# UNIT 4

# ORGANIC CHEMISTRY

# ANSWERS

# Organic Reactions

1. $H_2C=CH_2-CH_2-CH_3 + Br_2 \longrightarrow Br-CH_2-CH(Br)-CH_2-CH_3$

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

3. $CH_3-CH=CH_2 + \frac{9}{2}O_2 \longrightarrow 3CO_2 + 3H_2O$

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

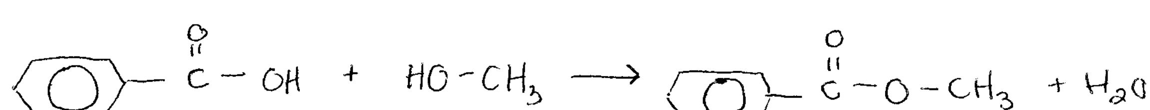
5. $H-C\equiv C-H + \frac{5}{2}O_2 \longrightarrow 2CO_2 + H_2O$

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

7. $H-C\equiv C-H + HClO_2 \longrightarrow H_2C=C(ClO_2)-H$

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

9. $CH_3-CH_2-C(=O)-OH + HO-CH_2-CH_2-CH_2-CH_3$
$\longrightarrow CH_3-CH_2-C(=O)-O-CH_2-CH_2-CH_2-CH_3 + H_2O$

10. 

organic rxns
#2

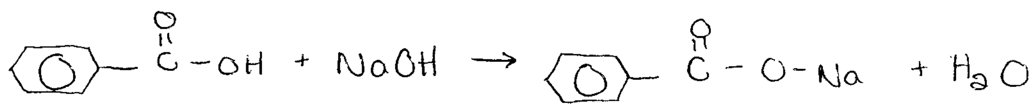


(11) $CH_3-CH_2-CH_2-CH_2-\overset{O}{\overset{\parallel}{C}}-OH + HO-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

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

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

(13)



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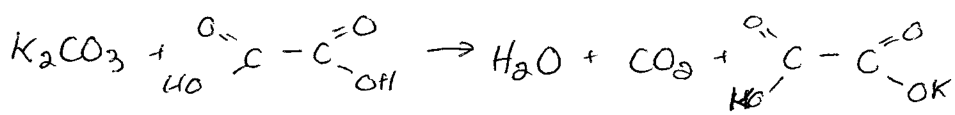
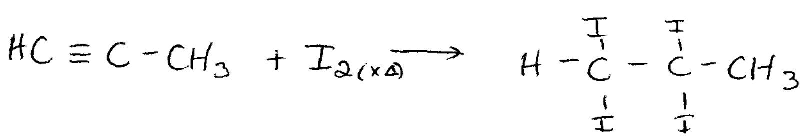


carbonate + acid → $CO_2$ + salt + $H_2O$

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

(15)



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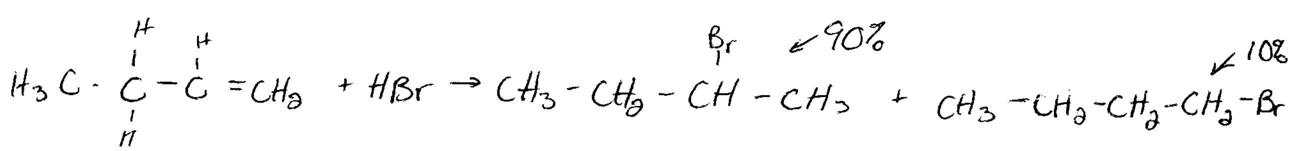

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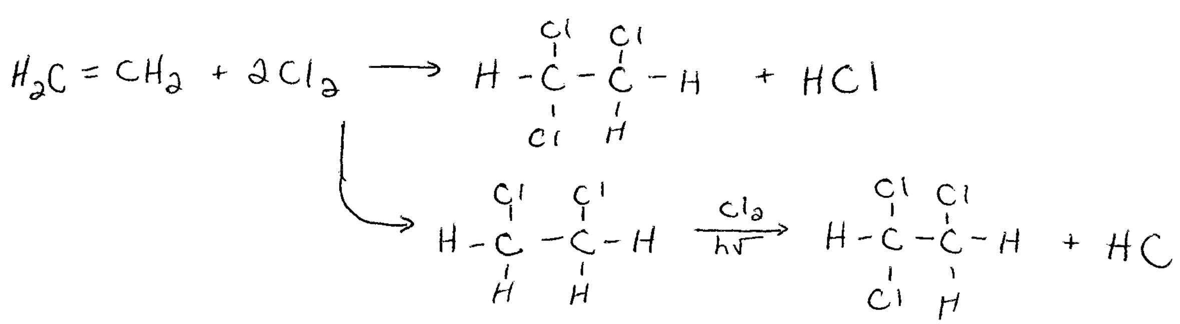


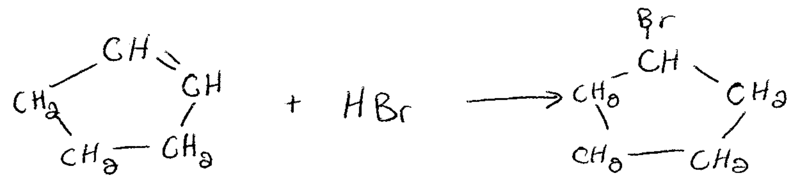
~~18. $HC\equiv CH + HCl \rightarrow H_2C=CH(Cl)$~~

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

(19) $Cl-CH_2-CH_3 + NaOH$ (dilute) $\rightarrow HO-CH_2-CH_3 + NaCl$

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

(20)

