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(

.

CH 3 – CH 2 – OH

R-CH CH 2

Alkyl Halides

C n H 2n+2 – H C n H 2n+1 X

C n H 2n+1 X

CH 3 – CH 2 – Br

CH 3 – CH 2 – CH 2 – I

CH 3 – C – CH 3

CH 3 – C – C – CH 3

CH 3 Cl

CH 3 – Cl

C 3 H 7 I

CH 3 – CH 2 – CH 2 – 1

C 3 H 7 Cl

CH 3 – CH – CH 3

C 4 H 9 Cl

CH 3 – CH 2 – CH – CH 3

C 3 H 6 Br 2

CH 3 – C – CH 3

C 4 H 8 BrCl

CH 3 – C – C – CH 3

CH 3 CH 2 CHCH 2 Br (ii) CH 3 CHCH 2 CH 3 (i)

R – X + OH – R – OH + X 

CH 3 – CH 2 – Br + NaOH CH 3 – CH 2 – OH + NaBr

CH 3 – C – CH 3 + KOH CH 3 – C – CH 3 + KCl

i) CH 3 – Cl + NaOH ........ + ........

ii) CH 3 – CH 2 – CH – CH 3 + KOH ........ + ........

X 2

CH 4 + Cl 2 CH 3 – Cl + HCl

CH 3 – CH 3 + Br 2 CH 3 – CH 2 Br + HBr

CH 2 CH 2

H 2 C CH 2 + Cl 2 CH 2 –– CHCl + HCl

CH C

H – C – C – H + Cl 2 Fe H – C C – Cl

C 8 H 18

CH 2 = CH 2 + HCl CH 3 – CH 2 Cl

I H

CH 3 – C = C – H + HI CH 3 – C – C – H

CH CH 2

CH 2 – C – H + HCl CH 2 – CHCl

CCl 4

CH 3 Cl

CH 3 Cl

CCl 4

i) NaOH + CH 3 – CH 2 Br ……. + …...

ii) LiOH + CH 3 – CH 2 – CH – CH 2 – CH 3 …… + ……

C n H 2n + 1 OH

R – CH 2 OH

R 2 CHOH 5 R-CHOH-R

OH

CH 3 CHCH 3 , CH 3 – CH 2 OH

CH 2 – CH 2

)

CH 2 OH – CHOH – CH 2 OH

CH 3 – CH 2 – OH (i)

CH 3

CH 3 – C – OH (ii)

CH 3

CH 3 – C – C – CH 3 (iii)

CH 3 -CHOH-CHOH-CH 3

CH 3 – CH 2 – CH 2 – OH

CH 3 – CH 2 – CH 2 – CH 2 – OH

OH CH 3

CH 3 – CH – CH – CH 2 – CH 3

CH 3 – CH – CH 3

CH 4 O

CH 3 OH

C 2 H 5 OH

CH 3 – CH 2 – OH

C 4 H 9 OH

CH 3 – CH 2 – CH 2 – CH 2 OH

C 5 H 11 OH

CH 3 – CH 2 – CH 2 – CH 2 – CH 2 OH

C 6 H 13 OH

CH 3 (CH 2 ) 4 – CH 2 OH

C 3 H 7 OH

CH 3 – CHOH – CH 3

C 4 H 9 OH

CH 3 – CH 2 – CHOH – CH 3

C 5 H 11 OH

CH 3 – CH 2 – CH 2 – CHOH – CH 3

C 5 H 11 OH

CH 3 – CH 2 – CHOH – CH 2 – CH 3

C 6 H 13 OH

CH 3 (CH 2 ) 3 – CHOH – CH 3

C 6 H 13 OH

CH 3 – (CH 2 ) 2 – CHOH – CH 2 – CH 3

C 5 H 11 OH

CH 3 – CH 2 – C OH – CH 3

CH 3

C 6 H 13 OH

CH 3 – CH 2 – CH 2 C OH – CH 3

CH 3

C 6 H 13 OH

CH 3 – CH 2 – C OH – CH 2 – CH 3

CH 3

C 2 H 5 OH (i)

CH 3 – CH 2 – CH 2 – CH 2 (ii)

