SL Paper 1

Which are definitions of an acid according to the Brønsted-Lowry and Lewis theories?

	Brønsted-Lowry theory	Lewis theory
A.	proton donor	electron pair acceptor
B.	proton acceptor	electron pair acceptor
C.	proton acceptor	electron pair donor
D.	proton donor	electron pair donor

Markscheme

A

Examiners report

[N/A]

Which statement is **incorrect** for a 0.10 mol dm^{-3} HCOOH solution?

A. pH = 1

B. $[H^+] << 0.10$ mol dm^{-3}

C. $[HCOO^-]$ is approximately equal to $[H^+]$

D. HCOOH is partially ionized

Markscheme

A

Examiners report

[N/A]

Which species behave as Brønsted-Lowry acids in the following reversible reaction?

$$H_2PO_4^-(aq) + CN^-(aq) \rightleftharpoons HCN(aq) + HPO_4^{2-}(aq)$$

A. HCN and CN^-

B. HCN and HPO_4^{2-}

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

D. HCN and $H_2PO_4^-$

Markscheme

D

Examiners report

[N/A]

Which row correctly describes $1.0\ mol\ dm^{-3}\ NaOH(aq)$?

	pH	Colour in universal indicator solution	Electrical conductivity
A.	14	purple	good
B.	10	green	poor
C.	14	red	good
D.	10	blue	poor

Markscheme

A

Examiners report

There was concern expressed that we expect candidates to know the colours of universal indicator by rote learning. Far from it, we would expect candidates to have absorbed this information during regular lab classes and demonstrations.

What is the formula of the conjugate base of the hydrogenphosphate ion, HPO_4^{2-}?

A. $H_2PO_4^-$

B. H_3PO_4

C. HPO_4^-

D. PO_4^{3-}

Markscheme

D

Examiners report

[N/A]

Consider the equilibrium below.

$$\mathrm{CH_3CH_2COOH(aq) + H_2O(l) \rightleftharpoons CH_3CH_2COO^-(aq) + H_3O^+(aq)}$$

Which species represent a conjugate acid-base pair?

A. $\mathrm{CH_3CH_2COOH}$ and $\mathrm{H_2O}$

B. $\mathrm{H_2O}$ and $\mathrm{CH_3CH_2COO^-}$

C. $\mathrm{H_3O^+}$ and $\mathrm{H_2O}$

D. $\mathrm{CH_3CH_2COO^-}$ and $\mathrm{H_3O^+}$

Markscheme

C

Examiners report

[N/A]

What will happen if the pressure is increased in the following reaction mixture at equilibrium?

$$\mathrm{CO_2\ (g) + H_2O\ (l) \rightleftharpoons H^+\ (aq) + HCO_3^-\ (aq)}$$

A. The equilibrium will shift to the right and pH will decrease.

B. The equilibrium will shift to the right and pH will increase.

C. The equilibrium will shift to the left and pH will increase.

D. The equilibrium will shift to the left and pH will decrease.

Markscheme

A

Examiners report

[N/A]

Activity series of selected elements:

$$\text{greatest activity} \xleftarrow{\text{K, Ca, Al, Fe, H, Cu, Ag, Au}} \text{least activity}$$

Which react with dilute sulfuric acid?

I. Cu

II. CuO

III. $CuCO_3$

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]

A student carried out a titration to determine the concentration of an acid and found that his value had good precision but poor accuracy. Which process explains this outcome?

A. Consistently overshooting the volume of solution from the burette into the flask.

B. Collection of insufficient titration data.

C. Reading the meniscus in the burette at a different angle each time.

D. Forgetting to rinse the flask after one of the titrations.

Markscheme

A

Examiners report

[N/A]

Three aqueous solutions of nitric acid are listed below.

W. $0.100\ \text{mol dm}^{-3}\ \text{HNO}_3\text{(aq)}$

X. $0.001\ \text{mol dm}^{-3}\ \text{HNO}_3\text{(aq)}$

Y. $0.010\ \text{mol dm}^{-3}\ \text{HNO}_3\text{(aq)}$

What is the correct order of **increasing** pH of these solutions?

