# 1.9 Log laws

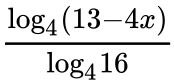
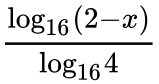
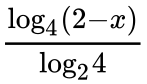
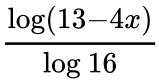
**1.** *[7 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**Note:** The first three ***A*** marks are awarded for correct application of log properties, including with incorrect expressions, and in any order.

correct application of change of base (accept any base)       ***(A1)***

*eg*   ,  ,  ,  

correct numerical value       ***(A1)***

*eg*   ,  

correct application of         ***(A1)***

*eg*   

correct equation without logs       ***A1***

*eg*   ,  ,  

correct working       ***A1***

*eg*   

       ***A2 N2***

***[7 marks]***

**2.** *[7 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

use of at least one “log rule” applied correctly for the first equation       ***M1***







       ***A1***

use of at least one “log rule” applied correctly for the second equation       ***M1***







       ***A1***

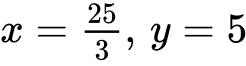
attempt to eliminate  (or ) from their two equations       ***M1***







       ***A1***

or        ***A1***

**Note:** ,  values do not have to be “paired” to gain either of the final two ***A*** marks.

***[7 marks]***

**3a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

correct approach      ***(A1)***

*eg*   3log*a*

log*a* = 3*b*     ***A1 N2***

***[2 marks]***

**3b.** *[2 marks]*

## Markscheme

correct working     ***(A1)***

*eg*   log8 + log*a*,  log8 = 3

log8*a* = 3 + *b*     ***A1 N2***

***[2 marks]***

**3c.** *[2 marks]*

## Markscheme

correct working     ***(A1)***

*eg*   ,  log*a*,  *b*log2

log*a* =     ***A1 N2***

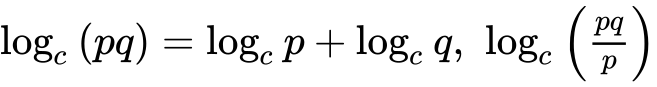
***[2 marks]***

**4a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

valid approach involving addition or subtraction       ***M1***  
*eg*  

correct application of log law      ***A1***  
*eg*  

    ***AG N0***

***[2 marks]***

**4b.** *[6 marks]*

## Markscheme

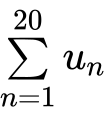
**METHOD 1** (finding  and *d*)

recognizing  (seen anywhere)      ***(A1)***

attempt to find  or *d* using      ***(M1)***  
eg  , , correct value of  or *d*

 = 2, *d* = 3 (seen anywhere)      ***(A1)(A1)***

correct working    ***(A1)***  
*eg*  

 = 610     ***A1 N2***

**METHOD 2** (expressing *S* in terms of *c*)

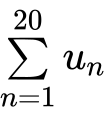
recognizing  (seen anywhere)      ***(A1)***

correct expression for *S* in terms of *c*      ***(A1)***  
*eg*  

  (seen anywhere)     ***(A1)(A1)***

correct working      ***(A1)***

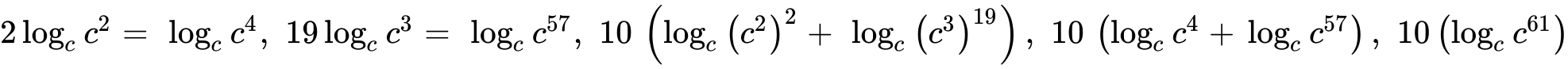
*eg*  

 = 610     ***A1 N2***

**METHOD 3** (expressing *S* in terms of *c*)

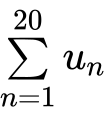
recognizing  (seen anywhere)      ***(A1)***

correct expression for *S* in terms of *c*      ***(A1)***  
*eg*  

correct application of log law     ***(A1)***  
eg  

correct application of definition of log      ***(A1)***  
eg  

correct working     ***(A1)***  
eg  

 = 610     ***A1 N2***

***[6 marks]***

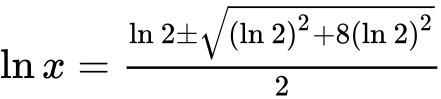
**5.** *[6 marks]*

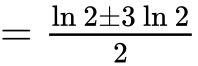
## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



