

Acid Unit: Reactions

- The Haber process uses hydrogen and nitrogen to produce ammonia for use as a feedstock for other processes or as a fertilizer. In industry, the goal of manufacturing is to obtain the highest yield of product for the lowest cost.

The equation for the equilibrium reaction is:

a	$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) + 91.8 \text{ kJ} \leftrightarrow 2\text{NH}_3(\text{g})$
b	$2\text{NH}_3(\text{g}) + 45.9 \text{ kJ} \leftrightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$
c	$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \leftrightarrow 2\text{NH}_3(\text{g}) + 91.8 \text{ kJ}$
d	$2\text{NH}_3(\text{g}) \leftrightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) + 45.9 \text{ kJ}$

- Cam and Brent make some observations about equilibrium reactions between acids and bases. Each box indicates if the reaction favours **Products** or favours **Reactants**.

	HX(aq)	HY(aq)	HM(aq)	HR(aq)
X ⁻ (aq)	-----	Products	Reactants	Products
Y ⁻ (aq)	Reactants	-----	Reactants	Products
M ⁻ (aq)	Products	Products	-----	Products
R ⁻ (aq)	Reactants	Reactants	Reactants	-----

The boys are asked to rank the acids from the strongest to the weakest acid.

a	HX(aq)	HM(aq)	HR(aq)	HY(aq)
b	HM(aq)	HX(aq)	HY(aq)	HR(aq)
c	HY(aq)	HR(aq)	HX(aq)	HM(aq)
d	HR(aq)	HY(aq)	HX(aq)	HM(aq)

- Cam and Brent make some observations about equilibrium reactions between acids and bases. Each box indicates if the reaction favours **Products** or favours **Reactants**.

	HX(aq)	HY(aq)	HM(aq)	HR(aq)
X ⁻ (aq)	-----	Products	Reactants	Products
Y ⁻ (aq)	Reactants	-----	Reactants	Products
M ⁻ (aq)	Products	Products	-----	Products
R ⁻ (aq)	Reactants	Reactants	Reactants	-----

The boys are asked to rank the BASES from the strongest to the weakest base.

a	Y ⁻ (aq)	R ⁻ (aq)	M ⁻ (aq)	X ⁻ (aq)
b	M ⁻ (aq)	X ⁻ (aq)	Y ⁻ (aq)	R ⁻ (aq)
c	X ⁻ (aq)	M ⁻ (aq)	R ⁻ (aq)	Y ⁻ (aq)
d	R ⁻ (aq)	Y ⁻ (aq)	X ⁻ (aq)	M ⁻ (aq)

4. Amy and Carlynn are given four reactions involving acids and bases. A dark arrow facing left ($\leftarrow$ $\rightarrow$) means the reaction favours the reactants. A dark arrow facing right ($\leftarrow$ $\rightarrow$) means the reaction favours products.

Reactants	Arrows	Products
$\text{HL(aq)} + \text{M}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{L}^{\text{'}}(\text{aq}) + \text{HM(aq)}$
$\text{HR(aq)} + \text{M}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{HM(aq)} + \text{R}^{\text{'}}(\text{aq})$
$\text{HM(aq)} + \text{N}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{HN(aq)} + \text{M}^{\text{'}}(\text{aq})$
$\text{HN(aq)} + \text{L}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{HL(aq)} + \text{N}^{\text{'}}(\text{aq})$

Based on this information, the girls determine the correct list of acids from strongest to weakest as:

a	HN(aq)	HM(aq)	HR(aq)	HL(aq)
b	HL(aq)	HR(aq)	HM(aq)	HN(aq)
c	HM(aq)	HN(aq)	HL(aq)	HR(aq)
d	HL(aq)	HR(aq)	HN(aq)	HM(aq)

5. Annette and Marilyn are given four reactions involving acids and bases. A dark arrow facing left ($\leftarrow$ $\rightarrow$) means the reaction favours the reactants. A dark arrow facing right ($\leftarrow$ $\rightarrow$) means the reaction favours products.

