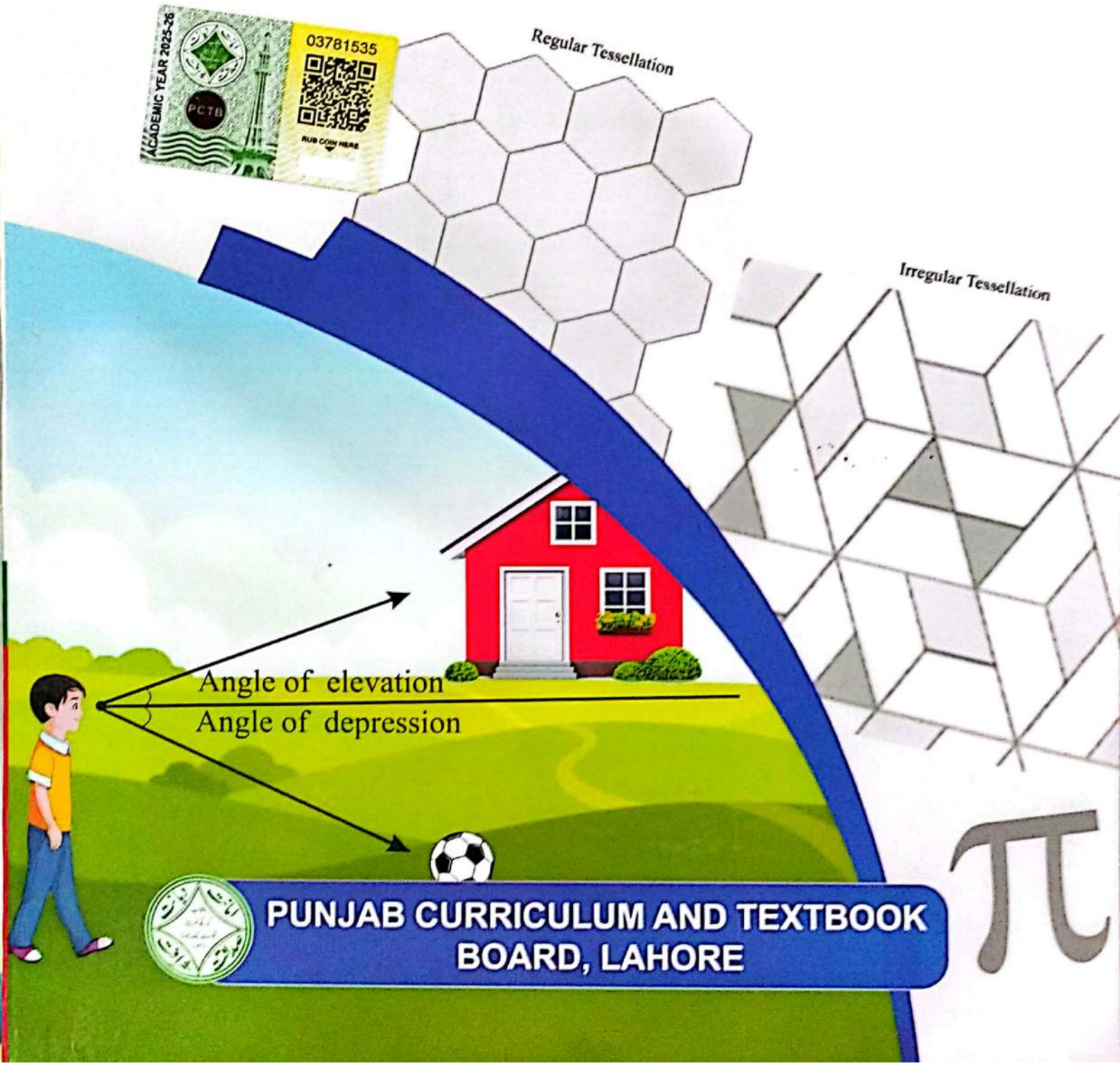
MATHEMATICS 9



PUNJAB CURRICULUM AND TEXTBOOK BOARD, LAHORE

ACADEMIC YEAR 2025-26
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UNIT 2 LOGARITHMS

EXERCISE 2.1

Q.1. Express the following numbers in scientific notation.

(i) 2000000

Sol. $= 2.000000 \times 10^6$

$= 2 \times 10^6$

(ii) 48900

Sol. $= 4.8900 \times 10^4$

$= 4.89 \times 10^4$

(iii) 0.0042

Sol. $= 4.2 \times 10^{-3}$

(iv) 0.0000009

Sol. $= 9.0 \times 10^{-7}$

(v) 73×10^3

Sol. $= 73.0 \times 10^3$

$= 7.30 \times 10^1 \times 10^3$

$= 7.30 \times 10^{1+3}$

$= 7.30 \times 10^4$

(vi) 0.65×10^2

Sol. $= 6.5 \times 10^{-1} \times 10^2$

$= 6.5 \times 10^{-1+2}$

$= 6.5 \times 10^1$

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Q.2. Express the following numbers in ordinary notation.

