___ - ___ - ___ = ___ /10

INCORRECT SIG FIGS | INCORRECT UNITS

Unit 11
Free Response Practice #2

Pre-AP Chemistry
Section II
Constructed-Response Questions

Directions: The suggested time is about 15 minutes for answering the constructed response section of the chemistry test. The parts within a question may not have equal weight. For calculations, show all your work in the spaces provided after each part. Pay particular attention to the proper use of units. Be sure your final answer is rounded to the correct number of significant figures. Make sure your work is legible. Illegible work will receive a grade of zero.

Question 1 [10 POINTS]

During exercise, muscles use up oxygen as they convert chemical energy in glucose to mechanical energy. This O_2 comes from hemoglobin in the blood. CO_2 and H^+ are produced during the breakdown of glucose, and are removed from the muscle via the blood. The production and removal of CO_2 and H^+, together with the use and transport of O_2, unless offset by other physiological functions, cause the pH of the blood to drop. If the pH of the body gets too low (below 7.4), a condition known as acidosis results.

A. To maintain blood pH, the following equilibrium reaction occurs:

$$H_2CO_3(aq) + H_2O(l) \leftrightharpoons H_3O^+(aq) + HCO_3^-(aq)$$

i. Write the equilibrium expression for this reaction. **[1 POINT]**

$$K_a = \frac{[H_3O^+][HCO_3^-]}{[H_2CO_3]}$$

ii. Identify **two** conjugate acid-base pairs in the system above. For each pair, label each species as acid, base, conjugate acid, or conjugate base. **[2 POINTS]**

H_2CO_3 and HCO_3^- (A, CB) ; H_2O and H_3O^+ (B, CA)

iii. Does the **base** in the system above function as an Arrhenius base, a Bronsted-Lowry base, both, or neither? Justify your response. **[1 POINT]**

H_2O, the base, is acting as a Bronsted-Lowry base (NOT Arrhenius), b/c it is accepting an H^+, not releasing OH^-

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B. The pH of a sample of human blood was measured to be 7.41 at 25°C.

i. Calculate pOH for the sample. **[1 POINT]**

$pOH = 14 - 7.41 = \boxed{6.59}$

ii. Calculate $[H_3O^+]$ and $[OH^-]$ for the sample. **[2 POINTS]**

$[H_3O^+] = 10^{-pH} = 10^{-7.41} = \boxed{3.9 \times 10^{-8}\ M}$

$[OH^-] = 10^{-pOH} = 10^{-6.59} = \boxed{2.6 \times 10^{-7}\ M}$

iii. Calculate the concentration of carbonic acid, H_2CO_3. **[1 POINT]**

$3.9 \times 10^{-8}\ M\ H^+ \times \frac{1\ H_2CO_3}{2\ H^+} = 1.95 \times 10^{-8} = \boxed{2.0 \times 10^{-8}\ M}$

C. If the pH of a blood sample changed from 7.41 to 9.41, by what factor did $[H_3O^+]$ change, and by what factor did $[OH^-]$ change? Justify your answer. **[2 POINTS]**

→ $[H_3O^+]$ decreased by factor of 100 (less acidic)

→ $[OH^-]$ increased by factor of 100 (more basic)

(1 pH point = factor of 10 for H^+!)