HL Paper 1

According to the Brønsted-Lowry theory, how does each species act in the equilibrium below?

$$CH_3COOH + H_2SO_4 \rightleftharpoons CH_3COOH_2^+ + HSO_4^-$$

	CH_3COOH	H_2SO_4	$CH_3COOH_2^+$	HSO_4^-
A.	acid	base	base	acid
B.	acid	base	acid	base
C.	base	acid	base	acid
D.	base	acid	acid	base

Markscheme

D

Examiners report

[N/A]

Aqueous solutions of a weak acid and a strong acid of equal concentration are compared. Which statements are correct?

I. The weak acid is less dissociated than the strong acid.
II. The strong acid reacts with a metal oxide but the weak acid does not.
III. The strong acid has greater conductivity than the weak acid.

A. I and II only
B. I and III only
C. II and III only
D. I, II and III

Markscheme

B

Examiners report

[N/A]

What is the pH of 1.0×10^{-3} mol dm^{-3} sodium hydroxide, NaOH(aq)?

$$K_w = 1.0 \times 10^{-14}$$

A. 3

B. 4

C. 10

D. 11

Markscheme

D

Examiners report

[N/A]

Which solutions have a pH less than 7?

I. $Na_2CO_3(aq)$

II. $[Fe(H_2O)_6]Cl_3(aq)$

III. $(NH_4)_2SO_4(aq)$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

C

Examiners report

[N/A]

What is the correct expression for the ionic product constant of water, K_w?

A. $K_W = \frac{[H^+]}{[OH^-]}$

B. $K_W = \frac{[H_2O]}{[H^+][OH^-]}$

C. $K_W = [H^+] + [OH^-]$

D. $K_{\mathrm{W}} = [\mathrm{H}^+][\mathrm{OH}^-]$

Markscheme

D

Examiners report

[N/A]

Which of the following is an example of a Lewis acid–base reaction, but not a Brønsted–Lowry acid–base reaction?

A. $2\mathrm{CrO}_4^{2-}(\mathrm{aq}) + 2\mathrm{H}^+(\mathrm{aq}) \rightarrow \mathrm{Cr}_2\mathrm{O}_7^{2-}(\mathrm{aq}) + \mathrm{H}_2\mathrm{O}(\mathrm{l})$

B. $\mathrm{Co(H_2O)}_6^{2+}(\mathrm{aq}) + 4\mathrm{HCl}(\mathrm{aq}) \rightarrow \mathrm{CoCl}_4^{2-}(\mathrm{aq}) + 4\mathrm{H}^+(\mathrm{aq}) + 6\mathrm{H}_2\mathrm{O}(\mathrm{l})$

C. $\mathrm{NH}_3(\mathrm{aq}) + \mathrm{H}^+(\mathrm{aq}) \rightarrow \mathrm{NH}_4^+(\mathrm{aq})$

D. $\mathrm{CH_3COO}^-(\mathrm{aq}) + \mathrm{H_2O}(\mathrm{l}) \rightarrow \mathrm{CH_3COOH}(\mathrm{aq}) + \mathrm{OH}^-(\mathrm{aq})$

Markscheme

B

Examiners report

[N/A]

What is the pH of a solution in which the hydroxide ion concentration is 1×10^{-11} mol dm^{-3} at 298 K?

$K_w = 1 \times 10^{-14}$ at 298 K

A. 3

B. 7

C. 11

D. 14

Markscheme

A

Examiners report

[N/A]

Which species acts as a Lewis and Brønsted–Lowry base?

A. $[Al(H_2O)_6]^{3+}$

B. BF_3

C. NH_4^+

D. OH^-

Markscheme

D

Examiners report

[N/A]

The table below shows data for the K_a and pK_b values for some acids and bases at 298 K.

Acid	K_a	Base	pK_b
HClO	2.9×10^{-8}	NH_3	4.75
$C_6H_5CH_2COOH$	4.9×10^{-5}	$C_6H_5NH_2$	9.13

Which two formulas represent the weakest acid and the weakest base in the table?

A. HClO and $C_6H_5NH_2$

B. $C_6H_5CH_2COOH$ and NH_3

C. $C_6H_5CH_2COOH$ and $C_6H_5NH_2$

D. HClO and NH_3

Markscheme

A

Examiners report

It was thought “good to mix the data types, pK_a and K_a”. This was the fifth hardest question (60.81% correct) with the wrong answers almost equally chosen.

Which species produced by the successive dissociations of phosphoric acid, H_3PO_4, are amphiprotic?

A. HPO_4^{2-} and PO_4^{3-}

B. $H_2PO_4^-$ and HPO_4^{2-}

C. $H_2PO_4^-$ and PO_4^{3-}

D. HPO_4^{2-} only

Markscheme

B

Examiners report

[N/A]

What is the conjugate base of phenol, C_6H_5OH?

A. $C_6H_4^-$–OH

B. C_6H_5–$\overset{+}{O}H_2$

C. C_6H_5–O^-

D. $C_6H_6^+$–OH

Markscheme

C

Examiners report

[N/A]

What are the conjugate acid–base pairs in the following reaction?

$$HCO_3^-(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + H_2CO_3(aq)$$

	Brønsted–Lowry acid	Brønsted–Lowry base	Conjugate acid	Conjugate base
A.	$HCO_3^-(aq)$	$H_2O(l)$	$H_2CO_3(aq)$	$OH^-(aq)$
B.	$H_2CO_3(aq)$	$OH^-(aq)$	$HCO_3^-(aq)$	$H_2O(l)$
C.	$H_2O(l)$	$HCO_3^-(aq)$	$H_2CO_3(aq)$	$OH^-(aq)$
D.	$H_2O(l)$	$HCO_3^-(aq)$	$OH^-(aq)$	$H_2CO_3(aq)$

Markscheme

C

Examiners report

[N/A]

If $20\ \mathrm{cm}^3$ samples of $0.1\ \mathrm{mol\,dm}^{-3}$ solutions of the acids below are taken, which acid would require a different volume of $0.1\ \mathrm{mol\,dm}^{-3}$ sodium hydroxide for complete neutralization?

A. Nitric acid

B. Sulfuric acid

C. Ethanoic acid

D. Hydrochloric acid

Markscheme

B

Examiners report

This question on the neutralization of an alkali by various acids proved to be a particularly good discriminator (Discrimination Index 0.68), with many of the weaker students considering that the strength of the acid would affect the amount required.

Which group of three compounds contains only weak acids and bases?

A.	$Ba(OH)_2$	CH_3NH_2	CH_3COOH
B.	$CH_3CH_2CH_2COOH$	$CH_3CH_2NH_2$	$HCOOH$
C.	NH_3	HNO_3	CH_3CH_2COOH
D.	NH_3	$NaOH$	H_2CO_3

Markscheme

B

Examiners report

[N/A]

Which salts will dissolve in water to give solutions with a pH above 7?

I. Na_2CO_3

II. CH_3COONa

III. Na_2SO_4

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

A

Examiners report

[N/A]

What describes HPO_4^{2-}?

A. Amphiprotic but not amphoteric

B. Amphoteric but not amphiprotic

C. Amphiprotic and amphoteric

D. Neither amphiprotic nor amphoteric

Markscheme

C

Examiners report

[N/A]