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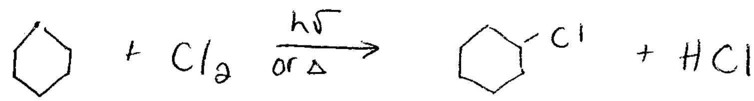


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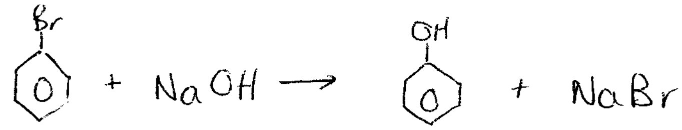



(23) $CH_3-OH \xrightarrow{[O]} H-C(=O)-H$ (stage 1)

(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)

$$H_2C=CH-CH_3 + H_2 \longrightarrow \text{no reaction}$$

$$H_2C=CH-CH_3 + H_2 \xrightarrow[\text{pressure}]{\text{cat}} CH_3-CH_2-CH_3$$

(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

$N \times 1 = 14$ g/mol
% = 14/17 × 100%
= 82.4%

$H \times 4 = 4$ g/mol
% = 4/17 × 100%
= 17.6%

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

Total mm = 180 g/mol

$C \times 6 = 72$ g/mol
% = 72/180 × 100%
= 40%

$H \times 12 = 12$ g/mol
% = 12/180 × 100%
= 6.67%

$O \times 6 = 96$ g/mol
% = 96/180
= 53.33%

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

1 mol 1 mol 0.65 mol

Actual ~~Theoretical~~ Yield

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

$m = n \cdot mm$

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

$m = 89.05\,g$

Theoretical Yield

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

$m = 1 \cdot 137$

$= 137\,g$

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

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

= 65% yield

b) Actual ~~Theoretical~~ Yield

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

$m = n \cdot mm$

$= 0.2 \cdot 137$

$= 27.4\,g$

Theoretical Yield

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

$m = n \cdot mm$

$= 0.5 \times 137$

$= 68.5$

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

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

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

in 100g $m = 56.8g$ | $= 6.5g$ | $= 28.4g$ | $= 8.28g$

$n = 4.73$ | $= 6.5mol$ | $= 1.775$ | $= 0.6$

$\div 0.6$ ~~$\times 1.5$~~ $n = 7.9$ | $= 10.8$ | $= 2.96$ | $= 1$

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

Extra Questions

Solutions

4. 1 mole $CH_2Cl_2 \rightarrow$ 1C → 12
2H → 2
2Cl → 71
85g/mol

$\frac{12.8g}{85g/mol}$ = 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 $CH_2$

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

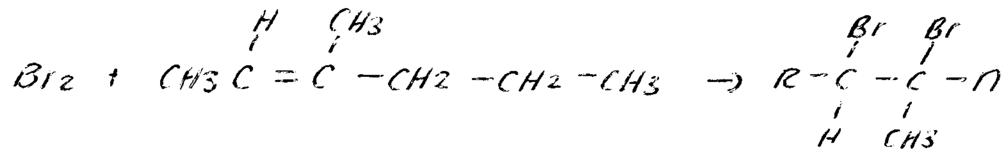
mass = 2.85g
V = 0.50 L
T = 293 K
P = 95 kPa
PV = nRT

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

3.00g = 0.0195 moles
xg = 1
x = 154g/mol

Extra questions

Solutions

6. 


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

14H = 14

98g/mol

x mole → 0.196g

x = 0.02moles of R

∴ 0.02 moles of $Br_2$ are needed

1L → 0.08mol

xL → 0.02mol

x = 25mL

∴ 25mL of the solution will react

7. In 100g

| | | | |
|---|---|---|---|
| 40.7g C → 3.39mole | | | 10.17 |
| 8.5gH → 8.5mole | ×3 | | 25.5 |
| 23.7gN → 1.693moles | | | 5.08 |
| 27.1gO → 1.693moles | | | 5.08 |

∴ empirical formula $C_2H_5ON$

$PV = nRT$

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

0.25g → 0.00212

xg = 1mole

x = 118.1g

~~MF = (MM / EM) EF~~

# Extra Questions

## Solutions

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

1 mole $CO_2 \rightarrow 12$     1.833g    1g

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

% H in $H_2O$ = 0.1111

= 0.2727     ∴ 0.1111g H

∴ 0.5C

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

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

1mol C → 12g     1 mole H → 1g

x mol → 0.5g     x mole → 0.1111g

x = 0.04165 moles     x = 0.1111 mole H

C : H

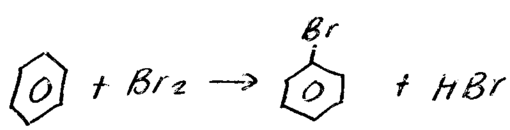
0.04165   0.1111   × 24

1 : 2.66

3 : 8

∴ 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 → x mole  x = 0.361 moles benzyne
78g → 1 mole

79.9g → x mole  x = 1 mole Bromine
79.9g → 1 mole

a) Theoretical yield is 0.361 moles bromobenzyne

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

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

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

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

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

$= 2(CH_2O)$

$= C_2H_4O_2$

∴ The mF is $C_2H_4O_2$

b) Zn + acid → $H_2$ + salt
HX → $0.5H_2$ + salt

∴ the acid has 1 proton

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

## Extra Questions

## Solutions

1.

11. $C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$
    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 $CH_3CH_2Br$ → 109g
x mole → 50g
x = 0.46 moles
∴ 0.46 moles of $CH_3CHOH$ is produced
1 mole → 46g
0.46 mol → x g   x = 21.16
∴ 21.16g of $CH_3CH_2OH$ can be produced.