii) $10^{-2} = 0.01$

Let us apply log, we get

$$\text{Log}_{10} 0.01 = -2$$

(viii) $(81)^{3/4} = 27$

Let us apply log, we get

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$$\text{Log}_{81} 27 = \frac{3}{4}$$

2. Convert the following into exponential form:

(i) $\log_2 32 = 5$

(ii) $\log_3 81 = 4$

(iii) $\log_3 \frac{1}{3} = -1$

(iv) $\log_3 4 = \frac{2}{3}$

(v) $\log_8 32 = \frac{5}{3}$

(vi) $\log_{10} (0.001) = -3$

(vii) $\log_2 0.25 = -2$

(viii) $\log_a (1/a) = -1$

Solution:

(i) $\log_2 32 = 5$

The exponential form of the expression is

$$2^5 = 32$$

(ii) $\log_3 81 = 4$

The exponential form of the expression is

$$3^4 = 81$$

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(iii) $\log_3 1/3 = -1$

The exponential form of the expression is

$$3^{-1} = 1/3$$

(iv) $\log_3 4 = 2/3$

The exponential form of the expression is

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

(v) $\log_8 32 = 5/3$

The exponential form of the expression is

$$(8)^{5/3} = 32$$

(vi) $\log_{10} (0.001) = -3$

The exponential form of the expression is

$$10^{-3} = 0.001$$

(vii) $\log_2 0.25 = -2$

The exponential form of the expression is

$$2^{-2} = 0.25$$

(viii) $\log_a (1/a) = -1$

The exponential form of the expression is

$$a^{-1} = 1/a$$

3. By converting to exponential form, find the values of:

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(i) $\log_2 16$

(ii) $\log_5 125$

(iii) $\log_4 8$

(iv) $\log_9 27$

(v) $\log_{10} (.01)$

(vi) $\log_7 1/7$

(vii) $\log_{.5} 256$

(viii) $\log_2 0.25$

Solution:

(i) $\log_2 16$

Let us consider $\log_2 16 = x$

So,

$$(2)^x = 16$$

$$= 2 \times 2 \times 2 \times 2$$

$$2^x = 2^4$$

By comparing the powers,

$$x = 4$$

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(ii) $\log_5 125$

Let us consider $\log_5 125 = x$

So,

$$(5)^x = 125$$

$$= 5 \times 5 \times 5$$

$$5^x = 5^3$$

By comparing the powers,

$$x = 3$$

(iii) $\log_4 8$

Let us consider $\log_4 8 = x$

So,

$$(4)^x = 8$$

$$(2 \times 2)^x = 2 \times 2 \times 2$$

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

By comparing the powers,

$$2x = 3$$

$$x = 3/2$$

(iv) $\log_9 27$

Let us consider $\log_9 27 = x$

So,

$$(9)^x = 27$$

$$(3 \times 3)^x = 3 \times 3 \times 3$$

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

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By comparing the powers,

$$2x = 3$$

$$x = 3/2$$

(v) $\log_{10} (.01)$

Let us consider $\log_{10} (.01) = x$

So,

$$(10)^x = 1/100$$

$$= 1/10 \times 1/10$$

$$10^x = 1/(10)^2$$

$$10^x = 10^{-2}$$

By comparing the powers,

$$x = -2$$

(vi) $\log_7 1/7$

Let us consider $\log_7 1/7 = x$

So,

$$(7)^x = 1/7$$

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

By comparing the powers,

$$x = -1$$

(vii) $\log_{.5} 256$

Let us consider $\log_{.5} 256 = x$

So,

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$$(.5)^x = 256$$

$$(5/10)^x = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$$

$$(1/2)^x = 2^8$$

$$(2)^{-x} = 2^8$$

By comparing the powers,

$$-x = 8$$

$$x = -8$$

(viii) $\log_2 0.25$

Let us consider $\log_2 0.25 = x$

So,

$$(2)^x = 0.25$$

$$= 25/100$$

$$2^x = 1/4$$

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

By comparing the powers,

$$x = -2$$

4. Solve the following equations for x:

(i) $\log_3 x = 2$

(ii) $\log_x 25 = 2$

(iii) $\log_{10} x = -2$

(iv) $\log_4 x = \frac{1}{2}$

(v) $\log_x 11 = 2.5$

(vi) $\log_x \frac{1}{4} = -1$

(vii) $\log_{81} x = \frac{3}{2}$

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(viii) $\log_9 x = 2.5$

(ix) $\log_4 x = -1.5$

Solution:

(i) $\log_3 x = 2$

Let us simplify the expression,

$$(3)^2 = x$$

$$x = 9$$

(ii) $\log_x 25 = 2$

Let us simplify the expression,

$$(x)^2 = 25$$

$$= 5 \times 5$$

$$x^2 = 5^2$$

Since the powers are same,

So,

$$x = 5$$

(iii) $\log_{10} x = -2$

Let us simplify the expression,

$$(10)^{-2} = x$$

$$x = 1/(10)^2$$

$$= 1/100$$

$$x = 0.01$$

(iv) $\log_4 x = \frac{1}{2}$

Let us simplify the expression,

$$(4)^{1/2} = x$$

$$x = (2 \times 2)^{1/2}$$

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

$$x = 2$$

$$(v) \log_x 11 = 2.5$$

Let us simplify the expression,

$$(x)^1 = 11$$

$$x = 11$$

$$(vi) \log_x \frac{1}{4} = -1$$

Let us simplify the expression,

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

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

Since the powers are same,

So,

$$x = 4$$

$$(vii) \log_{81} x = 3/2$$

Let us simplify the expression,

$$(81)^{3/2} = x$$

$$x = 81^{3/2}$$

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

$$= 3^4 x^{3/2}$$

$$= 3^6$$

$$= 3 \times 3 \times 3 \times 3 \times 3 \times 3$$

$$= 729$$

$$x = 729$$

$$(viii) \log_9 x = 2.5$$

$$\log_9 x = 5/2$$

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Let us simplify the expression,

$$(9)^{5/2} = x$$

$$x = (3^2)^{5/2}$$

$$= 3^2 \times 3^{5/2}$$

$$= 3^5$$

$$= 3 \times 3 \times 3 \times 3 \times 3$$

$$= 234$$

$$x = 234$$

$$(ix) \log_4 x = -1.5$$

$$\log_4 x = -3/2$$

Let us simplify the expression,

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

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

$$= 2^2 \times 2^{-3/2}$$

$$= 2^{-3}$$

$$= 1/2^3$$

$$= 1/(2 \times 2 \times 2)$$

$$= 1/8$$

$$x = 1/8$$

5. Given $\log_{10} a = b$, express 10^{2b-3} in terms of a.

Solution:

Given:

$$\log_{10} a = b$$

$$(10)^b = a$$

Now,

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$$10^{2b-3} = (10)^{2b} / (10)^3$$

$$= (10^b)^2 / (10 \times 10 \times 10)$$

Substitute the value of $(10)^b = a$, we get

$$= a^2/1000$$

6. Given $\log_{10} x = a$, $\log_{10} y = b$ and $\log_{10} z = c$,

(i) write down 10^{2a-3} in terms of x.

(ii) write down 10^{3b-1} in terms of y.

(iii) if $\log_{10} P = 2a + b/2 - 3c$, express P in terms of x, y and z.