**EITHER**

     ***M1***

     ***A1***

**OR**

    ***M1A1***

**THEN**

 or      ***A1***

 or       ***(M1)A1***

**Note:** ***(M1)*** is for an appropriate use of a log law in either case, dependent on the previous ***M1*** being awarded, **A1** for both correct answers.

solution is      ***A1***

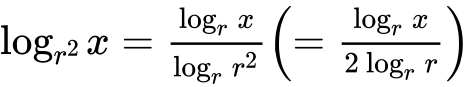
***[6 marks]***

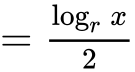
**6a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

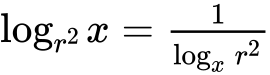
**METHOD 1**

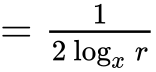
    ***M1A1***

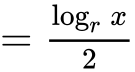
     ***AG***

***[2 marks]***

**METHOD 2**

     ***M1***

     ***A1***

     ***AG***

***[2 marks]***

**6b.** *[5 marks]*

## Markscheme

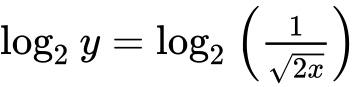
**METHOD 1**

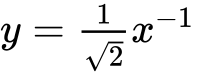


     ***M1***

     ***M1***



     ***M1A1***

     ***A1***

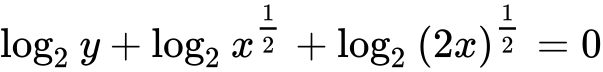
**Note**: For the final ***A*** mark,  must be expressed in the form .

***[5 marks]***

**METHOD 2**

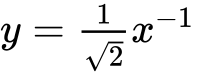


     ***M1***

     ***M1***

     ***M1***

     ***A1***

     ***A1***

**Note**: For the final ***A*** mark,  must be expressed in the form .

***[5 marks]***

**7.** *[5 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



     ***(M1)***

     ***M1A1***



     ***(A1)***

     ***A1***

***[5 marks]***

**8a.** *[3 marks]*

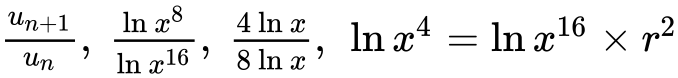
## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

correct use      ***A1***

*eg*

valid approach to find      ***(M1)***

*eg*

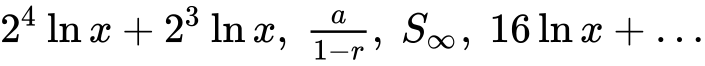
     ***A1***     ***N2***

***[3 marks]***

**8b.** *[5 marks]*

## Markscheme

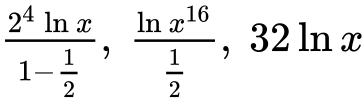
recognizing a sum (finite or infinite)     ***(M1)***

*eg*

valid approach (seen anywhere)     ***(M1)***

*eg*recognizing GP is the same as part (a), using **their**  value from part (a), 

correct substitution into infinite sum (only if  is a constant and less than 1)     ***A1***

*eg*

correct working     ***(A1)***

*eg*

     ***A1     N3***

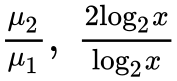
***[5 marks]***

**9a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

evidence of dividing terms (in any order)     ***(M1)***

*eg*

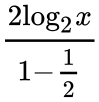
    ***A1     N2***

***[2 marks]***

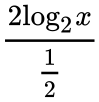
**9b.** *[2 marks]*

## Markscheme

correct substitution     ***(A1)***

*eg*

correct working     ***A1***

*eg*

     ***AG     N0***

***[2 marks]***

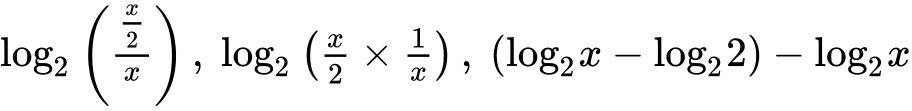
**9c.** *[4 marks]*

## Markscheme

evidence of subtracting two terms (in any order)     ***(M1)***

*eg*

correct application of the properties of logs     ***(A1)***

*eg*

correct working     ***(A1)***

*eg*

    ***A1     N3***

***[4 marks]***

**9d.** *[2 marks]*

## Markscheme

correct substitution into the formula for the sum of an arithmetic sequence     ***(A1)***

