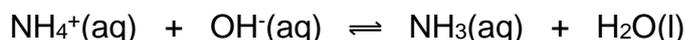
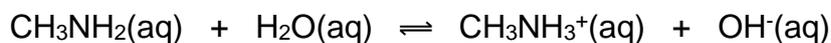
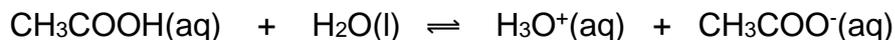


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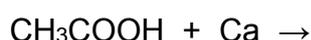
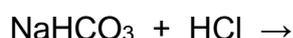
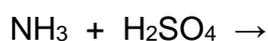
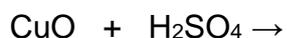
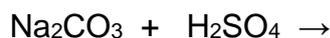
- 1 Define a Brønsted-Lowry acid
- 2 Define a Brønsted-Lowry base
- 3 Classify each of the species in the following reactions as Brønsted-Lowry acids and bases and identify conjugate acid-base pairs:



- 4 Identify the conjugate base of each of the following: H_2SO_4 HCO_3^- HPO_4^{2-}
- 5 Identify the conjugate acid of each of the following: HCOO^- H_2PO_4^- SO_4^{2-}
- 6 Explain the difference between the terms *amphoteric* and *amphiprotic*
- 7 Identify which of the following is/are amphiprotic?



- 8 Complete the following equations:



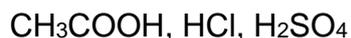
- 9 State whether the neutralisation reaction between an acid and an alkali is exothermic or endothermic.
- 10 State the names of the acid and alkali needed to make each of the following salts using titration:
Potassium chloride Sodium bromide ammonium nitrate potassium sulfate
- 11 State the names of an acid and another substance that could be reacted to make each of the following salts:
Copper(II) nitrate calcium chloride barium chloride magnesium sulfate

- 12 Explain the difference between a strong acid and a weak acid.

- 13 Classify the following acids and bases as strong or weak:

Hydrochloric acid		Sodium hydroxide	
Ethanoic acid		Ammonia	
Sulfuric acid		CH_3NH_2	
Carbonic acid		Potassium hydroxide	
Nitric acid		Barium hydroxide	

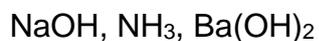
14 Write equations for the dissociation of the following acids:



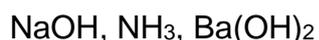
15 Arrange the following in order of decreasing conductivity of solutions of equal concentration:



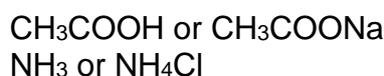
16 Write equations for the ionisation of the following bases:



17 Arrange the following in order of increasing conductivity of solutions of equal concentration:



18 Explain which of the following solutions of equal concentration conducts electricity better:



19 Explain two experimental procedures to distinguish between strong and weak acids and bases

20 Complete the following sentences:

A strong acid has a conjugate

A strong base has aconjugate

21 If methanoic acid is a stronger acid than ethanoic acid, explain whether the methanoate ion or the ethanoate ion is the stronger base.

22 Define pH

23 Complete the following table without using a calculator:

pH	$[\text{H}^+(\text{aq})]/\text{mol dm}^{-3}$	acidic/alkaline/neutral?
4		
	1.0×10^{-6}	
7		
	1.0×10^{-11}	
13		

24 Calculate the pH for each of the following solutions: 0.1 M HCl(aq) 0.020 M HNO₃(aq)

25 Deduce by how much does the pH changes when a solution of a strong acid with pH=3 is diluted by a factor of 10.

26 Calculate the relationship between the $[\text{H}^+(\text{aq})]$ in a solution of pH=2 and one of pH=6?

27 State two methods for measuring the pH of a solution.

28 Write an expression for the equilibrium that exists in any aqueous solution and for the ionic product constant of water.

29 State the value of K_w at 25 °C?

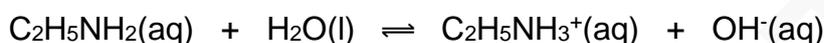
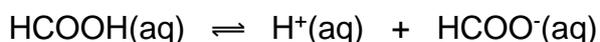
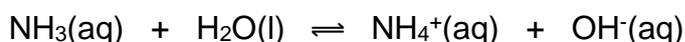
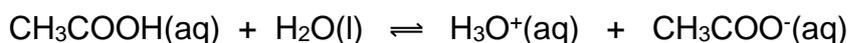
30 Complete the following table for aqueous solutions at 25 °C:

$[H^+(aq)]/\text{mol dm}^{-3}$	$[OH^-(aq)]/\text{mol dm}^{-3}$	acidic/alkaline/neutral?
1.0×10^{-6}		
	1.0×10^{-3}	
2.5×10^{-5}		
	1.2×10^{-11}	
3.6×10^{-12}		

