



Exponents and logarithms

IB Mathematics AA SL & HL | Section 1.5

60 questions: fluency, applications, exam practice and HL challenge

Learning goal	Simplify integer powers; interpret logarithms as exponents; calculate common and natural logarithms.
Syllabus link	SL 1.5, shared by AA SL and AA HL. HL challenges deepen the same content.
Structure	Q1–15 short response; Q16–30 extended response; Q31–50 original Paper 1 style; Q51–60 HL exclusive challenge.
Technology	Only Q24–30 use a calculator (🧮 GDC). Use TI-Nspire CX Scratchpad Calculate. All other questions: no calculator.

Instructions. Work on separate paper and show your reasoning. Give exact answers unless told to round. Use positive exponents in final simplified algebraic expressions. Throughout, $\log x = \log_{10} x$ and $\ln x = \log_e x$. For real logarithms, the argument is positive and the base is positive and not 1.

1 | Short response

1. Evaluate 6^0 , 3^{-3} and $(-2)^{-4}$.

2. Write $7^4 \times 7^{-6}$ as a single power, then as a fraction.

3. Simplify $\frac{a^{-3}}{a^{-7}}$, where $a \neq 0$.

4. Write $(5^{-2})^3$ as a single power of 5.

5. Evaluate $\left(\frac{2}{5}\right)^{-3}$.

6. Evaluate each expression.

(a) -5^2 .

(b) $(-5)^2$.

(c) $(-2)^{-3}$.



1 | Short response (continued)

7. Simplify $(3x^{-2})^2$, using positive exponents. Assume $x \neq 0$.

8. Simplify $\frac{12p^5q^{-2}}{3p^2q^{-4}}$. Assume $p, q \neq 0$.

9. Write each statement in logarithmic form.

(a) $10^5 = 100000$.

(b) $e^{-4} = \frac{1}{e^4}$.

(c) $3^4 = 81$.

10. Write each statement in exponential form.

(a) $\log 0.001 = -3$.

(b) $\ln 6 = k$.

(c) $\log_2 \left(\frac{1}{32} \right) = -5$.

11. Evaluate $\log 100$, $\log 0.00001$ and $\log 1$.

12. Evaluate $\ln e$, $\ln(e^6)$ and $\ln \left(\frac{1}{e^3} \right)$.

13. State which expressions have real values. Give the value of each valid expression.

(a) $\log(-100)$.

(b) $\ln 0$.

(c) $\log 0.01$.

(d) $\ln 1$.

14. Given $10^t = 80$, write t exactly using a logarithm and state the two consecutive integers between which it lies.

15. Find y when $\ln y = -3$. Give your answer with a positive exponent.



2 | Extended response

16. Let $E = \frac{(2x^{-2}y^3)^2}{8x^{-1}y^2}$, where $x, y \neq 0$.

- (a) Simplify E , using positive exponents.
- (b) Hence find E when $x = 2$ and $y = -2$.

17. A student writes $(4x)^{-2} = 4x^{-2}$. Assume $x \neq 0$.

- (a) Explain the error and correct the expression.
- (b) Write $4x^{-2}$ using positive exponents.
- (c) How many times as large is $4x^{-2}$ as $(4x)^{-2}$?

18. Complete the missing entries in the table.

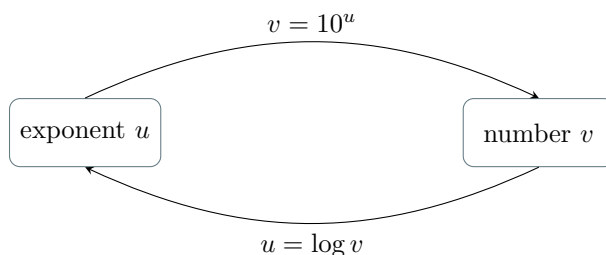
n	-3	-1	0	2	4
2^n					

- (a) Write the five missing values.
- (b) Use the first and last columns to write two logarithmic statements.
- (c) Describe what happens to 2^n when n increases by 1.

19. For $a \neq 0$, consider $\frac{a^4}{a^4}$ and $\frac{a^2}{a^5}$.

- (a) Use cancellation and an exponent law to explain why $a^0 = 1$.
- (b) Use the same two methods to explain why $a^{-3} = \frac{1}{a^3}$.
- (c) Explain why $a = 0$ is excluded.

