Applications of Logarithmic Functions

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Example 1.24

The magnitude of an eqrthquake measured on the Richter Scale is given by:

$$M = \log_{10}\left(\frac{I}{I_0}\right) \qquad M_S = 2.9$$

M – magnitude
I – intensity
I_0 – constant

$$M_S = \log_{10}\left(\frac{I}{I_0}\right) = 2.9$$

What is the magnitude of the eqrthquake is Wales?

$$M_W = \log_{10}\left(\frac{8 \times I}{I_0}\right) \quad (\times \to +)$$

$$= \log_{10} 8 + \log_{10}\left(\frac{I}{I_0}\right)$$

$$= \log_{10} 8 + 2.9$$

$$= 3.8$$

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pH Scale

1.a) The pH of ethanoic acid can be caluclated using the expression:

$$pH = -\frac{1}{2}\log_{10} Ka + \frac{1}{2}\log_{10} c \qquad Ka = 1.8 \times 10^{-5}, \; c = 2$$

$$= -\frac{1}{2}\log_{10}(1.8 \times 10^{-5}) + \frac{1}{2}\log_{10} 2$$

$$= 2.522878745$$

$$\Rightarrow 2.52 \text{ (to 2dp)}$$

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b) $pH = -\frac{1}{2}\log_{10} Ka + \frac{1}{2}\log_{10} c = -\log_{10} H$ → H&S

reorder

$\frac{1}{2}\log_{10} c = -\log_{10} H + \frac{1}{2}\log_{10} Ka$

x 2 $\quad \frac{1}{2}\log_{10} c = \frac{1}{2}\log_{10} Ka - \log_{10} H$

$\log_{10} c = \log_{10} Ka - 2\log_{10} H$

$\log_{10} c = \log_{10} Ka - \log_{10} H^2$

$\log_{10} c = \log_{10}\left(\frac{Ka}{H^2}\right)$ as expected.

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1 **a** 2.523

b $-\log_{10} H = -\frac{1}{2}\log_{10} Ka + \frac{1}{2}\log_{10} c$

$\log_{10} Ka - 2\log_{10} H = \log_{10} c$

$\log_{10} Ka - \log_{10} H^2 = \log_{10} c$

$\log_{10} c = \log\left(\frac{Ka}{H^2}\right)$

2 50

3 **a** Square in power of V becomes multiple of 2 since $\log\left(x^2\right) = 2\log x$

$10\log_{10}\left(\frac{V_1^2}{V_0^2}\right) = 20\log_{10}\left(\frac{V_1}{V_0}\right)$

b 19.95 V

4 0

5 1.5229