ROR /

R = R /

R ≠ R /

ROR /

C n H 2n+2 O

R – O – R /

R-O-R -

CH 3 – O – C 2 H 5

CH 3 – O – CH 3

CH 3 – O – C – CH 3

CH 3

OCH 3

CH 3 – CH – CH 3

H-CH 2 -CH 2 -O-CH 2 -CH 2 -CHCl-CH 3

C 2 H 6 O

CH 3 – O – CH 3

C 4 H 10 O

CH 3 – CH 2 – O – CH 2 – CH 3

C 3 H 8 O

CH 3 – CH 2 – O – CH 3

C 4 H 10 O

CH 3 – CH 2 – CH 2 – O – CH 3

CH 3 OC 2 H 5

CH 3 OC(CH 3 ) 3

1. CH 3 CH 2 CH 2 OH

2. CH 3 (CH 2 ) 3 CHCH 3 CH 2 OH

3. CH 3 CHOHCH 2 CH 3

4.CH 3 CH 2 COHCH 3 CH 3

CH 3- O-CH 3

CH 3 OC 2 H 5

CH 3 CH 2 OCH 2 CH 3

CH 3 CH 2 CH 2 OCH 3

C 4 H 10 O

Aldehydes , Ketones,Carboxilic Acids & Esters

O

C n H 2n O

O

CH 3 – C – H

CH 3 CH 2 C – H

CH 3 – CH – C – H

CH 3 – CH – CH 2 – C –

CH 2 O

C 2 H 4 O

C 3 H 6 O

C 4 H 8 O

C 4 H 8 O

C 5 H 10 O

C 5 H 10 O

CH 3 – C – H

CH 3 – CH 2 – C – H

CH 3 – CH 2 – CH 2 – C – H

CH 3 – CH – C – H

CH 3

CH 3 – CH 2 – CH 2 – CH 2 – C – H

CH 3 – CH 2 – CH – C – H

CH 3

O

 C – C – C 

CnH 2n O

R – CO-R

O

R ⁄

R ⁄

R – C – R ⁄

R ⁄ , R

C 2 H 5 – C – CH 3

CH 3 – C – CH 3

CH 3 O

CH 3 – CH – C – CH 3

CH 3 – C – CH – CH 3

O CH 2

CH 3

C 3 H 6 O

C 4 H 8 O

C 5 H 10 O

C 5 H 10 O

C 6 H 12 O

C 6 H 12 O

CH 3 – C – CH 3

CH 3 – CH 2 – C – CH 3

CH 3 – CH 2 – CH 2 – C – CH 3

CH 3 – CH 2 – C – CH 2 – CH 3

CH 3 – CH 2 – C – CH 2 – CH 2 – CH 3

CH 3 – CH 2 – CH 2 – CH 2 – C – CH 3

i) CH 3 – C – CH 2 – CH 2 – CH – CH 2 – CH 2 – CH 3

O Br

ii) H – C – CH 2 – CH 2 – CH – Br

O CH 2 CH 3

O

 C  OH

C n H 2n O 2

R – CO 2 H

CH 3 – C – OH

CH 3 – C – C – OH

CH 3 – CH 2 – C – C – OH

CH 3

CH 2 O 2

C 2 H 4 O 2

C 3 H 6 O 2

C 4 H 8 O 2

C 5 H 10 O 2

C 6 H 12 O 2

C 7 H 14 O 2

C 8 H 16 O 2

CH 3 – C – O – H

CH 3 – CH 2 – C – O – H

CH 3 – CH 2 – CH 2 – C – OH

CH 3 – (CH 2 ) 3 – C – OH

CH 3 – (CH 2 ) 4 – C – OH

CH 3 – (CH 2 ) 5 – C – OH

CH 3 – (CH 2 ) 6 – C – OH

CH 3 – CH 2 – C – C – OH

CH 3

HOOC – CH 2 – COOH

CH 3 CHOHCOOH

C n H 2n O 2

O

R – C – O – R ⁄

CH 3 – C – O – C 5 H 11

C 3 H 7 – C – O – C 5 H 11

CH 3 – C – O – C 8 H 17

CnH 2 nO 2

R – C – OR ⁄

CH 3 – CH – C – O – C 2 H 5

CH 3 – C – O – CH 3

H – C – O – CH 3

CH 3 – CH – C – O – C 2 H 5

CH 3 – C – O – CH 3

34

1

18

C 2 H 4 O 2

C 3 H 6 O 2

C 4 H 8 O 2

C 4 H 8 O 2

C 7 H 14 O 2

C 10 H 20 O 2

C 5 H 10 O 2

C 6 H 12 O 2

HCOO – CH 3

CH 3 COO – CH 3

CH 3 COO – CH 2 – CH 3

CH 3 – CH 2 COO – CH 3

CH 3 COO – (CH 2 ) 4 – CH 3

CH 3 COO – (CH 2 ) 7 – CH 3

CH 3 – (CH 2 ) 2 COO – CH 3

CH 3 – (CH 2 ) 2 COO – CH 2 – CH 3

1

O

CH 3 – CH 2 – C – O – C 2 H 5

O Cl

C 2 H 5 – C – O – CH – CH 3

2

2

3

1

3

4

1

1. C 2 H 4 O 2 2. C 3 H 8 O 3. C 5 H 10 O 4. C 6 H 12 O 2

2

3

:

1

2

2

2

3

35

3

4

3

4

1. CH 3 CH 2 COOCH 2 CH 3

2. CH 3 CH 2 CO(CH 2 ) 3 CH 3

3. CH 3 CH 2 CHCH 3 CH 2 CHO

4. CH 3 (CH 2 ) 2 CHO

5. CH 3 CH 2 CH 2 CHCH 3 OOH

6. (CH 3 ) 2 CO

5

7

1

2

3

4

5

36

) 1

4

1

1

2

3

.

1

4

2

1

2R – OH + 2Na 2R – ONa + H 2

2CH 3 – CH 2 OH + 2Na 2CH 3 CH 2 ONa + H 2

(

37

2

R – OH + HX ZnCl 2 R – X + H 2 O

1

12

CH 3 – CH 2 – CH 2 OH + HBr ZnCl 2 CH 3 CH 2 CH 2 Br + H 2 O

)

3

K 2 Cr 2 O 7  H 2 SO 4

KMnO 4  H 2 SO 4

:

O

(i) R – CH 2 OH K 2 Cr 2 O 7  H + R – C – H + H 2 O

O O

K 2 Cr 2 O 7  H + R – C – OH

(ii) R – C – H

(

i .

.

ii

.

O O

CH 3 CH 2 OH (O) CH 3 – C – H (O) CH 3 – C – OH

38

OH O

R – CH – R K 2 Cr 2 O 7  H + R – C – R + H 2 O

R

R – C – OH O No Reaction

R

4

) i (

200

OH

:

H

R – C – CH 2 OH Conc.H 2 SO 4 R – CH = CH 2 + H 2 O

200 C

H

39

1

13

CH 3 – C – CHOH – CH 3 Conc.H 2 SO 4 CH 3 – CH = CH – CH 3 + H 2 O

200 C

H

(

ii

135

:

R – OH + R / – OH Conc.H 2 SO 4 R – O – R / + H 2 O

R

R⎯

i .

2CH 3 -CH 2 OH Conc .H 2 SO 4 CH 3 CH 2 -O-CH 2 -CH 3 +H 2 O

ii

:

CH 3 CH 2 OH+CH 3 OH Conc. H 2 SO 4 CH 3 -CH 2 -O-CH 3 +H 2 O

135 C

40

:

R – X + KOH R – OH + KX

1

14

1

CH 3 – CH 2 – CH 2 – Br + KOH CH 3 CH 2 CH 2 OH + KBr

(

O OH

R – C – H + H 2 Ni R – C – H

H

)

1

15

O OH

CH 3 – C – H + H 2 Ni CH 3 – C – H

H

(

O OH

R – C – R / + H 2 Ni R – CH – R /

H

(

41

1

16

O OH

CH 3 – C – CH 3 + H 2 Ni CH 3 – CH – CH 3

(

330

:

H H H OH

R – C = C – R + H 2 O H 2 SO 4 Conc R – C – C – R

H H H H

1

17

CH 3 CH 3

CH 3 – C = CH – CH 3 + H 2 O Conc. H 2 SO 4 CH 3 – C – CH 2 – CH 3

Cl OH

O + NaOH O + NaCl

) ( ء

42

2

3

2

(.

1

4

3

12

t βθ å κ t J Ζ • Β

90

91

1

2

.

3

135

.

1

4

4

43

H OH

C C

H – C C – H H – C C – H

H – C C – H H – C C – H

C C

H

OH OH

C 6 H 5 OH

O

1

O – H

:

OH ONa

O + NaOH O + H 2 O

44

CHOH

CH 2 – CH 2 + NaOH

2

:

OH Cl

H – C + HCl H – C + H 2 O

H 2 C – CH 2 CH 2 – CH 2

OH

O + HCl

1

4

5

1

CH 3 OH

45

2

C 2 H 5 OH

A

(A )

.

3

1

4

6

1

(.

2

.

3

.

4

.

i. CH 3 – CH 2 – CH 2 OH

ii. CH 3 – (CH 2 ) 3 – CH 2 – CH 2 OH

iii. CH 3 – CHOH – CH 2 – CH 3

iv. CH 3 – CHOHCH 2 – CH 2 – CH 3

v. CH 3 OH

5

:

i .

.

ii

.

iii

.

iv

.

46

6

i.

CH 3 – CH 2 – CH 2 OH + K ………. + ............

ii.

CH 3 – CH 2 – CH 2 – CH 2 OH + HBr ZnCl 2 ..…… + .........

iii.

CH 3 – COH – CH 3 + HCl ZnCl 2 ………. + .............

H

iv.

CH 3 – (CH 2 ) 3 – CH 2 OH O ……… + ............

v.

CH 3 – CHOHCH 2 CH 3 O ……… + .............

vi.

CH 3 OH + Mg ………. + ............

vii.

CH 3 CH 2 – CHOHCH 3 K 2 Cr 2 O 7  H + ……… + ............

47

) 1

5

1

1

2

1

5

2

HX

R – OR + HX ROH + RX

1

18

CH 3 – O – CH 3 + HI CH 3 OH + CH 3 I

)

HX

2

R – OR + 2HX 2RX + H 2 O

1

19

CH 3 – O – CH 3 + 2HCI 2CH 3 CI + H 2 O

CO 2

H 2 O

48

'

1

5

3

i .

R – OR

135ْ

R – OH + R – OH H 2 SO 4 R – O – R + H 2 O

CH 3 – OH + CH 3 – OH H 2 SO 4 CH 3 – O – CH 3 + H 2 O

ii

RO

:

RONa + R ⁄ – X R – O – R ⁄ + NaX

CH 3 ONa + C 2 H 5 Cl CH 3 – O – C 2 H 5 + NaCl

(

) (

(

49

[(CH 3 ) 2 CH] 2 O

(C 4 H 9 ) 2 O

:

i. CH 3 CH 2 O – Na + + CH 3 Cl ………. + ……….

ii. 2CH 3 – CH – CH 3 H 2 SO 4 conc. …...... + …......

