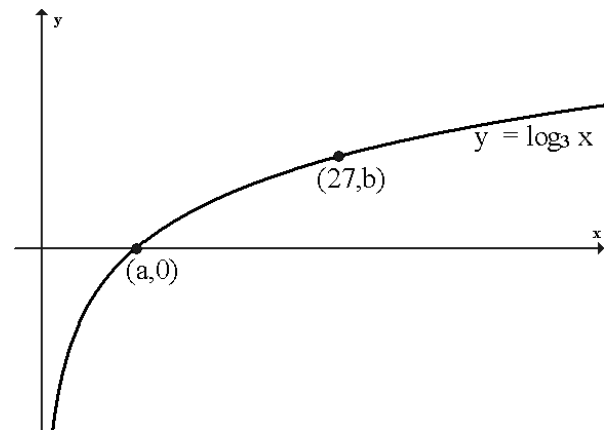


## Logarithms – Graphs/Exponential Growth

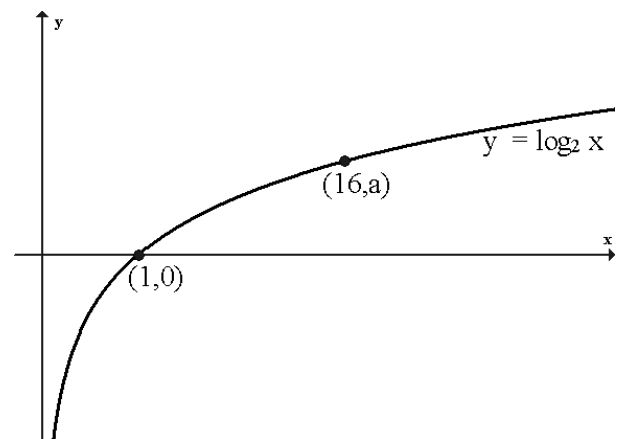
1. The diagram shows part of the graph of  $y = \log_3 x$ .

- (a) Find the values of  $a$  and  $b$ .  
(b) Sketch the graph of  $y = \log_3(x + 1) - 3$ .



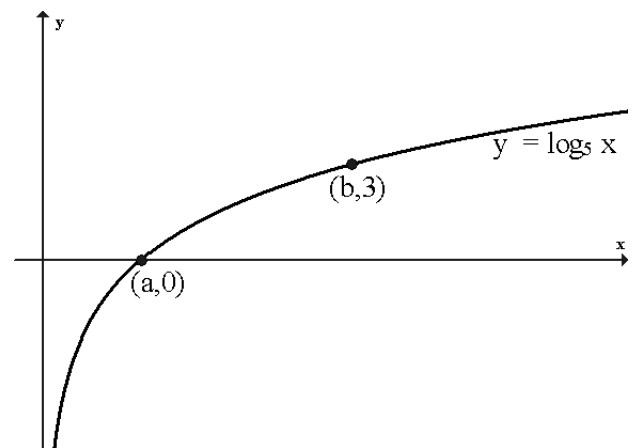
2. The diagram shows part of the graph of  $y = \log_2 x$ .

- (a) Find the value of  $a$ .  
(b) Sketch the graph of  $y = \log_2 x - 4$ .  
(c) Sketch the graph of  $y = \log_2 8x$ .



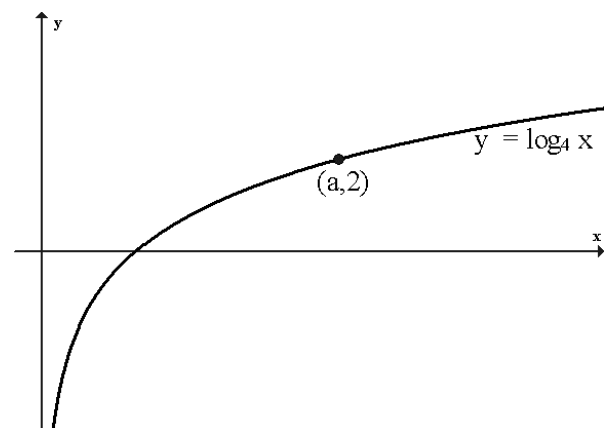
3. The diagram shows part of the graph of  $y = \log_5 x$ .

- (a) Find  $a$  and  $b$ .  
(b) Sketch the graph of  $y = \log_5 5x$ .  
(c) Sketch the graph of  $y = \log_5 x^2$ .  
(d) Sketch the graph of  $y = \log_5 \frac{1}{x}$ .



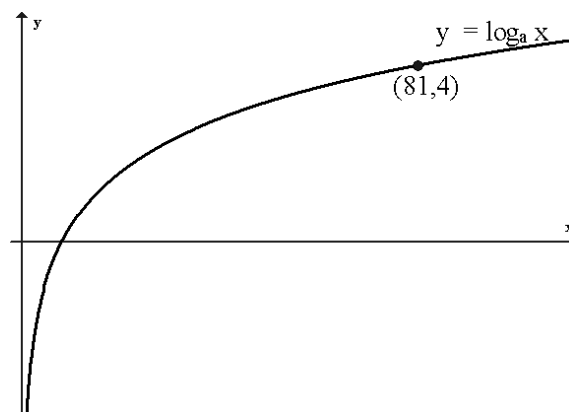
4. The diagram shows part of the graph of  $y = \log_4 x$ .

- (a) Find  $a$ .  
(b) Sketch the graph of  $y = \log_4 4x$ .  
(c) Sketch the graph of  $y = \log_4 x^3$ .