Solution:

Given:

$$\log_{10} x = a$$

- $(10)^a = x$

$$\log_{10} y = b$$

- $(10)^b = y$

$$\log_{10} z = c$$

- $(10)^c = z$

(i) Write down 10^{2a-3} in terms of x.

$$10^{2a-3} = (10)^{2a} / (10)^3$$

$$= (10^a)^2 / (10 \times 10 \times 10)$$

Substitute the value of $(10)^a = x$, we get

$$= x^2/1000$$

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(ii) Write down 10^{3b-1} in terms of y.

$$10^{3b-1} = (10)^{3b} / (10)^1$$

$$= (10^b)^3 / (10)$$

Substitute the value of $(10)^b = y$, we get

$$= y^3/10$$

(iii) If $\log_{10} P = 2a + b/2 - 3c$, express P in terms of x, y and z.

we know that,

$$(10)^a = x$$

$$(10)^b = y$$

$$(10)^c = z$$

By substituting the values

$$\log_{10} P = 2a + b/2 - 3c$$

$$= 2 \log_{10} x + \frac{1}{2} \log_{10} y - 3 \log_{10} z$$

$$= \log_{10} x^2 + \log_{10} y^{1/2} - \log_{10} z^3$$

$$= \log_{10} (x^2 + y^{1/2}) - \log_{10} z^3$$

$$= \log_{10} [(x^2\sqrt{y})/z^3]$$

$$P = (x^2\sqrt{y})/z^3$$

7. If $\log_{10}x = a$ and $\log_{10}y = b$, find the value of xy.

Solution:

Given:

$$\log_{10}x = a$$

$$(10)^a = x$$

$$\log_{10}y = b$$

$$(10)^b = y$$

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Then,

$$xy = (10)^a \times (10)^b$$

$$= (10)^{a+b}$$

8. Given $\log_{10} a = m$ and $\log_{10} b = n$, express a^3/b^2 in terms of m and n .

Solution:

Given:

$$\log_{10} a = m$$

$$(10)^m = a$$

$$\log_{10} b = n$$

$$(10)^n = b$$

So,

$$a^3/b^2 = (10^m)^3 / (10^n)^2$$

$$= 10^{3m} / 10^{2n}$$

$$= 10^{3m-2n}$$

9. Given $\log_{10} a = 2a$ and $\log_{10} y = -b/2$

(i) write 10^a in terms of x .

(ii) write 10^{2b+1} in terms of y .

(iii) if $\log_{10} P = 3a - 2b$, express P in terms of x and y .

Solution:

Given:

$$\log_{10} a = 2a$$

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$$(10)^{2a} = a$$

$$\log_{10} y = -b/2$$

$$(10)^{-b/2} = y$$

(i) Write 10^a in terms of x.

$$10^a = (10^{2a})^{1/2}$$

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

$$= \sqrt{x}$$

(ii) Write 10^{2b+1} in terms of y.

$$10^{2b+1} = 10^{2b} \times 10^1$$

$$= 10^{4(b/2)} \times 10^1$$

$$= (10^{b/2})^4 \times 10^1$$

$$= y^4 \times 10^1$$

$$= 10y^4$$

(iii) If $\log_{10} P = 3a - 2b$, express P in terms of x and y.

$$\log_{10} P = 3a - 2b$$

Substitute the values,

$$\log_{10} P = 3/2 (2a) - 4(b/2)$$

$$= 3/2 (\log_{10} x) - 4 (\log_{10} y)$$

$$= (\log_{10} x)^{3/2} - (\log_{10} y)^4$$

$$= \log_{10} [(x^{3/2}) / y^4]$$

$$P = (x^{3/2}) / y^4$$

10. If $\log_2 y = x$ and $\log_3 z = x$, find 72^x in terms of y and z.

Solution:

Given:

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$$\log_2 y = x$$

$$2^x = y$$

$$\log_3 z = x$$

$$3^x = z$$

So,

$$72^x = (2 \times 2 \times 2 \times 3 \times 3)^x$$

$$= (2^3 \times 3^2)^x$$

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

$$= (2^x)^3 \times (3^x)^2$$

$$= y^3 \times z^2$$

$$= y^3 z^2$$

11. If $\log_2 x = a$ and $\log_5 y = a$, write 100^{2a-1} in terms of x and y .

Solution:

Given:

$$\log_2 x = a$$

$$2^a = x$$

$$\log_5 y = a$$

$$5^a = y$$

So,

$$100^{2a-1} = (2 \times 2 \times 5 \times 5)^{2a-1}$$

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

$$= 2^{4a-2} \times 5^{4a-2}$$

$$= (2^{4a})/2^2 \times (5^{4a})/5^2$$

$$= [(2^a)^4 \times (5^a)^4] / (4 \times 25)$$

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$$= (x^4 y^4)/100$$

EXERCISE 9.2

1. Simplify the following:

(i) $\log a^3 - \log a^2$

(ii) $\log a^3 \div \log a^2$

(iii) $\log 4/\log 2$

(iv) $(\log 8 \log 9)/\log 27$

(v) $\log 27/\log \sqrt{3}$

(vi) $(\log 9 - \log 3)/\log 27$

Solution:

(i) $\log a^3 - \log a^2$

By using Quotient law,

$$\log a^3 - \log a^2 = \log (a^3/a^2)$$

$$= \log a$$

(ii) $\log a^3 \div \log a^2$

By using power law,

$$\log a^3 \div \log a^2 = 3\log a \div 2 \log a$$

$$= 3\log a / 2\log a$$

$$= 3/2$$

(iii) $\log 4/\log 2$

Let us simplify the expression,

$$\log 4/\log 2 = \log(2 \times 2)/\log 2$$

By using power law,

$$= 2 \log 2/\log 2$$

$$= 2$$

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(iv) $(\log 8 \log 9)/\log 27$

Let us simplify the expression,

$$(\log 8 \log 9)/\log 27 = (\log 2^3 \cdot \log 3^2)/\log 3^3$$

By using power law,

$$= [(3 \log 2) \cdot (2 \log 3)]/(3 \log 3)$$

$$= [(\log 2) \cdot 2] / 1$$

$$= 2 \log 2$$

$$= \log 2^2$$

$$= \log 4$$

(v) $\log 27/\log \sqrt{3}$

Let us simplify the expression,

$$\log 27/\log \sqrt{3} = \log(3 \times 3 \times 3)/\log(3)^{1/2}$$

$$= \log 3^3/\log 3^{1/2}$$

By using power law

$$= 3 \log 3 / ((1/2) \log 3)$$

$$= (3 \times 2)/1 (\log 3/\log 3)$$

$$= (6) (1)$$

$$= 6$$

(vi) $(\log 9 - \log 3)/\log 27$

Let us simplify the expression,

$$(\log 9 - \log 3)/\log 27 = [\log(3 \times 3) - \log 3] / \log(3 \times 3 \times 3)$$

$$= [\log 3^2 - \log 3] / \log 3^3$$

By using power law

$$= [2 \log 3 - \log 3]/3 \log 3$$

$$= \log 3/3 \log 3$$

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$$= 1/3$$

2. Evaluate the following:

(i) $\log (10 \div \sqrt[3]{10})$

(ii) $2 + \frac{1}{2} \log(10^{-3})$

(iii) $2 \log 5 + \log 8 - \frac{1}{2} \log 4$

(iv) $2 \log 10^3 + 3 \log 10^{-2} - \frac{1}{3} \log 5^{-3} + \frac{1}{2} \log 4$