135

OH

1

5

5

1

HX

.

2

1

5

6

1

:

i. CH 3 – O – CH 3

ii. CH 3 – O – C 2 H 5

iii. CH 3 CH 2 OCH 2 CH 3

iv. CH 3 – CH 2 – CH 2 – O – CH 3

OH

i) 2CH 3 – CH – CH 3 H 2 SO 4 conc ……… + ……….

ii) CH 3 CH 2 CH 2 ONa + CH 3 Br ……… + ………

C 3 H 8 O

52

) i

O OH

R – C – H + H 2 Ni R – C – H

H

:

O OH

R – C – R ⁄ + H 2 Ni R – C – R ⁄

H

ii

HBr , HCl

HCN

O OH

1) R – C – H + HCl R – C – H

Cl

O OH

2) R – C – R + HBr R – C – R

Br

53

O OH

3) CH 3 – CH 2 – C – H + HCl CH 3 – CH 2 – C – H

Cl

(

O OH

4) CH 3 – CH 2 – C – CH 3 + HBr CH 3 – CH 2 – C – CH 3

Br

O OH

5) CH 3 – CH 2 – C – H + HCN CH 3 – CH 2 – C – H

CN

O OH

6) CH 3 – CH 2 – C – CH 2 – CH 3 + HCN CH 3 – CH 2 – C – CH 2 – CH 3

CN

2

O O

R – C – H O R – C – OH

54

O O

CH 3 – CH 2 – C – H K 2 Cr 2 O 7  H + CH 3 – CH 2 – C – OH

O O

O – C – H O O – C – OH

O

(i) C 3 H 7 – C – CH 3 + H 2 Ni ………….

(ii) CH 3 CHO + H 2 Ni ………….

O

(iii) C 2 H 5 – C – H K 2 Cr 2 O 7  H + ……………

O

(iv) CH 3 – C – CH 3 + HBr …………..

(v) CH 3 CHO + HBr …………..

1

6

3

II

II

CuO

) I

O O

R – C – H - + 2CuO R – C – OH + Cu 2 O

(

55

O

R – C – R ⁄ + 2CuO

II

CuO

) I

Cu 2 O

R-CHO + 2CuO Heat R-COOH + Cu 2 O (s)

CH 2 OH – CHOH – CHOH – CHOH – CHOH – CHO

56

1

6

4

K 2 CrO 4

:

OH O

R – C – H K 2 CrO 4 R – C – H

H

1

20

OH O

CH 3 – C – H K 2 CrO 4 CH 3 – C – H

H

KMnO 4 , K 2 Cr 2 O 7

OH O

R – C – R ⁄ KMnO 4 R – C – R ⁄

H

)

R ⁄ = R

≠ R

(R ⁄

[O]

57

1

21

2

2

OH

CH 3 – CH 2 – CH 2 – CH 2 – C – CH 3 KMnO 4

H

2

O

CH 3 – CH 2 – CH 2 – CH 2 – C – CH 3

2

1

.

2

3

.

250

OH O

R – C – H Cu R – C – H + H 2

H 250 C

58

1

22

1

OH O

CH 3 – CH 2 – CH 2 – C – H Cu CH 3 - CH 2 – CH 2 – C – H + H 2

H 250 C

OH O

R – C – R Cu R – C – R + H 2

H 250 C

1

23

2

OH O

CH 3 – C – CH 3 Cu CH 3 – C – CH 3 + H 2

H 250 C

2

) i

ii

iii

CH 3 – CH 2 – C – CH 3

O

1

6

5

O

1

H – C – H

.

O

2

CH 3 – C – CH 3

.

59

3

.

4

.

4

3

1

6

6

1

i. C 6 H 12 O ii. C 4 H 10 O iii. C 3 H 6 O

vi. C 7 H 16 O vii. C 2 H 4 O iv. C 3 H 8 O

2

:

O

(i) CH 3 – CH 2 – CH 2 – C – H

(ii) CH 3 – CH 2 – CH 2 – C – CH 3

O

CH 3

(iii) CH 3 – CH – COH – CH 2 – CH 3

CH 3 CH 3

O

(iv) CH 3 – CH 2 – CH 2 – C – CH 2 – CH 3

3

2

.

( 2

3

.

60

3

.

4

:

O

CH 3 – CH 2 – C – H O …………

O

CH 3 – C – CH 3 + H 2 Ni ………….

OH

H – C – H O …………..

H

61

Carboxilic Acids

1

7

1

OH

 C 

O

1

2

.

1

7

2

O O

2R – C – OH + 2Na 2R – C – O – – Na + + H 2

(

62

1

24

2CH 3 – COOH + 2Na 2CH 3 COONa + H 2

(

:

O

R – COOH + NaOH R – C – O – Na + + H 2 O

1

25

O

CH 3 COOH + NaOH CH 3 – C – O – Na + + H 2 O

O O

2R – C – OH + Na 2 CO 3 2R – C – O – – Na + + H 2 O + CO 2

1

26

O – COOH + NaHCO 3 O – COO – Na + + H 2 O + CO 2

63

i .

.

ii

:

O O

R – C – OH + HOR H + R – C – OR + H 2 O

1

7

3

KMnO 4

OH O

R – C – H KMnO 4 R – C – OH

H O

64

1

27

OH O

CH 3 – C – H KMnO 4 CH 3 – C – OH

H

KMnO 4

K 2 Cr 2 O 7

O O

R – C – H K 2 Cr 2 O 7 R – C – OH

1

28

O O

CH 3 – C – H K 2 Cr 2 O 7 CH 3 – C – OH

:

O O

Mn +2

O O

2R – C – H + O 2 MnCl 2 2R – C – OH

65

1

29

O O

2CH 3 – C – H + O 2 MnCl 2 2CH 3 – C – OH

(i) CH 3 – CH 2 – OH O ……… O …………

(ii) CH 3 – CH 2 – CH 2 – CH 2 – OH KMnO 4 ……........

) i (

CH 3 CH 2 - COOH

ii

HCI

1

7

4

1

i .

.

ii

.

iii

CH 3 COOH

.

66

iv

C

C

.

2

COOH

O O

O – C – CH 3

1

7

5

1

1. CH 3 -CHO + HCl

2. CH 3 -CH 2 -CHO [O]

3. CH 3 CH 2 COOH + KOH

4.CH 3 CH 2 COCH 2 CH 3 + HBr

2

1

2

3

2

4

3

3

C 4 H 8 HBr C 4 H 9 Br NaOH C 4 H 10 O [O] C 4 H 8 O HCN

(A) (1) (B) (2) (C) (3) (D) (4)

C 5 H 9 ON

(E)

67

1

E – A

2

E – A

3

1

3

4

4

5

D

A

68

) 1

-

8 (ﺍﳋﻮﺍﺹ ﺍﻟﻔﻴﺰﻳﺎﺋﻴﺔ ﻭﺍﻟﻜﻴﻤﻴﺎﺋﻴﺔ

ﻟ

(Esters)

1

8

1

1

.

2

.

1

8

2

O O

R – C – OR′ + H 2 O H + R – C – OH + R′ – OH

H 2 SO 4

1

30

CH 3 – C – O – CH 2 CH 3 + H 2 O H + CH 3 – C – OH + CH 3 CH 2 OH

H 2 SO 4

O O

R – C – OR′ + OH – R – C – O – + R′OH

69

1

31

CH 3 – C – O – CH 2 CH 3 + NaOH CH 3 – C – O – Na + CH 3 CH 2 OH

1

H 2 SO 4

2

.

