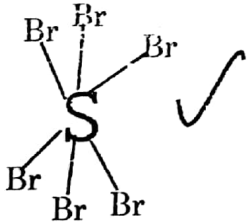
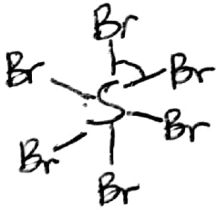
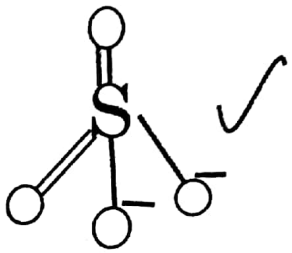
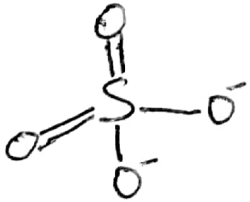
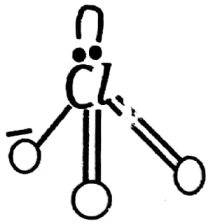
MATIGO EXAMINATIONS BOARD

P525/1
CHEMISTRY
MARKING GUIDE 2023
PAPER 1

Qn	Answer	Marks
1(a)	$3\ {}^{1}_{0}n$ ✓	04
(b)	${}^{4}_{2}He$ ✓	
(c)	${}^{0}_{-1}e$ ✓	
(d)	~~${}^{1}_{0}H$~~ ✓	
Qn.2	**Structure**  ✓   ✓ 	**Shape** - Angles should all be equal - Bonds should either touch or be close - Bonds should be of equal lengths. Octahedral ✓ Tetrahedral ✓

