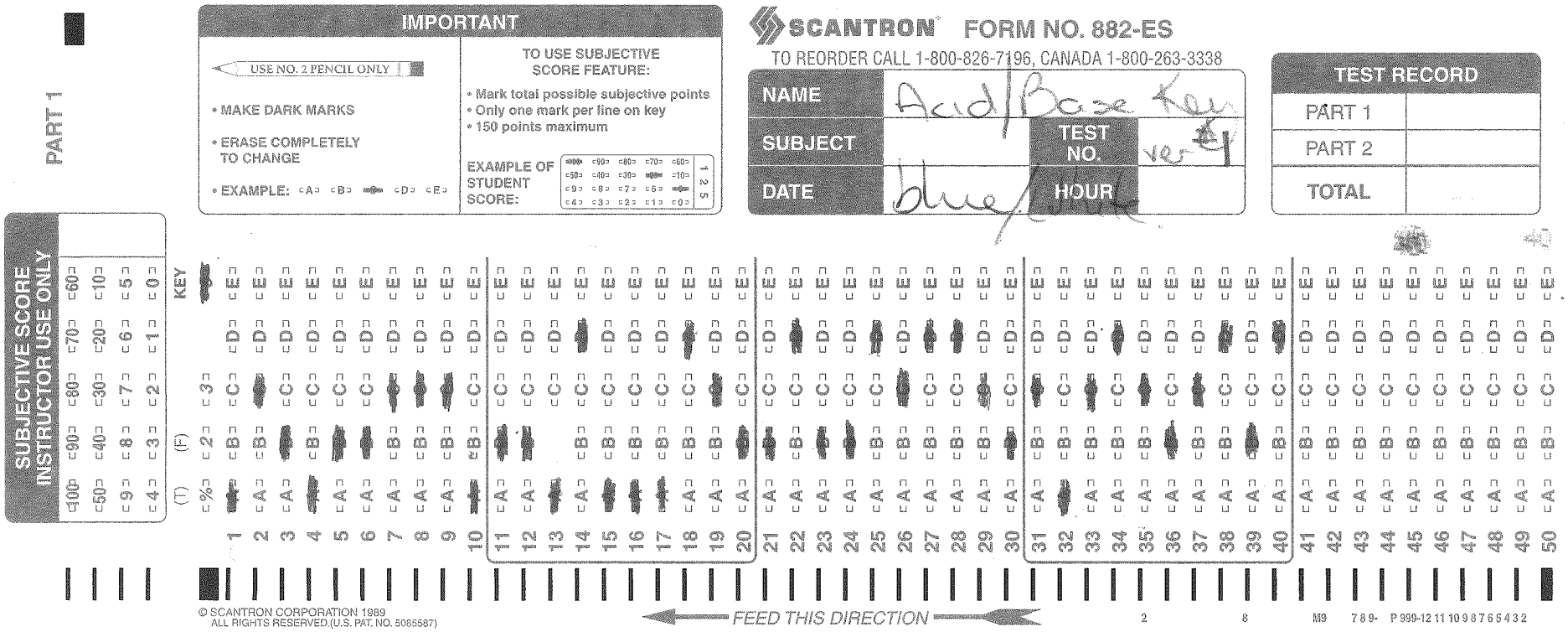
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Problem Solving (25 marks)

1. Define the term *strong Brönsted-Lowry acid.* **(2 marks)**

donates all protons (dissociate fully)

(acid = donates) (strong fully)

2. a) A concentrated ammonia solution is 15 M. Calculate the pH for this solution. **(5 marks)**

