UNIT 4

ORGANIC CHEMISTRY

ANSWERS

Organic Reactions

(1) $\underset{H}{\overset{H}{>}}C = CH_2 - CH_2 - CH_3 + Br_2 \longrightarrow Br - CH_2 - \overset{\overset{Br}{|}}{CH} - CH_2 - CH_3$

(2) $H_3C - CH = \overset{\overset{CH_3}{|}}{C} - CH_2 - CH_3 + H_2 \xrightarrow[\text{pressure}]{\text{cat}} CH_3 - CH_2 - \overset{\overset{CH_3}{|}}{CH} - CH_2 - CH_3$

(3) $CH_3 - CH = CH_2 + \frac{9}{2} O_2 \rightarrow 3CO_2 + 3H_2O$

(4) $H_3C - \overset{\overset{CH_3}{|}}{C} = \underset{\underset{CH_3}{|}}{C} - CH_3 \xrightarrow{H^+/H_2O} H_3C - \overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}} - \underset{\underset{CH_3}{|}}{CH} - CH_3$

(5) $H - C \equiv C - H + \frac{5}{2} O_2 \longrightarrow 2CO_2 + H_2O$

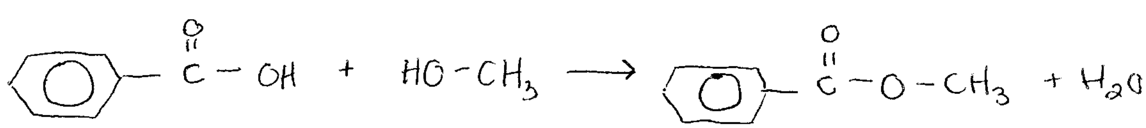
(6) $H - C \equiv C - CH_3 \xrightarrow[HCl]{\text{excess}} H - \overset{\overset{Cl}{|}}{CH} - \underset{\underset{Cl}{|}}{CH} - CH_3$

(7) $H - C \equiv C - H + HClO_2 \longrightarrow H_2C = \overset{\overset{ClO_2}{|}}{C} - H$

(8) $2CH_3CH_3 + 3Cl_2 \longrightarrow Cl_2CH - CH_2 - Cl + 3HCl$

(9) $CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - OH + HO - CH_2 - CH_2 - CH_2 - CH_3$

$\longrightarrow CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - O - CH_2 - CH_2 - CH_2 - CH_3 + H_2O$

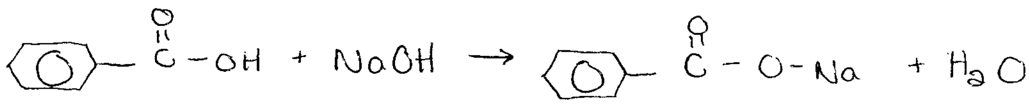
(10) 

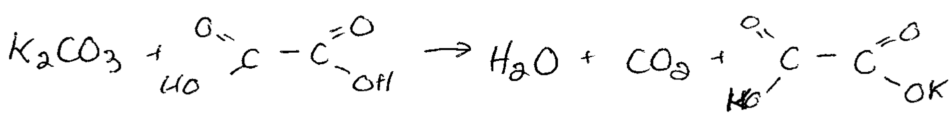
organic rxns
2

(11.) $CH_3-CH_2-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH + HO-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

$\longrightarrow CH_3-CH_2-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-O-(CH_2)_7-CH_3 + H_2O$

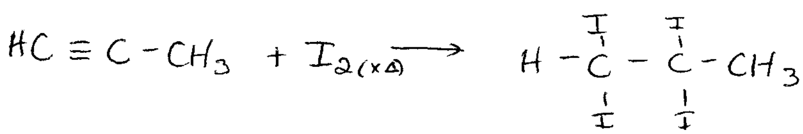
? (12.) $Mg^{+2} + CH_3-\overset{O}{\overset{\|}{C}}-OH \longrightarrow [CH_3-\overset{O}{\overset{\|}{C}}-O]_2 Mg + H_2$

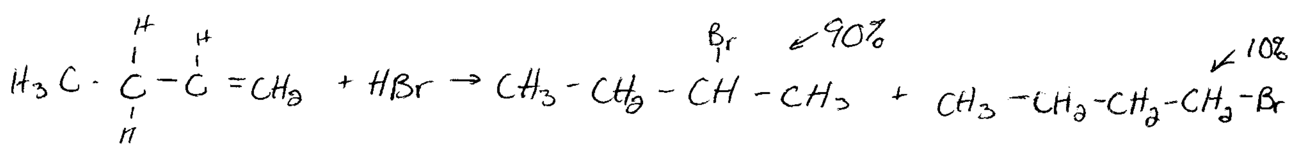
(13) 