04½

03

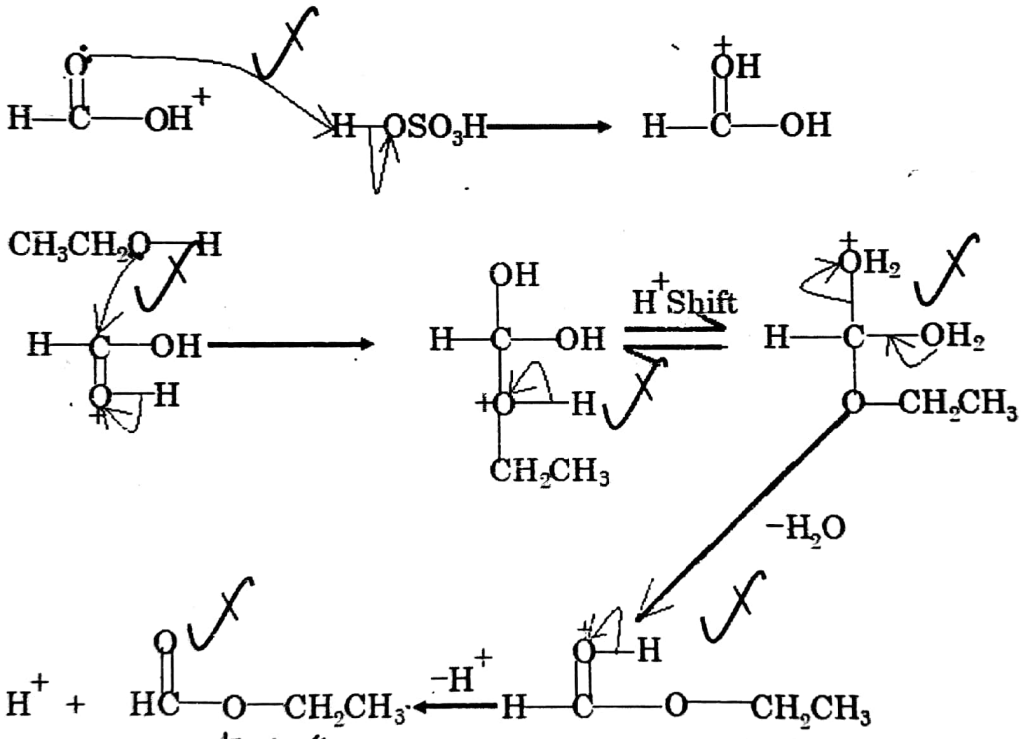


Trigonal Pyramidal

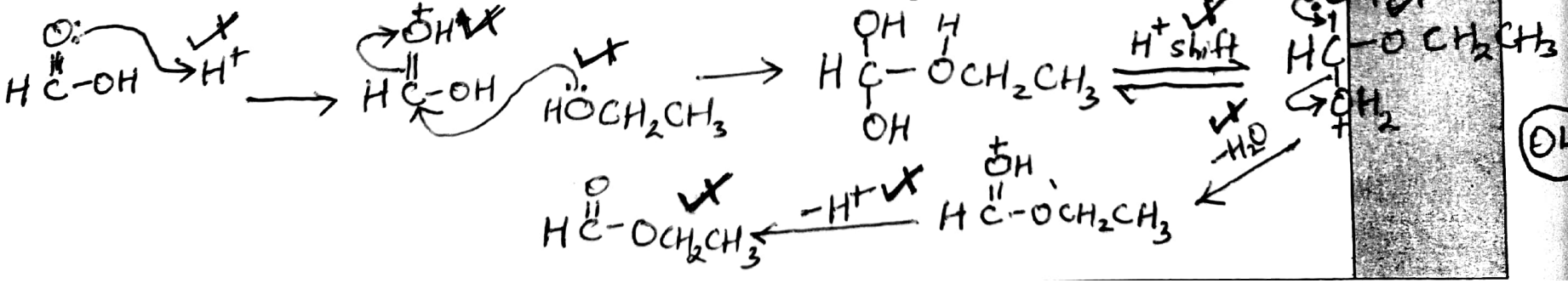
04

Q.n 3(a) Mechanism:

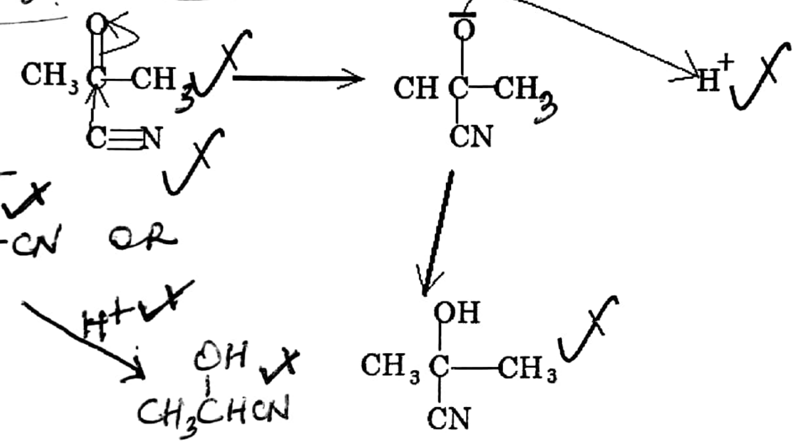
03



(b)