1

8

3

O O

R – C – OH + HOR – H + R – C - OR′ + H 2 O

H 2 SO 4

1

32

O

CH 3 – C – OH + HOC 2 H 5 H + CH 3 – C – O – C 2 H 5 + H 2 O

4 O

70

O O

R – C – O – R′ + H 2 O R – C – OH + R – OH

1

) i

ii

2

2 .

3

4

O Br O Cl O

(i) CH 3 – C – OH (ii) CH 3 – C – C – OH (iii) CH 3 – CH 2 – C – C – OH

H CH 3

5

2

3

.

6

) i

.

ii

7

:

71

O

(i) CH 3 CH 2 – C – OH + CH 3 CH 2 CH 2 OH H + ……. + …….

O

(ii) O – C – OH + CH 3 OH H + ………. + ……….

O

(iii) CH 3 C – OH + CH 3 CH 2 OH H + ……… + ………

8

:

O

(i) CH 3 – CH 2 – C – O – (CH 2 ) 3 – CH 3

O

(ii) CH 3 – CH 2 – CH 2 – O – C – CH 2 – CH 3

9

NaHCO 3

) 1

-

8

-

4

1

1. CH 3 COOH + Ca

2. CH 3 CH 2 COOCH 3 + KOH

3. HCOOH + Mg(OH) 2

4. CH 3 CHOHCH 3 + H-COO-CH 2 CH 3 H +

5. CH 3 COO(CH 2 ) 3 CH 3 + H 2 O H +

2 .

) 1

CH 3 -(CH 2 ) 2 -COO-CH 2 CH 3

) 2

CH 3 -CHCH 3 -COO-CH 2 CH 3

3

C 6 H 12 O 2 + H 2 O H + C 3 H 6 O 2 + C

(A) (B)

C , B , A

72

1

9

1

:

O

CH 2 – O – C – R

CH 2 – OH

O O

CH – O – C – R + 3NaOH CH – OH + 3R – C – ONa

O

CH 2 – O – C – R CH 2 – OH

1

33

CH 3 (CH 2 ) 16 – C – O – CH 2

O O

CH 3 (CH 2 ) 16 – C – O – CH 2 + 3NaOH 3CH 3 – (CH 2 ) 16 – C – ONa

O CH 2 – OH

CH 3 (CH 2 ) 16 – C – O – CH 2 + CH – OH

CH 2 – OH

73

1

9

2

O

CH 2 – OH CH 2 – O – C – R

O O

CH – OH + 3R – C – OH CH – O – C – R + 3H 2 O

O

CH 2 – OH CH 2 – O – C – R

O O

C 3 H 5 – (OH) 3 + HO – C – R C 3 H 5 – (O – C – R) 3 + 3H 2 O

.

74

1

CH 3 (CH 2 ) 16 – C – OH

O

O

2

CH 3 (CH 2 ) 7 – CH = CH(CH 2 ) 7 – C – OH

3

CH 3 (CH 2 ) 14 – C – OH

O

.

1

34

O

CH 2 – O – C – (CH 2 ) 7 – CH = CH – (CH 2 ) 7 – CH 3

O

CH – O – C – (CH 2 ) 7 – CH = CH – (CH 2 ) 7 – CH 3 + 3H 2

CH 2 – O – C – (CH 2 ) 7 – CH = CH – (CH 2 ) 7 – CH 3

O

75

O

CH 2 – O – C – (CH 2 ) 16 – CH 3

O

CH 2 – O – C – (CH 2 ) 16 – CH 3

O

CH 2 – O – C – (CH 2 ) 16 – CH 3

:

O

CH 2 – O – C – R CH 2 – OH

O O

CH – O – C – R + 3NaOH CH – OH + 3R – C – ONa

O

CH 2 – O – C – R CH 2 – OH

Saponofication

Na 2 SIO 3

76

1

9

3

1

2

3

O O O

(i) H – C – O – CH 3 (ii) CH 3 – C – O – CH 3 (iii) CH 3 – C – O – CH 3

4

O O

(i) CH 3 – C – O – CH 3 (ii) CH 3 – CH – C – O – C 2 H 5

O O

(iii) H – C – O – CH 3 (iv) CH 3 – CH – C – O – C 2 H 5

CH 3

5

2

3

6

7

1

2

3

77

) 1

-

10

(

ﺍﻟﺒﻠﻤﺮﺓ ﺍﻟﻌﻀﻮﻳﺔ Polimirization

ﻭﺍﻟﺘﻤﺎﻛﺐ Isomerism

1

10

1

1

Polymer

Monimer

2

.

1

10

1

1

Addition Polymers

C 2 H 4

CH 2 = CH 2

H H H H H H H H

n C = C – C – C– C – C – C – C –

H H H H H H H H n

78

H H H H

n C = C – C – C –

H H H H n

Initiator

CH 3

C 2 H 4

R + CH 2 CH 2 R – CH 2 – CH 2

R – CH 2 – CH 2 + CH 2 CH 2 R – CH 2 – CH 2 – CH 2 – CH 2

R – ( - CH 2 – CH 2 -)n – CH 2 – CH 2 – R R – (- CH 2 – CH 2 )n – CH 2 – CH 2 – R

R – (-CH 2 – CH 2 – CH 2 - )n – CH 2 – CH 2 + R R – (- CH 2 – CH 2 )n – CH 2 – CH 2 – R

n )

C 2 H 4

i .

:

nCH 2 = CH – CH 2 – CH –

n

CH 3 CH 3

79

ii

P . V . C

......

.

nCH 2 = CHCl – CH 2 – CH –

n

Cl

P . V . C

iii

:

n CF 2 = CF 2 (– CF 2 – CF 2 –) n

Condensation Polymers

:

O O

HO – CH 2 – CH 2 – OH+HO – C – O – C – OH

O O

HO – CH 2 – CH 2 – O – C – O – C – OH + H 2 O

:

O O

n (HO – CH 2 – CH 2 – O – C – O – C – OH)

80

O O

n H 2 O + (O – CH 2 – CH 2 – O – C – O – C) n

OH

1

2

3

1

10

2

Isomerism

1

10

2

1

i .

Chain Isomerim

.

ii

Position Isomerism

!6 !7"  
 \*! F C4 $" 8 6 /  
8

81

1

35

C 3 H 7 OH

CH 3 – CH – CH 3 , CH 3 – CH 2 – CH 2 – OH

OH

1

36

C 3 H 7 Br

CH 3 – CH – CH 3 , CH 3 – CH 2 – CH 2 – Br

Br

iii

Functional Group Isomerism

1

C 2 H 6 O

CH 3 – O – CH 3 , CH 3 – CH 2 – OH

2

:

(C 3 H 6 O)

CH 3 – C – CH 3 , CH 3 – CH 2 – CHO

O

]

CHo

[

]

[

3

C 3 H 6 O 2

O

CH 3 – C – O – CH 3 , CH 3 – CH 2 – COOH

82

1

.

2

.

3

.

1

10

3

1

i .

C 4 H 10 O

ii

C 3 H 6 O

iii

C 5 H 10 Br 2

83

1

CH 3 -C(CH 3 ) 2 -CHO

.

.

.

2

2

.

2

2

CH 3 H 2 CHICH 2 OH

CH 3 -CH 2 -CIOH-CH 3

CH 3 -CHOH-CHI-CH 3

CH 3 -CHI-CHOH-CH 3



1

2

3

4

1

84

2

135

.

