

EXAM IV – November 25, 2019

Answers to Calculation-Based Problems

2. (16 pts) Sulfuric acid, H_2SO_4 , is arguably the most commonly used chemical in the world, with myriad applications. Among them, you may know that it is the “battery acid” in most car batteries.

Suppose that a mechanic keeps a solution of lye (more formally known as sodium hydroxide, NaOH) on hand to neutralize any H_2SO_4 that happens to leak from used car batteries.

- a. What is the pH of a 6.0 M solution of NaOH ?

Answer: pH = 13.22

4. (18 pts) Radioactive iodine, ^{131}I , is used to treat hyperthyroidism (overactive thyroid) by shrinking the thyroid gland. It decays according to first-order kinetics. $\ln \frac{[A]_t}{[A]_0} = -kt$

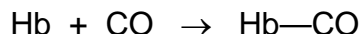
- b. The half-life of ^{131}I is 8.021 days. Calculate the rate constant for its decay.

Answer: k = 0.864 days⁻¹

- c. How much time must pass after administration of ^{131}I before its concentration has decayed to 5.0% of its initial value?

Answer: t = 35 days

5. (12 pts) The hemoglobin in our blood (abbreviated Hb) readily binds to carbon monoxide. (This is a key factor in CO poisoning, as the CO displaces oxygen.) The rate of this binding reaction was studied at 20 °C. [$1 \mu\text{M} = 1 \times 10^{-6} \text{ M} = 1 \mu\text{mol/L}$]

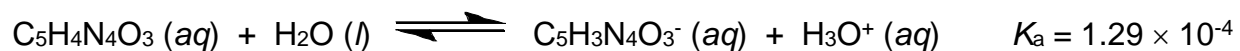


$[\text{Hb}]_0$ (μM)	$[\text{CO}]_0$ (μM)	Initial Rate ($\mu\text{M/s}$)
2.21	1.00	0.619
4.42	1.00	1.24
4.42	3.00	3.71

- b. Calculate the rate constant.

Answer: k = 0.280 $\mu\text{M}^{-1} \text{ s}^{-1}$

7. (17 pts) Uric acid ($C_5H_4N_4O_3$, $K_a = 1.29 \times 10^{-4}$) can collect in joints, giving rise to a medical condition known as gout. What is the pH of a 0.0650 M solution of uric acid? [Hint: Find the equilibrium concentration of H_3O^+ .]



Answer: pH = 2.548 (using quadratic formula)

OR

pH = 2.538 (using the shortcut, assuming $x \ll 0.0650$ M)