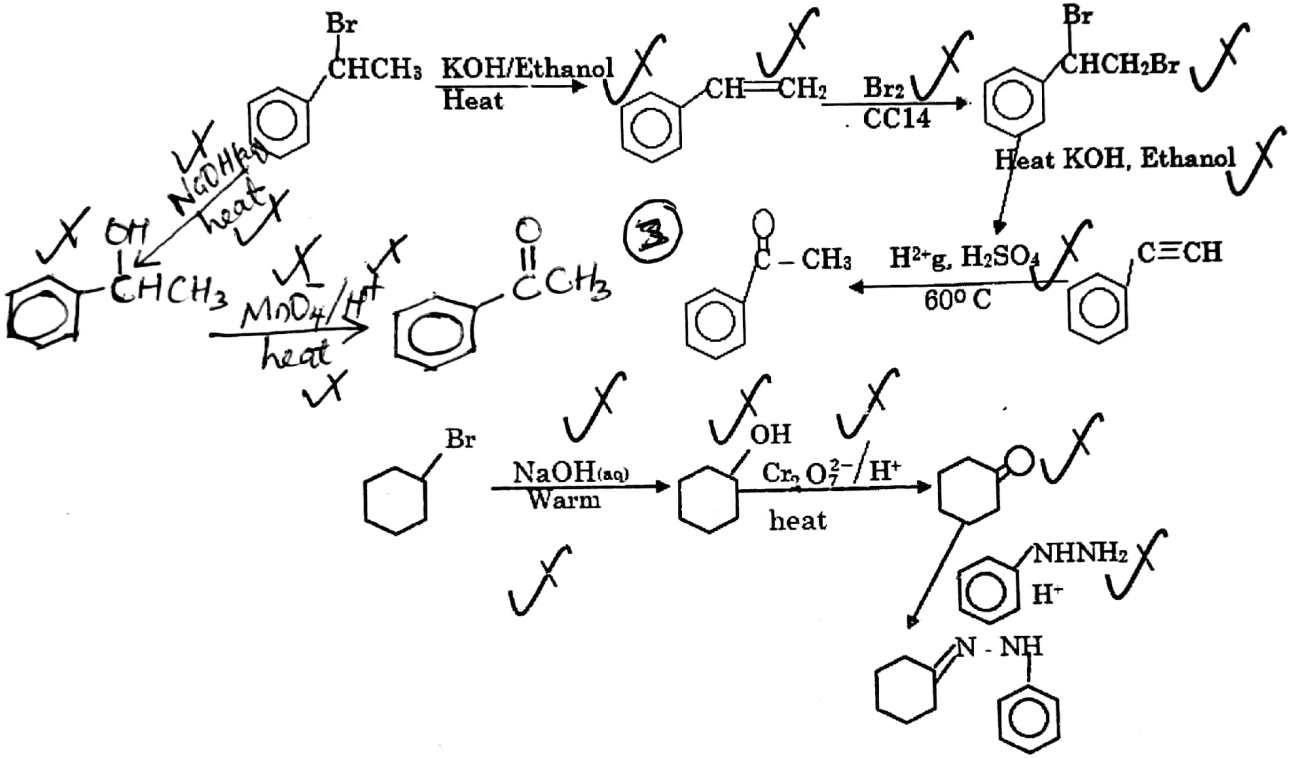


04

	$NaCN \longrightarrow Na^{+} + \bar{C}{\equiv}N$ $H_2SO_4 \longrightarrow 2H^{+} + SO_4^{2-}$ 	03
4(a) (i) (ii)	$ns^2\ np^2$ $+2$ *and* $+4$	$1\frac{1}{2}$
(b).	Inert pair effect is the reluctancy of the outer s-orbital electrons to participate in bonding.	01
(c).	Inert pair effect increases down group (IV) elements. As you move down the group, the number of electrons in the d and f – orbits with a poor shielding effect than the s and p – orbitals increases, the shielding effect of the d and f – orbitals further decreases causing the outer s – orbital electrons to be withdrawn into the atomic nucleus.	03
Qn.5(a)	$Zn_{(s)}$ / Zn^{2+}_{aq} // $H_gSO_4(aq)$ / $H_{g(l)}$ / $Pt_{(s)}$ (Deny $\frac{1}{2}$ if the state symbols are missing.)	$1\frac{1}{2}$