Cl

1. CH 3 – CH – CH 3 + LiOH ............. + ............

2. CH 3 OH + Na .............. + .............

3.

Q 4"  
 2 E%( CH 3 – O – CH 3 + K ........ + .........

4. CH 3 – CHO +CuO .......... + ..........

5. (CH 3 ) 2 – CO + HCN ........... + ..........

6. CH 3 – CH 2 – C – OH + NaHCO 3 ...........

O

7. CH 3 H 2 OH + HBr ...............

8. 2CH 3 – OH H 2 SO 4 conc ............. + ..............

135 C

9. CH 3 ONa + C 2 H 5 Br ............. + ............

1

2

3

4

5

2

6

85

) i

ii

iii

iv

C 5 H 10 O 2

C 5 H 10 O 2

C 3 H 8 O [O] C 3 H 6 O [O] C 3 H 6 O 2

1

O

O

R- C -H

R-C-R

R

2

1

CH 3 CH 2 OH

2

CH 3 COCH 3

3

CH 3 CH 2 CHO

4

CH 3 CHOHCH 3

5

(CH 3 ) 3 COH

86

1

2

.

3

.

4

.

5

.

6

1

2

3

4

5

1

1

3

2

3

2

3

4

2

1

5

2,2,3,3

87

2

1

2

3

4

CH 3 CH 2 CH 2 OH

5

CH 3 CH 2 CH 2 CH 2 CHO

1

2

:

1

2

.

3

.

3

:

.

.

4

5

.

(

1

2

.

3

2HCl + Mg MgCl 2 + H 2(q)

4

.

5

:

.

2NaOH + H 2 SO 4 Na 2 SO 4 + 2H 2 O

1

.

2

.

Oxy - gen

1859

1927

HX

H +

HX H + + X -

H + + H 2 O H 3 O +

HX + H 2 O H 3 O + + X -

HCl + H 2 O H 3 O + + Cl -

H 2 SO 4 + H 2 O H 3 O + + HSO 4

-

MOH

OH -

MOH M + + OH -

CO 2

SO 3

CO 2 + H 2 O H 2 CO 3

H 2 CO 3 + H 2 O H 3 O + + HCO 3

-

CO 2 + 2H 2 O H 3 O + + HCO 3

-

SO 3

SO 3 + H 2 O

H 2 SO 4

H 2 SO 4 + H 2 O

+ + HSO 4

SO 3 + 2H 2 O

H 3 O

+ + HSO 4

CaO + H 2 O Ca(OH) 2 Ca 2+ + 2OH -

NH 3 + H 2 O NH 4

+ + OH -

HX + MOH MX + H 2 O

NaOH + HCl NaCl + H 2 O

Ca(OH) 2 + 2HNO 3 Ca(NO 3 ) 2 + H 2 O

1

HCl

2

:

NH 3 + H 2 O NH 4 OH NH 4

+ + OH -

NH 4 OH

3

HCl

.

1

2

3

.

4

:

SO 2

Na 2 O

.

NH 4 Cl

HCl (g) + NH 3(g) NH 4 Cl (s)

NH 4 Cl

HCl

NH 2

1923

H +

HCl

NH 3

HCl + NH 3

[ NH 4

+ ] [Cl

-- ]

HCl

NH 3

HCl

NH 3

HCl

NH 3

H 2 CO 3

H 2 CO 3 + H 2 O

H 3 O

+ + HCO 3

H 2 CO 3

H 2 CO 3 + H 2 O H 3 O + + HCO 3

-

H 2 CO 3

HCO 3

-

HCO 3

-

H 2 CO 3

HCO 3

-

H 2 CO 3

H 3 O +

H 2 O

NH 3 + H 2 O NH 4

+ + OH -

NH 3

NH 4

+

H 2 O

OH -

HX + Y HY + + X -

HX

X -

Y

HY +

H +

H +

HF

H 2 SO 4

H 2 PO -

4

F -

HSO -

4

HPO 4

2-

PO 4

-3

NH -

2

S -2

HPO 4

-2

NH 3

HS -

CO 3

–2 + H 2 O HCO 3

– + OH –

HCO 3

– , CO 3

2+

H 2 O

OH

CO 3

-2 + H 2 O HCO 3

- + OH -

1

2

.

3

H 2 O

4

CH 3 NH 3

+

CH 3 NH 2

CH 3 NH 3

+

CH 3 NH 2

5

.

H 2 S + SO 4

2– HS – + HSO 4

–

Na 2 O + SO 3 Na 2 SO 4

(s)

g

) s (

Na 2 SO 4

NaOH

H 2 SO 4

SO 3

SO 3 + H 2 O H 2 SO 4

H 2 SO 4

NaOH

H 2 SO 4 + 2NaOH Na 2 SO 4 + H 2 O

Na 2 O

SO 3

+

+

H + : O – H H O – H

O H +

H +

H

H Cl + H – O – H H – O – H + Cl -

H H

H – N : + HCl H – N – H + Cl -

H H

NH 3

HCl

HCl

N H +

H F H F

H – N : + B – F H – N – B – F

H F

F

H

NH 3

BF 3

Na 2 O + SO 3 Na 2 SO 4

O : :O: 2-

2-

II

Cu 2+

2+

Cu(NH 3 ) 4

NH 3 2+

Cu 2+ + 4 : NH 3 H 3 N – Cu – NH 3

NH 3

H 2 O + NH 3 NH 4

+ + Cl - (i)

(ii)

H 2 O + HCl H 3 O + + Cl

Amphoteric

HCO 3

HCO 3

- + OH - CO 3

2- + H 2 O

HCO 3

- + H 3 O + H 2 CO 3 + H 2 O

NaOH

Al(OH) 3 + OH - Al(OH) 4

-

Al(OH) - AlO 2

- + H 2 O

Al(OH) 3 + 3H 3 O + Al 3+ + 6H 2 O

Sb(OH) 3 , As(OH) 3 , Pb(OH) 2 , Zn(OH) 2 , Cr(OH) 3

H 2 O + H 2 O H 3 O + + OH -

NH 3 + NH 3 NH 4

+ + NH 2

-

CH 3 COOH + CH 3 COOH CH 3 COOH 2

+ + CH 3 COO -

1

2

3

NH 3 + H + NH 4

+

4

H 2 O

5

Ag +

+ ]

Ag(NH 3 ) 2

.

6

.

HSO 4

-

7

.

NH 3

,

HCN

1

:

a) Cu 2+ b) Na + c) Ag + d) Fe 2+

2

:

H +

.

.

3

HCl

:

H 3 O +

.

.

1

2

.

3

:

HA + B HB + + A -

4

o

HS - , NO 3

- , H 2 S , HPO 4

2- , HNO 2 , CO 3

2- , Cl - ,

H 2 O , NH 4

+

1

Zn(OH) 2

ZnCl 2

Na 2 ZnO 2

1

2

3

H 3 PO 4

NH 3

HCO 3

HSO 4

NH 3

HPO 4

-

BCl 3

(C 2 H 5 ) 2 O

(C 2 H 5 ) 2 O BCl 3

.

.

.

(i) HF + NH 3

NH 4

+ + F

(ii) HSO 4

-- + HPO 4

--

SO 4

2-- + H 2 PO 4

(iii) C 2 H 5 OH + NH 2

--

C 2 H 5 O

-- + NH 3

2-- + H 2 O

-- + OH

(v) H 2 O + H 2 O

H 3 O

+ + OH

--

110

111

119

120

126

133

140

148

Qualitative Chemical Anlaysis

1

2

3

.

4

5

.

6

.

7

.

8

.

9

.

10

.

11

.

12

.