A. $\text{W} < \text{X} < \text{Y}$

B. $\text{W} < \text{Y} < \text{X}$

C. $\text{X} < \text{W} < \text{Y}$

D. $\text{X} < \text{Y} < \text{W}$

Markscheme

B

Examiners report

[N/A]

Which pH value is that of an aqueous solution of carbon dioxide?

A. 2.1

B. 5.6

C. 9.8

D. 12.2

Markscheme

B

Examiners report

[N/A]

Which is an acid-base conjugate pair?

A. H_3O^+ / OH^-

B. H_2SO_4 / SO_4^{2-}

C. CH_3COOH / H_3O^+

D. $CH_3NH_3^+$ / CH_3NH_2

Markscheme

D

Examiners report

[N/A]

Which statement is correct?

A. A strong acid is a good proton donor and has a strong conjugate base.

B. A weak acid is a poor proton acceptor and has a strong conjugate base.

C. A strong acid is a good proton donor and has a weak conjugate base.

D. A strong base is a good proton donor and has a weak conjugate acid.

Markscheme

C

Examiners report

[N/A]

When equal volumes of four $0.1\ \mathrm{mol\,dm^{-3}}$ solutions are arranged in order of increasing pH (lowest pH first), what is the correct order?

A. $\mathrm{CH_3COOH} < \mathrm{HNO_3} < \mathrm{CH_3CH_2NH_2} < \mathrm{KOH}$

B. $\mathrm{HNO_3} < \mathrm{CH_3COOH} < \mathrm{CH_3CH_2NH_2} < \mathrm{KOH}$

C. $\mathrm{CH_3CH_2NH_2} < \mathrm{HNO_3} < \mathrm{CH_3COOH} < \mathrm{KOH}$

D. $\mathrm{KOH} < \mathrm{CH_3CH_2NH_2} < \mathrm{CH_3COOH} < \mathrm{HNO_3}$

Markscheme

B

Examiners report

[N/A]

What is the pH of the solution formed when $10\ \mathrm{cm^3}$ of HCl(aq) with pH 1.0 is added to $990\ \mathrm{cm^3}$ of water?

A. 1.5

B. 2.0

C. 2.5

D. 3.0

Markscheme

D

Examiners report

[N/A]

Which are acid-base pairs according to the Brønsted-Lowry theory?

I. $\mathrm{HNO_3/NO_3^-}$

II. $\mathrm{H_3O^+/OH^-}$

III. $\mathrm{HCOOH/HCOO^-}$

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]

The pH of a solution changes from $\mathrm{pH} = 2$ to $\mathrm{pH} = 5$. What happens to the concentration of the hydrogen ions during this pH change?

A. It decreases by a factor of 1000

B. It increases by a factor of 1000

C. It decreases by a factor of 100

D. It increases by a factor of 100

Markscheme

A

Examiners report

[N/A]

What is the Brønsted–Lowry conjugate base of $H_2PO_4^-$?

A. H_3PO_4

B. HPO_4^{2-}

C. PO_4^{3-}

D. HO^-

Markscheme

B

Examiners report

[N/A]

10.0 cm^3 of an aqueous solution of sodium hydroxide of pH = 10 is mixed with 990.0 cm^3 of distilled water. What is the pH of the resulting solution?

A. 8

B. 9

C. 11

D. 12

Markscheme

A

Examiners report

[N/A]

Which of the following is correct?

A. A weak acid is a proton donor and its aqueous solution shows good conductivity.

B. A weak acid is a proton donor and its aqueous solution shows poor conductivity.

C. A weak acid is a proton acceptor and its aqueous solution shows good conductivity.

D. A weak acid is a proton acceptor and its aqueous solution shows poor conductivity.

Markscheme

B

Examiners report

[N/A]

A student adds 0.3 g of magnesium metal to equal volumes of hydrochloric acid and ethanoic acid of the same concentrations in separate flasks.

Which statement is correct?

A. Hydrochloric acid reacts more rapidly as it has a higher pH than ethanoic acid.

B. A greater total volume of $\mathrm{H_2}$ gas is produced with hydrochloric acid than with ethanoic acid.

C. The same total volume of $\mathrm{H_2}$ gas is produced with both hydrochloric acid and ethanoic acid.

D. Ethanoic acid reacts more slowly because it has a lower pH than hydrochloric acid.

Markscheme

C

Examiners report

Opinion was fairly evenly divided between answers B and C (correct).