Reactants	Arrows	Products
$\text{HL(aq)} + \text{M}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{L}^{\text{'}}(\text{aq}) + \text{HM(aq)}$
$\text{HR(aq)} + \text{M}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{HM(aq)} + \text{R}^{\text{'}}(\text{aq})$
$\text{HM(aq)} + \text{N}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{HN(aq)} + \text{M}^{\text{'}}(\text{aq})$
$\text{HN(aq)} + \text{L}^{\text{'}}(\text{aq})$	$\leftarrow$ $\rightarrow$	$\text{HL(aq)} + \text{N}^{\text{'}}(\text{aq})$

Based on this information, the girls determine the correct list of BASES from strongest to weakest as:

a	$\text{M}^{\text{'}}(\text{aq})$	$\text{N}^{\text{'}}(\text{aq})$	$\text{R}^{\text{'}}(\text{aq})$	$\text{L}^{\text{'}}(\text{aq})$
b	$\text{R}^{\text{'}}(\text{aq})$	$\text{L}^{\text{'}}(\text{aq})$	$\text{N}^{\text{'}}(\text{aq})$	$\text{M}^{\text{'}}(\text{aq})$
c	$\text{L}^{\text{'}}(\text{aq})$	$\text{R}^{\text{'}}(\text{aq})$	$\text{M}^{\text{'}}(\text{aq})$	$\text{N}^{\text{'}}(\text{aq})$
d	$\text{N}^{\text{'}}(\text{aq})$	$\text{M}^{\text{'}}(\text{aq})$	$\text{R}^{\text{'}}(\text{aq})$	$\text{L}^{\text{'}}(\text{aq})$

6. John and Kent are given four reactions involving acids and bases. A dark arrow facing left ($\leftarrow$ $\rightleftharpoons$) means the reaction favours the reactants. A dark arrow facing right ($\rightleftharpoons$ $\rightarrow$) means the reaction favours products.

Reactants	Arrows	Products
$\text{HL(aq)} + \text{M}^{\text{+}}(\text{aq})$	$\leftarrow \rightleftharpoons$	$\text{L}^{\text{-}}(\text{aq}) + \text{HM(aq)}$
$\text{HR(aq)} + \text{M}^{\text{+}}(\text{aq})$	$\rightleftharpoons \rightarrow$	$\text{HM(aq)} + \text{R}^{\text{-}}(\text{aq})$
$\text{HM(aq)} + \text{N}^{\text{-}}(\text{aq})$	$\rightleftharpoons \rightarrow$	$\text{HN(aq)} + \text{M}^{\text{+}}(\text{aq})$
$\text{HN(aq)} + \text{L}^{\text{-}}(\text{aq})$	$\leftarrow \rightleftharpoons$	$\text{HL(aq)} + \text{N}^{\text{-}}(\text{aq})$

The acid with the largest k_{a} value will be:

a	HL(aq)
b	HR(aq)
c	HN(aq)
d	HM(aq)

7. Kian and Grant are given four reactions involving acids and bases. A dark arrow facing left ($\leftarrow$ $\rightleftharpoons$) means the reaction favours the reactants. A dark arrow facing right ($\rightleftharpoons$ $\rightarrow$) means the reaction favours products.

Reactants	Arrows	Products
$\text{HL(aq)} + \text{M}^{\text{+}}(\text{aq})$	$\leftarrow \rightleftharpoons$	$\text{L}^{\text{-}}(\text{aq}) + \text{HM(aq)}$
$\text{HR(aq)} + \text{M}^{\text{+}}(\text{aq})$	$\rightleftharpoons \rightarrow$	$\text{HM(aq)} + \text{R}^{\text{-}}(\text{aq})$
$\text{HM(aq)} + \text{N}^{\text{-}}(\text{aq})$	$\rightleftharpoons \rightarrow$	$\text{HN(aq)} + \text{M}^{\text{+}}(\text{aq})$
$\text{HN(aq)} + \text{L}^{\text{-}}(\text{aq})$	$\leftarrow \rightleftharpoons$	$\text{HL(aq)} + \text{N}^{\text{-}}(\text{aq})$

The BASE with the largest k_{b} value will be:

a	$\text{L}^{\text{-}}(\text{aq})$
b	$\text{M}^{\text{+}}(\text{aq})$
c	$\text{R}^{\text{-}}(\text{aq})$
d	$\text{N}^{\text{-}}(\text{aq})$

Solutions:

1. C
2. D
3. B
4. B
5. D
6. B
7. D