13

H 2 SO 4

Qualitative Chemical Anlaysis

VI

SO 2

1

Dry-tests

2

Wet-tests

.

Quantitative Anlaysis)

3

1

Salt

1

NaCl

2

CaCO 3

.

3

AgNO 3

.

4

AL 2 (SO 4 ) 3

.

5

NH 4 Br

.

6

Na 2 S

.

, Al 3+ , Ag +

Na +

Ca 2+

NH 4

S 2- , Br - , Cl -

CO 3

NO 3

SO 4

ــ

+

OH -

1

.

3

1

Ca + S CaS

2

2K + 2HNO 3 2KNO 3 + H 2

3

.

3

2

2LiOH + H 2 SO 4 Li 2 SO 4 + 2H 2 O

4

.

2HCl + Na 2 CO 3 2NaCl + H 2 O + CO 2

3

1

1

Hydrolysis of salts

OH - ,

H 3 O +

H 3 O +

OH

.

1

NaCl

NaCl + H 2 O

Na + + Cl + OH + H 3 O +

(s) (aq) (aq) (aq) (aq)

3

1

.

.

.

H 2 O

NaOH HCl

2

NH 4 NO 3

.

1. NH 4 NO 3 NH 4 + + NO 3

(s) (aq) (aq)

2. NH 4

+ + H 2 O NH 3 + H 3 O +

H 3 O +

3

2

H 2 O

NH 4 NO 3 HN +

4 + NO 3

-

H 2 O OH - + H +

NH 4 OH HNO 3

H +

HNO 3

OH -

NH 4 OH

NH 4

+ NO 3 + H 2 O NH 4 OH + H + + NO 3

3

CH 3 COONa

1. CH 3 COONa CH 3 COO + Na +

(s)

2. NH 4

+ + H 2 O NH 3 + H 3 O +

OH

.

3

3

CH 3 COONa CH 3 COO - + Na +

H 2 O H + + OH -

CH 3 COOH + NaOH

OH -

NaOH

H +

CH 3 COOH

4

3

1

2

1

2

( :

KNO 3 , MgS , (NH 4 ) 2 CO 3 , Na 2 C 2 O 4 , NH 4 Cl

3

4

Na 2 CO 3

5

:

6

:

a) Mg + 2HCl

b) 2NaHCO 3 + H 2 SO 4

c) Na 2 S + 2HCl

) 3

2

H +

) i (

HCl , HBr , HI , HF

(.

HCl H + + Cl -

HBr H + + Br -

HI H + + I -

HF H + + F -

H 2 S

(.

H 2 S 2H + + S 2-

ii

H 2 SO 4 2H + + SO 4

HNO 3 H + + NO 3

-

H 3 PO 4 3H + + PO 4

H 2 SO 4

SO 4

H 3 PO 4

PO 4

Na 2 CO 3 + 2HCl 2NaCl + H 2 O + CO 2

2NaCl + H 2 SO 4 Na 2 SO 4 + 2HCl

HCl

)

Cl -

CO 3

H 2 SO 4

HCl

SO 4

Cl -

(

Cl -

SO 4

3

1

3

1

1

H 2 CO 3

HCO 3

-

CO 3

2

H 2 S

S 2-

3

H 2 SO 3

SO 3

4

HNO 2

NO 2

3

2

1

CO 3

2- , HCO 3

3

4

Ca(OH) 2

CaCO 3

CO 2

CO 3

2- + 2HCl 2Cl - + H 2 O + CO 2

HCO 3

- + HCl Cl - + H 2 O + CO 2

CO 2 + Ca(OH) 2 CaCO 3 + H 2 O

CaCO 3 + H 2 O + CO 2 Ca(HCO 3 ) 2

(aq)



3

2

1

1

CO 2

HCl

1

.

2

3

5

.

CO 3

2- + MgSO 4 MgCO 3 + SO 4

(s)

2HCO 3

- + MgSO 4 Mg(HCO 3 ) 2 + SO 4

Mg(HCO 3 ) 2 MgCO 3 + H 2 O + CO 2

(s)

3

6

CO 3

2- + HgCl 2 HgCO 3 + 2Cl -

(s) (s)

2HCO 3

- + HgCl 2 Hg(HCO 3 ) 2 + 2Cl -

Hg(HCO 3 ) 2 HgCO 3 + CO 2 + H 2 O

(s)

3

2

2

S 2-

3

7

S 2- + 2HCl 2Cl - + H 2 S

(g)

Pb(CH 3 COO) 2 + H 2 S PbS + 2CH 3 COOH

3

8

Na 2 S + Pb(CH 3 COO) 2 PbS + 2CH 3 COONa

(s)

3

9

Na 2 S + AgNO 3 Ag 2 S + 2NaNO 3

(s)

3

2

3

SO 3

SO 3

2- + 2HCl 2Cl - + H 2 O + SO 2

g

3SO 2 + K 2 Cr 2 O 7 + H 2 SO 4 K 2 SO 4 + Cr 2 (SO 4 ) 3 + H 2 O

3

10

.

K 2 SO 3 + Pb(CH 3 COO) 2 PbSO 3 + 2CH 3 COOK

(s)

3

11

.

K 2 SO 3 + 2AgNO 3 Ag 2 SO 3 + 2KNO 3

(s)

3

2

4

NO 2

(NO 2 )

NO 2

- + HCl HNO 2 + Cl -

3HNO 2 HNO 3 + H 2 O + 2NO

(g)

2NO + O 2 2NO 2

(g)

3

13

( Mn 7+ )

(Mn 2+ )

2KMnO 4 + 3H 2 SO 4 + 5NaNO 2 K 2 SO 4 + 2MnSO 4 + 5NaNO 3 + 3H 2 O

3

1

3

2

5

i. Na 2 S ii. Na 2 SO 3 iii. NaNO 2

3

1. Na 2 CO 3 + 2HCl ......... + ......... + ..........

2. NaHCO 3 ........... + ........... + ......... .

3. Ca(OH) 2 + CO 2 ........... + ...........

4. K 2 S + 2AgNO 3 ............. + ............

)

) 3

3

(V)

1

HCl

Cl ¯

2

HBr

Br ¯

3

Hl

l ¯

4

HNO 3

NO 3 ¯

3

3

1

(Cl ¯ )

3

15

H 2 SO 4

2Cl ¯ + H 2 SO 4 2HCl + SO 4

2-

(g)

HCl

NH 4 OH

HCl + NH 4 OH NH 4 Cl + H 2 O

3

16

(H 2 SO 4 )

(MnO 2 )

2NaCl + MnO 2 + 2H 2 SO 4 Na 2 SO 4 + MnSO 4 + 2H 2 O + Cl 2

(g)

3

17

HNO 3

NaCl + AgNO 3 AgCl + NaNO 3

3

18

2NaCl + Pb(CH 3 COO) 2 PbCl 2 + 2CH 3 COONa

3

3

2

(Br ¯ )

3

19

H 2 SO 4

HBr

Br 2

SO 2

2NaBr + H 2 SO 4 Na 2 SO 4 + 2HBr

(g)

Br 2

H 2 SO 4

HBr

H 2 SO 4

SO 2

2HBr + H 2 SO 4 Br 2 + SO 2 + 2H 2 O

(g)

(g)

HBr

Br 2

3

20

H 2 SO 4

2NaBr + MnO 2 + 2H 2 SO 4 Na 2 SO 4 + MnSO 4 + 2H 2 O + Br 2

(g)

3

21

HNO 3

NaBr + AgNO 3 AgBr + NaNO 3

(s)

