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2002

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CHEMISTRY

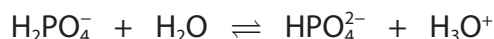
**Edexcel
AS & A LEVEL**

Topic Questions

**Paper 1: Advanced Inorganic
and Physical Chemistry**

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- 1 The dihydrogenphosphate-hydrogenphosphate ion system is an important buffer in the human body.



- (a) In this system, there are two acid-base conjugate pairs. These are

(1)

	acid with its conjugate base	base with its conjugate acid
<input type="checkbox"/> A	$\text{H}_2\text{PO}_4^- / \text{HPO}_4^{2-}$	$\text{H}_2\text{O} / \text{H}_3\text{O}^+$
<input type="checkbox"/> B	$\text{H}_2\text{O} / \text{H}_3\text{O}^+$	$\text{HPO}_4^{2-} / \text{H}_2\text{PO}_4^-$
<input type="checkbox"/> C	$\text{H}_3\text{O}^+ / \text{H}_2\text{O}$	$\text{H}_2\text{PO}_4^- / \text{HPO}_4^{2-}$
<input type="checkbox"/> D	$\text{H}_2\text{PO}_4^- / \text{HPO}_4^{2-}$	$\text{H}_3\text{O}^+ / \text{H}_2\text{O}$

- (b) A formula that can be used for the calculation of the pH of this buffer solution is

$$\text{pH} = \text{p}K_a + \log \left(\frac{[\text{HPO}_4^{2-}]}{[\text{H}_2\text{PO}_4^-]} \right)$$

Calculate the pH of this buffer using

$$\text{p}K_a = 7.20 \quad [\text{HPO}_4^{2-}] = 3.98 \times 10^{-8} \text{ mol dm}^{-3} \quad [\text{H}_2\text{PO}_4^-] = 3.89 \times 10^{-7} \text{ mol dm}^{-3}$$

(1)

- A 6.19
- B 6.21
- C 7.20
- D 8.19

(Total for Question = 2 marks)

- 2 Calculate the pH of a solution of HCl, of concentration 0.25 mol dm^{-3} .

- A -0.60
- B 0.25
- C 0.60
- D 1.39

(Total for Question = 1 mark)

3 Select the correct pH for each of the following solutions.

(a) 2 mol dm^{-3} nitric acid.

(1)

- A -2
- B -0.3
- C +0.3
- D +2

(b) 0.10 mol dm^{-3} barium hydroxide, Ba(OH)_2 . $K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$.

(1)

- A 13.0
- B 13.3
- C 13.7
- D 14.3

(c) A mixture of 20 cm^3 of 1.0 mol dm^{-3} hydrochloric acid and 10 cm^3 of 1.0 mol dm^{-3} sodium hydroxide.

(1)

- A 0
- B 0.30
- C 0.48
- D 7

(Total for Question = 3 marks)

4 Ammonia reacts with water in a reversible reaction. Which are the Brønsted-Lowry bases?

- A H_2O and OH^-
- B NH_3 and OH^-
- C NH_4^+ and H_2O
- D NH_4^+ and NH_3

(Total for Question = 1 mark)



5 Suggest the most likely pH for each of the following solutions.

(a) 5.0 mol dm^{-3} hydrochloric acid.

(1)

- A +5
 B +0.7
 C -0.7
 D -5

(b) 0.1 mol dm^{-3} strontium hydroxide, $\text{Sr}(\text{OH})_2$

$$K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$$

(1)

- A 13.3
 B 13.6
 C 14.0
 D 14.3

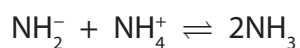
(c) A mixture of 20 cm^3 of 1.0 mol dm^{-3} nitric acid and 10 cm^3 of 1.0 mol dm^{-3} sodium hydroxide.

(1)

- A 0
 B 0.30
 C 0.48
 D 7

(Total for Question = 3 marks)

6 In liquid ammonia the following equilibrium is present.



Identify the Brønsted-Lowry base(s).

- A NH_2^- only
 B NH_4^+ only
 C NH_2^- and NH_3
 D NH_4^+ and NH_3

(Total for Question = 1 mark)

- 7 A solution of potassium manganate(VII) was used to determine the concentration of iron(II) ions in solution by titration in the presence of excess dilute sulfuric acid.
- (a) With the potassium manganate(VII) in the burette, the end-point of the reaction is when the solution in the conical flask turns (1)
- A colourless.
- B pink.
- C green.
- D orange.
- (b) If insufficient acid is added, the titre value is (1)
- A low and a brown precipitate forms.
- B low and a green precipitate forms.
- C high and a brown precipitate forms.
- D high and a green precipitate forms.