(b)(i)	$Hg^{2+}_{(aq)} + 2\bar{e} \longrightarrow H_{g(l)}$	1
(ii)	$Zn(s) \longrightarrow Zn^{2+}_{(aq)} + 2e^-$	$1\frac{1}{2}$
(c)	$Emf\ of\ cell = +0.6 - (-0.76)$ $= \cancel{+0.61} - (-076)$ $= (+)1.37V \quad = +1.36V$	$1\frac{1}{2}$ $1\frac{1}{2}$
Qn.6(a) (i)	A weak acid is a substance which partially ionizes to produce a low concentration of hydrogen ions.	01
(ii)	$HOOCCH_2CH_2COOH_{(aq)} \rightleftharpoons \bar{O}OCCH_2CH_2C\bar{O}\bar{O}(aq) + 2H^+_{(aq)}$ or $HOOCCH_2CH_2COOH_{(aq)} + 2H_2O_{(l)} \rightleftharpoons \bar{O}OCCH_2CH_2O\bar{O}_{(aq)} + 2H_3\overset{+}{O}$	01
(b)	Rfm of $HOOCCH_2CH_2COOH = 118$ $Molar\ concentration\ of\ acid = \frac{1000}{200} \times \frac{1.18}{118}$ $= 0.05M$ $pH = -\log[H^+]$ $[H^+] = 10^{-3.20}$ $[OOCCH_2CH_2CO\tilde{O}] = {}^1/_2[H^+]$ $= {}^1/_2 \times 10^{-3.20}$ $Ka = \frac{[\tilde{O}OCCH_2CH_2CO\tilde{O}]\,[H^+]^2}{[HOOCCH2CH2COOH}$ $[\bar{O}OCH_2CH_2C\bar{O}\bar{O}] = 3.155 \times 10^{-4}M$ $= \frac{({}^1/_2 \times 10^{-3.20}) \times (10^{-3.20})^2}{0.05}$ $= 2.512\ x\ 10^{-9} mol^2 dm^{-6}$	03

03

Qn.7(a)		03
(b)		03
Qn.8(a)	*Oxidation state*: + 3 *Co – ordination number*; 6	01
(b).	$[CO(NH_3)_5SO_4]^+ Br^-$	02
(c)	$[CO(NH3)5Br]^{2+}SO_4^{2-}$ Aqueous silver nitrate solution.	01
(d)	$[CO(NH_3)_5Br]^{2+}SO_4^{2-}$ Forms a white precipitate.	02

$[CO(NH_3)_5SO_4]^+Br^-$ Forms a pale yellow precipitate.

Accept any other alternative reagent that distinguishes between a SO_4^{2-} and Br^-.

Qn.9(a)

(b) Heat absorbed when one mole of covalent bonds is broken into its

Is the amount of heat absorbed to break one mole of a covalent bond to form gaseous atoms

$$2(H-O-O-H) + H-\underset{H}{\overset{H}{N}}-H \longrightarrow 4(H-O) + N\equiv N$$

$$\Delta H_{reaction} = \Sigma \text{Bond enthalpies of bonds broken} - \Sigma \text{bond enthalpies of bonds formed}$$

$$= 4[O-H] + 2(O-O) + 4(N-H) + (N-N) - [8(O-H) + N\equiv N]$$

$$= 4(463) + 2(146) + 4(388) - [8(463) + 944]$$

$$\Delta H\ reaction = -897 KJmol^{-1}$$

03 $\frac{1}{2}$

SECTION B:

10(i).

$$Percentage\ of\ Hydrogen = 100 - (38.710 + 51.613) = 9.677\%$$

02

Elements present:	C	H	O
%Mass presented:	38.710	9.677	51.613
Moles :	$\frac{38.710}{12}$	$\frac{9.677}{1}$	$\frac{51.613}{16}$
Mole ratio :	$\frac{3.2258}{3.2258}$	$\frac{9.677}{3.2258}$	$\frac{3.2258}{3.2258}$
	1	3	1

Empirical formula of B is CH_3O

(ii).

1dM³ of B weighs 2.7662g.
22.4dm³ of B weigh (22.4 x 2.7662)g
= 62

$(\varepsilon f)n = MM.$
$(12 + 3 + 16)n = 62$
$31n = 62$
$n = 2$
Molecular formula is $C_2H_6O_2$

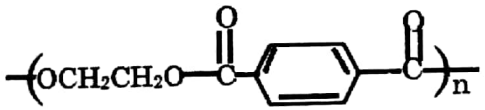
02

(b)(i). $HOCH_2CH_2OH$ 01

(ii). The two hydroxyl groups form extensive hydrogen bonds which require more heat to break than the hydrogen bonds in propanol with only one polar hydroxyl group. 01

(c) (i). Condensation polymerization. 01

(ii).



