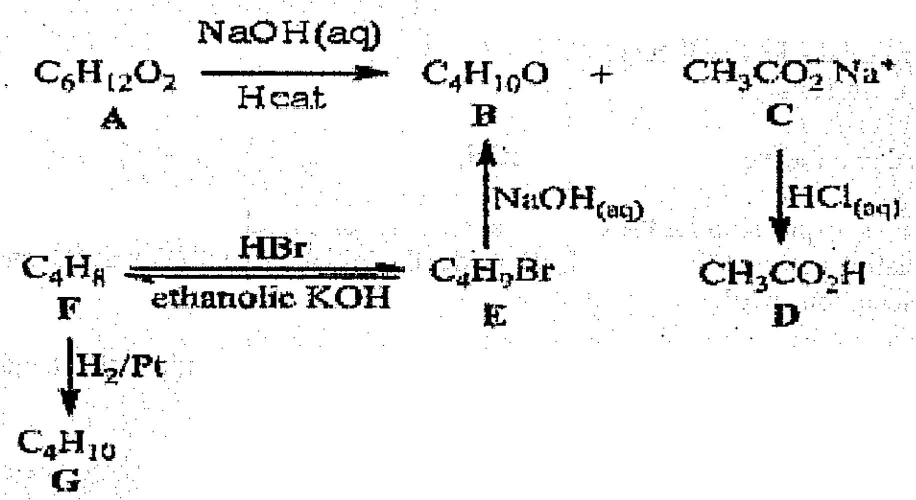
PSF 2303-Home Assignment I - 2011/12

1.



(i) What type of reaction is represented by the conversion of E to F?

(ii) The product F exists in two stereoisomeric forms. Draw the isomers and indicate what feature of this molecule makes this isomerism possible.

(iii) Give a simple chemical test for the functional group present in compound F and the observation.

(iv) Compound F is more reactive than compound G. Explain using bonding why this is so.

(v) Compound E shows optical isomerism. What is meant by "optical isomerism". Sketch the optical isomers of E.

(vi) The reaction of E to B is a nucleophilic substitution.
(a) Give the structural formula of B.
(b) Give a chemical test for the functional group present in B and the observation.
(c) Give the mechanism of the formation of B from E.

(vii) The type of reaction given by A → B + C is important in the manufacture of soap. What type of reaction is this?

(viii) Consider the reaction C → D. Give the IUPAC name of D. Identify the acid base conjugate pair in this reaction.

(ix) A quantity of A was heated with NaOH (aq), acidified and the volatile acid D distilled out. D was then added to a solution containing 0.0250 mol (an excess) of NaOH. The excess NaOH from this reaction required 28.70 cm^3 of 0.100 mol dm^{-3} HCl for complete reaction. What mass of A was reacted with NaOH in the first place? (C=12, H=1, O=16)

2. (a) Using an example each of an acid and a base, explain the behavior of an acid and a base according to

   (a) Bronsted – Lowry theory
   (b) L ewis Theory

   (b) Write down the expressions for pH, pOH, K_w and pK_w.

   (c) Derive the expression for the concentration of H^+ of a weak acid solution HA. Acid dissociation constant for HA is K_a. Consider the initial concentration as 'C' and the degree of dissociation as 'α'.

   (d) At temperature T °C, pH of pure water is 7.26. Calculate the ionic product and pK_w of water at temperature T °C.

   (e) If 0.465 g of an ammonium salt is dissolved in 100.00 cm^3 of water at temperature T °C, calculate the pH of the resultant solution. Molecular weight of the ammonium salt is 46.5 g mol^{-1}. K_a of NH_4^+ at T °C is 6.55 X 10^{-10} mol dm^{-3}.

3. (a) What is an acid – base indicator? Briefly explain the pH range of an indicator.

   (b) Name two indicators that can be used for a titration of strong acid with weak base. Explain your answer using a plot of pH vs volume.

   (c) Your friend is going to determine the concentration of an acetic acid solution by titrating it with 0.10 mol dm^{-3} NaOH solution.

      (i) What is the pH of the NaOH solution?