(i) 8.04×10^2

Sol. $= \frac{804}{100} \times 10^2$

$= \frac{804}{100} \times 100$

$= 804$

(ii) 3×10^5

Sol. $= 3 \times 100000$

$= 300000$

(iii) 1.5×10^{-2}

Sol. $= \frac{15}{10} \times 10^{-2}$

$= \frac{15}{10} - \frac{1}{10^2}$

$= \frac{15}{10 \times 100}$

$= \frac{15}{1000} = 0.015$

(iv) 1.77×10^7

Sol. $= \frac{177}{100} \times 10^7$

$= \frac{177}{100} \times 10000000$

$= 177 \times 100000$

$= 17700000$

(v) 5.5×10^{-6}

Sol. $= \frac{55}{10} \times \frac{1}{10^6} = \frac{55}{10^7}$

$= \frac{55}{10000000} = 0.0000055$

(vi) 4×10^{-5}

Sol. $= 4 \times \frac{1}{10^5}$

$= \frac{4}{100000} = 0.00004$

Q.3. The speed of light is approximately 3×10^8 metres per second. Express it in standard form.

Sol. Speed of light $= 3 \times 10^8$ m/sec

$= 3 \times 100000000$ m/sec

$= 300000000$ m/sec

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Q.4. The circumference of the Earth at the equator is about 40075000 m. Express this number in scientific notation.

Sol. Circumference of Earth at equator = 40075000 m

Scientific notation $= 4_{\wedge}0075000.0$

$= 4.0075 \times 10^7$ m/sec

Q.5. The diameter of Mars is 6.7779×10^3 km. Express this number in standard form.

Sol. Diameter of Mars $= 6.7779 \times 10^3$ km

$$\text{Standard form} = \frac{67779}{10000} \times 1000$$

$$= \frac{67779}{10}$$

$$= 6777.9 \text{ km}$$

Q.6. The diameter of Earth is about 1.2756×10^4 km. Express this number in standard form.

Sol. Diameter of Earth $= 1.2756 \times 10^4$ km

$$\text{Standard form} = \frac{12756}{10000} \times 10000$$

$$= 12756 \text{ km}$$

EXERCISE 2.2

Q.1. Express each of the following in logarithmic form:

(i) $\mathbf{10^3 = 1000}$

Sol. Logarithm form is

$$\log_{10} 1000 = 3$$

(ii) $\mathbf{2^8 = 256}$

Sol. Logarithm form is

$$\log_2 256 = 8$$

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

Sol. Logarithm form is

$$\text{Log}_3 \frac{1}{27} = -3$$

(iv) $20^2 = 400$

Sol. Logarithm form is

$$\log_{20} 400 = 2$$

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

Sol. Logarithm form is

$$\log_{16} \frac{1}{2} = \frac{1}{4}$$

(vi) $11^2 = 121$

Sol. Logarithm form is

$$\log_{11} 121 = 2$$

(vii) $p = q^r$

Sol. or $q^r = p$

Logarithm form is

$$\log_q p = r$$

(viii) $(32)^{-\frac{1}{5}} = \frac{1}{2}$

Sol. Logarithm form is

$$\log_{32} \frac{1}{2} = -\frac{1}{5}$$

Q.2. Express each of the following in exponential form:

(i) $\log_5 125 = 3$

Sol. Exponential form is

$$5^3 = 125$$

(ii) $\log_2 16 = 4$

Sol. Exponential form is

$$2^4 = 16$$

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(iii) $\log_{23} 1 = 0$

Sol. Exponential form is

$$23^0 = 1$$

(iv) $\log_5 5 = 1$

Sol. Exponential form is

$$5^1 = 5$$

(v) $\log_2 \frac{1}{8} = -3$

Sol. Exponential form is

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

(vi) $\frac{1}{2} = \log_9 3$

Sol. Exponential form is

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

(vii) $5 = \log_{10} 100000$

Sol. Exponential form is

$$10^5 = 100000$$

(viii) $\log_4 \frac{1}{16} = -2$

Sol. Exponential form is

$$4^{-2} = \frac{1}{16}$$

Q.3. Find the value of x in each of the following:

(i) $\log_x 64 = 3$

Sol. Exponential form is

$$x^3 = 64$$

$$\Rightarrow \quad x^3 = 4^3$$

$$\Rightarrow \quad x = 3$$

($\because$ Powers are equal to bases are also equal)