01

(iii). Terylene is used as a fibre in making garments. 01

(11)(a). Purple solution turned colourless.

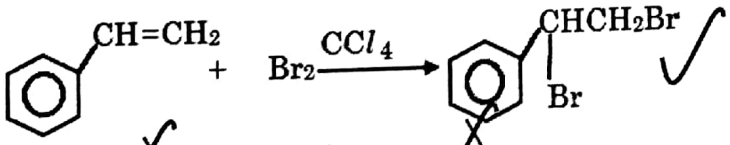
$$2MnO_{4(aq)}^{-} + 16H_{(aq)}^{+} + 5S_{n(aq)}^{2+} \longrightarrow 2Mn_{(aq)}^{2+} + 8H_2O_{(l)} + 5\,S_{n\,(aq)}^{4+}$$

$2\frac{1}{2}$

(b). Brown solution turned colorless

02

(c)



02

Green solution turned brown.

$$Cl_{2\,(aq)} + 2Fe_{(aq)}^{2+} \longrightarrow 2Fe_{(aq)}^{3+} + 2Cl_{(aq)}^{-}$$

(d) Blue solution turned to brown solution and a white precipitate is formed.

$2Cu^{2+}_{(aq)} + 4I^-_{(aq)} \longrightarrow Cu_2I_{2(s)} + I_{2(aq)}$ ✓ 2½

12(a).

$CH_3CH_2\text{—}Cl \longrightarrow CH_3CH_2OH + Cl^-$ 02

(b).

$:\bar{O}H$

Substitution nucleophilic bimolecular. ✓ 01

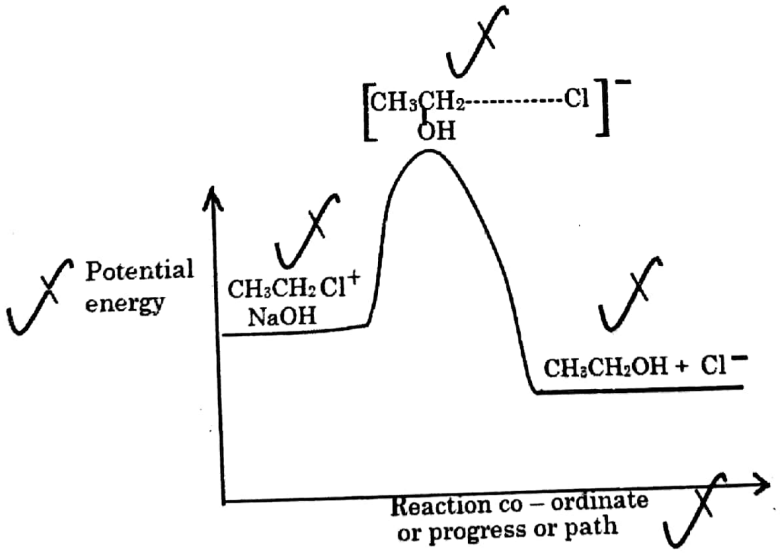
Or Nucleophilic substitution bimolecular.
Or Bimolecular nucleophilic substitution.
Or Substitution bimolecular nucleophilic reaction.

(c).

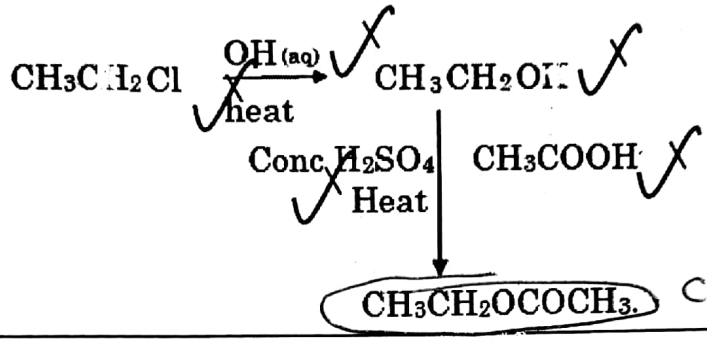
Rate = $K[CH_3CH_2Cl]\,[NaOH]$

Accept Rate = $K[CH_3CH_2Cl]\,[OH-]$

(d)