20. The conversion machine below has base 10.



- (a) Find v when $u = -4$.
- (b) Find u when $v = 1000$.
- (c) Explain why no real input u can give $v = -10$.



2 | Extended response (continued)

21. Let $p = \log 0.0001$ and $q = \ln(e^3)$.

- (a) Find p and q .
- (b) Evaluate $10^p e^q$ exactly.
- (c) Evaluate 10^{p+q} exactly.

22. Explain each statement without using a calculator.

- (a) $2 < \log 600 < 3$.
- (b) $-2 < \ln(e^{-1}) < 0$.
- (c) A logarithm can be negative even though its argument is positive.

23. For each expression, find all real values of x for which it is defined.

- (a) $\log(x - 4)$.
- (b) $\ln(7 - 3x)$.
- (c) x^{-2} .

24.  **GDC** Evaluate to 3 significant figures. Use Scratchpad Calculate.

- (a) $\log 44$.
- (b) $\ln 13$.
- (c) $\log 0.004$.
- (d) $\ln 0.25$.

25.  **GDC** The numbers u and v satisfy $10^u = 650$ and $e^v = 0.03$.

- (a) Write exact logarithmic expressions for u and v .
- (b) Find each value to 3 significant figures.
- (c) Check each result by substituting its unrounded value into the original equation.



2 | Extended response: calculator practice

26.  GDC Use the definition of a logarithm to find each positive number, to 3 significant figures.

- (a) $\log y = -2.6$.
- (b) $\ln z = 1.4$.

27.  GDC A simplified sound model is $L = 10 \log R$, where L is measured in decibels (dB) and $R > 0$ is a dimensionless intensity ratio.

- (a) Find L when $R = 4000$, to 1 decimal place.
- (b) Find R when $L = 27$, to 3 significant figures.
- (c) Explain what $L = 0$ means in this model.

28.  GDC In a simplified chemistry model, $\text{pH} = -\log c$, where $c > 0$ is the numerical value of a concentration measured in mol dm^{-3} .

- (a) Find the pH when $c = 2.5 \times 10^{-4}$, to 2 decimal places.
- (b) Find the concentration when the pH is 5.2, to 3 significant figures.
- (c) Which of these two solutions has the greater concentration?

29.  GDC A sensor records $r = \ln S$, where $S > 0$ is a dimensionless signal ratio.

- (a) Find r when $S = 18$, to 3 significant figures.
- (b) Find S when $r = -0.8$, to 3 significant figures.
- (c) A student enters $\log(18)$ for part (a). Is this correct? Explain.

30.  GDC A student rounds $\log 37$ to 1.57 and then calculates $10^{1.57}$.

- (a) Evaluate $10^{1.57}$ to 3 significant figures.
- (b) Evaluate $10^{\log 37}$, entering the whole expression at once.
- (c) Explain the difference and state a suitable rounding rule.



3 | IB exam-style: Paper 1

Original questions. No calculator. Marks are shown for each part.

31. [Maximum mark: 5]

Let $E = \frac{(3a^{-2}b)^2}{9a^{-1}b^{-3}}$, where $a, b \neq 0$.

- (a) Simplify E , giving your answer with positive exponents. [3]
(b) Hence find E when $a = 2$ and $b = -1$. [2]

32. [Maximum mark: 4]

Let $p = \log 0.00001$ and $q = \ln(e^2)$.

- (a) Write down p and q . [2]
(b) Hence find the exact value of 10^{p+2q} . [2]

33. [Maximum mark: 4]

The numbers a and b are defined by $\log a = -2$ and $\ln b = 3$.

- (a) Find the exact value of a and of b . [2]
(b) Find a^2b^{-1} , using positive exponents. [2]

34. [Maximum mark: 4]

A student claims that $2^{-4} = -16$ and $(2x)^3 = 2x^3$.

- (a) Correct both statements. [2]
(b) Hence simplify $\frac{(2x)^3}{2x^{-2}}$, where $x \neq 0$. [2]

35. [Maximum mark: 6]

The table gives exact powers of e .

k	-2	0	3
e^k	A	1	B

- (a) Write down A and B . [2]
(b) Find $\ln A$ and $\ln B$. [2]
(c) Hence find A^2B exactly. [2]



3 | IB exam-style: Paper 1 (continued)

36. [Maximum mark: 6]

Let $M = \frac{6x^{-3}y^2}{2x^{-1}y^{-2}}$, where $x, y \neq 0$.