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(ii) $\log_5 1 = x$

Sol. Exponential form is

$$5^x = 1$$

$$5^x = 5^0$$

$$\Rightarrow \quad x = 0$$

(iii) $\log_x 8 = 1$

Sol. Exponential form is

$$x^1 = 8$$

$$\Rightarrow \quad x = 8$$

(iv) $\log_{10} x = -3$

Sol. Exponential form is

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

$$\Rightarrow \quad x = 10^{-3}$$

$$= \frac{1}{10^3}$$

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

(v) $\log_4 x = \frac{3}{2}$

Sol. Exponential form is

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

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

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

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

$$x = 2^3$$

$$x = 8$$

(vi) $\log_2 1024 = x$

Sol. Exponential form is

$$2^x = 1024$$

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

$$\Rightarrow \quad x = 10$$

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EXERCISE 2.3

Q.1. Find characteristic of the following numbers:

(i) 5287

Sol. 5287.0

No. of digits to left of decimal point = 4

Characteristic $= 4 - 1$

$= 3$

Other Method

We express 5287 in scientific notation as

5^287.0

$= 5.287 \times 10^3$

Characteristic of 5287 = 3

(ii) 59.28

Sol. No. of digits to left of decimal point = 2

Characteristic of 59.28 = 2 – 1 = 1

OR

59.28 = 5^9.28

$= 5.928 \times 10^1$

Characteristic of 59.28 = 1

(iii) 0.0567

Characteristic

= –(number of zeroes between the decimal point and the first non-zero digit +1)

$= -(1 + 1)$

$= -2$ or $\overline{2}$

OR

0.05^67 $= 5.67 \times 10^{-2}$

Characteristic of 0.0567 = –2 or $\overline{2}$

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(iv) **234.7**

Sol. Characteristic of 234.7

$= 3 - 1$

$= 2$

OR

Scientific notation $= 2_{\wedge}34.7$

$= 2.347 \times 10^2$

Characteristic $= 2$

(v) **0.000049**

Sol. Scientific notation is 4.9×10^{-5}

Characteristic $= -5$

(vi) **145000**

Sol. No. of digits to left of decimal part = 6

Characteristic $= 6 - 1$

$= 5$

OR

$1_{\wedge}45000.0$

$= 1.45 \times 10^5$

Characteristic = 5

Q.2. **Find logarithm of the following numbers:**

(i) **43**

Sol. $\log 43 = ?$

$= \log(4.3 \times 10^1)$

$= 1 + 0.6335$

$\log 43 = 1.6335$

(ii) **579**

Sol. $\log 579 = ?$

$= \log(5.79 \times 10^2)$

$= 2 + 0.7627$

$\log 579 = 2.7627$

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(iii) **1.982**

Sol. $\log 1.982 = ?$

$= \log(1.982 \times 10^0)$

$= 0 + 1.982$

$\log 1.982 = 0.2971$

(iv) **0.0876**

Sol. $\log 0.0876 = ?$

$= \log(8.76 \times 10^{-2})$

$= -2 + 0.9425$

$\log 0.0876 = \overline{2}.9425$

(v) **0.047**

Sol. $\log 0.047 = ?$

$= \log(4.70 \times 10^{-2})$

$= -2 + 0.6721$

$\log 0.047 = \overline{2}.6721$

(vi) **0.000354**

Sol. $\log 0.000354 = ?$

$= \log(3.54 \times 10^{-4})$

$= -4 + 0.5490$

$\log 0.000354 = \overline{4}.5490$

Q.3. **If log 3.177 = 0.5019, then find:**

(i) **log 3177**

Sol. $\log 3177 = ?$

$\log 3177 = \log(3.177 \times 10^3)$

$= 3 + 0.5019$ $(\because \log 3.177 = 0.5019)$

$\log 3177 = 3.5019$

(ii) **log 31.77**

Sol. $\log 31.77 = ?$

$\log 31.77 = \log(3.177 \times 10^1)$

$= 1 + 0.5019$ $(\because \log 3.177 = 0.5019)$

$\log 31.77 = 1.5019$

(iii) **log 0.03177**

Sol. $\log 0.03177 = ?$

$= \log(3.177 \times 10^{-2})$

$= -2 + 0.5019$

$\log 0.03177 = \bar{2}.5019$

Q.4. **Find the value of x.**

(i) **log x = 0.0065**

Sol. $x = \text{antilog } 0.0065$

$x = 1.015$ (see antilog table)

$x = 1.015$

(ii) **log x = 1.192**

Sol. $x = \text{antilog } 1.192$

$x = 15.56$

(iii) **log x = –3.434**

Sol. $x = \text{antilog } -3.434$

$x = 0.002716$

(iv) **log x = –1.5726**

Sol. $x = \text{antilog } -1.5726$

$x = 0.3738$

(v) **log x = 4.3561**

Sol. $x = \text{antilog } 4.3561$

$x = 22710$

(vi) **log x = –2.0184**

Sol. $x = \text{antilog}(-2.0184)$

$x = -3 + 3 - 2.0184$

$x = -3 + 0.9816$

$x = \bar{3}.9816$

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Characteristics

$$x = -3$$

Table value of

$$0.9816 = 9585$$

So $$x = 0.009585$$

EXERCISE 2.4

Q.1. Without using calculator, evaluate the following?