(v) $2 \log 2 + \log 5 - \frac{1}{2} \log 36 - \log 1/30$

(vi) $2 \log 5 + \log 3 + 3 \log 2 - \frac{1}{2} \log 36 - 2 \log 10$

(vii) $\log 2 + 16 \log 16/15 + 12 \log 25/24 + 7 \log 81/80$

(viii) $2 \log_{10} 5 + \log_{10} 8 - \frac{1}{2} \log_{10} 4$

Solution:

(i) $\log (10 \div \sqrt[3]{10})$

Let us simplify the expression,

$$\log (10 \div \sqrt[3]{10}) = \log (10 \div 10^{1/3})$$

$$= \log (10^{1 - 1/3})$$

$$= \log (10^{2/3})$$

$$= \frac{2}{3} \log 10$$

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

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

(ii) $2 + \frac{1}{2} \log(10^{-3})$

Let us simplify the expression,

$$2 + \frac{1}{2} \log(10^{-3}) = 2 + \frac{1}{2} \times (-3) \log 10$$

$$= 2 - \frac{3}{2} \log 10$$

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

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

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

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

(iii) $2 \log 5 + \log 8 - \frac{1}{2} \log 4$

Let us simplify the expression,

$$2 \log 5 + \log 8 - \frac{1}{2} \log 4 = \log 5^2 + \log 8 - \frac{1}{2} \log 2^2$$

$$= \log 25 + \log 8 - \frac{1}{2} 2 \log 2$$

$$= \log 25 + \log 8 - \log 2$$

$$= \log (25 \times 8) / 2$$

$$= \log (25 \times 4)$$

$$= \log 100$$

$$= \log 10^2$$

$$= 2 \log 10$$

$$= 2 (1)$$

$$= 2$$

(iv) $2 \log 10^3 + 3 \log 10^{-2} - \frac{1}{3} \log 5^{-3} + \frac{1}{2} \log 4$

Let us simplify the expression,

$$2 \log 10^3 + 3 \log 10^{-2} - \frac{1}{3} \log 5^{-3} + \frac{1}{2} \log 4 = 2 \times 3 \log 10 + 3(-2) \log 10 - \frac{1}{3} (-3) \log 5 + \frac{1}{2} \log 2^2$$

$$= 6 \log 10 - 6 \log 10 + \log 5 + \frac{1}{2} 2 \log 2$$

$$= 6 \log 10 - 6 \log 10 + \log 5 + \log 2$$

$$= 0 + \log 5 + \log 2$$

$$= \log (5 \times 2)$$

$$= \log 10$$

$$= 1$$

(v) $2 \log 2 + \log 5 - \frac{1}{2} \log 36 - \log \frac{1}{30}$

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Let us simplify the expression,

$$2 \log 2 + \log 5 - \frac{1}{2} \log 36 - \log \frac{1}{30} = \log 2^2 + \log 5 - \frac{1}{2} \log 6^2 - \log (1/30)$$

$$= \log 4 + \log 5 - \log 6 - \log 1/30$$

$$= \log 4 + \log 5 - \log 6 - (\log 1 - \log 30)$$

$$= \log 4 + \log 5 - \log 6 - \log 1 + \log 30$$

$$= \log 4 + \log 5 + \log 30 - (\log 6 + \log 1)$$

$$= \log (4 \times 5 \times 30) - \log (6 \times 1)$$

$$= \log (4 \times 5 \times 30) / (6 \times 1)$$

$$= \log (4 \times 5 \times 5)$$

$$= \log 100$$

$$= \log 10^2$$

$$= 2 \log 10$$

$$= 2 (1)$$

$$= 2$$

(vi) $2 \log 5 + \log 3 + 3 \log 2 - \frac{1}{2} \log 36 - 2 \log 10$

Let us simplify the expression,

$$2 \log 5 + \log 3 + 3 \log 2 - \frac{1}{2} \log 36 - 2 \log 10 = \log 5^2 + \log 3 + \log 2^3 - \frac{1}{2} \log 6^2 - \log 10^2$$

$$= \log 25 + \log 3 + \log 8 - \log 6 - \log 100$$

$$= \log (25 \times 3 \times 8) - \log (6 \times 100)$$

$$= \log (25 \times 3 \times 8) / (6 \times 100)$$

$$= \log (1 \times 3 \times 8) / (6 \times 4)$$

$$= \log 24/24$$

$$= \log 1$$

$$= 0$$

(vii) $\log 2 + 16 \log 16/15 + 12 \log 25/24 + 7 \log 81/80$

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Let us simplify the expression,

$$\log 2 + 16 \log 16/15 + 12 \log 25/24 + 7 \log 81/80 = \log 2 + 16(\log 16 - \log 15) + 12(\log 25 - \log 24) + 7(\log 81 - \log 80)$$

$$= \log 2 + 16 (\log 2^4 - \log (3 \times 5)) + 12 (\log 5^2 - \log (3 \times 2 \times 2 \times 2)) + 7 (\log (3 \times 3 \times 3 \times 3) - \log (2^4 \times 5))$$

$$= \log 2 + 16(4\log 2 - (\log 3 + \log 5)) + 12 (2\log 5 - \log (3 \times 2^3)) + 7 (\log 3^4 - (\log 2^4 + \log 5))$$

$$= \log 2 + 16 (4\log 2 - \log 3 - \log 5) + 12 (2\log 5 - (\log 3 + 3\log 2)) + 7 (4\log 3 - 4\log 2 - \log 5)$$

$$= \log 2 + 64\log 2 - 16\log 3 - 16\log 5 + 24\log 5 - 12\log 3 - 36\log 2 + 28\log 3 - 28\log 2 - 7\log 5$$

$$= (\log 2 + 64\log 2 - 36\log 2 - 28\log 2) + (-16\log 3 - 12\log 3 + 28\log 3) + (-16\log 5 + 24\log 5 - 7\log 5)$$

$$= (65\log 2 - 64\log 2) + (-28\log 3 + 28\log 3) + (-23\log 5 + 24\log 5)$$

$$= \log 2 + 0 + \log 5$$

$$= \log (2 \times 5)$$

$$= \log 10$$

$$= 1$$

(viii) $2 \log_{10} 5 + \log_{10} 8 - \frac{1}{2} \log_{10} 4$

Let us simplify the expression,

$$2 \log_{10} 5 + \log_{10} 8 - \frac{1}{2} \log_{10} 4 = \log_{10} 5^2 + \log_{10} 8 - \log_{10} 4^{1/2}$$

$$= \log_{10} 25 + \log_{10} 8 - \log_{10} (2)^2 \times 1/2$$

$$= \log_{10} 25 + \log_{10} 8 - \log_{10} 2$$

$$= \log_{10} [(25 \times 8)/2]$$

$$= \log_{10} (25 \times 4)$$

$$= \log_{10} 100$$

$$= \log_{10} 10^2$$

$$= 2 \log_{10} 10$$

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$$= 2 (1)$$

$$= 2$$

3. Express each of the following as a single logarithm:

(i) $2 \log 3 - \frac{1}{2} \log 16 + \log 12$

(ii) $2 \log_{10} 5 - \log_{10} 2 + 3 \log_{10} 4 + 1$

(iii) $\frac{1}{2} \log 36 + 2 \log 8 - \log 1.5$

(iv) $\frac{1}{2} \log 25 - 2 \log 3 + 1$

(v) $\frac{1}{2} \log 9 + 2 \log 3 - \log 6 + \log 2 - 2$

Solution:

(i) $2 \log 3 - \frac{1}{2} \log 16 + \log 12$

Let us simplify the expression into single logarithm,

$$2 \log 3 - \frac{1}{2} \log 16 + \log 12 = 2 \log 3 - \frac{1}{2} \log 4^2 + \log 12$$

$$= 2 \log 3 - \log 4 + \log 12$$

$$= \log 3^2 - \log 4 + \log 12$$

$$= \log 9 - \log 4 + \log 12$$

$$= \log (9 \times 12) / 4$$

$$= \log (9 \times 3)$$

$$= \log 27$$

(ii) $2 \log_{10} 5 - \log_{10} 2 + 3 \log_{10} 4 + 1$

Let us simplify the expression into single logarithm,

$$2 \log_{10} 5 - \log_{10} 2 + 3 \log_{10} 4 + 1 = \log_{10} 5^2 - \log_{10} 2 + \log_{10} 4^3 + \log_{10} 10$$

$$= \log_{10} 25 - \log_{10} 2 + \log_{10} 64 + \log_{10} 10$$

$$= \log_{10} (25 \times 64 \times 10) - \log_{10} 2$$

$$= \log_{10} (16000) - \log_{10} 2$$

$$= \log_{10} (16000/2)$$

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$$= \log_{10} 8000$$

$$\text{(iii)} \quad \frac{1}{2} \log 36 + 2 \log 8 - \log 1.5$$

Let us simplify the expression into single logarithm,

$$\frac{1}{2} \log 36 + 2 \log 8 - \log 1.5 = \log 36^{1/2} + \log 8^2 - \log 1.5$$

$$= \log (6)^{2 \times 1/2} + \log 64 - \log 1.5$$

$$= \log 6 + \log 64 - \log (15/10)$$

$$= \log 6 + \log 64 - (\log 15 - \log 10)$$

$$= \log (6 \times 64) - \log 15 + \log 10$$

$$= \log (6 \times 64 \times 10) - \log 15$$

$$= \log [(6 \times 64 \times 10)/15]$$

$$= \log (4 \times 64)$$

$$= \log 256$$

$$\text{(iv)} \quad \frac{1}{2} \log 25 - 2 \log 3 + 1$$

Let us simplify the expression into single logarithm,

$$\frac{1}{2} \log 25 - 2 \log 3 + 1 = \log 25^{1/2} - \log 3^2 + \log 10$$

$$= \log (5)^{2 \times 1/2} - \log 9 + \log 10$$

$$= \log 5 - \log 9 + \log 10$$

$$= \log (5 \times 10) - \log 9$$

$$= \log ((5 \times 10)/9)$$

$$= \log 50/9$$

$$\text{(v)} \quad \frac{1}{2} \log 9 + 2 \log 3 - \log 6 + \log 2 - 2$$

Let us simplify the expression into single logarithm,

$$\frac{1}{2} \log 9 + 2 \log 3 - \log 6 + \log 2 - 2 = \log 9^{1/2} + \log 3^2 - \log 6 + \log 2 - \log 100$$

$$= \log 3^{2 \times 1/2} + \log 9 - \log 6 + \log 2 - \log 100$$

$$= \log 3 + \log 9 - \log 6 + \log 2 - \log 100$$

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$$= \log [(3 \times 9 \times 2) / (6 \times 100)]$$

$$= \log 9/100$$

4. Prove the following:

(i) $\log_{10} 4 \div \log_{10} 2 = \log_3 9$

(ii) $\log_{10} 25 + \log_{10} 4 = \log_5 25$

Solution:

(i) $\log_{10} 4 \div \log_{10} 2 = \log_3 9$

Let us consider LHS, $\log_{10} 4 \div \log_{10} 2$

$$\log_{10} 4 \div \log_{10} 2 = \log_{10} 2^2 \div \log_{10} 2$$

$$= 2 \log_{10} 2 \div \log_{10} 2$$

$$= 2 \log_{10} 2 / \log_{10} 2$$

$$= 2 (1)$$

$$= 2$$

Now let us consider RHS,

$$\log_3 9 = \log_3 3^2$$

$$= 2 \log_3 3$$

$$= 2(1)$$

$$= 2$$

$$\therefore \text{LHS} = \text{RHS}$$

Hence proved.

(ii) $\log_{10} 25 + \log_{10} 4 = \log_5 25$

Let us consider LHS, $\log_{10} 25 + \log_{10} 4$

$$\log_{10} 25 + \log_{10} 4 = \log_{10} (25 \times 4)$$

$$= \log_{10} 100$$

$$= \log_{10} 10^2$$

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$$= 2 \log_{10} 10$$

$$= 2(1)$$

$$= 2$$

Now, let us consider RHS,

$$\log_5 25 = \log_5 5^2$$

$$= 2 \log_5 5$$

$$= 2(1)$$

$$= 2$$

$$\therefore \text{LHS} = \text{RHS}$$

Hence proved.

5. If $x = (100)^a$, $y = (10000)^b$ and $z = (10)^c$, express $\log [(10\sqrt{y})/x^2z^3]$ in terms of a, b, c.

Solution:

Given:

$$x = (100)^a = (10^2)^a = 10^{2a}$$

$$y = (10000)^b = (10^4)^b = 10^{4b}$$

$$z = (10)^c$$

It is given that, $\log [(10\sqrt{y})/x^2z^3]$

$$\log [(10\sqrt{y})/x^2z^3] = (\log 10 + \log \sqrt{y}) - (\log x^2 + \log z^3)$$

$$= (1 + \log(y)^{1/2}) - (\log x^2 + \log z^3) \text{ [we know that, } \log 10 = 1]$$

$$= (1 + \frac{1}{2} \log y) - (2 \log x + 3 \log z)$$

Now substitute the values of x, y, z, we get

$$= (1 + \frac{1}{2} \log 10^{4b}) - (2 \log 10^{2a} + 3 \log 10^c)$$

$$= (1 + \frac{1}{2} 4b \log 10) - (2 \times 2a \log 10 + 3 \times c \log 10)$$

$$= (1 + \frac{1}{2} 4b) - (2 \times 2a + 3c) \text{ [Since, } \log 10 = 1]$$

$$= (1 + 2b) - (4a + 3c)$$

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$$= 1 + 2b - 4a - 3c$$

6. If $a = \log_{10} x$, find the following in terms of a :

(i) x

(ii) $\log_{10} \sqrt[5]{x^2}$

(iii) $\log_{10} 5x$

Solution:

Given:

$$a = \log_{10} x$$

(i) x

$$10^a = x$$

$$\therefore x = 10^a$$

(ii) $\log_{10} \sqrt[5]{x^2}$

$$\log_{10} \sqrt[5]{x^2} = \log_{10} (x^2)^{1/5}$$

$$= \log_{10} (x)^{2/5}$$

$$= \frac{2}{5} \log_{10} x$$

$$= \frac{2}{5} (a)$$

$$= \frac{2a}{5}$$

(iii) $\log_{10} 5x$

$$x = (10)^a$$

$$= \log_{10} 5x$$

$$= \log_{10} 5(10)^a$$

$$= \log_{10} 5 + \log_{10} 10$$

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$$= \log_{10} 5 + a(1)$$

$$= a + \log_{10} 5$$

7. If $a = \log 2/3$, $b = \log 3/5$ and $c = 2 \log \sqrt{(5/2)}$. Find the value of

(i) $a + b + c$

(ii) 5^{a+b+c}

Solution:

Given:

$$a = \log 2/3$$

$$b = \log 3/5$$

$$c = 2 \log \sqrt{(5/2)}$$

(i) $a + b + c$

Let us substitute the given values, we get

$$a + b + c = \log 2/3 + \log 3/5 + 2 \log \sqrt{(5/2)}$$

$$= (\log 2 - \log 3) + (\log 3 - \log 5) + 2 \log (5/2)^{1/2}$$

$$= \log 2 - \log 3 + \log 3 - \log 5 + 2 \times \frac{1}{2} (\log 5 - \log 2)$$

$$= \log 2 - \log 3 + \log 3 - \log 5 + \log 5 - \log 2$$

$$= 0$$

(ii) 5^{a+b+c}

$$5^{a+b+c} = 5^0$$

$$= 1$$

8. If $x = \log 3/5$, $y = \log 5/4$ and $z = 2 \log \sqrt{3/2}$, find the value of

(i) $x + y - z$

(ii) 3^{x+y-z}

Solution:

Given:

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$$x = \log 3/5 = \log 3 - \log 5$$

$$y = \log 5/4 = \log 5 - \log 4$$

$$z = 2 \log \sqrt{3/2} = \log (\sqrt{3/2})^2 = \log 3/2 = \log 3 - \log 2$$

(i) $x + y - z$

Let us substitute the given values, we get

$$x + y - z = \log 3 - \log 5 + \log 5 - \log 4 - (\log 3 - \log 2)$$

$$= \log 3 - \log 5 + \log 5 - \log 4 - \log 3 + \log 2$$

$$= 0$$

(ii) 3^{x+y-z}

$$3^{x+y-z} = 3^0$$

$$= 1$$

9. If $x = \log_{10} 12$, $y = \log_4 2 \times \log_{10} 9$ and $z = \log_{10} 0.4$, find the values of

(i) $x - y - z$

(ii) 7^{x-y-z}

Solution:

Given:

$$x = \log_{10} 12$$

$$y = \log_4 2 \times \log_{10} 9$$

$$z = \log_{10} 0.4$$

(i) $x - y - z$

Let us substitute the given values, we get

$$x - y - z = \log_{10} 12 - \log_4 2 \times \log_{10} 9 - \log_{10} 0.4$$

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$$\begin{aligned} &= \log_{10} (3 \times 4) - \log_4 4^{1/2} \times \log_{10} 3^2 - \log_{10} 4/10 \\ &= \log_{10} 3 + \log_{10} 4 - \frac{1}{2} \log_4 4 \times 2 \log_{10} 3 - (\log_{10} 4 - \log_{10} 10) \\ &= \log_{10} 3 + \log_{10} 4 - \frac{1}{2} \times 1 \times 2 \log_{10} 3 - \log_{10} 4 + 1 \\ &= \log_{10} 3 + \log_{10} 4 - \log_{10} 3 - \log_{10} 4 + 1 \\ &= 1 \end{aligned}$$

(ii) 7^{x-y-z}

$$7^{x-y-z} = 7^1$$

$$= 7$$

10. If $\log V + \log 3 = \log \pi + \log 4 + 3 \log r$, find V in terms of other quantities.

Solution:

Given:

$$\log V + \log 3 = \log \pi + \log 4 + 3 \log r$$

Let us simplify the given expression to find V ,

$$\log (V \times 3) = \log (\pi \times 4 \times r^3)$$

$$\log 3V = \log 4\pi r^3$$

$$3V = 4\pi r^3$$

$$V = 4\pi r^3/3$$

11. Given $3 (\log 5 - \log 3) - (\log 5 - 2 \log 6) = 2 - \log n$, find n .

Solution:

Given:

$$3 (\log 5 - \log 3) - (\log 5 - 2 \log 6) = 2 - \log n$$

Let us simplify the given expression to find n ,

$$3 \log 5 - 3 \log 3 - \log 5 + 2 \log 6 = 2 - \log n$$

$$2 \log 5 - 3 \log 3 + 2 \log 6 = 2 (1) - \log n$$

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$$\log 5^2 - \log 3^3 + \log 6^2 = 2 \log 10 - \log n \text{ [Since, } 1 = \log 10 \text{]}$$

$$\log 25 - \log 27 + \log 36 - \log 10^2 = -\log n$$

$$\log n = -\log 25 + \log 27 - \log 36 + \log 100$$

$$= (\log 100 + \log 27) - (\log 25 + \log 36)$$

$$= \log (100 \times 27) - \log (25 \times 36)$$

$$= \log (100 \times 27) / (25 \times 36)$$

$$\log n = \log 3$$

$$n = 3$$

12. Given that $\log_{10} y + 2 \log_{10} x = 2$, express y in terms of x .

Solution:

Given:

$$\log_{10} y + 2 \log_{10} x = 2$$

Let us simplify the given expression,

$$\log_{10} y + \log_{10} x^2 = 2(1)$$

$$\log_{10} y + \log_{10} x^2 = 2 \log_{10} 10$$

$$\log_{10} (y \times x^2) = \log_{10} 10^2$$

$$yx^2 = 100$$

$$y = 100/x^2$$

13. Express $\log_{10} 2 + 1$ in the form $\log_{10} x$.

Solution:

Given:

$$\log_{10} 2 + 1$$

Let us simplify the given expression,

$$\log_{10} 2 + 1 = \log_{10} 2 + \log_{10} 10 \text{ [Since, } 1 = \log_{10} 10 \text{]}$$

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$$= \log_{10} (2 \times 10)$$

$$= \log_{10} 20$$

14. If $a^2 = \log_{10} x$, $b^2 = \log_{10} y$ and $a^2/2 - b^2/3 = \log_{10} z$. Express z in terms of x and y .

Solution:

Given:

$$a^2 = \log_{10} x$$

$$b^2 = \log_{10} y$$

$$a^2/2 - b^2/3 = \log_{10} z$$

Let us substitute the given values in the expression, we get

$$\log_{10} x/2 - \log_{10} y/3 = \log_{10} z$$

$$\log_{10} x^{1/2} - \log_{10} y^{1/3} = \log_{10} z$$

$$\log_{10} \sqrt{x} - \log_{10} \sqrt[3]{y} = \log_{10} z$$

$$\log_{10} \sqrt{x/\sqrt[3]{y}} = \log_{10} z$$

$$\sqrt{x/\sqrt[3]{y}} = z$$

$$z = \sqrt{x/\sqrt[3]{y}}$$

15. Given that $\log m = x + y$ and $\log n = x - y$, express the value of $\log m^2n$ in terms of x and y .

Solution:

Given:

$$\log m = x + y$$

$$\log n = x - y$$

$$\log m^2n$$

Let us simplify the given expression,

$$\log m^2n = \log m^2 + \log n$$

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$$= 2 \log m + \log n$$

By substituting the given values, we get

$$= 2(x + y) + (x - y)$$

$$= 2x + 2y + x - y$$

$$= 3x + y$$

16. Given that $\log x = m + n$ and $\log y = m - n$, express the value of $\log (10x/y^2)$ in terms of m and n .

Solution:

Given:

$$\log x = m + n$$

$$\log y = m - n$$

$$\log (10x/y^2)$$

Let us simplify the given expression,

$$\log (10x/y^2) = \log 10x - \log y^2$$

$$= \log 10 + \log x - 2 \log y$$

$$= 1 + \log x - 2 \log y$$

$$= 1 + (m + n) - 2(m - n)$$

$$= 1 + m + n - 2m + 2n$$

$$= 1 - m + 3n$$

17. If $\log x/2 = \log y/3$, find the value of y^4/x^6 .

Solution:

Given:

$$\log x/2 = \log y/3$$

Let us simplify the given expression,

By cross multiplying, we get

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$$3 \log x = 2 \log y$$

$$\log x^3 = \log y^2$$

$$\text{so, } x^3 = y^2$$

now square on both sides, we get

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

$$x^6 = y^4$$

$$y^4/x^6 = 1$$

18. Solve for x:

$$(i) \log x + \log 5 = 2 \log 3$$

$$(ii) \log_3 x - \log_3 2 = 1$$

$$(iii) x = \log 125/\log 25$$

$$(iv) (\log 8/\log 2) \times (\log 3/\log \sqrt{3}) = 2 \log x$$

Solution:

$$(i) \log x + \log 5 = 2 \log 3$$

Let us solve for x,

$$\log x = 2 \log 3 - \log 5$$

$$= \log 3^2 - \log 5$$

$$= \log 9 - \log 5$$

$$= \log (9/5)$$

$$\therefore x = 9/5$$

$$(ii) \log_3 x - \log_3 2 = 1$$

Let us solve for x,

$$\log_3 x = 1 + \log_3 2$$

$$= \log_3 3 + \log_3 2 \text{ [Since, 1 can be written as } \log_3 3 = 1]$$

$$= \log_3 (3 \times 2)$$

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$$= \log_3 6$$

$$\therefore x = 6$$

$$\text{(iii)} \quad x = \log 125 / \log 25$$

$$x = \log 5^3 / \log 5^2$$

$$= 3 \log 5 / 2 \log 5$$

$$= 3/2 \quad [\text{Since, } \log 5 / \log 5 = 1]$$

$$\therefore x = 3/2$$

$$\text{(iv)} \quad (\log 8 / \log 2) \times (\log 3 / \log \sqrt{3}) = 2 \log x$$

$$(\log 2^3 / \log 2) \times (\log 3 / \log 3^{1/2}) = 2 \log x$$

$$(3 \log 2 / \log 2) \times (\log 3 / \frac{1}{2} \log 3) = 2 \log x$$

$$3 \times 1 / (\frac{1}{2}) = 2 \log x$$

$$3 \times 2 = 2 \log x$$

$$6 = 2 \log x$$

$$\log x = 6/2$$

$$\log x = 3$$

$$x = (10)^3$$

$$= 1000$$

$$\therefore x = 1000$$

19. Given $2 \log_{10} x + 1 = \log_{10} 250$, find

(i) x

(ii) $\log_{10} 2x$

Solution:

Given:

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$$2 \log_{10} x + 1 = \log_{10} 250$$

(i) let us simplify the above expression,

$$\log_{10} x^2 + \log_{10} 10 = \log_{10} 250 \text{ [Since, 1 can be written as } \log_{10} 10]$$

$$\log_{10} (x^2 \times 10) = \log_{10} 250$$

$$(x^2 \times 10) = 250$$

$$x^2 = 250/10$$

$$x^2 = 25$$

$$x = \sqrt{25}$$

$$= 5$$

$$\therefore x = 5$$

(ii) $\log_{10} 2x$

We know that, $x = 5$

$$\text{So, } \log_{10} 2x = \log_{10} 2 \times 5$$

$$= \log_{10} 10$$

$$= 1$$

20. If $\log x/\log 5 = \log y^2/\log 2 = \log 9/\log (1/3)$, find x and y .

Solution:

Given:

$$\log x/\log 5 = \log y^2/\log 2 = \log 9/\log (1/3)$$

let us consider,

$$\log x/\log 5 = \log 9/\log (1/3)$$

$$\log x = (\log 9 \times \log 5)/\log (1/3)$$

$$= (\log 3^2 \times \log 5) / (\log 1 - \log 3)$$

$$= (2 \log 3 \times \log 5) / (-\log 3) [\log 1 = 0]$$

$$= -2 \times \log 5$$

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

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

$$= 1/5^2$$

$$= 1/25$$

Now,

$$\log y^2 / \log 2 = \log 9 / \log (1/3)$$

$$\log y^2 = (\log 9 \times \log 2) / \log (1/3)$$

$$= (\log 3^2 \times \log 2) / (\log 1 - \log 3)$$

$$= (2 \log 3 \times \log 2) / (-\log 3) [\log 1 = 0]$$

$$= -2 \times \log 2$$

$$= \log 2^{-2}$$

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

$$= 1/2^2$$

$$= 1/4$$

$$= \sqrt{(1/4)}$$

$$= 1/2$$

21. Prove the following:

(i) $3^{\log 4} = 4^{\log 3}$

(ii) $27^{\log 2} = 8^{\log 3}$

Solution:

(i) $3^{\log 4} = 4^{\log 3}$

Let us take log on both sides,

$$\text{If } \log 3^{\log 4} = \log 4^{\log 3}$$

$$\log 4 \cdot \log 3 = \log 3 \cdot \log 4$$

$$\log 2^2 \cdot \log 3 = \log 3 \cdot \log 2^2$$

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$$2 \log 2 \cdot \log 3 = \log 3 \cdot 2 \log 2$$

Which is true.

Hence proved.

$$(ii) 27^{\log 2} = 8^{\log 3}$$

Let us take log on both sides,

$$\text{If } \log 27^{\log 2} = \log 8^{\log 3}$$

$$\log 2 \cdot \log 27 = \log 3 \cdot \log 8$$

$$\log 2 \cdot \log 3^3 = \log 3 \cdot \log 2^3$$

$$\log 2 \cdot 3 \log 3 = \log 3 \cdot 3 \log 2$$

$$3 \log 2 \cdot \log 3 = 3 \log 2 \cdot \log 3$$

Which is true.

Hence proved.