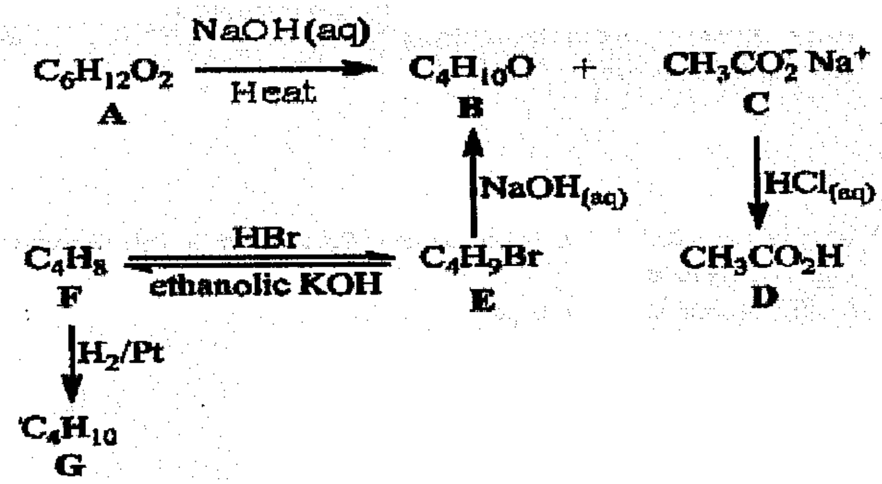
      (ii) Explain the difference between equivalence point and the end point of an acid-base Titration.

      (iii) Your friend did the above titration using 25.0 cm^3 of the acetic acid solution. If the burette reading at the end point of the above titration is 10.80 cm^3, calculate the concentration of acetic acid solution. Name the indicator used for the titration.

      (iv) Calculate the pH at the equivalence point of the above titration. pKa of the acetic acid is 4.76.

      (v) Can you use a NaOH solution as a primary standard? Explain your answer.

1.



(i) E ⟶ F බවට පරිවර්තනය වීම කුමන වර්ගයේ ප්‍රතික්‍රියාවක්ද?

(ii) F නම් වූ ඵලය ත්‍රිමාණ සමාවයවික දෙයාකාරයකින් පවතී. මෙම සමාවයවිකතාවයට හේතු වන මෙම අණුවට අදාළ ලක්ෂණය රූපසටහනක් මගින් පෙන්වන්න.

(iii) F නම් සංයෝගයේ ඇති ක්‍රියාකාරී කාණ්ඩය හඳුනා ගැනීම සඳහා සරල රසායනික පරීක්ෂණයක් නම් කර, එහි නිරීක්ෂණයද ලියා දක්වන්න.

(iv) 'F නම් සංයෝගයේ ප්‍රතික්‍රියාශීලීත්වය G නම් සංයෝගයේ ප්‍රතික්‍රියාශීලීත්වයට වඩා වැඩිය.' මෙම සංසිද්ධිය සංයෝගයේ බන්ධන ආශ්‍රයෙන් පැහැදිලි කරන්න.

(v) E නම් සංයෝගය ප්‍රකාශ සමාවයවිකතාවය පෙන්වයි. "ප්‍රකාශ සමාවයවිකතාවය" යනුවෙන් අදහස් කරන්නේ කුමක්ද? E සංයෝගයේ ප්‍රකාශ සමාවයවික ඇඳ පෙන්වන්න.

(vi) E ⟶ B ට පරිවර්තනය වීම නියුක්ලියෝෆිලික ආදේශ ප්‍රතික්‍රියාවකි.
   (a) B සංයෝගයේ ව්‍යුහ සූත්‍රය ලියා දක්වන්න.
   (b) B හි ඇති ක්‍රියාකාරී කාණ්ඩය හඳුනාගැනීම සඳහා රසායනික පරීක්ෂණයක් නම් කර, එහි නිරීක්ෂණයද ලියා දක්වන්න.
   (c) E ගෙන් B සෑදීමේ ප්‍රතික්‍රියාවේ යාන්ත්‍රණය ලියා දක්වන්න.

(vii) A ⟶ B + C යන ප්‍රතික්‍රියාව අයත් වන ප්‍රතික්‍රියා වර්ගය සබන් නිෂ්පාදනයේදී වැදගත් වේ. එම ප්‍රතික්‍රියා වර්ගය කුමක්ද?

(viii) C ⟶ D ප්‍රතික්‍රියාව සලකන්න. D සංයෝගයේ IUPAC නාමකරණය ලියන්න. එම ප්‍රතික්‍රියාවේ සංයුග්මක අම්ල භෂ්ම යුගලය ලියා දක්වන්න.