	$NH_3 + H_2O$	$\rightleftharpoons$	NH_4^+	$+ OH^-$
I	15			
C	$-x$			
E	$15-x$		x	x

$$K_b = \frac{1.0\times10^{-14}}{5.6\times10^{-10}} = 1.786\times10^{-5}$$

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

$$1.786\times10^{-5} = \frac{x^2}{15}$$

$$x = 0.0164\ M$$

$$pOH = -\log(0.0164) = 1.79$$

$$\therefore pH = 12.21$$

3. Lactic acid, $HC_3H_5O_3$, is a compound that accumulates in muscle tissue during exertion. Write the equation and the K_a expression for the ionization of lactic acid in water. **(2 marks)**

$$HC_3H_5O_3 + H_2O \rightleftharpoons H_3O^+ + C_3H_5O_3^-$$

$$K_a = \frac{[H_3O^+][C_3H_5O_3^-]}{[HC_3H_5O_3]}$$

4. **A solution of 0.0100 M lactic acid, $HC_3H_5O_3$, has a pH of 2.95. Calculate the K_a value.** **(3 marks)**

$$HC_3H_5O_3 + H_2O \rightleftharpoons H_3O^+ + C_3H_5O_3^-$$

	$HC_3H_5O_3$		H_3O^+	$C_3H_5O_3^-$
I	0.0100		0	0
C	-.00112		+0.00112	+0.00112
E	0.00888		0.00112	0.00112

$pH = 2.95$

$[H^+] = 10^{-2.95}$

$= 1.122 \times 10^{-3}\ M$

$$K_a = \frac{[H_3O^+][C_3H_5O_3^-]}{[HC_3H_5O_3]}$$

$$= \frac{(0.00112)^2}{0.00888}$$

$K_a = 1.4 \times 10^{-4}$

5. a) Identify an oxide that produces an acidic solution. **(1 mark)**

any non-metal oxide

eg) SO_2

b) Write an equation representing the reaction between this oxide and water. **(1 mark)**

$SO_2 + H_2O \rightarrow H_2SO_3$

6. a) Write the net ionic equation for the predominant reaction between $NaHSO_3$ and $NaHC_2O_4$. **(2 marks)**

HSO_3^- (K_a) > $HC_2O_4^-$ (K_a)

$K_a = 1.0\times10^{-7}$ ⟷ $K_a = 6.4\times10^{-5}$

$K_b = 6.7\times10^{-13}$ $K_b = 1.69\times10^{-13}$

∴ $HC_2O_4^-$ acts as acid

$HSO_3^- + HC_2O_4^- \rightleftharpoons H_2SO_3 + C_2O_4^{-2}$

b) Explain why the reactants are favoured in the above reaction. ∴ rxn ← **(1 mark)**

H_2SO_3 is stronger than $HC_2O_4^-$

7. A 2.0 L solution contains one mole of the weak acid, H_3PO_4, in equilibrium with one mole of the salt, NaH_2PO_4.

a) Write an equation that represents this equilibrium. **(2 marks)**

$H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+$

a b b a

b) Explain why the pH of this solution does not change significantly when 10.0 mL of 1.0 M KOH is added. **(1 mark)**

because this represents a buffer system. The OH^- reacts with the H^+ but there is only a slight Δ because of the relatively large [ ] of H_3PO_4 & $H_2PO_4^-$

8. a) Identify a compound that could be added to 1.0 M HNO_2 to form a buffer. **(1 mark)**

NO_2^- ∴ $NaNO_2$

b) What happens to the acidity of the HNO_2 solution as this compound is added? **(1 mark)**

acidity (pH ↑) ↓ because the reaction shifts left as NO_2^- is added; ∴ H_3O^+ ↓, pH ↑ (see below)

c) Write the net ionic equation for the buffer equilibrium. **(1 mark)**

$HNO_2 + H_2O \rightleftharpoons NO_2^- + H_3O^+$

9. Calculate the pH of a 25.0 mL solution formed by mixing 0.0300 mol HNO_3 and 0.0280 mol NaOH. **(2 marks)**

$HNO_3 + NaOH \rightleftharpoons HOH + NaNO_3$

extra HNO_3

0.0300 mol HNO_3 added

− 0.0280 mol used

0.0020 mol left

$[HNO_3] = \frac{0.0020\ mol}{0.025\ L} = 0.0800\ M\ HNO_3$

$HNO_3 \rightarrow H^+ + NO_3^-$

.08 .08

$pH = -\log(0.08)$

$pH = 1.097$

S.F.?