22. Solve the following equations:

$$(i) \log (2x + 3) = \log 7$$

$$(ii) \log (x + 1) + \log (x - 1) = \log 24$$

$$(iii) \log (10x + 5) - \log (x - 4) = 2$$

$$(iv) \log_{10} 5 + \log_{10} (5x + 1) = \log_{10} (x + 5) + 1$$

$$(v) \log (4y - 3) = \log (2y + 1) - \log 3$$

$$(vi) \log_{10} (x + 2) + \log_{10} (x - 2) = \log_{10} 3 + 3 \log_{10} 4$$

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(vii) $\log (3x + 2) + \log (3x - 2) = 5 \log 2$

Solution:

(i) $\log (2x + 3) = \log 7$

Let us simplify the expression,

$$2x + 3 = 7$$

$$2x = 7 - 3$$

$$2x = 4$$

$$x = 4/2$$

$$= 2$$

(ii) $\log (x + 1) + \log (x - 1) = \log 24$

Let us simplify the expression,

$$\log [(x + 1) (x - 1)] = \log 24$$

$$\log (x^2 - 1) = \log 24$$

$$(x^2 - 1) = 24$$

$$x^2 = 24 + 1$$

$$= 25$$

$$x = \sqrt{25}$$

$$= 5$$

(iii) $\log (10x + 5) - \log (x - 4) = 2$

Let us simplify the expression,

$$\log (10x + 5) / (x - 4) = 2 \log 10$$

$$\log (10x + 5) / (x - 4) = \log 10^2$$

$$(10x + 5) / (x - 4) = 100$$

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$$10x + 5 = 100(x - 4)$$

$$10x + 5 = 100x - 400$$

$$5 + 400 = 100x - 10x$$

$$90x = 405$$

$$x = 405/90$$

$$= 81/18$$

$$= 9/2$$

$$= 4.5$$

$$(iv) \log_{10} 5 + \log_{10} (5x + 1) = \log_{10} (x + 5) + 1$$

Let us simplify the expression,

$$\log_{10} [5 \times (5x + 1)] = \log_{10} (x + 5) + \log_{10} 10$$

$$\log_{10} [5 \times (5x + 1)] = \log_{10} [(x + 5) \times 10] \quad [5 \times (5x + 1)] = [(x + 5) \times 10]$$

$$25x + 5 = 10x + 50$$

$$25x - 10x = 50 - 5$$

$$15x = 45$$

$$x = 45/15$$

$$= 3$$

$$(v) \log (4y - 3) = \log (2y + 1) - \log 3$$

Let us simplify the expression,

$$\log (4y - 3) = \log (2y + 1) / 3$$

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

By cross multiplying, we get

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

$$12y - 9 = 2y + 1$$

$$12y - 2y = 9 + 1$$

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$$10y = 10$$

$$y = 10/10$$

$$= 1$$

$$(vi) \log_{10}(x+2) + \log_{10}(x-2) = \log_{10}3 + 3 \log_{10}4$$

Let us simplify the expression,

$$\log_{10}[(x+2) \times (x-2)] = \log_{10}3 + \log_{10}4^3$$

$$\log_{10}[(x+2) \times (x-2)] = \log_{10}(3 \times 4^3)[(x+2) \times (x-2)] = (3 \times 4^3)$$

$$(x^2 - 4) = (3 \times 4 \times 4 \times 4)$$

$$(x^2 - 4) = 192$$

$$x^2 = 192 + 4$$

$$= 196$$

$$x = \sqrt{196}$$

$$= 14$$

$$(vii) \log(3x+2) + \log(3x-2) = 5 \log 2$$

Let us simplify the expression,

$$\log(3x+2) + \log(3x-2) = \log 2^5$$

$$\log[(3x+2) \times (3x-2)] = \log 32$$

$$\log(9x^2 - 4) = \log 32$$

$$(9x^2 - 4) = 32$$

$$9x^2 = 32 + 4$$

$$9x^2 = 36$$

$$x^2 = 36/9$$

$$x^2 = 4$$

$$x = \sqrt{4}$$

$$= 2$$

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23. Solve for x:

$$\log_3 (x + 1) - 1 = 3 + \log_3 (x - 1)$$

Solution:

Given:

$$\log_3 (x + 1) - 1 = 3 + \log_3 (x - 1)$$

Let us simplify the expression,

$$\log_3 (x + 1) - \log_3 (x - 1) = 3 + 1$$

$$\log_3 (x + 1) / (x - 1) = 4 \log_3 3 \text{ [Since, } \log_3 3 = 1 \text{]}$$

$$\log_3 (x + 1) / (x - 1) = \log_3 3^4$$

$$(x + 1) / (x - 1) = 3^4$$

By cross multiplying, we get

$$(x + 1) = 81 (x - 1)$$

$$x + 1 = 81x - 81$$

$$81x - x = 1 + 81$$

$$80x = 82$$

$$x = 82/80$$

$$= 41/40$$

$$= 1 \frac{1}{40}$$

24. Solve for x:

$$5^{\log x} + 3^{\log x} = 3^{\log x+1} - 5^{\log x - 1}$$

Solution:

Given:

$$5^{\log x} + 3^{\log x} = 3^{\log x+1} - 5^{\log x - 1}$$

Let us simplify the expression,

$$5^{\log x} + 3^{\log x} = 3^{\log x} \cdot 3^1 - 5^{\log x} \cdot 5^{-1}$$

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$$5^{\log x} + 3^{\log x} = 3 \cdot 3^{\log x} - \frac{1}{5} \cdot 5^{\log x}$$

$$5^{\log x} + \frac{1}{5} \cdot 5^{\log x} = 3 \cdot 3^{\log x} - 3^{\log x}$$

$$(1 + \frac{1}{5}) 5^{\log x} = (3 - 1) 3^{\log x}$$

$$(\frac{6}{5}) 5^{\log x} = 2(3^{\log x})$$

$$5^{\log x} / 3^{\log x} = (2 \times 5)/6$$

$$(\frac{5}{3})^{\log x} = 10/6$$

$$(\frac{5}{3})^{\log x} = 5/3$$

$$(\frac{5}{3})^{\log x} = (\frac{5}{3})^1$$

So, by comparing the powers

$$\log x = 1$$

$$\log x = \log 10$$

$$x = 10$$

25. If $\log (x-y)/2 = \frac{1}{2} (\log x + \log y)$, prove that $x^2 + y^2 = 6xy$

Solution:

Given:

$$\log (x-y)/2 = \frac{1}{2} (\log x + \log y)$$

Let us simplify,

$$\log (x-y)/2 = \frac{1}{2} (\log x \times y)$$

$$\log (x-y)/2 = \frac{1}{2} \log xy$$

$$\log (x-y)/2 = \log (xy)^{1/2}$$

$$(x-y)/2 = (xy)^{1/2}$$

By squaring on both sides, we get $[(x-y)/2]^2 = [(xy)^{1/2}]^2$

$$(x - y)^2/4 = xy$$

By cross multiplying, we get

$$(x - y)^2 = 4xy$$

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$$x^2 + y^2 - 2xy = 4xy$$

$$x^2 + y^2 = 4xy + 2xy$$

$$x^2 + y^2 = 6xy$$

Hence proved.

26. If $x^2 + y^2 = 23xy$, Prove that $\log (x + y)/5 = \frac{1}{2} (\log x + \log y)$

Solution:

Given:

$$x^2 + y^2 = 23xy$$

So, the above equation can be written as

$$x^2 + y^2 = 25xy - 2xy$$

$$x^2 + y^2 + 2xy = 25xy$$

$$(x + y)^2 = 25xy$$

$$(x + y)^2 / 25 = xy$$

Now by taking log on both sides, we get

$$\log [(x + y)^2 / 25] = \log xy$$

$$\log [(x + y)/5]^2 = \log xy$$

$$2 \log (x+y)/5 = \log x + \log y$$

$$\log (x+y)/5 = \frac{1}{2} \log x + \log y$$

Hence proved.