2NaBr + Pb(CH 3 COO) 2 PbBr 2 + 2CH 3 COONa

(s)

3

3

3

(I¯ )

3

23

H 2 SO 4

2NaI + H 2 SO 4 2HI + Na 2 SO 4

(g)

I 2

H 2 SO 4

HI

H 2 SO 4

SO 2

2HI + H 2 SO 4 I 2 + SO 2 + 2H 2 O

(g)

(g)

3

24

H 2 SO 4

:

2NaI + MnO 2 + 2H 2 SO 4 Na 2 SO 4 + MnSO 4 + 2H 2 O + I 2

(g)

3

25

HNO 3

NaI + AgNO 3 AgI + NaNO 3

(s)

3

26

2NaI + Pb(CH 3 COO) 2 PbI 2 + 2CH 3 COONa

(s)

3

3

4

(NO 3 ¯ )

3

27

H 2 SO 4

HNO 3

HNO 3

(II)

NO 2

NaNO 3 + H 2 SO 4 HNO 3 + NaHSO 4

4HNO 3 (conc.) + Cu Cu(NO 3 ) 2 + 2H 2 O + 2NO 2

(g)

3

28

1

3

2

3

3

(II)

)

(FeSO 4

2

3

3

H 2 SO 4

NaNO 3 + H 2 SO 4 HNO 3 (coc.) + NaHSO 4

2HNO 3 + 3H 2 SO 4 + 6FeSO 4 3Fe 2 (SO 4 ) 3 + 4H 2 O + 2NO

(g)

FeSO 4 + NO FeSO 4 .NO

3

2

H 2 SO 4

AgNO 3

Pb (CH 3 COO) 2

Cl -

HCl

N H 4 OH

AgCl

NH 4 OH

PbCl 2

H 2 SO 4 (conc.)

MnO 2

Br -

HBr

Br 2

SO 2

AgBr

NH 4 OH

PbBr 2

H 2 SO 4 (conc.)

MnO 2

I -

HI

I 2

SO 2

AgI

NH 4 OH

PbI 2

H 2 SO 4 (conc.)

MnO 2

NO 3

3

3

5

1

NaCl

NaBr

NaI

HCl

HBr

HI

NaBr

NaI

Br 2

I 2

HBr

HI

H 2 SO 4

Cl 2

NaCl

.

Br -

Br 2

I -

I 2

Cl

2

:

.

3

.

4

(NO 3 ) -

) 3

4

HPO 4

2- , H 2 PO 4

,

SO 4

SO 4 2 ¯

PO 4 3 ¯

H 2 PO ¯ 4

HPO 4

[ B 4 O 7

2

¯

3

4

1

(SO 4 2 ¯ ) Sulphate

(I)

3

29

Na 2 SO 4 + BaCl 2 BaSO 4 + 2NaCl

(s)

3

30

Na 2 SO 4 + Pb(CH 3 COO) 2 PbSO 4 + 2CH 3 COONa

(s)

3

31

Na 2 SO 4 + 2AgNO 3 Ag 2 SO 4 + 2NaNO 3

(s)

3

4

2

(HPO 4 2 ¯ )

H 3 PO 4

H 2 PO 4

HPO 4

PO 4

3 PO 4

NH 4

Na

K

3

32

Na 2 HPO 4 + BaCl 2 BaHPO 4 + 2NaCl

(s)

3

33

Ag 3 PO 4

2Na 2 HPO 4 + 3AgNO 3 Ag 3 PO 4 + 3NaNO 3 + NaH 2 PO 4

(s)

3

4

3

1

CO 2

H 2 CO 3

Ca(OH) 2

CO 2 + Ca(OH) 2 CaCO 3 + H 2 O

(s)

CO 2

SO 2

H 2 SO 3

3SO 2 + K 2 Cr 2 O 7 + H 2 SO 4 K 2 SO 4 + Cr 2 (SO 4 ) 3 + H 2 O

H 2 S

H 2 S + Pb(CH 3 COO) 2 PbS + 2CH 3 COOH

(s)

NO

2NO + O 2 2NO 2

(g)

HCl

NH 4 OH

HCl + NH 4 OH NH 4 Cl + H 2 O

Br 2

I 2

2

3

SO 2

4

CO 2

5

CO 2

H 2 CO 3

3

3

SO 2 + H 2 O H 2 SO 3

1

3

HCl

CO 2

HCO 3 ¯

CO 3

2 ¯

CO 2

HCl

CO 3

2 ¯

H 2 S

S 2 ¯

NO 2 ¯

SO 2

SO 3

:

H 2 SO 4

NH 4 OH

HCl

Cl ¯

HBr

Br 2

Br ¯

I 2

HI

I ¯

NO 2

NO

NO 3 ¯

AgNO 3

SO 4 2 ¯

HPO 4

2 ¯

3

4

5

1

2

.

3

.

4

.

5

NaOH

.

6

:

i

ii

7

) 3

5

(NH 4 ) +

Cations

3

5

1

Pb 2+

Hg 2+

Ag +

Ag +

Cu 2+

Al 3+

Ca 2+

3

5

2

Ag +

3

34

HCl

Ag + + HCl AgCl + H +

3

35

K 2 CrO 4

2Ag + + K 2 CrO 4 Ag 2 CrO 4 + 2K +

3

36

H 2 S

2Ag + + H 2 S Ag 2 S + 2H +

3

5

3

II

Cu 2+

II

II

II

II

Cu(OH) 2 + 2HCl CaCl 2 + 2H 2 O

(s) (aq) (aq)

3

37

II

II

Cu 2+ + H 2 S CuS + 2H +

(s)

3

38

II

(II)

Cu 2+ + 2NaOH Cu(OH) 2 + 2Na +

(s)

3

39

II

II

Cu (NH 3 ) 4 2+

Cu 2+ + 2NH 4 OH Cu(OH) 2 + 2NH 4

(s)

(II)

3

5

4

Al 3 +

Al 3 +

.

NH 4 Cl

NH 4 OH

NH 4 Cl

NH 4 OH

OH ¯

.

3

40

Al 3+ + 3NH 4 OH NH 4 Cl Al(OH) 3 + 3NH 4

(s)

i .

.

Al(OH) 3 + 3HCl AlCl 3 + 3H 2 O

(aq.)

ii

.

Al(OH) 3 + NaOH NaAlO 2 + 2H 2 O

(aq.)

3

41

Al 3+ + 3NaOH Al(OH) 3 + 3Na +

(s)

3

5

5

Ca 2 +

Ca 2 +

NH 4 OH

.

3

42

Ca 2+ + (NH 4 ) 2 CO 3 CaCO 3 + 2NH 4

(s)

3

43

Ca 2+ + (NH 4 ) 2 C 2 O 4 CaC 2 O 4 + 2NH 4

(s)

3

44

CaCl 2 + H 2 SO 4 CaSO 4 + 2HCl

(s)

3

5

6

(Flame test)

5

1

3

2

2

.

3

.

4

.

Cu 2+

.

Ca 2+

Na +

K +

3

2

3

5

7

1

.

2

i .

.

ii

iii

3

1

.

) i

ii

iii

iv

2

:

) i (

CO 2

ii

H 2 S

iii

SO 2

iv

HCl

3

.

) i (

Cu 2+

ii

Na +

iii

Ca 2+

iv

K +



1

2

(

3

(

4

(

5

(

.

:

i .

.

ii

.

iii

.

1

A

B

C

A

C

D

C

.

i .

A , B , C , D

ii

2

) i

ii

iii

.7 % \* !' 5/

C , B , A

1

A

B

.C

2

1

A

B

A

B

D

3

C

B

A

D

B

C

E

E

F

A

.

i .