What is the conjugate base of $\mathrm{H_2CO_3}$ according to the Brønsted-Lowry theory?

A. $\mathrm{CO_3^{2-}}$

B. $\mathrm{HCO_3^-}$

C. $\mathrm{H_3CO_3^+}$

D. $\mathrm{CO_2}$

Markscheme

B

Examiners report

[N/A]

Which products would be formed when hydrochloric acid reacts with magnesium oxide?

A. magnesium chloride and carbon dioxide

B. magnesium chloride, hydrogen gas and water

C. magnesium, hydrogen gas and water

D. magnesium chloride and water

Markscheme

D

Examiners report

[N/A]

A solution of acid A has a pH of 1 and a solution of acid B has a pH of 2. Which statement **must** be correct?

A. Acid A is stronger than acid B.

B. $[\mathrm{A}] > [\mathrm{B}]$.

C. The concentration of H^+ ions in A is higher than in B.

D. The concentration of H^+ ions in B is twice the concentration of H^+ ions in A.

Markscheme

C

Examiners report

[N/A]

Which gas in the atmosphere causes the pH of unpolluted rain to be approximately 6?

A. Carbon dioxide

B. Sulfur dioxide

C. Oxygen

D. Nitrogen

Markscheme

A

Examiners report

Students found this question to be difficult with 38.16% correct answers; about 28% of students chose either C (oxygen) or D (nitrogen). Presence of CO_2 in the air causes pH of unpolluted rain water to be approximately 6 in many parts of the world.

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]

Which of the following are weak acids in aqueous solution?

I. CH_3COOH

II. H_2CO_3

III. HCl

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]

Which list contains only strong bases?

A. ammonia, sodium hydroxide, ethylamine

B. potassium hydroxide, ammonia, sodium hydroxide

C. lithium hydroxide, potassium hydroxide, barium hydroxide

D. ammonia, ethylamine, barium hydroxide

Markscheme

C

Examiners report

[N/A]

$10.0\ \mathrm{cm}^3$ of a solution of a strong acid with a pH of 3 is added to a volumetric flask and the total volume is made up to $1.00\ \mathrm{dm}^3$ by adding distilled water. The resulting solution is then thoroughly mixed.

What is the pH of the diluted solution?

A. 1

B. 2

C. 4

D. 5

Markscheme

D

Examiners report

[N/A]

A solution of acid HX has a pH = 1 and a solution of acid HY has a pH = 3. Which statement **must** be correct?

A. HX is a stronger acid than HY.

B. HY is a stronger acid than HX.

C. The $[\mathrm{H}^+]$ in the solution of HX is 100 times greater than the $[\mathrm{H}^+]$ in the solution of HY.

D. The $[H^+]$ in the solution of HY is 100 times greater than the $[H^+]$ in the solution of HX.

Markscheme

C

Examiners report

[N/A]

Which compound reacts with calcium oxide, CaO?

A. K_2O

B. Na_2O

C. SO_2

D. MgO

Markscheme

C

Examiners report

This question assumed an understanding of Periodicity (3.3.2) and Acid-Base (8.2.1). The majority of candidates (69%) had no difficulty in determining that calcium oxide is a basic oxide and choosing the only acidic oxide, sulfur dioxide, as the answer.

Which 1.0 mol dm^{-3} solution has the highest pH?

A. Ammonium chloride

B. Sulfuric acid

C. Sodium chloride

D. Ammonia

Markscheme

D

Examiners report

[N/A]

Which is **not** a conjugate acid-base pair?

A. HNO_3 and NO_3^-

B. CH_3COOH and CH_3COO^-

C. H_3O^+ and OH^-

D. HSO_4^- and SO_{42}^{2-}

Markscheme

C

Examiners report

[N/A]

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 compound is a strong acid?

A. NH_3

B. HNO_3

C. H_2CO_3

D. CH_3COOH

Markscheme

B

Examiners report

[N/A]

What occurs when solid sodium hydrogen carbonate reacts with aqueous sulfuric acid?

A. Bubbles of sulfur dioxide form.

B. Bubbles of both hydrogen and carbon dioxide form.

C. Bubbles of hydrogen form.

D. Bubbles of carbon dioxide form.

Markscheme

D

Examiners report

[N/A]

A solution of $50\ \text{cm}^3$ hydrochloric acid has a pH of 4. What is the final pH if $450\ \text{cm}^3$ of water is added?