(Total for Question = 2 marks)

- 8 Separate 0.1 mol dm^{-3} aqueous solutions of ammonia, methylamine and phenylamine were prepared. Which of the following sequences shows the solutions in order of **increasing** pH?
- A phenylamine, methylamine, ammonia
- B phenylamine, ammonia, methylamine
- C methylamine, ammonia, phenylamine
- D methylamine, phenylamine, ammonia

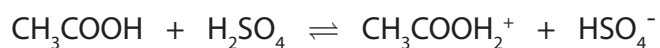
(Total for Question = 1 mark)

9 The dissociation constant of water, K_w , increases with increasing temperature. When the temperature increases, water

- A remains neutral.
- B dissociates less.
- C becomes acidic.
- D becomes alkaline.

(Total for Question = 1 mark)

10 The reaction between concentrated sulfuric acid and pure ethanoic acid is



The Brønsted-Lowry acids in this equilibrium are

- A CH_3COOH and H_2SO_4
- B $\text{CH}_3\text{COOH}_2^+$ and HSO_4^-
- C H_2SO_4 and $\text{CH}_3\text{COOH}_2^+$
- D CH_3COOH and HSO_4^-

(Total for Question = 1 mark)

11 An aqueous solution of ethanoic acid is gradually diluted. Which of the following statements is **incorrect**?

- A The pH decreases.
- B The value of K_a is unchanged.
- C The concentration of ethanoic acid molecules decreases.
- D The proportion of ethanoic acid molecules which dissociates increases.

(Total for Question = 1 mark)



12 Methyl orange and phenolphthalein are both acid-base indicators. In the titration of a strong acid against a weak alkali

- A methyl orange is a suitable indicator but phenolphthalein is not.
- B phenolphthalein is a suitable indicator but methyl orange is not.
- C both phenolphthalein and methyl orange are suitable indicators.
- D neither phenolphthalein nor methyl orange is a suitable indicator.

(Total for Question = 1 mark)

13 Which of the following statements is true about **all** substances that form acidic solutions in water?

- A They are corrosive.
- B They are liquids.
- C They contain hydrogen atoms.
- D They form $\text{H}^+(\text{aq})$ ions.

(Total for Question = 1 mark)

14 Select the correct pH for each of the following solutions.

(a) Nitric acid, HNO_3 , of concentration 2 mol dm^{-3} , assuming it is fully dissociated. (1)

A -0.3

B 0.0

C 0.3

D 2.0

(b) Sodium hydroxide, NaOH , of concentration 2 mol dm^{-3} ,
using $K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (1)

A -13.7

B 13.7

C 14.0

D 14.3

(c) Ethanoic acid, CH_3COOH , of concentration 2 mol dm^{-3} , making the usual assumptions.

$$K_a = \frac{[\text{H}^+][\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]} = 1.7 \times 10^{-5} \text{ mol dm}^{-3} \quad (1)$$

A 2.2

B 2.4

C 4.5

D 4.8

(d) The mixture formed when 25 cm^3 of 2 mol dm^{-3} sodium hydroxide solution is added to 50 cm^3 of 2 mol dm^{-3} ethanoic acid, for which $K_a = 1.7 \times 10^{-5} \text{ mol dm}^{-3}$. (1)

A 2.2

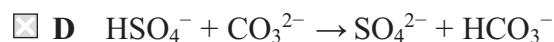
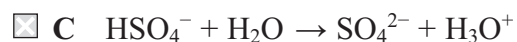
B 2.5

C 4.5

D 4.8

(Total for Question = 4 marks)

15 In which of these reactions is the hydrogensulfate ion, HSO_4^- , behaving as a Brønsted-Lowry base?



(Total for Question 1 mark)

16 A solution of hydrochloric acid has pH 3.0. When it is made 10 times more dilute, the pH is

A 0.3

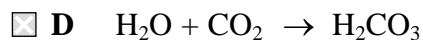
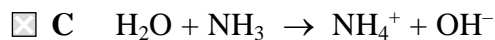
B 2.0

C 4.0

D 13.0

(Total for Question 1 mark)

17 In which reaction is water acting as a Brønsted-Lowry acid?



(Total for Question = 1 mark)

18 Which of the following solutions has the lowest pH?

- A 0.010 mol dm⁻³ hydrochloric acid.
- B 0.100 mol dm⁻³ hydrochloric acid.
- C 0.010 mol dm⁻³ ethanoic acid.
- D 0.100 mol dm⁻³ ethanoic acid.

(Total for Question = 1 mark)

19 An aqueous solution of ammonium chloride, NH₄Cl, has a pH of less than 7 because

- A the ammonium ions donate protons to water molecules giving rise to oxonium ions, H₃O⁺(aq).
- B the chloride ions combine with hydrogen ions from water to form hydrochloric acid, HCl(aq).
- C an aqueous solution of ammonium chloride is unstable and evolves ammonia gas, NH₃(g), leaving dilute hydrochloric acid.
- D the ammonium chloride reacts with carbon dioxide from the atmosphere giving ammonium carbonate, (NH₄)₂CO₃(aq), and hydrochloric acid, HCl(aq).