(ix) A සංයෝගයේ යම් ප්‍රමාණයක් NaOH සමග ප්‍රතික්‍රියා කර ආම්ලීකෘත කරවා, D නම් වාෂ්පශීලි අම්ලය ආසවනය කරන ලදී. අනතුරුව D, 0.025 mol NaOH ද්‍රාවණයකට (වැඩිපුර අඩංගු) එකතුකරන ලදී. මෙම ප්‍රතික්‍රියාවෙන් පසු ඉතිරිවූ වැඩිපුර NaOH සම්පූර්ණයෙන්ම ප්‍රතික්‍රියා කිරීම සඳහා 0.100 $mol\ dm^{-3}$ HCl 28.70 cm^3 අවශ්‍ය විය. NaOH සමග ප්‍රතික්‍රියා කළ A හි ස්කන්ධය ගණනය කරන්න.
(C = 12, H = 1, O = 16)

2.

(a) අම්ලයක් සහ භෂ්මයක් උදාහරණ ලෙස ගෙන අම්ල සහ භෂ්ම වල හැසිරීම පහත සඳහන් වාද වලට අනුව පැහැදිලි කරන්න.
   (i) බ්‍රොන්ස්ටඩ් - ලෝරි වාදය
   (ii) ලුවිස් වාදය

(b) pH, pOH, K_w සහ pK_w සඳහා ප්‍රකාශන ලියා දක්වන්න.

(c) HA නම් දුබල අම්ලයක H^+ සාන්ද්‍රණය සඳහා අදාළ ප්‍රකාශනය ව්‍යුත්පන්න කරන්න. HA අම්ලයේ විඝටන නියතය k_a වේ. අම්ලයේ ආරම්භක සාන්ද්‍රණය 'C' ලෙසද, විඝටන ප්‍රමාණය 'α' ලෙසද සලකන්න.

(d) උෂ්ණත්වය T °C හිදී සංශුද්ධ ජලයේ pH අගය 7.26 වේ. T °C උෂ්ණත්වයේදී සංශුද්ධ ජලයේ අයනික ගුණිතය සහ pk_w ගණනය කරන්න.

(e) ඇමෝනියම් ලවණයක 0.465 g ක් උෂ්ණත්වය T °C වන ජලය 100.00 cm^3ක ද්‍රාවණය කළ විට ලැබෙන ද්‍රාවණයේ pH අගය ගණනය කරන්න. ඇමෝනියම් ලවණයේ අණුක ස්කන්ධය 46.5 $g\ mol^{-1}$ වේ. T °C උෂ්ණත්වයේදී NH_4^+ හි ka අගය 6.55×10^{-10} $mol\ dm^{-3}$ වේ.

3.

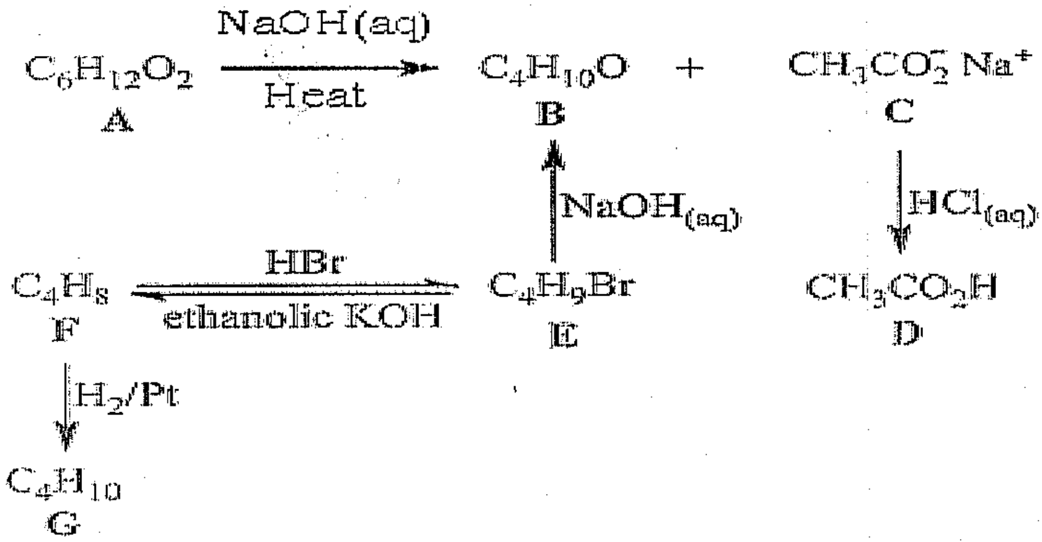
(a) "අම්ල-භෂ්ම දර්ශකයක්" යනු කුමක්ද ? 'දර්ශකයක pH පරාසය' යන්න කෙටියෙන් පැහැදිලි කරන්න.

