Exercise 1

1 2
2 -2
3 1.5
4 1.63
5 1.16
6 0.861
7 2.77
8 $\frac{1}{4}$
9 1
10 16
11 1, 4
12 $x > 3$
13 $x < 5$
14 $x > 5$
15 $x > 2.10$
16 $x > 1.58$
17 $\log_x\left(\frac{5}{9}\right), \frac{1}{3}\sqrt{5}$
18 $\log_3\left(\frac{y}{x^2}\right), y = 3x^2$
19 $y^2, 1$
20 $x = 0$
21 1.03

Question 22

(i) $x < 7$
(ii) $x \geqslant 3$
(iii) $x \geqslant 3$
(iv) $x > 0.437$
(v) $x \leqslant 1$
(vi) $x \geqslant 0.322$
(vii) $0.431 \leqslant x < 1.29$
(viii) $0 \leqslant x < 0.827$
(ix) $1 < x < 2.58$
(x) $0.68 < x < 1.49$

Question 23

$\log_{10}\frac{x^2}{7}, x = 21$

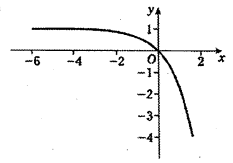
Question 24

(i) 25
(ii) 17

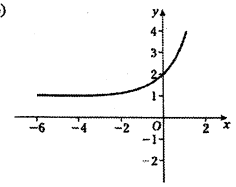
Exercise 2

1 (a) 7.39 (b) 0.368
(c) 4.48 (d) 0.741
(e) 20.1 (f) 6.05
(g) 0.135 (h) 1.05

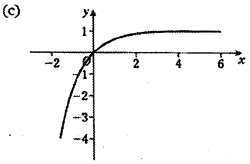
2 (a)



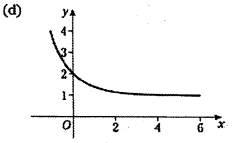
(b)



(c)

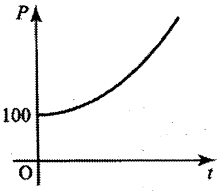


(d)



Question 3

(i)



(ii) 100
(iii) 1218
(iv) 184 years

Exercise 4

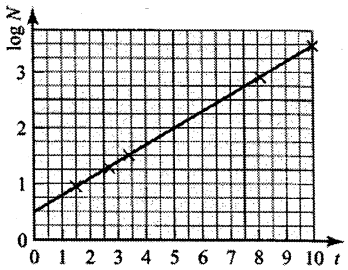
1 $a = 0.091, b = 0.787$
2 $a = 148, b = 0.607$
3 (b) $b = 1$
4 2
5 (1.83, 0)
6 $a = 8760, b = 1.13$
7 $\frac{1}{25}$
8 (a) $\ln s = \ln k - nt$: plotting $\ln s$ against t gives a straight line
(b) $k = 5500, n = 1.5$

Exercise 3

1 (a) $\ln 4 = x$ (b) $\ln y = 2$ (c) $\ln b = a$
2 (a) $e^4 = x$ (b) $e^a = 0.5$ (c) $e^b = a$
3 (a) 1.10 (b) 0.875 (c) -1.60
(d) 2.85
4 (a) 1 (b) 2 (c) 0
5 (a) $\ln 5 + \ln x$
(b) $\ln 5 + 2\ln x$
(c) $\ln 3 + \ln(x + 1)$
(d) $\ln(x + 1) - \ln x$
(e) $\ln(2x - 1) - \ln x$
(f) $\ln x + 2\ln y$
(g) $\frac{1}{2}\ln(x + 1)$
(h) $\ln x + \ln(x + 4)$
(i) $\ln(x + 1) + \ln(x - 1)$
(j) $2\ln x + \ln(x + y)$
(k) $1 + \ln x$
(l) $2 + \ln x + \ln(x - e)$
(m) $2\ln x - \ln(x + 1)$
(n) $\ln(a + b) + \ln(a - b)$
(o) $\ln \sin x - \ln \cos x$
6 (a) $\ln 2x$ (b) $\ln\left(\frac{3}{x}\right)$
(c) $\ln\left(\frac{x^2}{4}\right)$ (d) $\ln\left(\frac{x}{(1-x)^2}\right)$
(e) $\ln\left(\frac{e}{x}\right)$ (f) $\ln(e^2x)$
(g) $\ln\left(\frac{x^2}{\sqrt{x-1}}\right)$ (h) $\ln\frac{\cos x}{\sin x}$
(i) $\ln(ex)$ (j) $\ln(x-1)^{\frac{2}{3}}$
7 (a) 2.10 (b) 0 (c) 1.05
(d) $\frac{3}{2}$ or -1 (e) -3 or 1
8 $\ln(e + 1)$
9 $\frac{3e^3}{(e^3 - 1)}$

Exercise 4

Question 9



(iii) $a \approx 3, b \approx 2$
(v) Just over 3 million.

Question 10

(i) 1 m
(ii) 4.61 m, 6.09 years
(iii) $a = e^{-2} = 0.135, b = 2.5$
(iv) 11 years