(Total for Question = 1 mark)

20 Which one of the following indicators is most suitable for titrating ethanoic acid with 0.1 mol dm⁻³ sodium hydroxide?

(Refer to page 19 of your data booklet.)

- A Thymol blue (acid)
- B Bromothymol blue
- C Thymol blue (base)
- D Alizarin yellow R

(Total for Question = 1 mark)

21 What is the conjugate base of the acid, HCO_3^- ?

- A H_2CO_3
- B CO_3^{2-}
- C OH^-
- D CO_2

(Total for Question = 1 mark)

22 The pH of a 1.5 mol dm^{-3} solution of hydrochloric acid, HCl(aq) , is

- A 1.50
- B 0.18
- C 0.18
- D 1.50

(Total for Question 1 mark)

23 Which sequence shows the bases in order of decreasing strength?

- A $\text{C}_6\text{H}_5\text{NH}_2 > \text{CH}_3\text{NH}_2 > \text{NH}_3$
- B $\text{NH}_3 > \text{CH}_3\text{NH}_2 > \text{C}_6\text{H}_5\text{NH}_2$
- C $\text{CH}_3\text{NH}_2 > \text{NH}_3 > \text{C}_6\text{H}_5\text{NH}_2$
- D $\text{NH}_3 > \text{C}_6\text{H}_5\text{NH}_2 > \text{CH}_3\text{NH}_2$

(Total for Question 1 mark)

24 Which of the following is **not** a reaction of a Brønsted-Lowry acid and base?

- A $\text{CH}_3\text{Cl} + \text{OH}^- \rightarrow \text{CH}_3\text{OH} + \text{Cl}^-$
- B $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4^+ + \text{Cl}^-$
- C $\text{H}_2\text{O} + \text{HSO}_4^- \rightarrow \text{H}_2\text{SO}_4 + \text{OH}^-$
- D $\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{CO}_3^{2-} + \text{H}_3\text{O}^+$

(Total for Question 1 mark)

25 Information about four samples of acid is shown below.

Sample 1: $1.0 \text{ mol dm}^{-3} \text{ HCl}$

Sample 2: $1.0 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$

Sample 3: $0.1 \text{ mol dm}^{-3} \text{ HCl}$

Sample 4: $0.1 \text{ mol dm}^{-3} \text{ CH}_3\text{COOH}$

Which of the following lists shows the samples in order of increasing pH?

- A 1, 2, 3, 4
- B 4, 3, 2, 1
- C 2, 1, 3, 4
- D 4, 3, 1, 2

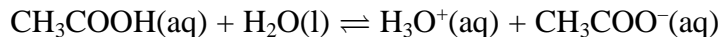
(Total for Question 1 mark)

26 In which of the following reactions is nitric acid acting as a base?

- A $\text{HNO}_3 + \text{NaOH} \rightarrow \text{NaNO}_3 + \text{H}_2\text{O}$
- B $\text{HNO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{NO}_3^-$
- C $\text{HNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{NO}_3^+ + \text{HSO}_4^-$
- D $\text{HNO}_3 + \text{NaHCO}_3 \rightarrow \text{NaNO}_3 + \text{H}_2\text{O} + \text{CO}_2$

(Total for Question = 1 mark)

27 The dissociation of ethanoic acid in aqueous solution is represented by



Which of the following statements is true for this equilibrium?

- A CH_3COOH is an acid and its conjugate base is CH_3COO^- .
- B H_2O is an acid and its conjugate base is OH^- .
- C At equilibrium, the concentrations of each substance are the same.
- D At equilibrium, the reaction from left to right and the reaction from right to left have stopped.

(Total for Question = 1 mark)

28 Why are aqueous solutions of sodium ethanoate slightly alkaline?

- A The sodium ions react with water to give an alkali.
- B The ethanoate ions react with water to give hydroxide ions.
- C All sodium salts give alkaline solutions.
- D The sodium ethanoate is fully ionized in solution.

(Total for Question = 1 mark)

29 A solution of a weak acid cannot be titrated with a weak base using an indicator to find the end-point because

- A the pH change is too gradual close to the equivalence point.
- B there are too few H^+ ions to affect the indicator.
- C there are too few OH^- ions to affect the indicator.
- D the pH change occurs outside the range of any indicator.

(Total for Question = 1 mark)

- 30 At 100 °C, pure water has a pH of 6, whereas at 25 °C it has a pH of 7. This is because
- A the dissociation of water is endothermic, so the concentration of hydrogen ions is lower at 100 °C than it is at 25 °C.
 - B the dissociation of water is exothermic, so the concentration of hydrogen ions is lower at 100 °C than it is at 25 °C.
 - C the dissociation of water is endothermic, so the concentration of hydrogen ions is higher at 100 °C than it is at 25 °C.
 - D at 100 °C, water has a higher concentration of hydrogen ions than of hydroxide ions.

(Total for Question = 1 mark)