Logarithms (Advanced)

Standard difficulty · 20 questions · 40 marks · Time: 32 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The value of $\log_2 16$ is:
(a) −4 **(b)** 5 **(c)** 8 **(d)** 4

2. $\log_5 1375 + \log_5 5 - \log_5 11$ equals:
(a) 8 **(b)** 3 **(c)** 4 **(d)** 5

3. $\log_a 1$ equals ($a > 0$, $a \neq 1$):
(a) a **(b)** undefined **(c)** 1 **(d)** 0

4. $\log_3 5 \times \log_5 243$ equals:
(a) 15 **(b)** 6 **(c)** 5 **(d)** 4

5. If $\log_5 2 = p$ and $\log_5 3 = q$, then $\log_5 20$ equals:
(a) 3p + 1 **(b)** 2q + 1 **(c)** 2p + 2 **(d)** 2p + 1

6. On the Richter scale, an earthquake of magnitude 7 compared with one of magnitude 5 is:
(a) 7/5 times as strong **(b)** 2 times as strong
(c) 20 times as strong **(d)** 100 times as strong

7. $pH = -\log_{10}[H^+]$. How many times as acidic is a solution of pH 4 as one of pH 6?
(a) 1,000 **(b)** 2 **(c)** 100 **(d)** 20

8. The solution of $\log_3 (5x + 66) = 4$ is:
(a) x = 3 **(b)** x = 4 **(c)** x = 2 **(d)** x = 5

Section B — Short answer — 8 × 2 = 16 marks

9. Write as a single logarithm: $3 + \log_2 14$.

10. Find the exact value of $\log_{25} 5$.

11. Solve $\log_7 x + \log_7 (x - 6) = 1$.

12. Solve $(\log_5 x)^2 - 5 \log_5 x + 4 = 0$.

13. Solve $\log_5 (\log_3 (\log_7 x)) = 0$.

14. Solve $2 \log_2 x = \log_2 (2x + 15)$.

15. Find the value of $\log_3 (1/2) + \log_3 (2/3) + \log_3 (3/4) + \ldots + \log_3 (26/27)$.

16. If $\log_{10} 2 = a$ and $\log_{10} 3 = b$, express $\log_{10} 135$ in terms of a and b.

Section C — Word problems — 4 × 4 = 16 marks

17. (a) On the Richter scale, how many times as strong is an earthquake of magnitude 7 as one of magnitude 3? (b) A solution has $[H^+] = 10^{-4}$ mol per litre. Find its pH, given $pH = -\log_{10} [H^+]$. (c) Another solution is 10 times as acidic. Find its pH.

18. Solve $\log_{10} (x + 8) + \log_{10} (x - 187) = 3$, and check each root.

19. Solve $(\log_5 x)^2 + \log_5 x^2 = 24$.

20. Given $\log_{10} 2 = 0.3010$ and $\log_{10} 3 = 0.4771$, find (a) $\log_{10} 432$ (b) $\log_{10} 2{,}250$ (c) $\log_{10} 0.72$.

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Answer key

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Q	Answer	Working
1	**(d) 4**	$16 = 2^4$
2	**(c) 4**	$\log_5 (1375 \times 5 \div 11) = \log_5 625 = 4$
3	**(d) 0**	$a^0 = 1$
4	**(c) 5**	change of base: $\log_3 5 \times \log_5 243 = \log_3 243 = 5$
5	**(d) 2p + 1**	$20 = 2^2 \times 5$
6	**(d) 100 times as strong**	each unit is 10 times: $10^2 = 100$
7	**(c) 100**	$[H^+]$ = 10 to the power −pH; $10^6 \div 10^4 = 10^2$
8	**(a) x = 3**	$5x + 66 = 3^4 = 81$, so $5x = 15$
9	**$\log_2 112$**	$3 = \log_2 8$; $\log_2 8 + \log_2 14 = \log_2 (8 \times 14)$
10	**1/2**	$25 = 5^2$ and $5 = 5^1$, so the value is 1/2
11	**x = 7**	$x(x - 6) = 7^1 = 7$; $(x - 7)(x + 1) = 0$; $x = -1$ is rejected (log of a negative number)
12	**x = 5 or x = 625**	put $y = \log_5 x$: $(y - 1)(y - 4) = 0$, so y = 1 or 4; both values of x are positive
13	**x = 343**	$\log_3 (\log_7 x) = 5^0 = 1$; $\log_7 x = 3^1 = 3$; $x = 7^3$
14	**x = 5**	$x^2 = 2x + 15$; $(x - 5)(x + 3) = 0$; $x = -3$ is rejected ($\log_2 (-3)$ is not defined)
15	**−3**	product rule: $\log_3 (1/2 \times 2/3 \times \ldots \times 26/27) = \log_3 (1/27) = -3$
16	**−a + 3b + 1**	$135 = 3^3 \times 5$, and $\log_{10} 5 = \log_{10} (10/2) = 1 - a$
17	**(a) 10,000; (b) 4; (c) 3**	(a) 10^4; (b) $-\log_{10} 10^{-4} = 4$; (c) $[H^+]$ is 10^1 times larger, so the pH falls by 1
18	**x = 192**	$(x + 8)(x - 187) = 1000$; $x^2 - 179x - 2496 = 0$; $(x - 192)(x + 13) = 0$; $x = -13$ makes both arguments negative, so it is rejected
19	**x = 625 or x = 1/15625**	power rule: $\log_5 x^2 = 2 \log_5 x$; with $y = \log_5 x$: $y^2 + 2y - 24 = 0$, $(y - 4)(y + 6) = 0$, y = 4 or −6
20	**(a) 2.6353; (b) 3.3522; (c) −0.1428**	(a) $4 \times 0.3010 + 3 \times 0.4771$; (b) $\log_{10} 5 = 1 - 0.3010 = 0.6990$; (c) $0.72 = 72 \div 10^2$, so subtract 2

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