Deacon's Challenge No. 40 Answer

The SHO in ITU carried out a blood gas analysis but failed to record all of the results in the patient's notes. The only available results are:

H^+ concentration	=	93 nmol/L
Standard bicarbonate	=	15 mmol/L
Actual bicarbonate	=	21 mmol/L

Calculate the pH and Pco_2 (in kPa). Assume the solubility coefficient of CO_2 (in kPa) is 0.225.

$$pH = -\log_{10} [H^+]$$

To convert the H^+ concentration from nmol/L to mol/L divide by 1,000,000,000.

$$[H^+] = \frac{93}{1,000,000,000} = 0.000\ 000\ 093 \text{ mol/L}$$

$$pH = -(\log_{10} 0.000\ 000\ 093) = -(-7.03) = \mathbf{7.03}$$

The Henderson-Hasselbalch equation for the bicarbonate – CO_2 pair is:

$$pH = pKa + \log_{10} \frac{[HCO_3^-]}{\alpha\ Pco_2}$$

substitute:

$pH = 7.03$
$pKa = 6.1$
$[HCO_3^-]$ = actual bicarbonate = 21 mmol/L
α = solubility coefficient for CO_2 in water = 0.225

then solve for Pco_2

$$7.03 = 6.1 + \log_{10} \frac{21}{0.225\ Pco_2}$$

$$7.03 - 6.1 = \log_{10} \frac{21}{0.225\ Pco_2}$$

$$0.93 = \log_{10} \frac{21}{0.225\ Pco_2}$$

$$\text{antilog}_{10}\ 0.93 = \frac{21}{0.225\ Pco_2}$$

$$Pco_2 = \frac{21}{0.225\ \text{antilog}_{10}\ 0.93} = \frac{21}{0.225 \times 8.51} = \frac{21}{1.92} = \mathbf{10.9\ kPa}$$

Exam tip: The pKa for carbonic acid-bicarbonate was not given. The examiners expect you to know important constants such as the pKa for carbonic acid, phosphate and ammonia. Knowledge of these is a requirement for an understanding of acid-base homeostasis – an important subject that should be covered in detail.

Question 41

If the half life of a radionucleotide is 20 hours, at the end of how many complete days will the activity have fallen to less than 2% of the initial value?