- (a) Simplify M , using positive exponents. [3]
- (b) Explain why M is positive for all permitted real x, y . [2]
- (c) Find M when $x = -4$ and $y = 2$. [1]

37. [Maximum mark: 5]

The real numbers u and v satisfy $10^u = 0.0001$ and $e^v = e^{-2}$.

- (a) Write down u and v . [2]
- (b) Find 10^{u-v} . [2]
- (c) Find e^{uv} . [1]

38. [Maximum mark: 5]

A simplified sound model is $L = 10 \log R$, where $R > 0$ is a dimensionless intensity ratio and L is measured in dB. Two sounds have ratios $R_A = 10^4$ and $R_B = 10^7$.

- (a) Find the sound level of each sound. [2]
- (b) Find the ratio R_B/R_A . [2]
- (c) Find the difference between the two sound levels. [1]

39. [Maximum mark: 5]

The number t satisfies $t = \log 3500$.

- (a) Write this statement in exponential form. [1]
- (b) Show that $3 < t < 4$. [2]
- (c) Find 10^{t-2} exactly. [2]

40. [Maximum mark: 5]

Let $p = \ln 7$.

- (a) Write down e^p . [1]
- (b) Find e^{-p} exactly. [2]
- (c) Find e^{2p} exactly. [2]



3 | IB exam-style: Paper 1 (continued)

41. [Maximum mark: 5]

A rectangle has length $3a^2b^{-1}$ cm and width $2a^{-1}b^3$ cm, where $a, b > 0$.

- (a) Find an expression for its area, using positive exponents. [3]
- (b) Find the area when $a = 2$ and $b = 3$. [2]

42. [Maximum mark: 5]

Let $p = \log 500$.

- (a) Write down 10^p . [1]
- (b) Use an exponent law to find 10^{p+1} . [2]
- (c) Find 10^{-p} . [2]

43. [Maximum mark: 4]

Consider $\ln(5 - x)$.

- (a) State the set of real values of x for which the expression is defined. [1]
- (b) Use the definition of a logarithm to find x when $\ln(5 - x) = 0$. [2]
- (c) Check that your answer is permitted by part (a). [1]

44. [Maximum mark: 5]

Let $a = \log 1000$ and $b = \ln(e^{-4})$.

- (a) Find a and b . [2]
- (b) Find $(-2)^a$ and 2^b . [2]
- (c) Hence find $\frac{(-2)^a}{2^b}$. [1]

45. [Maximum mark: 6]

A simplified chemistry model is $\text{pH} = -\log c$, where $c > 0$ is the numerical concentration in mol dm^{-3} .

- (a) Find the pH of solutions A and B, with $c_A = 10^{-3}$ and $c_B = 10^{-6}$. [2]
- (b) Find c_A/c_B and interpret your answer. [2]
- (c) Find the concentration of a solution whose pH is 4. [2]



3 | IB exam-style: Paper 1 (continued)

46. [Maximum mark: 6]

Let $E = \frac{(2a^{-1}b^2)^{-2}}{4ab^{-1}}$, where $a, b \neq 0$.

- (a) Simplify E , using positive exponents. [4]
(b) Hence find E when $a = 8$ and $b = -2$. [2]

47. [Maximum mark: 5]

Let $A = \ln(e^{-5})$ and $B = \log 0.001$.

- (a) Find A and B . [2]
(b) Find e^{A-B} exactly, using a positive exponent. [2]
(c) Explain why both original logarithms are defined. [1]

48. [Maximum mark: 6]

A display shows $n = \log R$, where $R > 0$. The table contains three readings.

R	10^{-2}	10^3	C
n	A	B	-5

- (a) Find A , B and C . [3]
(b) Find the ratio of the second input R to the first. [2]
(c) Explain why a negative reading does not imply a negative input. [1]

49. [Maximum mark: 5]

The number p satisfies $e^p = 12$.

- (a) Write p exactly using a natural logarithm. [1]
(b) Find e^{p-2} exactly. [2]
(c) Show that $e^p e^{-p} = 1$. [2]

50. [Maximum mark: 6]

Consider $E = \frac{(x^{-2}y^3)^2}{x^{-5}y}$, where $x, y \neq 0$.

- (a) Show that $E = xy^5$. [3]
(b) Find E when $x = -2$ and $y = -1$. [1]
(c) A student says that $x = 0$ is now allowed. Explain why this is incorrect. [2]



4 | AA HL exclusive challenge

For HL students: more demanding use of section 1.5 ideas. Use exponent laws and the definition of a logarithm; no laws of logarithms or change of base are required.

