

EGT3

ENGINEERING TRIPOS PART IIB

Module 4B6

SOLID STATE DEVICES AND CHEMICAL/BIOLOGICAL SENSORS

List of Answers

1. (b) (i)

$$K_b = \frac{[\text{SiOH}_2^+]}{[\text{H}_s^+][\text{SiOH}]} \quad K_a = \frac{[\text{H}_s^+][\text{SiO}^-]}{[\text{SiOH}]}$$

(ii)

$$\frac{K_a}{K_b} = \frac{[\text{H}_s^+]^2 [\text{SiO}^-]}{[\text{SiOH}_2^+]} \quad \therefore [\text{H}_s^+] = \sqrt{\frac{K_a [\text{SiOH}_2^+]}{K_b [\text{SiO}^-]}}$$

(iii)

$$-\ln [\text{H}_b^+] + \ln \left(\frac{K_a}{K_b} \right)^{\frac{1}{2}} = -\frac{q\psi_L}{kT} + \ln \left(\frac{[\text{SiO}^-]}{[\text{SiOH}_2^+]} \right)^{\frac{1}{2}}$$

$$-\ln [\text{H}_b^+] + \ln \left(\frac{K_a}{K_b} \right)^{\frac{1}{2}} \approx -\frac{q\psi_L}{kT} \quad \underbrace{\ln \left(\frac{[\text{SiO}^-]}{[\text{SiOH}_2^+]} \right)^{\frac{1}{2}}}_{\text{negligible}}$$

2. (a) (i) $25 \mu\text{C cm}^{-2}$; (ii) 80 kV cm^{-1} ; (iii) $8 \times 10^6 \text{ J m}^{-3}$

(b) (i) 2.9 fC for '1', 19 fC for '2'; (ii) 1.5 mV for '1', 9.5 mV for '0';
(iii) $58 \text{ nm} \times 58 \text{ nm}$

(c) $\sim 10 \text{ yrs}$ at 80°C , $\sim 1,000 \text{ yrs}$ at 30°C

3.

4. (b) 1.79 V ; (c) 9.99 V