(i) $\log_2 18 - \log_2 9$

Sol. $= \log_2 \frac{18}{9}$

$= \log_2 2 = 1$

(ii) $\log_2 64 - \log_2 2$

Sol. $= \log_2 \frac{64}{2}$

$= \log_2 32$

$= \log_2 2^5$

$= 5 \log_2 2 = 5(1) = 5$

(iii) $\frac{1}{3} \log_3 8 - \log_3 18$

Sol. $= \log_3 8^{1/3} - \log_3 18$

$= \log_3 (2^3)^{1/3} - \log_3 18$

$= \log_3 2 - \log_3 (2 \times 9)$

$= \log_3 2 - \log_3 2 - \log_3 9$

$= -\log_3 9$

$= -\log_3 3^2$

$= -2 \log_3 3$

$= -2(1) = -2$ $\quad (\because \log_3 3 = 1)$

(iv) $2 \log 2 + \log 25$

Sol. $= \log 2^2 + \log 25$

$= \log 4 + \log 25$

$= \log 4 \times 25$

$= \log 100$

$= \log 10^2$

$= 2\log 10$

$= 2(1)$ $\quad (\because \log 10 = 1)$

$= 2$

(v) $\frac{1}{3}\log_4 64 + 2\log_5 25$

Sol. $= \log_4 (64)^{1/3} + 2\log_5 5^2$

$= \log_4 (4^3)^{1/3} + 2 \times 2\log_5 5$

$= \log_4 4 + 4\log_5 5$ $\quad (\because \log_4 4 = \log_5 5 = 1)$

$= 1 + 4(1)$

$= 1 + 4 = 5$

(vi) $\log_5 12 + \log_3 0.25$

Sol. $= \log_3 (12 \times 0.25)$

$= \log_3 (3)$

$= 1$

Q.2. Write as a single logarithm.

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

Sol. $= \log 25^{1/2} + \log 3^2$

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

$= \log 5 + \log 9$

$= \log (5 \times 9)$

$= \log 45$

(ii) $\log 9 - \log \frac{1}{3}$

Sol. $= \log \frac{9}{\frac{1}{3}}$

$= \log (9 \times 3)$

$= \log 27$

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(iii) $\log_5 b . \log_a 5$

Sol. $= 2 \times 3 \log_5 b . \log_a 5$

$= 6 \log_b 5 \log_a 5$

By change of Base Law

$= 6 \log_a b$

$\log_b x = \dfrac{\log_a x}{\log_a b}$

$\log_b x \log_a b = \log_a x$

(iv) $2\log_3 x + \log_3 y$

Sol. $= \log_3 x^2 + \log_3 y$

$= \log_3 x^2 y$

(v) $4\log_5 x - \log_5 y + \log_5 z$

Sol. $= \log_5 x^4 - \log_5 y + \log_5 z$

$= \log_5 x^4 + \log_5 z - \log_5 y$

$= \log_5 x^4 z - \log_5 y$

$= \log_5 \left(\dfrac{x^4 z}{y}\right)$

(vi) $2 \ln a + 3 \ln b - 4 \ln c$

Sol. $= \ln a^2 + \ln b^3 - \ln c^4$

$= \ln (a^2 \times b^3) - \ln c^4$

$= \ln a^2 b^3 - \ln c^4$

$= \ln \left(\dfrac{a^2 b^3}{c^4}\right)$

Q.3. Expand the following logarithms:

(i) $\log\left(\dfrac{11}{5}\right)$

Sol. $= \log 11 - \log 5$

(ii) $\log_5 \sqrt{8a^6}$

Sol. $= \log_5 (8a^6)^{1/2}$

$= \dfrac{1}{2} \log_5 8a^6$

$= \dfrac{1}{2} [\log_5 8 + \log_5 a^6]$

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OR.

$$= \log_5 (8a^6)^{1/2}$$

$$= \log_5 \left(2\sqrt{2}a^3\right)$$

$$= \log_5 2 + \log_5 \sqrt{2} + \log_5 a^3$$

$$= \log_5 2 + \frac{1}{2} \log_5 2 + 3\log_5 a$$

$$= \frac{3}{2} \log_5 2 + 3\log_5 a$$

(iii) $\ln\left(\frac{a^2b}{c}\right)$

Sol. $= \ln a^2b - \log c$

$$= \ln a^2 + \log b - \ln c$$

$$= 2\ln a + \log b - \ln c$$

(iv) $\log\left(\frac{xy}{z}\right)^{\frac{1}{9}}$

Sol. $= \frac{1}{9} \log\left(\frac{xy}{z}\right)$

$$= \frac{1}{9} [\log (xy) - \log z]$$

$$= \frac{1}{9} [\log x + \log y - \log z]$$

(v) $\ln\sqrt[3]{16x^3}$

Sol. $= \ln (16x^3)^{1/3}$

$$= \frac{1}{3} \ln 16x^3$$

$$= \frac{1}{3} [\ln 16 + \ln x^3]$$

$$= \frac{1}{3} [\ln 16 + 3\ln x]$$

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(vi) $\log_2\left(\frac{1-a}{b}\right)^5$