51. For $a, b \neq 0$, simplify $\left[\frac{(2a^{-3}b^2)^{-2}}{(4ab^{-1})^{-1}} \right]^{-1}$.

52. For every $x, y > 0$, the identity $\frac{(x^m y^{-2})^3}{x^{-1} y^n} = \frac{x^7}{y^5}$ holds. Find the integers m and n .

53. For every integer n , simplify $\frac{2^{n+2} - 2^n}{2^{n+1} + 2^{n-1}}$. Show why your answer is independent of n .

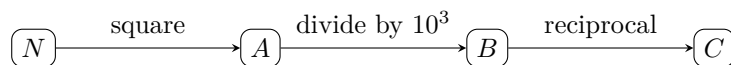
54. Let $p = \log 24$ and $q = \ln 5$. Without approximating either logarithm, evaluate $\frac{10^{2p-1} e^{-2q}}{10^{-p}}$.

55. For every nonzero real x , simplify $F(x) = \frac{(2x^{-1})^{-2} - (x^{-1})^{-2}}{x^2}$. State the domain of the original expression.



4 | AA HL exclusive challenge (continued)

56. Let $u = \log N$, where $N > 0$. A sequence of operations acts on N .



Express C as one power of 10 in terms of u . Hence find C when $u = -2$.

57. For an integer n , define $A = \frac{(-2)^{n+3}}{(-2)^n}$ and $B = \frac{-2^{n+3}}{2^n}$. Are A and B equal for every integer n ? Justify your answer, then explain how their numerators can still have different signs.

58. Two positive numbers a, b satisfy $\ln a = -2$ and $\ln b = 5$. Let $R = \frac{a^{-3}b^2}{(ab^{-1})^2}$. Find R as a single power of e , then find $\ln R$.

59. Let n be an integer. The expression $K = \frac{(3^{n+1})^2}{9^{n-2}}$ is independent of n . Find K and hence evaluate $\log_3 K$ directly from the definition.

60. A positive number a satisfies $a \neq 1$ and $\log_a 64 = 3$.

(a) Find a using the definition of a logarithm.

(b) Hence evaluate $\log_a \left(\frac{1}{256} \right)$.

(c) Find the positive number b for which $\log_a b = -2$.



Answer key and solution outlines

Section 1 | Short response

1. $1, \frac{1}{27}, \frac{1}{16}$. A negative exponent means a reciprocal.
2. $7^{4-6} = 7^{-2} = \frac{1}{49}$.
3. $a^{-3-(-7)} = a^4$.
4. $5^{(-2)(3)} = 5^{-6}$.
5. $\left(\frac{5}{2}\right)^3 = \frac{125}{8}$.
6. (a) -25 ; (b) 25 ; (c) $-\frac{1}{8}$. The brackets determine the base.
7. $9x^{-4} = \frac{9}{x^4}$.
8. $4p^{5-2}q^{-2-(-4)} = 4p^3q^2$.
9. (a) $\log 100000 = 5$; (b) $\ln(e^{-4}) = -4$; (c) $\log_3 81 = 4$.
10. (a) $10^{-3} = 0.001$; (b) $e^k = 6$; (c) $2^{-5} = \frac{1}{32}$.
11. $2, -5, 0$, since the arguments are $10^2, 10^{-5}, 10^0$.
12. $1, 6, -3$, by identifying the exponent on e .
13. (a) No real value; (b) no real value; (c) -2 ; (d) 0 . Real logarithms require a positive argument.
14. $t = \log 80$ and $1 < t < 2$, since $10 < 80 < 100$.
15. $y = e^{-3} = \frac{1}{e^3}$.