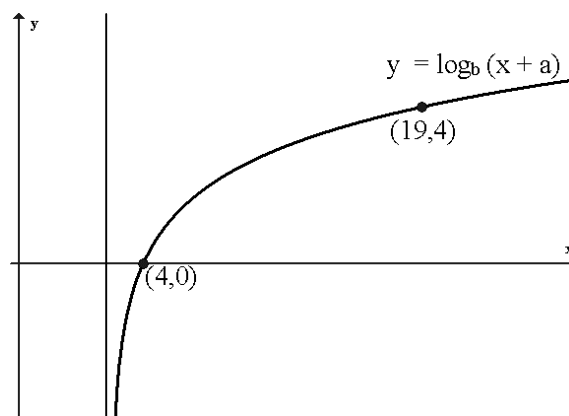
5. The diagram shows part of the graph of  $y = \log_a x$ .

- (a) Determine the value of  $a$ .
- (b) Sketch the graph of  $y = \log_a 9x^2$
- (c) Sketch the graph of  $y = \log_a \frac{1}{x}$ .



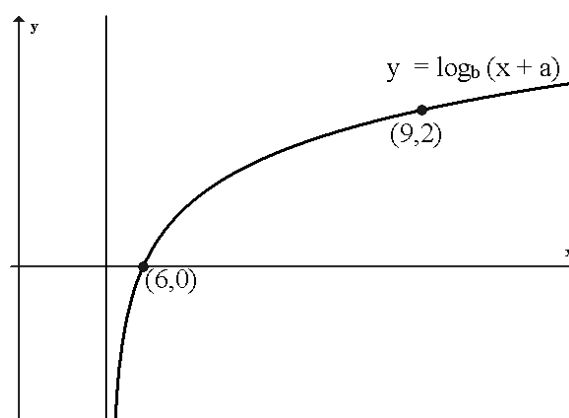
6. The diagram shows the graph of  $y = \log_b (x + a)$ .

Find the values of  $a$  and  $b$ .



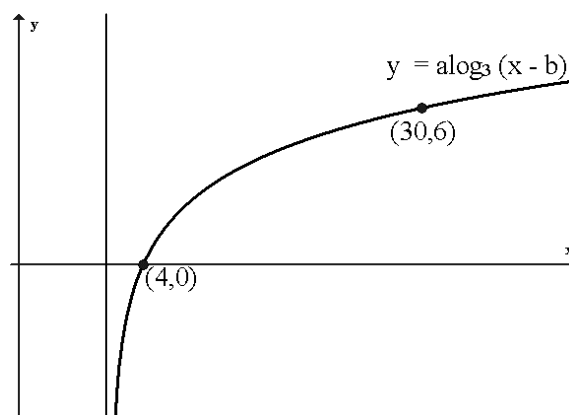
7. The diagram shows the graph of  $y = \log_b (x + a)$ .

Find  $a$  and  $b$ .



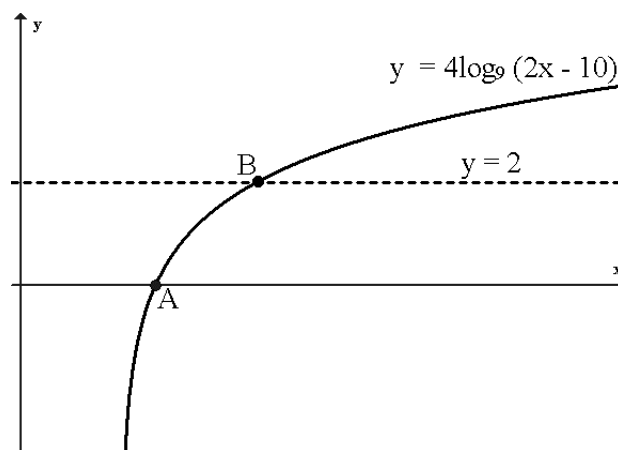
8. The diagram shows the graph of  $y = a \log_3 (x - b)$ .

Find  $a$  and  $b$ .



9. The diagram shows the graph of  $y = 4\log_9(2x - 10)$ .

Find the coordinates of A and B.



10. The number of bacteria of a particular strain is given by  $B(t) = 45e^{1.5t}$ , where  $t$  is the time in hours.
- How many bacteria are there at time zero?
  - How long will it take for the number of bacteria to treble?
11. A radioactive material has mass  $m$ , at time  $t$  years, given by  $m = m_0e^{-0.02t}$ , where  $m_0$  is the original mass.
- If the original mass is 500g, find the mass after 25 years.
  - Find the percentage of the material left after 10 years.
12. For a radioactive substance  $A = A_0e^{-kt}$ , where  $A_0$  is the original mass and  $t$  is the time in minutes. In 5 minutes, 20g of this substance is reduced to 16g.
- Find  $k$  to 2 significant figures.
  - Find the half life of this substance ( the time taken for the amount of the substance to fall by half).
13. For a radioactive substance the mass at time  $t$  years is given by  $m = m_0e^{-0.02t}$  where  $m_0$  is the original mass.
- If the original mass is 600g find the mass after 10 years.
  - Find the half life of this substance.
14. A radioactive substance is defined by  $M = M_0e^{-kt}$ , where  $M_0$  is the original mass and  $M$  is the mass after  $t$  years. Experiments have shown that  $M = 0.8M_0$  after 3 years.
- Find the value of  $k$ .
  - Find the percentage reduction in mass after 20 years.