*eg*

correct working     ***A1***

*eg*

    ***AG     N0***

***[2 marks]***

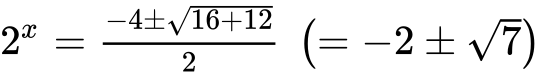
**10.** *[5 marks]*

## Markscheme

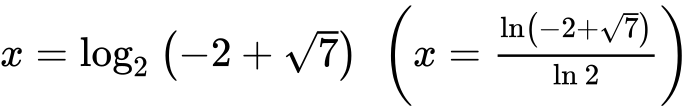
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

attempt to form a quadratic in      ***M1***

    ***A1***

    ***M1***

    ***R1***

    ***A1***

**Note:** Award ***R0 A1*** if final answer is .

***[5 marks]***

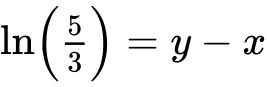
**11a.** *[2 marks]*

## Markscheme

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correct approach     ***(A1)***

*eg*

    ***A1     N2***

***[2 marks]***

**11b.** *[4 marks]*

## Markscheme

recognizing factors of 45 (may be seen in log expansion)     ***(M1)***

*eg*

correct application of      ***(A1)***

*eg*

correct working     ***(A1)***

*eg*

    ***A1     N3***

***[4 marks]***

**12.** *[4 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**METHOD 1**



    ***M1***

    ***(M1)***

    ***(M1)***

    ***A1***

**Note:** First ***M1*** is for any correct change of base, second ***M1*** for writing as a single logarithm, third ***M1*** is for writing 6 as .

**METHOD 2**



    ***M1***

    ***(M1)***

    ***(M1)***

    ***A1***

**Note:** First ***M1*** is for any correct change of base, second ***M1*** for writing 6 as  and third ***M1*** is for forming an expression without .

***[4 marks]***

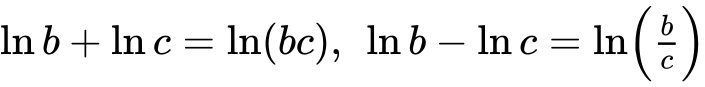
**13.** *[6 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**Note:** There are many approaches to this question, and the steps may be done in any order. There are 3 relationships they may need to apply at some stage, for the 3rd, 4th and 5th marks. These are

equating bases *eg* recognising 9 is 

log rules: ,

exponent rule: .

The exception to the ***FT*** rule applies here, so that if they demonstrate correct application of the 3 relationships, they may be awarded the ***A*** marks, even if they have made a previous error. However all applications of a relationship need to be correct. Once an error has been made, do not award ***A1FT*** for their final answer, even if it follows from their working.

Please check working and award marks in line with the markscheme.