Section 2 | Extended response

16. (a) $E = \frac{4x^{-4}y^6}{8x^{-1}y^2} = \frac{y^4}{2x^3}$. (b) $E = \frac{16}{16} = 1$.
17. (a) The exponent must apply to 4 as well as x : $(4x)^{-2} = \frac{1}{16x^2}$. (b) $4x^{-2} = \frac{4}{x^2}$. (c) The second is 64 times the first.
18. (a) $\frac{1}{8}, \frac{1}{2}, 1, 4, 16$. (b) $\log_2(\frac{1}{8}) = -3$ and $\log_2 16 = 4$. (c) Multiply by 2.
19. (a) Cancelling gives 1; subtracting exponents gives a^0 . (b) Cancelling gives $\frac{1}{a^3}$; subtracting exponents gives a^{-3} . (c) The original denominators would be zero.
20. (a) $v = 10^{-4} = 0.0001$. (b) $u = 3$. (c) No real u : every real power of 10 is positive.
21. (a) $p = -4, q = 3$. (b) $10^p e^q = \frac{e^3}{10000}$. (c) $p + q = -1$, so $10^{p+q} = \frac{1}{10}$.
22. (a) $100 < 600 < 1000$, so its base-10 exponent is between 2 and 3. (b) $e^{-2} < e^{-1} < e^0$, so the natural logarithm is between -2 and 0 . (c) A negative exponent gives a positive reciprocal; for example $\ln(e^{-1}) = -1$.
23. (a) $x > 4$. (b) $x < \frac{7}{3}$. (c) $x \neq 0$. The logarithm arguments in (a) and (b) must be positive.



Answer key and solution outlines

Section 2 | Calculator practice

24. (a) 1.64; (b) 2.56; (c) -2.40 ; (d) -1.39 . Keep full calculator values until rounding.
25. (a) $u = \log 650$, $v = \ln 0.03$. (b) $u = 2.81$, $v = -3.51$ (3 s.f.). (c) $10^{\log 650} = 650$; $e^{\ln 0.03} = 0.03$.
26. (a) $y = 10^{-2.6} = 0.00251$. (b) $z = e^{1.4} = 4.06$.
27. (a) $L = 10 \log 4000 = 36.0$ dB (1 d.p.). (b) $\log R = 2.7$, so $R = 10^{2.7} = 501$ (3 s.f.). (c) $\log 1 = 0$: the intensity equals the reference intensity; it is not zero.
28. (a) $-\log(2.5 \times 10^{-4}) = 3.60$. (b) $\log c = -5.2$, so $c = 10^{-5.2} = 6.31 \times 10^{-6}$; concentration 6.31×10^{-6} mol dm $^{-3}$. (c) In (a), since $2.5 \times 10^{-4} > 6.31 \times 10^{-6}$.
29. (a) $r = \ln 18 = 2.89$. (b) $S = e^{-0.8} = 0.449$. (c) No: $\log 18 = 1.26$ (3 s.f.); the prescribed base is e .
30. (a) $10^{1.57} = 37.1535229\dots$, so 37.2 (3 s.f.). (b) $10^{\log 37} = 37$ (up to calculator rounding). (c) Rounding the exponent early changes the reconstructed number; retain the unrounded value.

Section 3 | Paper 1: questions 31–40

31. (a) $E = \frac{9a^{-4}b^2}{9a^{-1}b^{-3}} = \frac{b^5}{a^3}$. (b) At $(2, -1)$, $E = -\frac{1}{8}$.
32. (a) $p = -5$, $q = 2$. (b) $p + 2q = -1$, so $10^{p+2q} = \frac{1}{10}$.
33. (a) $a = 10^{-2} = \frac{1}{100}$, $b = e^3$. (b) $a^2b^{-1} = \frac{1}{10000e^3}$.
34. (a) $2^{-4} = \frac{1}{16}$ and $(2x)^3 = 8x^3$. (b) $\frac{(2x)^3}{2x^{-2}} = \frac{8x^3}{2x^{-2}} = 4x^5$.
35. (a) $A = \frac{1}{e^2}$, $B = e^3$. (b) $\ln A = -2$, $\ln B = 3$. (c) $A^2B = e^{-4}e^3 = e^{-1} = \frac{1}{e}$.
36. (a) $M = 3x^{-2}y^4 = \frac{3y^4}{x^2}$. (b) $x^2 > 0$ and $y^4 > 0$, so the quotient is positive. (c) $M = 3$.
37. (a) $u = -4$, $v = -2$. (b) $u - v = -2$; $10^{u-v} = \frac{1}{100}$. (c) $e^{uv} = e^8$.
38. (a) $L_A = 40$ dB and $L_B = 70$ dB. (b) $R_B/R_A = 10^3 = 1000$. (c) $70 - 40 = 30$ dB.
39. (a) $10^t = 3500$. (b) $10^3 < 3500 < 10^4$, so $3 < t < 4$. (c) $10^{t-2} = 10^t/10^2 = 35$.
40. (a) $e^p = 7$. (b) $e^{-p} = 1/e^p = \frac{1}{7}$. (c) $e^{2p} = (e^p)^2 = 49$.