Sol. $= 5\log_2\left(\frac{1-a}{b}\right)$

$= 5[\log_2(1-a) - \log_2 b]$

Q.4. Find the value of x in the following equations:

(i) $\log 2 + \log x = 1$

Sol. $\log(2 \times x) = \log 10 \quad (\because \log 10 = 1)$

$\Rightarrow \quad \log 2x = \log 10$

$2x = 10$

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

$x = 5$

(ii) $\log_2 x + \log_2 8 = 5$

Sol. $\log_2(x \times 8) = 5$

$\log_2 8x = 5$

Exponential form is

$8x = 2^5$

$8x = 32$

$x = \frac{32}{8}$

$x = 4$

(iii) $(81)^x = (243)^{x+2}$

Sol. $(3^4)^x = (3^5)^{x+2}$

$3^{4x} = 3^{5x+10}$

Bases are equal so powers/exponents are equal.

$4x = 5x + 10$

$5x - 4x = -10$

$x = -10$

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(iv) $\left(\frac{1}{27}\right)^{x-6} = 27$

Sol. $\left(\frac{1}{3^3}\right)^{x-6} = 3^3$

$3^{-3x+18} = 3^3$

$\Rightarrow \quad -3x + 18 = 3$

$-3x = -15$

$x = \frac{-15}{-3}$

$x = 5$

(v) $\log(5x - 10) = 2$

Sol. Exponential form is

$5x - 10 = 10^2$

$5x - 10 = 100$

$5x = 100 + 10$

$5x = 110$

$x = \frac{110}{5}$

$x = 22$

(vi) $\log_2 (x + 1) - \log_2 (x - 4) = 2$

Sol. $\log_2 \frac{x+1}{x-4} = 2$

Exponential form is

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

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

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

$4x - 16 = x + 1$

$4x - x = 16 + 1$

$3x = 17$

$x = \frac{17}{3} = 5\frac{2}{3}$

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Q.5. Solve with the help of logarithm table:

(i) $\dfrac{3.68 \times 4.21}{5.234}$

Sol. Taking log of both sides

$$\log x = \log \frac{3.68 \times 4.21}{5.234}$$

$$= \log(3.68 \times 4.21) - \log 5.234$$

$$= \log 3.68 + \log 4.21 - \log 5.234$$

$$= \log (3.68 \times 10^0) + \log (4.21 \times 10^0) - \log (5.234 \times 10^0)$$

$$= 0 + 0.5658 + 0.6243 - (0 + 0.7188)$$

$$\log x = 0.4713$$

$$x = \text{antilog } (0.4713)$$

$$x = 2.960$$

So, $\dfrac{3.68 \times 4.21}{5.234} = 2.960$

(ii) $\mathbf{4.67 \times 2.11 \times 2.397}$

Sol. Let $x = 4.67 \times 2.11 \times 2.397$

$$\log x = \log(4.67 \times 2.11 \times 2.397)$$

$$= \log 4.67 + \log 2.11 + \log 2.397$$

$$= \log (4.97 \times 10^0) + \log (2.11 \times 10^0) + \log (2.397 \times 10^0)$$

$$= 0 + 0.6693 + 0.3243 + 0 + 0.3798$$

$$= \log x \ 1.3734$$

$$x = \text{antilog } (1.3734)$$

$$x = 23.62$$

So, $4.67 \times 2.11 \times 2.397 = 23.62$

(iii) $\dfrac{(20.46)^2 \times (2.4122)}{754.3}$

Sol. Let $x = \dfrac{(20.46)^2 \times 2.4122}{754.3}$

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$$\log x = \log \frac{(20.46)^2 \times 2.4122}{754.3}$$

$$= \log (20.46)^2 + \log 2.4122 - \log 754.3$$

$$= 2\log (2_\wedge 0.46) + \log 2.4122 - \log 7_\wedge 54.3$$

$$= 2\log(2.046 \times 10^1) + \log(2.4122 \times 10^0) - \log(7.543 \times 10^2)$$