31 Calculate $[H^+(aq)]$ and $[OH^-(aq)]$ for each of the following solutions:

0.1 M HCl, 0.01 M NaOH, 0.020 M Ba(OH)₂.

32 Write expressions for K_a or K_b (as appropriate) for each of the following reactions:



33 Calculate the value of K_a of HA given that the pH of a 0.0100 M solution of HA is 5.20.

34 Define pK_a and pK_b

35 Arrange the following acids in order of decreasing acid strength (strongest first)

ACID	K_a
Propanoic	1.3×10^{-5}
Nitrous (HNO ₂)	4.7×10^{-4}
Hydrofluoric (HF)	5.6×10^{-4}
Chloric(I)	3.7×10^{-8}

36 Arrange the following acids in order of decreasing acid strength (strongest first)

ACID	pK_a
Ethanoic (CH ₃ COOH)	4.8
Carbonic (H ₂ CO ₃)	6.4
Benzoic (C ₆ H ₅ COOH)	4.2
Ammonium Ion (NH ₄ ⁺)	9.3
Phosphoric(V) (H ₃ PO ₄)	2.1

37 Calculate the pH for each of the following weak acids. State any assumptions you make?

ACID	pK_a	concentration / mol dm ⁻³	pH
HA ₁	4.60	0.100	
HA ₂	5.24	0.0250	
HA ₃	7.40	0.0640	

38 Define pOH and pK_w

39 Calculate the pH for each of the following weak bases. State any assumptions you make?

BASE	pK_b	concentration / mol dm ⁻³	pH
B ₁	4.20	0.100	
B ₂	6.46	0.0200	
B ₃	8.80	0.0400	

- 40 State the relationship between K_a and K_b for a conjugate acid-base pair.
- 41 State the relationship between pK_a and pK_b for a conjugate acid-base pair.
- 42 Using the pK_a values above, work out the pK_b values of the following bases at 25°C.

BASE	pK_b
CH_3COO^-	
HCO_3^-	
$C_6H_5COO^-$	
NH_3	

- 43 Calculate the pH of pure water at 50°C given that the value of K_w at 50 °C is 5.48×10^{-14} .
- 44 Explain whether a solution with pH=6.8 is acidic, alkaline or neutral at 50 °C
- 45 Calculate the pH of 0.100 mol dm⁻³ NaOH at 50°C given that the value of pK_w at 50 °C is 13.3.
- 46 Sketch titration curves for the following titration combinations:

Strong acid - Strong base [25 cm³ 0.100 mol dm⁻³ HCl and 0.100 mol dm⁻³ NaOH]

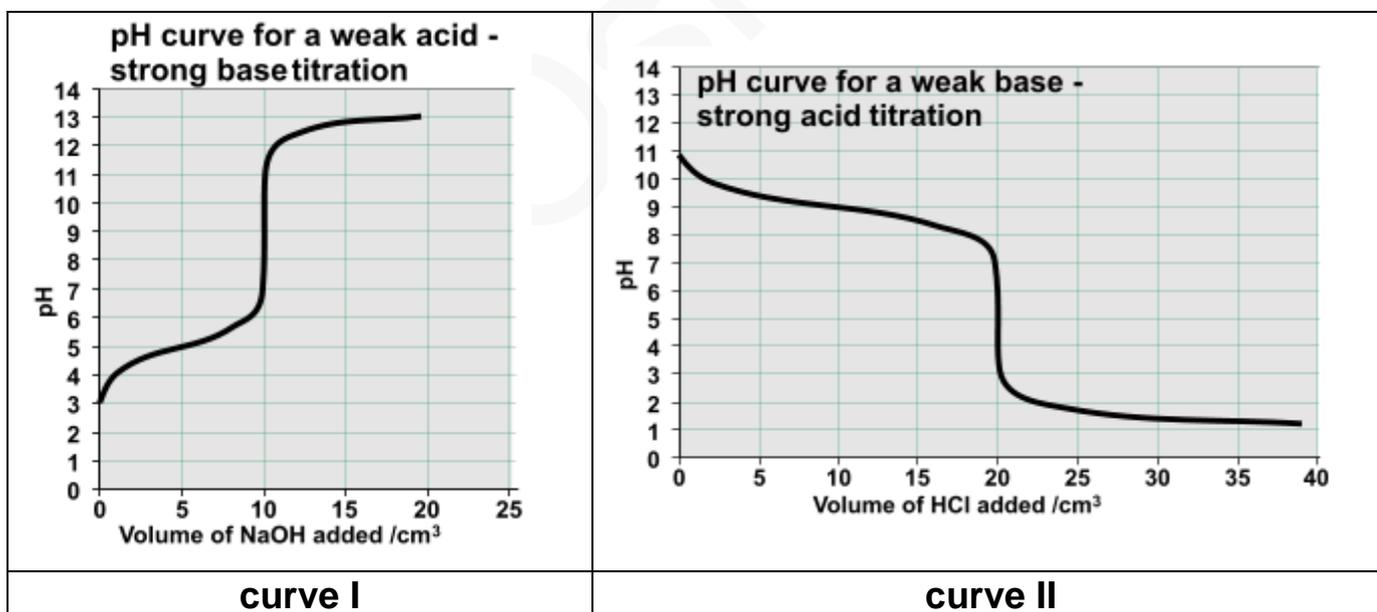
Strong acid - Weak base [25 cm³ 0.100 mol dm⁻³ HCl and 0.100 mol dm⁻³ NH₃ ($pK_b=4.75$)]