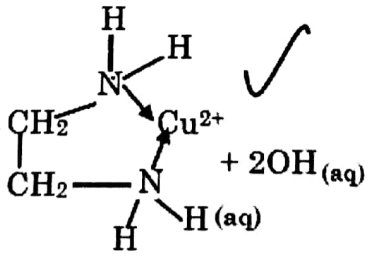


2½

(c)		2
Qn.13(a)	Sodium (or potassium) chromate (VI) solution and ethanoic acid. $Ba^{2+}_{(aq)}$; yellow *ppt* insoluble in the acid. $Ca^{2+}_{(aq)}$; yellow *ppt* soluble in the acid. Allow: Sodium (or ammonium) oxalate solution and ethanoic acid. $Ba^{2+}_{(aq)}$; White *ppt* soluble in the acid. $Ca^{2+}_{(aq)}$; White *ppt* insoluble in the acid.	01 03
(b)	Acidified silver Nitrate solution. $I^-_{(aq)}$; yellow *ppt*. $Cl^-_{(aq)}$; white *ppt*. Or: Silver Nitrate, dilute Nitric acid and dilute ammonia solution. (for all) $I^-_{(aq)}$; Yellow *ppt* insoluble in ammonia. $Cl^-_{(aq)}$; White *ppt* soluble in ammonia	03

	Or: Acidified lead (II) Nitrate solution. ✓	
(c)	Dilut hydrochloric acid. ✓ $SO_{3\,(aq)}^{2-}$; Bubbles of a colourless gas. ✓ $S2O_{3(aq)}^{2-}$; Bubbles of a colourless gas and yellow *ppt/solid.* ✓	03
Qn.14(a)	Elements: C H Br. %composition: 12.8 2.1 85.1 Number of Moles: $\frac{12.8}{12}$ $\frac{2.1}{1}$ $\frac{85.1}{79.9}$ ✓ Mole ratio: $\frac{1.067}{1.065}$ $\frac{2.1}{1.065}$ $\frac{1.065}{1.065}$ ✓ ✓ 1 ✓ : 2 : 1 ✓ Empirical formula is CH_2Br. ✓ $(\varepsilon f)_n = MM$ $(CH_2Br)_n = 190$ $(12 + 2 + 79.9)n = 190.$ $93.9n = 190.$ $n = 2.$ ✓ *Molecular formula is* $C_2H_4Br_2$ *or* $BrCH_2Br$	04
(b).	X is $HOCH_2CH_2OH$ Accept Ethane – 1,2 – diol. ✓ B is $H_2C_2O_4$ Accept oxalic acid. ✓	02
(c).	$2MnO_{4(aq)}^{-} + 5H_2C_2O_{4(aq)} + 6H_{(aq)}^{+} \rightarrow 10CO_{2(g)} + 8H_2O_{(l)} + Mn_{(aq)}^{2-}$ ✓✓	02
(d).	CH_3CHBr_2. ✓	01
Qn.15(a)	Moles of HCl that reacted with NH_3 in $CHCl_3$.	02

	Layer $= \left(\frac{20 \times 0.01}{100}\right)$ *moles* $= 0.0002$ moles. ✓	
	$NH_3(aq) + HCl_{(aq)} \longrightarrow NH_4Cl_{(aq)}$ ✓ Mole ratio of $NH_3 : HCl = 1:1$ Moles of ammonia = 0.0002moles. ✓ $25cm^3$ *of* $CHCl_3$ *layer contains* 0.0002 *moles of* NH_3 $1000cm^3$ *of* $CHCl_3$ *layer contains* $\left(\frac{0.0002 \times 1000}{25}\right)$ $= 0.008M.$ ✓	
(b).	KD $= \frac{[NH_3]_{free\ in\ water}}{[NH_3]\ CHCl_3}$ ✓ $25 = \frac{[NH_3]_{free}}{0.008}$ $[NH_3]_{free}$ in water $= 0.2M$ ✓	**01**
(c)	$[NH_3]_{Complexed} = [NH_3]_{total} - [NH_3]_{free}$ in water. ✓ $[NH_3]_{Complexed} = 0.8 - 0.2$ ✓ ✓ $= 0.6M$	**03**
(d).	$n = \frac{[NH_3]_{Complexed}}{[Co^{2+}]}$ ✓	**03**