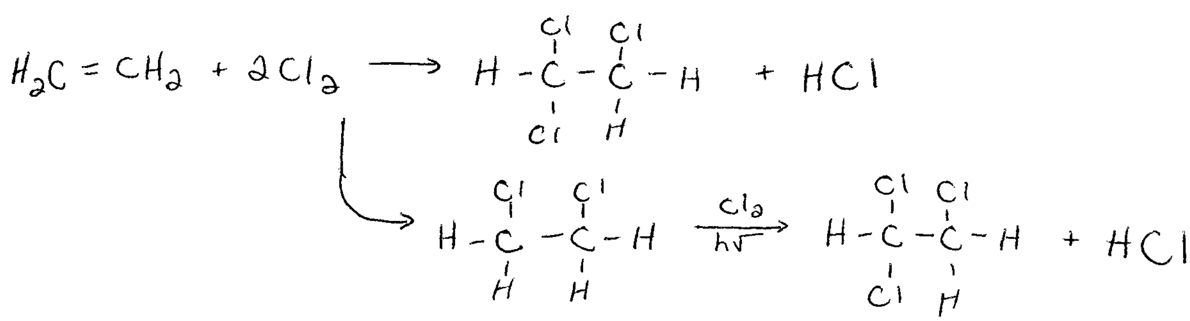
? (14) 

carbonate + acid → CO_2 + salt + H_2O

$K_2CO_3 + 2HCl \rightarrow CO_2 + H_2O + 2KCl$

(15.) 

(16.) 

(17) 

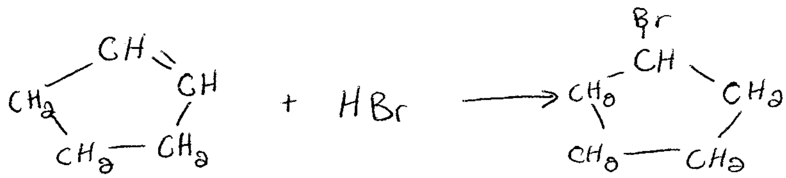
~~18. $HC\equiv CH + HCl \rightarrow H_2C=\overset{Cl}{\overset{|}{C}}H$~~

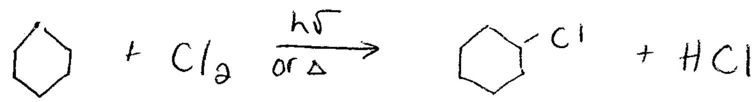
organic
rxns #3

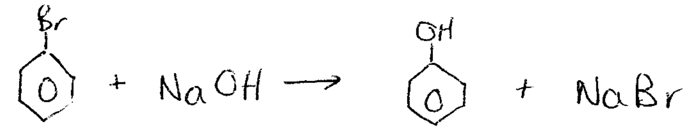
(18) $H_2C=CH_2 + H_2O \xrightarrow{H^+} CH_3-CH_2OH$

(19.) $Cl-CH_2-CH_3 + NaOH\ (\text{dilute}) \rightarrow HO-CH_2-CH_3 + NaCl$

$(\text{concentrated}) \rightarrow CH_2=CH_2 + HCl + NaO + H_2O + NaCl$

(20) 

(21.) 

(22.) 

(23) $CH_3-OH \xrightarrow{[O]} H-C(=O)-H$ (stage 1)

(24) $CH_3-CH(OH)-CH_3 \xrightarrow{[O]} CH_3-C(=O)-CH_3$ (stage 1)

(25) $H-C(=O)-H \xrightarrow{[O]} H-C(=O)-OH$

(26). $H_3C-C(=O)-OH + Mg^{2+}(OH)_2 \rightarrow Mg(CH_3-C(=O)-O)_2 + 2H_2O$

(27) $H_3C-CH_2-CH_2-CH(CH_3)-C(=O)-OH + 8O_2 \rightarrow 6CO_2 + 6H_2O$

(28) $CH_3-CH=CH-CH_2-CH_3 + Br_2 \rightarrow CH_3-CH(Br)-CH(Br)-CH_2-CH_3$

(29) $HO-CH_2-CH_3 + CH_3-CH_2-CH_2-C(=O)-OH \rightarrow$

$CH_3-CH_2-CH_2-C(=O)-O-CH_2-CH_3 + H_2O$

(30) $H_2C=CH-CH_3 + H_2 \longrightarrow$ no reaction

$\xrightarrow[\text{pressure}]{\text{cat}} CH_3-CH_2-CH_3$

(31) $HC\equiv CH + HCl \rightarrow H_2C=\overset{H}{\overset{|}{C}}-Cl$

Extra Questions

Solutions

1. a) Ammonia (NH_3)