(b) ප්‍රබල අම්ල - දුබල භෂ්ම අනුමාපනයක් සඳහා භාවිතා කළ හැකි දර්ශක දෙකක් නම් කරන්න. ඔබේ පිළිතුර, පරිමාවට එදිරිව pH ප්‍රස්තාරයක් ආශ්‍රයෙන් පැහැදිලි කරන්න.

(c) ඔබේ මිතුරෙක් ඇසිටික් අම්ල ද්‍රාවණයක සාන්ද්‍රණය සෙවීම සඳහා එය සාන්ද්‍රණය 0.10 $mol\ dm^{-3}$ක් වන NaOH ද්‍රාවණයක් සමග අනුමාපනය කිරීමට තීරණය කර ඇත.
   (i) NaOH ද්‍රාවණයේ pH අගය ගණනය කරන්න.
   (ii) අම්ල - භෂ්ම අනුමාපනයක සමකතා ලක්ෂ්‍යය සහ අන්ත ලක්ෂ්‍යය අතර වෙනස පැහැදිලි කරන්න.
   (iii) ඔබේ මිතුරා ඉහත අනුමාපනය සඳහා ඇසිටික් අම්ල ද්‍රාවණයෙන් 25.0 cm^3 ක් භාවිතා කළේය. එම අනුමාපනයේදී අන්ත ලක්ෂ්‍යයේදී වැය වූ NaOH පරිමාව 10.00 cm^3 නම් ඇසිටික් අම්ල ද්‍රාවණයේ සාන්ද්‍රණය ගණනය කරන්න. මෙම අනුමාපනය සඳහා භාවිතා කළ හැකි දර්ශකයක් නම් කරන්න.
   (iv) ඉහත අනුමාපනයේ සමකතා ලක්ෂ්‍යයේදී pH අගය ගණනය කරන්න. ඇසිටික් අම්ලයේ pK_a අගය 4.76 වේ.
   (v) NaOH ද්‍රාවණයක් ප්‍රාථමික ප්‍රාමාණික ද්‍රාවණයක් ලෙස භාවිතා කළ හැකිද? ඔබේ පිළිතුර පැහැදිලි කරන්න.

PSF 2303-Home Assignment I - 2011/12

1



(i) E யிலிருந்து Fற்கு நடைபெறும் மாற்றீடு எவ்வகையான தாக்கம் ஆகும்?

(ii) Fஆனது இரண்டு கட்டமைப்பு சமபகுதியங்களை கொண்டது. F இன் எந்த இயல்பானது இந்த இரண்டு கட்டமைப்பு சமபகுதியங்கள் இருக்க காரணம்?

(iii) F இல் இருக்கும் தொழிற்பாட்டு கூட்டத்திற்குரிய இலகுவான இரசாயனப் பரிசோதனையையும் அதன் பெறுபேறுகளையும் தருக?

(iv) F ஆனது G ஐ விட தாக்குதிறன் கூடியது என பிணைப்பினை உபயோகித்து விளக்குக.

(v) E யானது ஒளியியல் சமபகுதியத்தை கொண்டது. 'ஒளியியல் சமபகுதியம்' என்றால் என்ன? E யின் ஒளியியல் சமபகுதியத்தை வரைக.

(vi) E யிலிருந்து Bற்கான தாக்கம் கருநாட்ட பிரதியீட்டுத்தாக்கம் ஆகும்
   (a) B யின் கட்டமைப்பு அலகை வரைக
   (b) B யில் இருக்கும் தொழிற்பாட்டுக் கூட்டத்திற்குரிய இரசாயனப் பரிசோதனையையும் அதன் பெறுபேறுகளையும் தருக?
   (c) B → E ற்கான பொறிமுறையை தருக

(vii) A → B + C என்பது சவர்க்காரத்தயாரிப்பில் முக்கியமான தாக்கமாகும். இது எவ்வகையான தாக்கமாகும்?

(viii) C→ D எனும் தாக்கத்தில் Dயின் பெயர் என்ன? இணை அமில - இணைமூல சோடியை பெயரிடுக.. இத்தாக்கம் ஏன் நடைபெறுகின்றது என விளக்குக.