A. 3

B. 4

C. 5

D. 6

Markscheme

C

Examiners report

[N/A]

What are the products of the reaction between sulfuric acid and sodium hydrogen carbonate?

A. $NaSO_4 + H_2O + CO_2$

B. $Na_2SO_4 + CO_2$

C. $Na_2SO_4 + H_2O + CO_2$

D. $NaSO_4 + H_2CO_3$

Markscheme

C

Examiners report

[N/A]

An example of a strong acid solution is perchloric acid, $HClO_4$, in water. Which statement is correct for this solution?

A. $HClO_4$ is completely dissociated in the solution.

B. $HClO_4$ exists mainly as molecules in the solution.

C. The solution reacts only with strong bases.

D. The solution has a pH value greater than 7.

Markscheme

A

Examiners report

[N/A]

Which is a conjugate Brønsted–Lowry acid-base pair?

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

A. CH_3COO^- / H_3O^+
B. H_2O / CH_3COO^-
C. H_2O / H_3O^+
D. CH_3COOH / H_2O

Markscheme

C

Examiners report

[N/A]

Which $0.10\ \mathrm{mol\,dm^{-3}}$ solution would have the highest conductivity?

A. HCl

B. $\mathrm{NH_3}$

C. $\mathrm{CH_3COOH}$

D. $\mathrm{H_2CO_3}$

Markscheme

A

Examiners report

[N/A]

Which list contains only strong acids?

A. $\mathrm{CH_3COOH}$, $\mathrm{H_2CO_3}$, $\mathrm{H_3PO_4}$

B. HCl, $\mathrm{HNO_3}$, $\mathrm{H_2CO_3}$

C. $\mathrm{CH_3COOH}$, $\mathrm{HNO_3}$, $\mathrm{H_2SO_4}$

D. HCl, $\mathrm{HNO_3}$, $\mathrm{H_2SO_4}$

Markscheme

D

Examiners report

[N/A]

For equal volumes of $1.0\ \mathrm{mol\,dm^{-3}}$ solutions of hydrochloric acid, HCl(aq), and methanoic acid, HCOOH(aq), which statements are correct?

I. HCl dissociates more than HCOOH

II. HCl is a better electrical conductor than HCOOH

III. HCl will neutralize more NaOH than HCOOH

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

A

Examiners report

With a difficulty index of 24%, this was the second most challenging question on the paper and the responses seem to indicate that the vast majority of candidates think that a strong acid requires more moles of alkali for neutralization than a weak acid. Surprisingly the question proved quite a weak discriminator, with a discrimination index of only 0.15.

Which of the following gases does **not** result in acid deposition?

A. CO_2
B. NO_2
C. NO
D. SO_2

Markscheme

A

Examiners report

[N/A]

Which classification is correct for the reaction?

$$H_2PO_4^-(aq) + H_2O(l) \rightarrow HPO_4^{2-}(aq) + H_3O^+(aq)$$

	Brønsted–Lowry Acid	Brønsted–Lowry Base
A.	H_2O	$H_2PO_4^-$
B.	HPO_4^{2-}	$H_2PO_4^-$
C.	$H_2PO_4^-$	H_3O^+
D.	$H_2PO_4^-$	H_2O

Markscheme

D

Examiners report

[N/A]

Which descriptions are correct for both a Brønsted–Lowry acid and a Lewis acid?

	Brønsted–Lowry acid	Lewis acid
A.	proton donor	electron pair donor
B.	proton donor	electron pair acceptor
C.	proton acceptor	electron pair donor
D.	proton acceptor	electron pair acceptor

Markscheme

B

Examiners report

[N/A]

Which species behave as Brønsted–Lowry bases in the following reaction?

$$H_2SO_4 + HNO_3 \rightleftharpoons H_2NO_3^+ + HSO_4^-$$

A. HNO_3 and HSO_4^-

B. HNO_3 and $H_2NO_3^+$

C. H_2SO_4 and HSO_4^-

D. $H_2NO_3^+$ and HSO_4^-

Markscheme

A

Examiners report

[N/A]