correct substitution into  formula     ***(A1)***

*eg*

set up equation for  in any form (seen anywhere)     ***(M1)***

*eg*

correct application of relationships     ***(A1)(A1)(A1)***

     ***A1     N3***

***[6 marks]***

**Examples of application of relationships**

**Example 1**

correct application of exponent rule for logs     ***(A1)***

*eg*

correct application of addition rule for logs     ***(A1)***

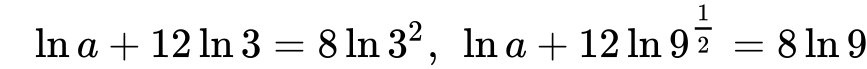
*eg*

substituting for 9 or 3 in ln expression in equation     ***(A1)***

*eg*

**Example 2**

recognising       ***(A1)***

*eg*

one correct application of exponent rule for logs relating  to      ***(A1)***

*eg*

another correct application of exponent rule for logs     ***(A1)***

*eg*

**14a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

     ***A1A1     N2***

***[2 marks]***

**14b.** *[4 marks]*

## Markscheme

attempt to apply      ***(M1)***

*eg*

equating **their** powers of  (seen anywhere)     ***M1***

*eg*

correct working     ***A1***

*eg*

     ***A1     N2***

***[4 marks]***

***Total [6 marks]***

**15a.** *[3 marks]*

## Markscheme

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correct application of  (seen anywhere)     ***(A1)***

*eg*

correct working     ***(A1)***

*eg*

     ***A1     N2***

***[3 marks]***

**15b.** *[3 marks]*

## Markscheme

**METHOD 1**

attempt to substitute **their** answer into the equation     ***(M1)***

*eg*

correct application of a log rule     ***(A1)***

*eg*

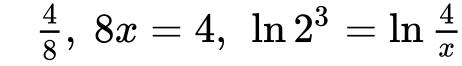
     ***A1     N2***

**METHOD 2**

attempt to rearrange equation, with   written as  or      ***(M1)***

*eg*

correct working applying      ***(A1)***

*eg*

     ***A1     N2***

***[3 marks]***

***Total [6 marks]***

**16a.** *[1 mark]*

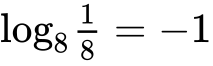
## Markscheme

(i)          ***A1     N1***

***[1 mark]***

**16b.** *[1 mark]*

## Markscheme

(ii)          ***A1     N1***

***[1 mark]***

**16c.** *[1 mark]*

## Markscheme

(iii)          ***A1     N1***

***[1 mark]***

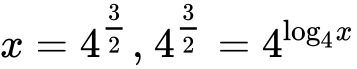
**16d.** *[3 marks]*

## Markscheme

correct equation with **their** three values     ***(A1)***

*eg*     

correct working involving powers     ***(A1)***

*eg*     

     ***A1     N2***

***[3 marks]***

**17a.** *[2 marks]*

## Markscheme

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correct approach     ***(A1)***

*eg*     

      ***A1     N2***

***[2 marks]***

**17b.** *[2 marks]*

## Markscheme

correct simplification     ***(A1)***

*eg*     

      ***A1      N2***

***[2 marks]***

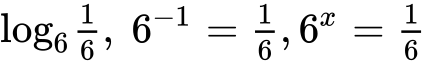
**17c.** *[3 marks]*

## Markscheme

correct simplification     ***(A1)***

*eg*     

correct working     ***(A1)***

*eg*     

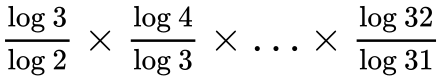
     ***A1     N2***

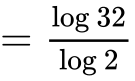
***[3 marks]***

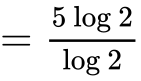
**18.** *[5 marks]*

## Markscheme

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     ***M1A1***

     ***A1***

     ***(M1)***

     ***A1***

hence 

**Note:** Accept the above if done in a specific base *eg* .

***[5 marks]***

**19.** *[5 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**METHOD 1**

     ***M1***

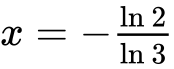
**Note:**     Award ***M1*** for writing in terms of 2 and 3.



     ***A1***

     ***(M1)***

     ***A1***

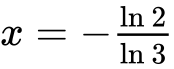
     ***A1***

**METHOD 2**

     ***(M1)***

     ***M1A1***

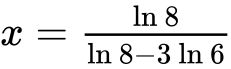
     ***A1***

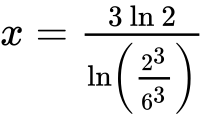
     ***A1***

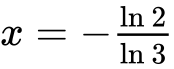
**METHOD 3**

     ***(M1)***

     ***A1***

     ***A1***

     ***M1***

     ***A1***

***[5 marks]***

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