(ix) A யானது NaOH உடன் தாக்கம் புரிந்து அமிலத்தன்மையான ஆவிப்பறப்புள்ள D ஐ உருவாக்கியது. பின் D யானது மிகையாக 0.0250mol NaOH இல் இடப்பட்டது. மிகையான NaOH ஆனது இந்த தாக்கத்தை பூர்த்தி செய்ய 28.70 cm^3,0.100 $moldm^{-3}$ HCl இனை உபயோகித்தது. A யின் என்ன திணிவு NaOH உடன் ஆரம்பத்தில் தாக்கம் அடைந்தது.

2

(a) அமிலம், காரம் என்பவற்றக்கு உதாரணம் தந்து அவற்றின் இயல்புகளை பின்வரும் அடிப்படையை கொண்டு விளக்குக.

i, புரொண்சட் லொரிக்கொள்கை

ii, லூயிஸின் கொள்கை

(b) pH, pOH, Kw & pKw என்பவற்றை சமன்பாடுகள் மூலம் விளக்குக.

(c) HA எனும் மென்னமிலத்தின், H^+ இன் செறிவிற்கான கோவையை எழுதுக. இங்கு அமில பிரிகை மாறிலி Ka, ஆரம்ப செறிவு C, பிரிகை மாறிலி α.

(d) T° C வெப்பநிலையில், .தூயநீரின் pH 7.26 ஆகும். அயன் பெருக்கத்தையும் pKw வையும் கணிக்க.

(e) 0.465g அமோனிய உப்பானது $100.00cm^3$ நீரில் கரைசலாக்கப்பட்டது.இதன் வெப்பநிலை T° C ஆகும். கரைசலின் pH ஐக் காண்க. அமோனிய உப்பின் சார்மூலக்கூற்றுத் திணிவு $46.5gmol^{-1}$, $Ka = 6.55 \times 10^{-10} moldm^{-3}$

3

(a) அமில - மூல காட்டி என்றால் என்ன? அதன் pH எல்லை யாது?

(b) வன்னமில மென்னமில நியமிப்பிற்கு பயன்படும் 2 காட்டிகளை பெயரிடுக.உமது விடையை pH – கனவளவு வரைபு மூலம் விளக்குக.

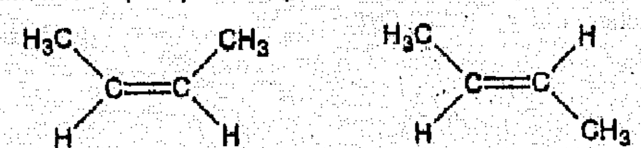
(c) உமது நண்பர் இந்த நியமிப்பில் $25.00cm^3$ அசெற்றிக்கமிலத்தை உபயோகித்த பொழுது அளவியின் வாசிப்பு $10.80cm^3$ காட்டியதெனின், அசெற்றிக்கமிலத்தின் செறிவை காண்க. காட்டியின் பெயரை குறிப்பிடுக.

(d) சமவலுப்புள்ளியை பயன்படுத்தி மேற்படி நியமிப்பின் pH இனை காண்க. அசெற்றிக்கமிலத்தின் pKa = 4.76 ஆகும்

(e) NaOH இனை முதனியமமாக உபயோகிக்கமுடியுமா? விளக்குக.

PSF 2303 – Home Assignment 1 – Answer Guide

1.(i) Elimination (Dehydrohalogenation)

(ii) 

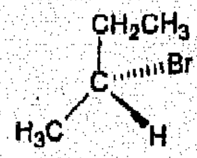
Due to the presence of C=C double bond

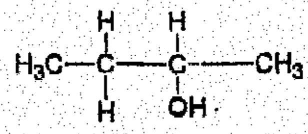
(iii) Test – Br_2 or alkaline $KMnO_4$ Observation – Decolourization

(iv) 'F' is an alkene. 'G' is an alkane. 'F' has weaker π bonds which can be reacted to get additional products.

(v) Optical isomers are mirror images. They rotate plane polarized light.

Compounds containing an asymmetric carbon (chiral) shows optical isomerism.



