1 **(i)** On the same axes, sketch the curves $y = 3^x$ and $y = 3^{2x}$, identifying clearly which is which. **[3]**

(ii) Given that $3^{2x} = 729$, find in either order the values of 3^x and x. **[2]**

2 Fig. 8 shows the graph of $\log_{10} y$ against $\log_{10} x$. It is a straight line passing through the points $(2, 8)$ and $(0, 2)$.

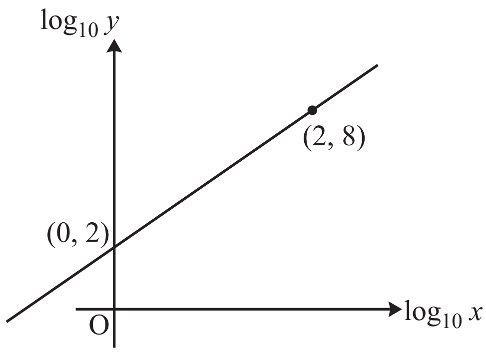

Fig. 8

Find the equation relating $\log_{10} y$ and $\log_{10} x$ and hence find the equation relating y and x. **[4]**

3 Use logarithms to solve the equation $3^{x+1} = 5^{2x}$. Give your answer correct to 3 decimal places. **[4]**

4 The thickness of a glacier has been measured every five years from 1960 to 2010.

The table shows the reduction in thickness from its measurement in 1960.

Year	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Number of years since 1960 (t)	5	10	15	20	25	30	35	40	45	50
Reduction in thickness since 1960 (h m)	0.7	1.0	1.7	2.3	3.6	4.7	6.0	8.2	12	15.9

An exponential model may be used for these data, assuming that the relationship between h and t is of the form $h = a \times 10^{bt}$, where a and b are constants to be determined.

(i) Show that this relationship may be expressed in the form $\log_{10} h = mt + c$, stating the values of m and c in terms of a and b. **[2]**

(ii) Complete the table of values in the answer book, giving your answers correct to 2 decimal places, and plot the graph of $\log_{10} h$ against t, drawing by eye a line of best fit. **[4]**

(iii) Use your graph to find h in terms of t for this model. **[4]**

(iv) Calculate by how much the glacier will reduce in thickness between 2010 and 2020, according to the model. **[2]**

(v) Give one reason why this model will not be suitable in the long term. **[1]**

5 A hot drink when first made has a temperature which is 65°C higher than room temperature. The temperature difference, d °C, between the drink and its surroundings decreases by 1.7% each minute.

(i) Show that 3 minutes after the drink is made, $d = 61.7$ to 3 significant figures. **[2]**

(ii) Write down an expression for the value of d at time n minutes after the drink is made, where n is an integer. **[1]**

(iii) Show that when $d < 3$, n must satisfy the inequality

$$n > \frac{\log_{10} 3 - \log_{10} 65}{\log_{10} 0.983}.$$

Hence find the least integer value of n for which $d < 3$. **[4]**

(iv) The temperature difference at any time t minutes after the drink is made can also be expressed as $d = 65 \times 10^{-kt}$, for some constant k. Use the value of d for 1 minute after the drink is made to calculate the value of k. Hence find the temperature difference 25.3 minutes after the drink is made. **[4]**

6 Fig. 6 shows the relationship between $\log_{10} x$ and $\log_{10} y$.

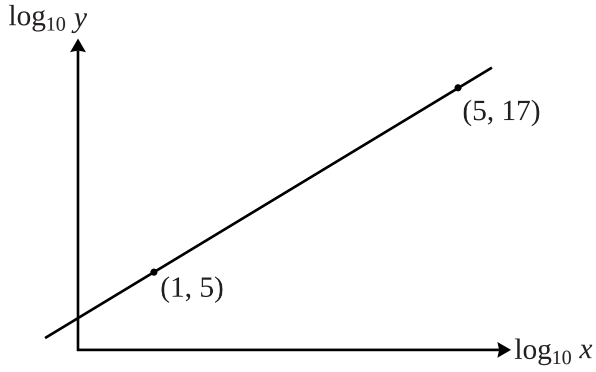

Fig. 6

Find y in terms of x. **[5]**

7 The graph of $y = ab^x$ passes through the points (1, 6) and (2, 3.6). Find the values of a and b. **[3]**

8 Using logarithms, rearrange $p = st^n$ to make n the subject. **[3]**

9 You are given that

$$\log_a x = \tfrac{1}{2}\log_a 16 + \log_a 75 - 2\log_a 5.$$

Find the value of x. **[3]**