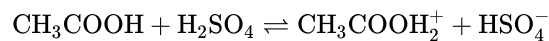


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# HL Paper 1

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



	$\text{CH}_3\text{COOH}$	$\text{H}_2\text{SO}_4$	$\text{CH}_3\text{COOH}_2^+$	$\text{HSO}_4^-$
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]

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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]

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What is the pH of  $1.0 \times 10^{-3} \text{ mol dm}^{-3}$  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]

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Which solutions have a pH less than 7?

- I.  $\text{Na}_2\text{CO}_3(\text{aq})$
  - II.  $[\text{Fe}(\text{H}_2\text{O})_6]\text{Cl}_3(\text{aq})$
  - III.  $(\text{NH}_4)_2\text{SO}_4(\text{aq})$
- 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]

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

- A.  $K_w = \frac{[\text{H}^+]}{[\text{OH}^-]}$
- B.  $K_w = \frac{[\text{H}_2\text{O}]}{[\text{H}^+][\text{OH}^-]}$
- C.  $K_w = [\text{H}^+] + [\text{OH}^-]$

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

## Markscheme

D

## Examiners report

[N/A]

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

- A.  $2\text{CrO}_4^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- B.  $\text{Co}(\text{H}_2\text{O})_6^{2+}(\text{aq}) + 4\text{HCl}(\text{aq}) \rightarrow \text{CoCl}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 6\text{H}_2\text{O}(\text{l})$
- C.  $\text{NH}_3(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{NH}_4^+(\text{aq})$
- D.  $\text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{COOH}(\text{aq}) + \text{OH}^-(\text{aq})$

## Markscheme

B

## Examiners report

[N/A]

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

$$K_{\text{w}} = 1 \times 10^{-14} \text{ at } 298 \text{ K}$$

- 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.  $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$
- B.  $\text{BF}_3$
- C.  $\text{NH}_4^+$
- D.  $\text{OH}^-$

## Markscheme

D

## Examiners report

[N/A]

The table below shows data for the  $K_a$  and  $\text{p}K_b$  values for some acids and bases at 298 K.

Acid	$K_a$	Base	$\text{p}K_b$
HClO	$2.9 \times 10^{-8}$	$\text{NH}_3$	4.75
$\text{C}_6\text{H}_5\text{CH}_2\text{COOH}$	$4.9 \times 10^{-5}$	$\text{C}_6\text{H}_5\text{NH}_2$	9.13

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

- A. HClO and  $\text{C}_6\text{H}_5\text{NH}_2$
- B.  $\text{C}_6\text{H}_5\text{CH}_2\text{COOH}$  and  $\text{NH}_3$
- C.  $\text{C}_6\text{H}_5\text{CH}_2\text{COOH}$  and  $\text{C}_6\text{H}_5\text{NH}_2$
- D. HClO and  $\text{NH}_3$

## Markscheme

A

## Examiners report

It was thought “good to mix the data types,  $\text{p}K_a$  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,  $\text{H}_3\text{PO}_4$ , are amphiprotic?

- A.  $\text{HPO}_4^{2-}$  and  $\text{PO}_4^{3-}$

- B.  $\text{H}_2\text{PO}_4^-$  and  $\text{HPO}_4^{2-}$
- C.  $\text{H}_2\text{PO}_4^-$  and  $\text{PO}_4^{3-}$
- D.  $\text{HPO}_4^{2-}$  only

## Markscheme

B

## Examiners report

[N/A]

What is the conjugate base of phenol,  $\text{C}_6\text{H}_5\text{OH}$ ?

- A.  $\text{C}_6\text{H}_4^--\text{OH}$
- B.  $\text{C}_6\text{H}_5-\overset{+}{\text{O}}\text{H}_2$
- C.  $\text{C}_6\text{H}_5-\text{O}^-$
- D.  $\text{C}_6\text{H}_6^+-\text{OH}$

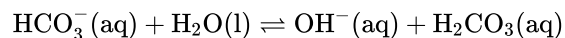
## Markscheme

C

## Examiners report

[N/A]

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



	Bronsted–Lowry acid	Bronsted–Lowry base	Conjugate acid	Conjugate base
A.	$\text{HCO}_3^-(\text{aq})$	$\text{H}_2\text{O}(\text{l})$	$\text{H}_2\text{CO}_3(\text{aq})$	$\text{OH}^-(\text{aq})$
B.	$\text{H}_2\text{CO}_3(\text{aq})$	$\text{OH}^-(\text{aq})$	$\text{HCO}_3^-(\text{aq})$	$\text{H}_2\text{O}(\text{l})$
C.	$\text{H}_2\text{O}(\text{l})$	$\text{HCO}_3^-(\text{aq})$	$\text{H}_2\text{CO}_3(\text{aq})$	$\text{OH}^-(\text{aq})$
D.	$\text{H}_2\text{O}(\text{l})$	$\text{HCO}_3^-(\text{aq})$	$\text{OH}^-(\text{aq})$	$\text{H}_2\text{CO}_3(\text{aq})$

## Markscheme

## Examiners report

[N/A]

If 20 cm<sup>3</sup> samples of 0.1 mol dm<sup>-3</sup> solutions of the acids below are taken, which acid would require a different volume of 0.1 mol dm<sup>-3</sup> 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) <sub>2</sub>	CH <sub>3</sub> NH <sub>2</sub>	CH <sub>3</sub> COOH
B.	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> COOH	CH <sub>3</sub> CH <sub>2</sub> NH <sub>2</sub>	HCOOH
C.	NH <sub>3</sub>	HNO <sub>3</sub>	CH <sub>3</sub> CH <sub>2</sub> COOH
D.	NH <sub>3</sub>	NaOH	H <sub>2</sub> CO <sub>3</sub>

## Markscheme

B

## Examiners report

[N/A]

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

- I.  $\text{Na}_2\text{CO}_3$
  - II.  $\text{CH}_3\text{COONa}$
  - III.  $\text{Na}_2\text{SO}_4$
- 
- 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]

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What describes  $\text{HPO}_4^{2-}$ ?

- 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]

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