Answer key and solution outlines

Section 3 | Paper 1: questions 41–50

41. (a) $A = (3a^2b^{-1})(2a^{-1}b^3) = 6ab^2 \text{ cm}^2$. (b) $A = 6(2)(3^2) = 108 \text{ cm}^2$.
42. (a) $10^p = 500$. (b) $10^{p+1} = 10^p \times 10 = 5000$. (c) $10^{-p} = 1/10^p = \frac{1}{500}$.
43. (a) $5 - x > 0$, so $x < 5$. (b) $5 - x = e^0 = 1$, so $x = 4$. (c) $4 < 5$ and the argument is 1, hence valid.
44. (a) $a = 3$, $b = -4$. (b) $(-2)^a = -8$, $2^b = \frac{1}{16}$. (c) Their quotient is -128 .
45. (a) $\text{pH}_A = 3$, $\text{pH}_B = 6$. (b) $c_A/c_B = 10^{-3}/10^{-6} = 10^3 = 1000$: solution A has 1000 times the concentration of B. (c) $-\log c = 4 \Rightarrow c = 10^{-4}$, giving $10^{-4} \text{ mol dm}^{-3}$.
46. (a) Numerator $= \frac{1}{4}a^2b^{-4}$, so $E = \frac{a}{16b^3}$. (b) $E = \frac{8}{16(-8)} = -\frac{1}{16}$.
47. (a) $A = -5$, $B = -3$. (b) $A - B = -2$, so $e^{A-B} = \frac{1}{e^2}$. (c) $e^{-5} > 0$ and $0.001 > 0$; it is the values of the logarithms that are negative.
48. (a) $A = -2$, $B = 3$, $C = 10^{-5}$. (b) $10^3/10^{-2} = 10^5 = 100000$. (c) $R = 10^n$ is always positive, including when $n < 0$.
49. (a) $p = \ln 12$. (b) $e^{p-2} = e^p/e^2 = \frac{12}{e^2}$. (c) $e^p e^{-p} = e^0 = 1$.
50. (a) $E = x^{-4-(-5)}y^{6-1} = xy^5$. (b) $E = (-2)(-1)^5 = 2$. (c) No: x^{-2} and x^{-5} are undefined at zero; simplification does not extend the original domain.

Section 4 | AA HL exclusive challenge

51. Inside the bracket: $\frac{\frac{1}{4}a^6b^{-4}}{\frac{1}{4}a^{-1}b} = a^7b^{-5}$. Taking the reciprocal gives $\boxed{\frac{b^5}{a^7}}$.
52. The left side is $x^{3m+1}y^{-6-n}$. Equality for every positive x, y gives $3m + 1 = 7$ and $-6 - n = -5$, hence $m = 2$, $n = -1$.
53. Numerator $= 2^n(4 - 1) = 3 \cdot 2^n$; denominator $= 2^{n-1}(4 + 1) = 5 \cdot 2^{n-1}$. Quotient $= \frac{6}{5}$; the nonzero common power cancels.
54. $10^p = 24$, $e^q = 5$. The expression is $\frac{10^{3p}}{10e^{2q}} = \frac{24^3}{10 \cdot 25} = \frac{6912}{125}$.
55. $F(x) = \frac{x^2/4 - x^2}{x^2} = -\frac{3}{4}$. The original domain remains $x \in \mathbb{R} \setminus \{0\}$.
56. $N = 10^u$, so $A = 10^{2u}$, $B = 10^{2u-3}$, $C = 10^{3-2u}$. At $u = -2$, $C = 10^7$.
57. $A = (-2)^3 = -8$ and $B = -2^3 = -8$, so they are always equal. For odd n , the numerator of A is positive and its denominator negative; the numerator of B is always negative and its denominator positive. Quotients still agree.
58. $a = e^{-2}$, $b = e^5$. Exponent laws give $R = a^{-5}b^4 = e^{10}e^{20} = e^{30}$. Thus $\ln R = 30$ by definition.
59. $K = 3^{2n+2}/3^{2n-4} = 3^6 = 729$. Since $3^6 = K$, $\log_3 K = 6$.
60. (a) $a^3 = 64$, so the positive base is $a = 4$. (b) $\frac{1}{256} = 4^{-4}$, so $\log_a(\frac{1}{256}) = -4$. (c) $a^{-2} = 4^{-2} = \frac{1}{16}$.