Total mm = 17 g/mol

N × 1 = 14 g/mol

% = 14/17 × 100%

= 82.4%

H × 4 = 4 g/mol

% = 4/17 × 100%

= 17.6%

b) Glucose ($C_6H_{12}O_6$)

Total mm = 180 g/mol

C × 6 = 72 g/mol

% = 72/180 × 100%

= 40%

H × 12 = 12 g/mol

% = 12/180 × 100%

= 6.67%

O × 6 = 96 g/mol

% = 96/180

= 53.33%

2. a) $CH_3CH_2CH_2CH_3 + Br_2 \longrightarrow CH_3CHBrCH_2CH_3 + HBr$

1 mol 1 mol 0.65 mol

~~Theoretical~~ Actual Yield

$n = \frac{m}{mm}$

$m = n \cdot mm$

$m = 0.65 mol (137 g/mol)$

$m = 89.05 g$

Theoretical Yield

$n = \frac{m}{mm}$

$m = 1 \cdot 137$

$= 137 g$

$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\%$

$= \frac{89.05}{137} \times 100\%$

$= 65\%$ yield

b) ~~Theoretical~~ Actual Yield

$n = \frac{m}{mm}$

$m = n \cdot mm$

$= 0.2 \cdot 137$

$= 27.4 g$

Theoretical Yield

$n = \frac{m}{mm}$

$m = n \cdot mm$

$= 0.5 \times 137$

$= 68.5$

$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\%$

$= \frac{27.4}{68.5} \times 100$

$= 40\%$ yield

3. $C = 56.8\%$ $H = 28.4\%$ $O = 8.2\%$

Assume 100g $= 56.8g$ $= 28.4g$ $= 8.2g$

# of moles $= 4.73$ moles # of moles $= 28.4$ moles # of moles $= 0.5125$ moles

$\times 4$ $= 19$ $= 114$ $= 2.05$

3. $C = 56.8\%$ $H = 6.5\%$ $O = 28.4\%$ $N = 8.28\%$

	C	H	O	N
in 100g	$m = 56.8g$	$= 6.5g$	$= 28.4g$	$= 8.28g$
	$n = 4.73$	$= 6.5mol$	$= 1.775$	$= 0.6$
$\div 0.6$ ~~x1.5~~	$n = 7.9$	$= 10.8$	$= 2.96$	$= 1$

$\therefore$ EF is $C_8H_{11}O_3N$

Extra Questions

Solutions

4. 1 mole CH_2Cl_2 → $1C \rightarrow 12$

$2H \rightarrow 2$

$2Cl \rightarrow 71$

85g/mol

$\frac{12.8g\ \cancel{/mol}}{85g/mol}$ = 0.1506 moles produced

$CH_2Cl + Cl_2 \longrightarrow CH_2Cl_2 + HCl$

1 : 1

0.25 0.25 (theoretical)

% yield = $\frac{actual}{theoretical} = \frac{0.1506}{0.25} = 0.602 = 60.2\%$

5. In 100g → 86g C, 14g H

1 mole C = 12g 1 mole H → 1

x mole = 86g x mole → 14

x = 7.17 mol x = 14 moles

C	H
7.17	14
1 :	2

∴ empirical formula CH_2

$mF = \left(\frac{mm}{Em}\right) EF = \frac{15.4}{14} \times (CH_2) = C_{11}H_{22}$

mass = 2.85g

V = 0.50 L

T = 293 K

P = 95 kPa

PV = nRT

$n = \frac{PV}{RT} = \frac{(95)(0.5)}{(8.314)(293)} = 0.0195$ moles

3.00g = 0.0195 moles

xg = 1

x = 154 g/mol

Extra questions

Solutions

6. $Br_2 + CH_3\overset{\displaystyle H}{\overset{|}{C}} = \overset{\displaystyle CH_3}{\overset{|}{C}} - CH_2 - CH_2 - CH_3 \rightarrow R - \underset{\displaystyle H}{\underset{|}{\overset{\displaystyle Br}{\overset{|}{C}}}} - \underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle Br}{\overset{|}{C}}}} - R$