27. If $p = \log_{10} 20$ and $q = \log_{10} 25$, find the value of x if $2 \log_{10} (x + 1) = 2p - q$

Solution:

Given:

$$p = \log_{10} 20$$

$$q = \log_{10} 25$$

Then,

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$$2 \log_{10} (x + 1) = 2p - q$$

Now substitute the values of p and q, we get

$$2 \log_{10} (x + 1) = 2 \log_{10} 20 - \log_{10} 25$$

$$= 2 \log_{10} 20 - \log_{10} 5^2$$

$$= 2 \log_{10} 20 - 2 \log_{10} 5$$

$$2 \log_{10} (x + 1) = 2 (\log_{10} 20 - \log_{10} 5)$$

$$\log_{10} (x + 1) = (\log_{10} 20 - \log_{10} 5)$$

$$= \log_{10} (20/5)$$

$$\log_{10} (x + 1) = \log_{10} 4$$

$$(x + 1) = 4$$

$$x = 4 - 1$$

$$= 3$$

28. Show that:

$$(i) 1/\log_2 42 + 1/\log_3 42 + 1/\log_7 42 = 1$$

$$(ii) 1/\log_8 36 + 1/\log_9 36 + 1/\log_{18} 36 = 2$$

Solution:

$$(i) 1/\log_2 42 + 1/\log_3 42 + 1/\log_7 42 = 1$$

Let us consider LHS:

$$1/\log_2 42 + 1/\log_3 42 + 1/\log_7 42$$

By using the formula, $\log_n m = \log_m / \log_n$

$$1/\log_2 42 + 1/\log_3 42 + 1/\log_7 42 = 1/(\log 42/\log_2) + 1/(\log 42/\log_3) + 1/(\log 42/\log_7)$$

$$= \log_2/\log 42 + \log_3/\log 42 + \log_7/\log 42$$

$$= (\log_2 + \log_3 + \log_7)/\log 42$$

$$= (\log 2 \times 3 \times 7)/\log 42$$

$$= \log 42 / \log 42$$

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$$= \log 42 / \log 42$$

$$= 1$$

$$= \text{RHS}$$

$$(ii) \ 1/\log_8 36 + 1/\log_9 36 + 1/\log_{18} 36 = 2$$

Let us consider LHS:

$$1/\log_8 36 + 1/\log_9 36 + 1/\log_{18} 36$$

By using the formula, $\log_n m = \log_m / \log_n$

$$1/\log_8 36 + 1/\log_9 36 + 1/\log_{18} 36 = 1/(\log 36 / \log_8) + 1/(\log 36 / \log_9) + 1/(\log 36 / \log_{18})$$

$$= \log_8 / \log 36 + \log_9 / \log 36 + \log_{18} / \log 36$$

$$= (\log_8 + \log_9 + \log_{18}) / \log 36$$

$$= (\log 8 \times 9 \times 18) / \log 36$$

$$= \log 36^2 / \log 36$$

$$= 2 \log 36 / \log 36$$

$$= 2$$

$$= \text{RHS}$$

29. Prove the following identities:

$$(i) \ 1/\log_a abc + 1/\log_b abc + 1/\log_c abc = 1$$

$$(ii) \ \log_b a \cdot \log_c b \cdot \log_d c = \log_d a$$

Solution:

$$(i) \ 1/\log_a abc + 1/\log_b abc + 1/\log_c abc = 1$$

Let us consider LHS:

$$1/\log_a abc + 1/\log_b abc + 1/\log_c abc$$

By using the formula, $\log_n m = \log_m / \log_n$

$$1/\log_a abc + 1/\log_b abc + 1/\log_c abc = 1/(\log abc / \log_a) + 1/(\log abc / \log_b) + 1/(\log abc / \log_c)$$

$$= \log_a / \log abc + \log_b / \log abc + \log_c / \log abc$$

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$$= (\log_a + \log_b + \log_c) / \log abc$$

$$= (\log a \times b \times c) / \log abc$$

$$= \log abc / \log abc$$

$$= 1$$

$$= \text{RHS}$$

$$(ii) \log_b a \cdot \log_c b \cdot \log_d c = \log_d a$$

Let us consider LHS:

$$\log_b a \cdot \log_c b \cdot \log_d c = (\log a / \log b) \times (\log b / \log c) \times (\log c / \log d)$$

$$= \log a / \log d$$

$$= \log_d a$$

$$= \text{RHS}$$

30. Given that $\log_a x = 1/\alpha$, $\log_b x = 1/\beta$, $\log_c x = 1/\gamma$, find $\log_{abc} x$.

Solution:

It is given that:

$$\log_a x = 1/\alpha, \log_b x = 1/\beta, \log_c x = 1/\gamma$$

So,

$$\log_a x = 1/\alpha \Rightarrow \log x / \log_a = 1/\alpha \Rightarrow \log_a = \alpha \log x$$

$$\log_b x = 1/\beta \Rightarrow \log x / \log_b = 1/\beta \Rightarrow \log_b = \beta \log x$$

$$\log_c x = 1/\gamma \Rightarrow \log x / \log_c = 1/\gamma \Rightarrow \log_c = \gamma \log x$$

Now,

$$\log_{abc} x = \log x / \log abc$$

$$= \log x / (\log a + \log b + \log c)$$

$$= \log x / (\alpha \log x + \beta \log x + \gamma \log x)$$

$$= \log x / \log x (\alpha + \beta + \gamma)$$

$$= 1 / (\alpha + \beta + \gamma)$$

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31. Solve for x:

(i) $\log_3 x + \log_9 x + \log_{81} x = 7/4$

(ii) $\log_2 x + \log_8 x + \log_{32} x = 23/15$

Solution:

(i) $\log_3 x + \log_9 x + \log_{81} x = 7/4$

let us simplify the expression,

$$1/\log_x 3 + 1/\log_x 9 + 1/\log_x 81 = 7/4$$

$$1/\log_x 3^1 + 1/\log_x 3^2 + 1/\log_x 3^4 = 7/4$$

$$1/\log_x 3 + 1/2\log_x 3 + 1/4\log_x 3 = 7/4$$

$$1/\log_x 3 [1 + 1/2 + 1/4] = 7/4$$

$$1/\log_x 3 [(4+2+1)/4] = 7/4$$

$$\log_3 x [7/4] = 7/4$$

$$\log_3 x = (7/4) \times (4/7)$$

$$\log_3 x = 1$$

$$\log_3 x = \log_3 3 \text{ [Since, } 1 = \log_a a\text{]}$$

On comparing, we get

$$x = 3$$

(ii) $\log_2 x + \log_8 x + \log_{32} x = 23/15$

let us simplify the expression,

$$1/\log_x 2 + 1/\log_x 8 + 1/\log_x 32 = 23/15$$

$$1/\log_x 2^1 + 1/\log_x 2^3 + 1/\log_x 2^5 = 23/15$$

$$1/\log_x 2 + 1/3\log_x 2 + 1/5\log_x 2 = 23/15$$

$$1/\log_x 2 [1 + 1/3 + 1/5] = 23/15$$

$$\log_2 x [(15 + 5 + 3)/15] = 23/15$$

$$\log_2 x [23/15] = 23/15$$

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$$\log_2 x = (23/15) \times (15/23)$$

$$\log_2 x = 1$$

$$\log_2 x = \log_2 2 \text{ [Since, } 1 = \log_a a \text{]}$$

On comparing, we get

$$x = 2$$



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