1) (a) $2\log_3(x+y) + 6\log_3(x) - \frac{1}{3}$

$= \log_3(x+y)^2 + \log_3 x^6 - \log_3 3^{-\frac{1}{3}}$

$= \log_3(x+y)^2 x^6 \log_3 \frac{1}{\sqrt[3]{3}}$

$= \log_3 \frac{x^6 + 2x^7y + x^6y^2}{\sqrt[3]{3}}$

(b)(i) $\because Q_0 = 2$

$\therefore Q(t) = 2e^{kt}$

$\therefore Q(1750) = 2e^{1750k} = 1.5$

$\therefore e^{1750k} = 0.75$

$\therefore k = \frac{1}{1750}\ln 0.75 \approx -1.64 \times 10^{-4}$

$\therefore Q(t) = 2e^{\frac{\ln 0.75}{1750}t}$

(ii) $\because Q(t) = 2e^{\frac{\ln 0.75}{1750}t} = 2 \times \frac{1}{2} = 1$

$\therefore t \approx 4216$

(iii) $\because Q(t) = 2e^{\frac{\ln 0.75}{1750}t} = 0.25$

$\therefore t \approx 12649$

2) (a) $\lim\limits_{x \to \infty} \frac{3x^4 + 6x^2 + 3x + 12}{-2x^4 - 6x^3 + 70x - 27} + 2^{-x} + 3$

$= \lim\limits_{x \to \infty} \frac{3 + 6/x^2 + 3/x^3 + 12/x^4}{-2 - 6/x + 70/x^3 - 27/x^4} + 0 + 3$

$= -\frac{3}{2} + 0 + 3$

$= \frac{3}{2}$

(b) $\lim\limits_{x \to 3} \frac{1}{(x-3)^3}$

$\because \lim\limits_{x \to 3^-} \frac{1}{(x-3)^3} = -\infty$

$\lim\limits_{x \to 3^+} \frac{1}{(x-3)^3} = +\infty$

$\therefore \lim\limits_{x \to 3^-} \frac{1}{(x-3)^3} \neq \lim\limits_{x \to 3^+} \frac{1}{(x-3)^3}$

$$\therefore \lim_{x\to 3}\frac{1}{(x-3)^3}\ \text{DNE}$$

(C) $\lim_{x\to 2}\dfrac{(x^2-x-2)(x^2-5x+6)}{x^2-4x+4}$

$= \lim_{x\to 2}\dfrac{(x-2)(x+1)(x-2)(x-3)}{(x-2)^2}$

$= \lim_{x\to 2}(x+1)(x-3)$

$= -3$

3> (a) $f'(x) = \lim_{a\to 0}\dfrac{f(x+a)-f(x)}{a}$

$= \lim_{a\to 0}\dfrac{\frac{1}{x+a+1}-\frac{1}{x+1}}{a}$

$= \lim_{a\to 0}-\dfrac{1}{(x+a+1)(x+1)}$

$= -\dfrac{1}{(x+1)^2}$

(a) $h'(7) = \lim_{a\to 0}\dfrac{h(7+a)-h(7)}{a}$

$= \lim_{a\to 0}\dfrac{2(7+a)^2+2(7+a)-(2\times 7^2+2\times 7)}{a}$

$= \lim_{a\to 0}\dfrac{2a^2+30a}{a}$

$= \lim_{a\to 0}2a+30$

$= 30$