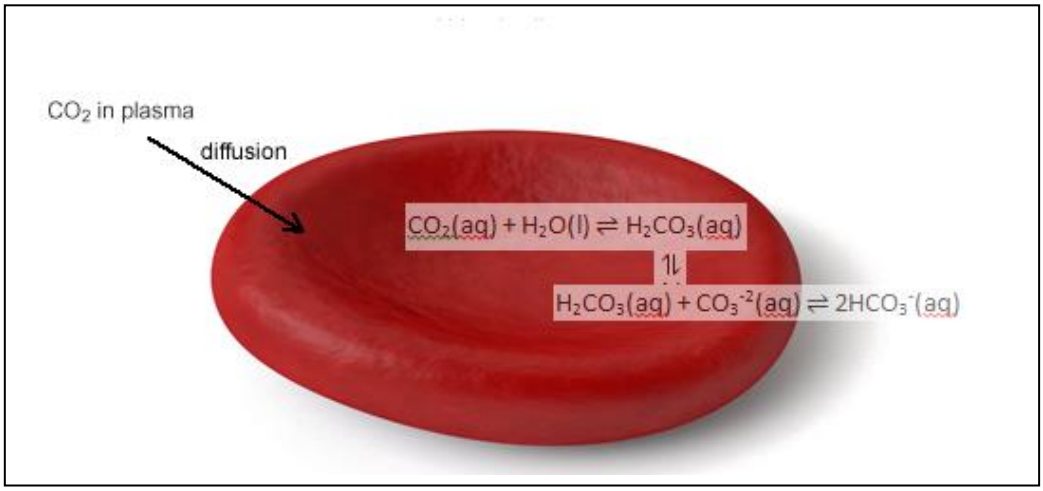
**Friday Worksheet** **Name: …….**

## Chemical equilibrium worksheet 5

1) Below are two reactions that are part of the bicarbonate system in the blood.
$CO_2(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$ ---------- 1)
$H_2CO_3(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$ ---------- 2)
$CO_2$ is a product of cellular respiration. It diffuses out of the cell's membrane and accumulates in the fluid surrounding the cell. $CO_2$ reacts with water to produce carbonic acid, reaction 1) above. This reaction is catalysed by an enzyme called carbonic anhydrase. Carbonic acid is a weak acid that if allowed to accumulate can disrupt vital cellular functions.




a) The bicarbonate system can be summarised below.
$CO_2(aq) + 2H_2O(l) \rightleftharpoons H_2CO_3(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + HCO_3^-(aq)$

People who hyperventilate, during a moment of crisis, are often advised to breath into a paper bag.
Using Le Chatelier's principle explain:

- the effect on blood pH of hyperventilating,
- the effect on blood pH of breathing into a paper bag.

b) The concentration of carbon dioxide in the lungs is very low, how does this affect the:

- equilibrium position of the following reaction $CO_2(g) \rightleftharpoons CO_2(aq)$
- the pH of the blood leaving the lungs as compared to the pH coming into the lungs.

2) It is proposed to indirectly determine the concentration of $Fe^{3+}$ ions in a solution by using UV-visible spectroscopy to measure the concentration of red coloured $FeSCN^{2+}$ ions generated by the equilibrium reaction.

$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons FeSCN^{2+}(aq)$ $\Delta H$ = positive

Tick the conditions that this procedure must be conducted under, that would provide the most accurate estimate of $Fe^{3+}$ ions in the original solution.

| | | |
|---|---|---|
| Equilibrium constant | High | |
| | Low | |
| Temperature | High | |
| | Low | |
| Concentration of $SCN^{-}$ | Excess | |
| | Limiting | |

3) 1) The equation below shows the steam reforming reaction for the industrial production of hydrogen gas using a Ni catalyst, high temperature and high pressure.

$CH_4(g) + H_2O(g) \Rightarrow CO(g) + 3H_2(g)$ $\Delta H = +207$ kJ $mol^{-1}$

a) Write an equilibrium expression for the steam reforming reaction.

b) According to Le Chatelier's principle what are the ideal conditions for maximum yield for this reaction?

c) Suggest one reason why high pressure is used in the industrial process described above.

d) At 1500 °C the concentrations of the gases in a particular equilibrium mixture were found to be $[CH_4] = 0.200$ M, $[CO] = 0.580$ M, $[H_2O] = 0.038$ M

If $K = 5.70\ M^2$ at 1500 °C for the reaction, calculate the molar concentration of $H_2$ in the equilibrium mixture.