$$= 2[1 + 0.3109] + (0 + 0.3824) - (2 + 0.8776)$$

$$= 2(1.3109) + 0.3824 - 2.8776$$

$$= 2.6218 + 0.3824 - 2.8776$$

$$\log x = 0.1266$$

$$x = \text{antilog } 0.1266$$

$$x = 1.339$$

So, $$\frac{(20.46)^2 \times 2.4122}{754.3} = 1.339$$

(iv) $$\frac{\sqrt[3]{9.364} \times 21.64}{3.21}$$

Sol. Let $$x = \frac{\sqrt[3]{9.364} \times 21.64}{3.21}$$

$$\log x = \log \frac{\sqrt[3]{9.364} \times 21.64}{3.21}$$

$$= \log \frac{(9.364)^{1/3} \times 21.64}{3.21}$$

$$= \log (9.364)^{1/3} + \log 21.64 - \log 3.21$$

$$= \frac{1}{3} \log (9.364) + \log (2_\wedge 1.64) - \log (3.21)$$

$$= \frac{1}{3} \log(9.364 \times 10^0) + \log(2.164 + 10^1) - \log(3.21 \times 10^0)$$

$$= \frac{1}{3} [0 + 0.9715] + [1 + 0.3353] - [0 + 0.5065]$$

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$$= \frac{1}{3}(0.9715) + 1.3353 - 0.5065$$

$$= 0.3238 + 1.3353 - 0.5065$$

$$\log x = 1.1526$$

$$x = \text{antilog } 1.1526$$

$$x = 14.21$$

So, $$\frac{\sqrt[3]{9.364} \times 21.64}{3.21} = 14.21$$

Q.6. The formula for measure the magnitude of earthquake is given by $M = \log_{10}\left(\frac{A}{A_0}\right)$. If amplitude (A) is 10,000 and reference amplitude (A_0) is 10. What is the magnitude of the earthquake?

Sol. $M = \log_{10}\left(\frac{A}{A_0}\right)$

Put $A = 10000$, $A_0 = 10$ in above formula.

$$M = \log_{10}\left(\frac{10000}{10}\right)$$

$$= \log_{10} 10000 - \log_{10} 10$$

$$= \log_{10} 10^4 - \log_{10} 10$$

$$= 4 \log_{10} 10 - \log_{10} 10$$

$$= 4(1) - 1 \qquad (\because \log_{10} 10 = 1)$$

$$= 4 - 1$$

$$M = 3$$

So magnitude of the earthquake is 3.

Q.7 Abdullah invested Rs.100,000 in a saving scheme and gains interest at the rate of 5% per annum so that the total value of this investment after t years is Rs y. This is modeled by an equation $y = 100{,}000(1.05)^t$, $t \geq 0$. Find after how many years the investment will be double.

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Sol. $y = 100000\,(1.05)^t$

Total value of investment $= 100000 + 5\%$ of 100000

$= 100000 + 5000$

$=$ Rs.105000

By given condition, after t years, amount is doubled. i.e.
$2 \times 105000 =$ Rs.210000

Now,
$$210000 = 100000\,(1.05)^t$$
$$\frac{21}{10} = (1.05)^t$$
$$\log \frac{21}{10} = \log (1.05)^t$$
$$\log 2.1 = t \log (1.05)$$
$$0.3222 = t(0.0212)$$
$$t = \frac{0.3222}{0.0212}$$
$$t = 15 \text{ years}$$

Q.8. Huria is hiking up a mountain where the temperature decreases by 3% (or a factor of 0.97) for every 100 metres gained in altitude. The initial temperature at sea level is 20°C. Using the formula $T = T_i \times (0.97)^{\frac{h}{100}}$, calculate the temperature (T_i) at an altitude of 500 metres.

Sol. Initial temperature $= T_i = 20^0$

Altitude $= h = 500$ m

$$T = T_i \times (0.97)^{\frac{h}{100}}$$
$$= 20 \times (0.97)^{\frac{500}{100}}$$
$$T = 20 \times 0.97^5 = 20 \times 0.8587 = 17.174$$
$$\log T = \log 17.174$$
$$= 1 + 0.2349$$

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$\log T = 1.2349$

$T = \text{antilog } 1.2349$

$T = 17_{\wedge}18$

$T = 17.18$

REVIEW EXERCISE 2

Q.1. Choose the correct option.

(i) The standard form of 5.2×10^6 is:

(a) 52,000 (b) 520,000

(c) 5,200,000 (d) 52,000,000

Sol. 5.2×10^6

$= \frac{52}{10} \times 1000000$

$= 52 \times 100000$

$= 5,200,000$

So, option (c) is correct.

(ii) Scientific notation of 0.00034 is:

(a) 3.4×10^3 (b) 3.4×10^{-4}

(c) 3.4×10^4 (d) 3.4×10^{-3}

Sol. $0.0003_{\wedge}4$

$= 3.4 \times 10^{-4}$

So, option (b) is correct.

(iii) The base of common logarithm is:

(a) 2 (b) 10

(c) 5 (d) e

Sol. Base of common logarithm is e.

So, option (d) is correct.

(iv) $\log_2 2^3 =$ _____

(a) 1 (b) 2

(c) 5 (d) 3

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Sol. $\log_2 2^3 = 3\log_2 2$

$= 3(1)$ $\quad (\because \log_2 2 = 1)$

$= 3$

So, option (d) is correct.