(vi) (a) 

(b) Tests : Esterification

Reaction with PCl_5

Iodoform test

Reaction with Na

Lucas test

(vii) Hydrolysis / Saponification

(viii) 'D' – Ethanoic acid CH_3COOH / CH_3COO^-

(ix) NaOH remaining $= 0.1\ mol\ dm^{-3} \times \frac{28.70}{1000}\ dm^3 = 2.87 \times 10^{-3}\ mol$

NaOH used $= (0.025 - 2.87 \times 10^{-3})$ mol = 0.0221 mol

Mass of 'A' = 0.0221 mol x 116 g mol^{-1} = 2.56 g

2. (a)

a) Bronsted – Lowry Theory

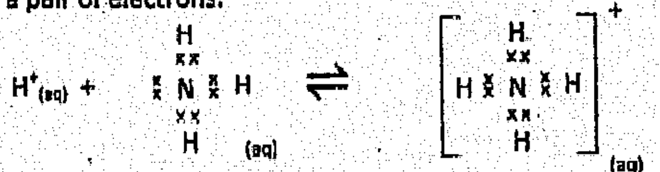
Acid is a substance which can donate a proton (H^+) while a base is a substance that can accept a proton (H^+). E.g.: $CH_3COOH_{(l)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$

Since CH_3COOH donates a proton to H_2O, it acts as an acid. H_2O accepts a proton and hence it acts as a base.

b) Lewis Theory

Acid is a substance that can accept (and share) a pair of electrons and a base is a substance that donate (and share) a pair of electrons.

E.g.:



H^+ ion accepts and shares a pair of electrons while NH_3 donates and shares a pair of electrons. So that, H^+ behaves as an acid and NH_3 behaves as a base.

(b). $pH = -log_{10}[H_3O^+_{(aq)}]$ $pOH = -log_{10}[OH^-_{(aq)}]$ $K_w = [H_3O^+_{(aq)}][OH^-_{(aq)}]$

$pK_w = -log_{10} K_w$

(c) $HA_{(aq)} \rightleftharpoons H^+_{(aq)} + A^-_{(aq)}$

Initial Concentration C - -

At equilibrium C_{HA} C_{H^+} C_{A^-}

$$K_a = \frac{[H^+_{(aq)}][A^-_{(aq)}]}{[HA_{(aq)}]} \qquad K_a = \frac{C_{H^+} \times C_{A^-}}{C_{HA}} \quad ; \quad C_{HA} = C - C_{H^+} \text{ ——— (1)}$$

According to the balanced equation; $C_{H^+} = C_{A^-}$

Since dissociation of HA is small, $C_{H^+} <<< 1$; $C - C_{H^+} \sim C$ ——— (2)

From (1) and (2); $K_a = \frac{C^2_{H^+}}{C}$; $C_{H^+} = \sqrt{K_a C}$

(d)pH = $-\log_{10}[H_3O^+]$; 7.26 = $-\log_{10}[H_3O^+]$

$[H_3O^+]$= antilog -7.26 = 5.50×10^{-8} mol dm^{-3}

(e)$K_w = [H^+][OH^-]$

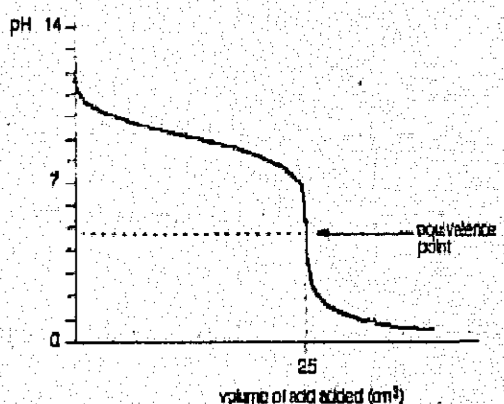
Since $[H^+]=[OH^-]$, $K_w = (5.50 \times 10^{-8} \text{ mol dm}^{-3})^2 = 3.03 \times 10^{-15} \text{ mol}^2 \text{ dm}^{-6}$

p $K_w = -\log_{10} K_w = -\log_{10}(3.03 \times 10^{-15} \text{ mol}^2 \text{ dm}^{-6}) = 14.52$

3. (a)Acid – base indicator is a substance that shows a sharp colour change at some pH or over a somewhat small range of pH values.

pH range of an indicator is the range of pH values where it shows the colour change

(b) Titration curve for a strong acid – weak base titration can be shown as follows.



Indicators:- Methyl Red, Methyl Orange, Bromophenol, Chlorophenol

Explanation :- pH at the equivalence point of a strong acid – weak base titration is less than 7 (❑ 5.5). So that, the indicators of which pH ranges lie in the acidic pH values can be used for this titration.