1 mole 3methyl-2-hexene $= 7C = 84$

$14H = \underline{14}$

98g/mol

x mole $\rightarrow$ 0.196g

x = 0.02 moles of R

$\therefore$ 0.02 moles of Br_2 are needed

1L $\rightarrow$ 0.08mol

xL $\rightarrow$ 0.02mol

x = 25mL

$\therefore$ 25mL of the solution will react

7. In 100g

$$\left.\begin{array}{l} 40.7g\ C \rightarrow 3.39\text{mole} \\ 8.5g\ H \rightarrow 8.5\text{mole} \\ 23.7g\ N \rightarrow 1.693\text{moles} \\ 27.1g\ O \rightarrow 1.693\text{moles} \end{array}\right. \times 3 \left.\begin{array}{l} \\ \\ \\ \\ \end{array}\right\} \begin{array}{l} 10.17 \\ 25.5 \\ 5.08 \\ 5.08 \end{array}$$

$\therefore$ empirical formula C_2H_5ON

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(98.66)(0.0523)}{(8.314)(293)} = 0.00212 \text{ moles}$$

0.25g $\rightarrow$ 0.00212

xg = 1 mole

x = 118.1g

$\cancel{MF = \left(\frac{MM}{EM}\right) EF}$

Extra Questions

Solutions

8. $C_xH_y + O_2 \longrightarrow CO_2 + H_2O$

$1\text{ mole } CO_2 \rightarrow 12$ $\quad 1.833g \quad 1g$

% C in CO_2 $\frac{32}{44g}$ $\quad 1\text{ mol } H_2O \rightarrow 18g$

% H in H_2O $= 0.1111$

$= 0.2727$ $\quad \therefore 0.1111g\,H$

$\therefore 0.5C$

$\frac{1.833g}{44} = 0.0417\text{ moles}$

$\frac{1}{18} = 0.055\text{ moles}$

$1\text{ mol } C \rightarrow 12g$

$x\text{ mol } \rightarrow 0.5g$

$x = 0.04165\text{ moles}$

$1\text{ mole } H \rightarrow 1g$

$x\text{ mole} \rightarrow 0.1111g$

$x = 0.1111\text{ mole } H$

$C : H$

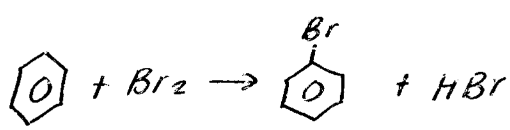
$0.04165 \quad 0.1111 \quad \times 24$

$1 : 2.66$

$3 : 8$

$\therefore$ formula of HC is C_3H_8

9. Reaction:



$879\frac{kg}{m^3} \times \frac{1000g}{kg} \times \frac{m^3}{10^6 cm^3} = 0.879g/ml \times 32ml = 28.128g$ of benzene

Benzene - C_6H_6

Extra Questions

Solutions

9. cont'd

$28.129g \rightarrow x$ mole $x = 0.361$ moles benzyne
$78g \rightarrow 1$ mole

$79.9g \rightarrow x$ mole $x = 1$ mole Bromine
$79.9g \rightarrow 1$ mole

a) Theoretical yield is 0.361 moles bromobenzyne

b) $30g \rightarrow x$ mol C_6H_5Br
$157g \rightarrow 1$ mol $x = 0.191$ moles bromobenzyne

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} = \frac{0.191}{0.361} = 52.9\%$$

10a) $$EFM = \frac{0.601g}{0.01 \text{ mole}} = 60.1g/mol$$

$$n = \frac{PV}{RT} = \frac{(101.3)(0.388)}{(8.314)(473)} = 0.01 \text{ moles}$$

$$mF = \frac{60.1g/mol}{30} = (EF)$$

$= 2(CH_2O)$

$= C_2H_4O_2$

$\therefore$ The mF is $C_2H_4O_2$

b) $Zn + \text{acid} \rightarrow H_2 + \text{salt}$

$HX \rightarrow 0.5H_2 + \text{salt}$

$\therefore$ the acid has 1 proton

$$CH_3\overset{\overset{O}{\|}}{C}-OH$$

Extra Questions

Solutions

1.

11. $CxHyOz + O_2 \rightarrow CO_2 + H_2O$

100g 149g 45.5g

CO_2 is 0.2727C

∴ 40.6323g C

∴ 3.39 moles of C

H_2O is 0.1111 H

∴ 5.05g H

∴ 5 moles H

O is 100 - 40.6323 - 5.05

= 54.312g

= 3.39 moles O

C : H : O

3.39 : 5 : 3.39

10 : 15 : 10

∴ empirical formula is $C_{10}H_{15}O_{10}$ or $C_2H_3O_2$

12. $CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH$

1 mole $CH_3CH_2Br \rightarrow 109g$

x mole $\rightarrow 50g$

x = 0.46 moles

∴ 0.46 moles of CH_3CHOH is produced

1 mole → 46g

0.46 mol → xg x = 21.16

∴ 21.16g of CH_3CH_2OH can be produced.