	$n = \frac{0.6}{0.1}$ ✓ $n = 6.$ ✓	
Qn. 16(a)	• Compounds formed by copper are coloured. ✓ • Copper forms complexes. ✓ • Copper acts as a catalyst in chemical reaction. ✓	$1\frac{1}{2}$
(b).	Copper reacts with cold dilute Nitric acid to form copper (II) Nitrate, Water and Nitrogen monoxide. $3Cu_{(s)} + 8HNO_{3(aq)} \longrightarrow 3Cu(NO_3)_{2(aq)} + 2NO_{(g)} + 4H_2O_{(l)}$ ✓ ✓ Copper reacts with cold concentrated Nitric acid to form copper (II) Nitrate, water and Nitrogen dioxide. $Cu_{(s)} + 4HNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + 2H_2O_{(1)} + 2NO_{2(g)}$ ✓ ✓	**04**
(c)(i).	A blue *ppt* forms which dissolves forming a deep blue solution. ✓ ✓	
(ii).	$Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \longrightarrow Cu(OH)_{2(s)}$ ✓	**02**
	$H_2NCH_2CH_2NH_{2(aq)} + Cu(OH)_{2(s)} \longrightarrow$  ✓	**01**
Qn.17(a)	A solution of either *a weak base and its salt from a strong acid* or *a weak acid and its salt from a strong base* that *resists change in p^H* when a small amount of *acid or alkali is added or is diluted*. ✓ ✓ ✓	**02**

(b).

Rfm of $C_7H_6O_2 = 7 \times 12 + 6 \times 1 + 16 \times 2.$
$= 122$

$$[C_7H_6O_2] = \frac{0.6}{122} = 0.005M$$

$$K_a = \frac{[C_6H_5CO\bar{O}][H^+]}{[C_6H_5COOH]}$$

$$6.3 \times 10^{-5} = \frac{0.02[H^+]}{0.005}$$

$$[H^+] = 1.575 \times 10^{-5}M$$

(c)(i)

$$p^H = \log[H^+]$$

$$p^H = -\log(1.575 \times 10^{-5}) \equiv 4.80$$

Allow: $p^H = P^{ka} + \log_{10}\left(\frac{[salt]}{[acid]}\right)$

$$= \log_{10}(6.3 \times 10^{-5}) + \log\left(\frac{0.02}{0.005}\right)$$

$$p^H = 4.80.$$

Benzoic acid (molecules) react with hydroxide ions from Potassium hydroxide added to form water and benzoate ions thus p^H remains constant.

$$C_6H_5COOH_{(aq)} + \bar{O}H_{(aq)} \longrightarrow C_6H_5CO\bar{O}_{(aq)} + H_2O_{(l)}$$

Or: Hydrogen ions from benzoic acid react with hydroxide ions from potassium hydroxide added to form water.

02

02

(ii).	$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$. More benzoic acid molecules ionize and this keeps the p^H constant. ✓ The benzoate ions from *sodium benzoate* (or salt) react with the hydrogen ions from hydrochloric acid to *form benzoic acid molecules*; this keeps the PH constant. $C_6H_5COO^-_{(aq)} + H^+_{(aq)} \longrightarrow C_6H_5COOH_{(aq)}$ Or: $C_3H_5COONa_{(aq)} + HCl_{(aq)} \longrightarrow C_6H_5COOH_{(aq)} + NaCl_{(aq)}$. ✓	02

END

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