(v) $\log 100 =$ _____

(a) 2 (b) 3

(c) 10 (d) 1

Sol. $\log 100 = \log 10^2$

$= 2\log 10$

$= 2(1)$

$= 2$

So, option (a) is correct.

(vi) If $\log 2 = 0.3010$, then $\log 200$ is:

(a) 1.3010 (b) 0.6010

(c) 2.3010 (d) 2.000

Sol. $\log 2 = 0.3010$

$\log 200 = \log (2 \times 100)$

$= \log 2 + \log 100$

$= \log 2 + \log 10^2$

$= \log 2 + 2 \log 10$

$= 0.3010 + 2(1)$

$= 0.3010 + 2$

$= 2.3010$

So, option (c) is correct.

(vii) $\log (0) =$

(a) positive (b) negative

(c) zero (d) undefined

Sol. $\log (0)$ is undefined.

So, option (d) is correct.

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(viii) log 10,000 =

(a) 2 (b) 3

(c) 4 (d) 5

Sol. log 10,000

$= \log 10^4$

$= 4 \log 10$

$= 4(1)$

$= 4$

So, option (c) is correct.

(ix) log 5 + log 3 = _____

(a) log 0 (b) log 2

(c) $\log\left(\frac{5}{3}\right)$ (d) log 15

Sol. log 5 + log 3

$= \log (5 \times 3)$

$= \log 15$

So, option (d) is correct.

(x) The logarithmic form of $3^4 = 81$ is:

(a) $\log_3 4 = 81$ (b) $\log_4 3 = 81$

(c) $\log_3 81 = 4$ (d) $\log_4 81 = 3$

Sol. $3^4 = 81$

logarithm form is

$\log 81 = 4$

So, option (c) is correct.

Q.2. While each number in scientific notations.

(i) 0.000567

Sol. $= 5.67 \times 10^{-4}$

(ii) 734

Sol. $= 7.34 \times 10^2$

(iii) 0.33×10^3

Sol. $= \frac{33}{100} \times 10^3$

$= 33 \times 10^{-2} \times 10^{3}$

$= 33 \times 10^{-2+3}$

$= 3.3 \times 10^{1}$

$= 3.3 \times 10^{1} \times 10^{1}$

$= 3.3 \times 10^{2}$

Q.3. Convert the following numbers in ordinary notation.

(i) $\mathbf{2.6 \times 10^{3}}$

Sol. $= \frac{26}{10} \times 1000 = 26 \times 100 = 2600$

(ii) $\mathbf{8.794 \times 10^{-4}}$

Sol. $= \frac{8794}{1000} \times \frac{1}{10^{4}} = \frac{8794}{1000} \times \frac{1}{10000}$

$= \frac{8794}{10000000} = 0.00008794$

(iii) $\mathbf{6 \times 10^{-6}}$

Sol. $= \frac{6}{10^{6}} = \frac{6}{1000000} = 0.000006$

Q.4. Express each of the following in logarithmic form.

(i) $\mathbf{3^{7} = 2187}$

Sol. Logarithmic form is

$\log_3 2187 = 7$

(ii) $\mathbf{a^{b} = c}$

Sol. Logarithmic form is

$\log_a c = b$

(iii) $\mathbf{(12)^{2} = 144}$

Sol. Logarithmic form is

$\log_{12} 144 = 2$

Q.5. Express each of the following is exponential form.

(i) $\mathbf{\log_4 8 = x}$

Sol. $4^{x} = 8$

(ii) $\mathbf{\log_9 729 = 3}$

Sol. Exponential form is

$9^{3} = 729$

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(iii) $\log_4 1024 = 5$

Sol. Exponential form is

$$4^5 = 1024$$

Q.6. Find value of x

(i) $\log_9 x = 0.5$

Sol. Exponential form's

$$x = 9^{0.5}$$

$$x = \sqrt{9}$$

$$x = 3$$

(ii) $\left(\frac{1}{9}\right)^{3x} = 27$

Sol.

$$\left(\frac{1}{3^2}\right)^{3x} = 27$$

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

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

$$-6x = 3$$

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

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

(iii) $\left(\frac{1}{32}\right)^{2x} = 64$

Sol.

$$\left(\frac{1}{2^5}\right)^{2x} = 64$$

$$(2^{-5})^{2x} = 2^6$$

$$2^{-10x} = 2^6$$

$$-10x = 6$$

$$x = \frac{-6}{10}$$

$$x = \frac{-3}{5}$$

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Q.7. Write as a single logarithm.