Weak acid - Strong base [25 cm³ 0.100 mol dm⁻³ CH₃COOH ($pK_a=4.76$) and 0.100 mol dm⁻³ NH₃]

Weak acid - Weak base [25 cm³ 0.100 mol dm⁻³ CH₃COOH ($pK_a=4.76$) and 0.100 mol dm⁻³ NH₃ ($pK_b=4.75$)]

In each case calculate the initial pH, state whether the pH at the equivalence point is less than 7, equal to 7 or greater than 7

- 47 Mark on **curve I** the point at which $pH=pK_a$ of the weak acid and deduce pK_a of the weak acid.
Mark on **curve II** the point at which $pOH=pK_b$ of the weak base and deduce pK_b of the weak base.



- 48 Calculate the pH when 10.0 cm³ of 0.100 mol dm⁻³ NaOH is added to 20.0 cm³ of 0.100 mol dm⁻³ weak acid HA ($pK_a=6$)

Calculate the pH when 10.0 cm³ of 0.100 mol dm⁻³ HCl is added to 20.0 cm³ of 0.100 mol dm⁻³ of weak base B ($pK_b=4$)

- 49 Explain how an acid-base indicator works.
- 50 Explain what is meant by the 'pH range of an indicator'.
- 51 Explain the connection between the pH range of an indicator that is a weak acid and the value of pK_a for the indicator?
- 52 From the following list of indicators select appropriate ones for each of the titrations in 46.

Indicator	pK_a	pH range
Methyl Yellow	3.5	2.9-4.0
Methyl Red	5.1	4.2-6.3
Phenol Red	7.9	6.8-8.4
Phenolphthalein	9.3	8.2-10.0

- 53 Explain what you understand by a *buffer solution*.
- 54 State the composition of an acidic buffer and a basic buffer
- 55 Explain how your chosen buffer will work when small amounts of acid or alkali are added.
- 56 Explain which of the following mixtures will result in a buffer solution:
- I 25.0 cm³ 0.100 mol dm⁻³ NaOH and 40.0 cm³ 0.100 mol dm⁻³ CH₃COOH
- II 25.0 cm³ 0.100 mol dm⁻³ NH₃ and 50.0 cm³ 0.100 mol dm⁻³ HCl
- III 25.0 cm³ 0.200 mol dm⁻³ NaOH and 50.0 cm³ 0.100 mol dm⁻³ CH₃COOH
- IV 20.0 cm³ 0.200 mol dm⁻³ NH₃ and 30.0 cm³ 0.100 mol dm⁻³ HCl
- 57 Mark on your pH curve for a weak acid-strong base titration in 46 the *buffer region*.
- 58 Predict whether solutions of the following salts will be acidic, alkaline or neutral:

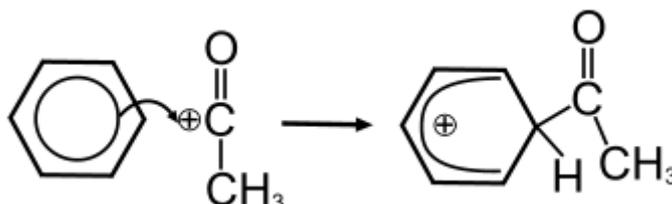


- 59 Explain using equations why a solution of sodium ethanoate has a pH > 7.
- 60 Explain using equations why a solution of CH₃NH₃NO₃ is acidic.
- 61 Explain why FeCl₃(aq) is acidic
- 62 State the Lewis definition of an acid and a base.
- 63 State what type of bond is formed when a Lewis acid reacts with a Lewis base.
- 64 Classify each of the following as a Lewis Acid or a Lewis Base:



- 65 Classify Lewis acids/bases as electrophiles/nucleophiles

- 66 Explain whether H₃CCO⁺ acts as a Lewis acid or Lewis base in the following step from an organic mechanism



- 67 Explain whether AlCl₃ is a Lewis acid or Lewis base in the following reaction:



- 68 Explain why rain is naturally acidic and state its approximate pH.
- 69 Explain what is meant by *acid deposition*
- 70 Identify 2 gases that can result in acid deposition and write an equation for the formation of each
- 71 State one source of each of the gases in 70
- 72 Write equations to show how HNO_2 , HNO_3 , H_2SO_3 and H_2SO_4 can be formed in the atmosphere.
- 73 Explain the difference between pre- and post-combustion methods for reducing SO_2 emissions.
State which method would be used
- (a) for producing fuels for cars
 - (b) in a power station
- 74 Describe some of the problems associated with acid deposition.