1 **Answer the whole of this question on the insert provided.**

A colony of bats is increasing. The population, P, is modelled by $P = a \times 10^{bt}$, where t is the time in years after 2000.

(i) Show that, according to this model, the graph of $\log_{10} P$ against t should be a straight line of gradient b. State, in terms of a, the intercept on the vertical axis. [3]

(ii) The table gives the data for the population from 2001 to 2005.

Year	2001	2002	2003	2004	2005
t	1	2	3	4	
P	7900	8800	10000	11300	12800

Complete the table of values on the insert, and plot $\log_{10} P$ against t. Draw a line of best fit for the data. [3]

(iii) Use your graph to find the equation for P in terms of t. [4]

(iv) Predict the population in 2008 according to this model. [2]

2 **(i)** Write down the value of $\log_5 5$. [1]

(ii) Find $\log_3\left(\frac{1}{9}\right)$. [2]

(iii) Express $\log_a x + \log_a (x^5)$ as a multiple of $\log_a x$. [2]

3 Sketch the graph of $y = 2^x$.

Solve the equation $2^x = 50$, giving your answer correct to 2 decimal places. [5]

4 There is a flowerhead at the end of each stem of an oleander plant. The next year, each flowerhead is replaced by three stems and flowerheads, as shown in Fig. 11.

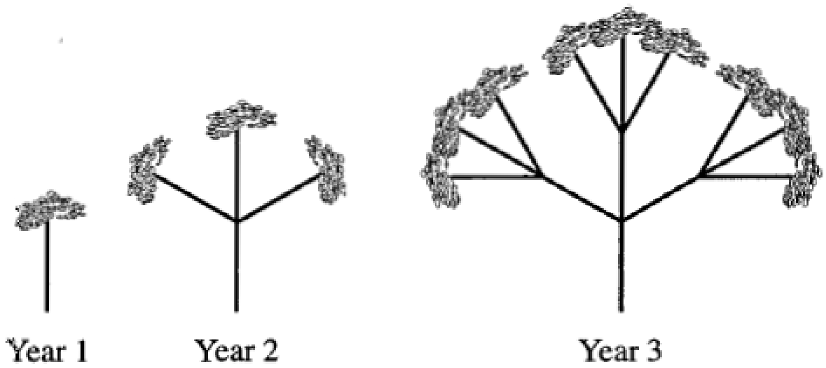

Fig. 11

(i) How many flowerheads are there in year 5? [1]

(ii) How many flowerheads are there in year n? [1]

(iii) As shown in Fig. 11, the total number of stems in year 2 is 4, (that is, 1 old one and 3 new ones). Similarly, the total number of stems in year 3 is 13, (that is, $1 + 3 + 9$).

Show that the total number of stems in year n is given by $\frac{3^n - 1}{2}$. [2]

(iv) Kitty's oleander has a total of 364 stems. Find

(A) its age, [2]

(B) how many flowerheads it has. [1]

(v) Abdul's oleander has over 900 flowerheads.

Show that its age, y years, satisfies the inequality $y > \frac{\log_{10}900}{\log_{10}3} + 1$.

Find the smallest integer value of y for which this is true. [4]

5 **(i)** Sketch the graph of $y = 3^x$. **[2]**

(ii) Solve the equation $3^{5x-1} = 500000$. **[3]**

6 The table shows population data for a country.

Year	1969	1979	1989	1999	2009
Population in millions (p)	58.81	80.35	105.27	134.79	169.71

The data may be represented by an exponential model of growth. Using t as the number of years after 1960, a suitable model is $p = a \times 10^{kt}$.

(i) Derive an equation for $\log_{10} p$ in terms of a, k and t. **[2]**

(ii) Complete the table and draw the graph of $\log_{10} p$ against t, drawing a line of best fit by eye. **[3]**

(iii) Use your line of best fit to express $\log_{10} p$ in terms of t and hence find p in terms of t. **[4]**

(iv) According to the model, what was the population in 1960? **[1]**

(v) According to the model, when will the population reach 200 million? **[3]**