(c) (i) $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

0.1 mol dm^{-3} 0.1 mol dm^{-3} 0.1 mol dm^{-3}

$[OH^-]$= 0.1 mol dm^{-3}; pOH = $-\log_{10}[OH^-]$; pOH = 1

pH + pOH = 14; pH = 13

Alternative Method:

$[H^+] = K_w/[OH^-] = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6} / 0.1 \text{ mol dm}^{-3}$

$= 1.0 \times 10^{-13}$ mol dm^{-3}

pH = $-\log_{10}[H_3O^+] = -\log_{10}(1.0 \times 10^{-13} \text{ mol dm}^{-3})$= 13

(ii) Equivalence point is the point at which the titrand is just completely reacted with the titrant. In order to determine the equivalence point acid – base indicators are used. End point is the point at which the completion of the neutralization reaction is visualized by the colour change of indicator.

(iii) No. of moles of NaOH reacted = $0.10\ mol\ dm^{-3} \times \frac{10.80}{1000}\ dm^3 = 1.08 \times 10^{-3}\ mol$

$NaOH_{(aq)} + CH_3COOH_{(aq)} \rightarrow CH_3COO^-Na^+_{(aq)} + H_2O_{(l)}$

1 1

No. of moles of CH_3COOH reacted = 1.08×10^{-3} mol

Concentration of CH_3COOH $= 1.08 \times 10^{-3}\ mol \times \frac{1000}{25.0}\ dm^{-3} = 0.0432\ mol\ dm^{-3}$

- If the burette reading at the end point is 10.00 dm^{-3},

No. of moles of NaOH reacted = $0.10\ mol\ dm^{-3} \times \frac{10.00}{1000}\ dm^3 = 1.08 \times 10^{-3}\ mol$

Concentration of CH_3COOH $= 1.00 \times 10^{-3}\ mol \times \frac{1000}{25.0}\ dm^{-3} = 0.0400\ mol\ dm^{-3}$

(iv) At the equivalence point,

$$CH_3COO^-Na^+_{(aq)} \rightarrow Na^+_{(aq)} + CH_3COO^-_{(aq)}$$

CH_3COO^- acts according to the following reaction,

$$CH_3COO^-_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COOH_{(aq)} + OH^-_{(aq)}$$

$$K_b = \frac{[CH_3COOH_{(aq)}][OH^-_{(aq)}]}{[CH_3COO^-_{(aq)}]}$$

Since $[CH_3COOH_{(aq)}] = [OH^-_{(aq)}]$ and $K_w = [H^+][OH^-]$; $K_b = \frac{[OH^-_{(aq)}]^2}{[CH_3COO^-_{(aq)}]}$; $(\frac{K_w}{[H^+_{(aq)}]})^2 = K_b[CH_3COO^-_{(aq)}]$

$[H^+_{(aq)}]^2 = K_w \times \frac{K_a}{[CH_3COO^-_{(aq)}]}$; $[H^+_{(aq)}] = (K_w \times \frac{K_a}{[CH_3COO^-_{(aq)}]})^{1/2}$ ——— (1)

Taking '–log' form of (1) ; pH = 1/2 ($pK_a + pK_w + \log_{10}[CH_3COO^-_{(aq)}]$) ——— (2)

Calculation of $[CH_3COO^-_{(aq)}]$

No. of moles of $CH_3COO^-Na^+$ = 1.08×10^{-3} mol

$[CH_3COO^-_{(aq)}] = 1.08 \times 10^{-3}\ mol \times \frac{1000}{(25.0+10.80)}\ dm^{-3} = 0.030\ mol\ dm^{-3}$

From equation (2) ; pH = ½(4.76 + 14 + $\log_{10}$ 0.030) = 8.618

- If the burette reading at the end point is 10.00 dm^{-3},

$[CH_3COO^-_{(aq)}] = 1.00 \times 10^{-3}\ mol \times \frac{1000}{(25.0+10.00)}\ dm^{-3} = 0.029\ mol\ dm^{-3}$

From equation (2) ; pH = ½(4.76 + 14 + $\log_{10}$ 0.029) = 8.605

(v) No. NaOH can't be used as a primary standard.

NaOH has a low purity. It can't be accurately weighed because NaOH is a hygroscopic compound. It also can react with moisture in air.