(i) $7 \log x - 3 \log y^2$

Sol. $= \log x^7 - \log y^{2\times3}$

$= \log x^7 - \log y^6$

$= \log \frac{x^7}{y^6}$

(ii) $3 \log 4 - \log 32$

Sol. $= \log 4^3 - \log 32$

$= \log 64 - \log 32$

$= \log \frac{64}{32}$

$= \log 2$

(iii) $\frac{1}{3}(\log_5 8 + \log_5 27) - \log_5 3$

Sol. $= \frac{1}{3} \log_5 (8 + 27)^{1/3} - \log_5 3$

$= \log_5 (8 \times 27)^{1/3} - \log_5 3$

$= \log_5 (8^{1/3} \times 27^{1/3}) - \log_5 3$

$= \log_5 (2 \times 3) - \log_5 3$

$= \log_5 6 - \log_5 3$

$= \log_5 \left(\frac{6}{3}\right)$

$= \log_5 2$

Q.8. Expand the following logarithms:

(i) $\log (x\, y\, z^6)$

Sol. $= \log x + \log y + \log z^6$

$= \log x + \log y + 6 \log z$

(ii) $\log_3 \sqrt[6]{m^5 n^3}$

Sol. $= \log_3 (m^5 n^3)^{1/6}$

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$$= \frac{1}{6} \log_3 (m^5 n^3)$$

$$= \frac{1}{6} [\log_3 m^5 + \log_3 n^3]$$

$$= \frac{1}{6} [5\log 3\ m + 3 \log_3 n]$$

(iii) $\log \sqrt{8x^3}$

Sol. $= \log (8x^3)^{1/2}$

$$= \frac{1}{2} \log 8x^3$$

$$= \frac{1}{2} [\log 8 + \log x^3]$$

$$= \frac{1}{2} [\log 2^3 + \log x^3]$$

$$= \frac{1}{2} [3\log 2 + 3\log x]$$

Q.9. Find the values of the following with the help of logarithm table:

(i) $\sqrt[3]{68.24}$

Sol. Let $x = \sqrt[3]{68.24}$

$$\log x = \log \sqrt[3]{68.24}$$

$$= \frac{1}{3} \log 6_{\wedge}8.24$$

$$= \frac{1}{3} \log (6.824 \times 10^1)$$

$$= \frac{1}{3} (1 + 0.8341)$$

$$= \frac{1}{3} (1.8341)$$

$$\log x = 0.6114$$

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$x = \text{antilog } 0.6114$

$x = 4.087$

So, $\sqrt[3]{68.24} = 4.087$

(ii) $\mathbf{319.8 \times 3.543}$

Sol. Let $x = 319.8 \times 3.543$

$\log x = \log (319.8 \times 3.543)$

$= \log 3_\wedge 19.8 + \log 3.543$

$= \log (3.198 \times 10^2) + \log (3.543 \times 10^0)$

$= 2 + 0.5049 + 0 + 0.5494$

$\log x = 3.0543$

$x = \text{antilog } 3.0543$

$x = 1134_\wedge 0$

$x = 1134$

(iii) $\mathbf{\dfrac{36.12 \times 750.9}{113.2 \times 9.98}}$

Sol. Let $x = \dfrac{36.12 \times 750.9}{113.2 \times 9.98}$

$\log x = \log \dfrac{36.12 \times 750.9}{113.2 \times 9.98}$

$= \log (36.12 \times 750.9) - \log(113.2 \times 9.98)$

$= \log 3_\wedge 6.12 + \log 7_\wedge 50.9 - \log 1_\wedge 13.2 - \log 9.98$

$= \log (3.612 \times 10^1) + \log(7.509 \times 10^2) -$

$\log (1.132 \times 10^2) - \log (9.98 \times 10^0)$

$= 1 + 0.5577 + 2 + 0.8756 - (2 + 0.0539) - (0 + 0.9991)$

$= 1.5577 + 2.8756 - 2.0539 - 0.9991$

$= 1.3803$

$x = \text{antilog } 1.3803$

$x = 24.01$

So, $\dfrac{36.12 \times 750.9}{113.2 \times 9.98} = 24.01$

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Q.10. In the year 2016, the population of a city was 22 millions and was growing at a rate of 2.5% per year. The function $p(t) = 22(1.025)^t$ gives the population in millions, t years after 2016. Use the model to determine in which year the population will reach 35 millions. Round to the nearest year.

Sol. $p(t) = 22(1.025)^t$

Here

$p(t) = 35$ million

So, $35 = 22(1.025)^t$

$$\log 35 = \log(22(1.025)^t)$$

$$\log(3.5 \times 10^1) = \log 22 + \log(1.025)^t$$

$$1 + 0.5441 = 1 + 0.3424 + t \log(1.025)$$

$$1.5441 = 1.3424 + t(\log 1.025 \times 10^0)$$

$$1.5441 - 1.3424 = t(0 + 0.0107)$$

$$0.2117 = t(0.0107)$$

$$t = \frac{0.2117}{0.0107}$$

$$= 19.8 \text{ years}$$

$$t \approx 20 \text{ years}$$

So, in 2035, population will reach 35 millions.

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