C , B , A

.

ii

F , E , D

.

iii

C

iv

2

3



NH 4

NH 3

1

2

3

4

3 )

5

6

7

8

9

10

11

12

(.

13

.

14

.

15

.

1

2

3

1

2

.

1503

100

0.9346

0.3502

2

65.4

304.8

3

.

ZnH 4 PO 4

Zn 2 P 2 O 7

2Zn 2+ Zn 2 P 2 O 7

Zn = 65.4 , P = 31 , O = 16

Zn

0.1503

Zn

16.08

1

2

.

3

1

2

3

1

2

3

.

4

.

5

.

6

:

i .

.

ii

70

30

(.

iii

100

3

250

500

i .

ii

iii

3 .

iv

Molarity

.

100

4

100

50

80

80

100

5

4

46

4

46

50

100

8

5

80

100

5

100

1600



1600

4

1

0.4

12

100

3

12

3

100

:

3 )

4

0

3

10

3

10

3

4

0.4

3

3 .

4

0.4

3



1

3 .



10

3

3

3

24 . 5

500

1000

24.5

1000

500

1000

3



3

500

3

24.5

3

3

1000

3

3

49



3

3

3

0.1

NaCl

0.1

0.1

58.5

5.85

NaCl

3

0.1

58.5

3

1

M

1

0.1

0.1

0.1

) 1

0.02

0.1

3

0.4

1

2

3

0.02

V

H 3 PO 4

0.4

3

0.02

0.4

3

1

3

0.05

3

0.05

0.05

3

1

H 2 SO 4 (V1)

3

49







4

16

32

2



1

98

49



98

0.5



3

0.5



1

0.5

3

0.5

NaOH

8

500

40

NaOH



NaOH

8



40

0.2



3

3

3



3

500



1000

3

0.2



500



1000

0.2

1000



500

0.4

1000

0.2

1000

250

1000

3

3

1000

1000

3 (

8

1000

500

40



3 )

1000

3

0.4

KOH

0.2

250

3

0.8

(V)

25

3

0.1

31

P

16

O

1

H



0.1

25

1000

0.0025

H 3 PO 4

4

16

31

3

1

98

0.0025

98

0 . 245

1

2

.

3

200

10

.

4

5

3

45

3

.

5

3

6

400

8

.

7

Na 2 CO 3

500

3

0.1

, .

8

9.8

0.2

3 .

9

v

HNO 3

02

.

i (

0.2

ii

400

3

10

H 2 SO 4

245

3

0.05

.

i

ii

3

11

vi

H 2 SO 4

250

3

0.2

.

12

:

i

3

0.5

ii

0.5

3

0.5

.

iii

1

3

13

2.4

250

3

3 .

H

1

S

32

C

12

O

16

= Na

23

1440

70

100

3

HNO 3

1.44

3

70

i (

3

.

ii

3

.

iii

3

( .

1

H

14

N

16

O

3

1.44

3

1.44

1000

1440

3

3

1008

3

3

1008

63

16

1000

100

1000

100



16

1.18

3

40

H = 1 , Cl = 35.5

HCl

36.5

1.18



40



1000

12.93

100



36.5

3

12

3

HCl

3



12



1

12

3

HCl

12

HCl

3

2

3

1



1

2



1

2

1

2

2

1

HCl

12

3

3

1



1

2



1

12

1

1

2

2

2

1



12



1

6

2

1000

1.0

0.8

0.1

100

3

250

3

1

250

3

1

0.1

2

250

100

350



250



0.1

350



2

2

25 0



0.1

0.07

350

3

0.8

1

2

1000

3

1.0

2

0.8

2

1250



1250

1000

250

70

3

30

3

0.2

30

0.2

100

1

1

2

30

0.2

30

70

30

0.2

100



0.06

1

NH 4 Cl

1.22

53.5

.

3

.

3

.

NH 4 Cl

3

.

100

3

1.22

, .

1000

3

2.44

3 .

2

3

500

3

1

0.1

3

36.5

1.2

3 .

4

200

3

68

1.4

3

10

1.08

3 .

5

20

3

80

3

0.2

3

500

3

250

3

100

3

50

3

4

1

1

.

2

3

1000

1000

1

500

1000

3

.

4

.

5

.

6

3

500

3

250

1

Na 2 CO 3

106

1

1

1

106

106



1

106

1

3 .

2

0.5

5,

106

53

1

53

500

)

0.5

3 (.

26.5

250

3 .



1

2

.

i (

100

.

ii

iii

.

]

[

]

[

iv

.

v

Na 2 CO 3

H 2 C 2 O 4 . 2H 2 O

3

Na 2 B 4 O 7 .10H 2 O

.

Na 2 CO 3

Na 2 B 4 O 7 .10H 2 O

Na 2 CO 3

H 2 CO 3

Na 2 B 4 O 7

H 3 BO 3

285ْ

1

250

0.1

1000

1000

1000

0.5

200

126

1000

2

NaHCO 3

Na 2 CO 3

2NaHCO 3 Na 2 CO 3 + H 2 O + CO 2

0.1

250

3

0 . 025

0.025

106

2.650

3

0. 1

250

106

2.650

1000

1000

0.5

200

3 .

12.6

21.2

106

0.2

1

21.2

3

Na 2 CO 3

0.2

0.2

Titration

Titration

1

2

.

3

12.6

250

3 U

4

NaOH

.

5

0.5

500

3 .

Na

23

O

16

C

12

H

1

6

H 2 C 2 O 4 . 2H 2 O

ﺮﺓ

H 2 SO 4

NaOH

H 2 SO 4(aq) + 2NaOH Na 2 SO 4(aq) + 2H 2 O (l)

NaOH

H 2 SO 4

H +

OH

H + (aq) + OH - (aq) H 2 O

Ag + (aq) + Cl - (aq) AgCl (s)

KMnO 4

K 2 Cr 2 O 7

II

Fe 2+

C 2 O 4

(

H 2 SO 4 +NH 4 OH

H 2 C 2 O 4 + KOH

4

2

5

3

50

.

4

3

4

4

4

5

1

2

3

3

0.05

4

5

6

7

8

9

10

11

12

0.1

3

13

1

2

3

4

1

HCl

NH 4 OH

H 2 SO 4

NaOH

CH 3 COOH

NaOH

HCl

Na 2 CO 3

2

3

.

4

1000

NaOH + HCl NaCl + H 2 O

4

3

1

10

1

10

1

2

20

0.25

40

0.125

3

50

0.50

10

2.5

2 0

0.25

1000

40

0.125

1000

50

0.5

1000

10

2.5

1000

4

4

1

2

i (

1

1

2

2

ii

HaOH

HCl

1

1

.

NaOH + HCl NaCl + H 2 O

2NaOH + H 2 SO 4 Na 2 SO 4 + 2H 2 O

1

2

1

3 (

1

3 (

2

H 2 SO +

1 3

2 3

1

10

1

0.01

1000

5

1

0.005

1000

2

1

2

20

1

0.02

1000

125

0.8

0.01

1000

2

1

3

50

×

0 . 05

0.0025

1000

12.5

0 . 1

0.00125

1000

2

1

1

2

2

1

3NaOH + H 3 PO 4 Na 3 PO 4 + 3H 2 O

1

3

H 3 PO 4

H 3 PO 4

4

8

1

1

2

2

1

1

2

NaOH

H 3 PO 4

3

1

2

1

2

1 ,

1

2 ,

2

.

(

3

25

3

25

0.025

3

2NaOH + H 2 SO 4 Na 2 SO 4 + 2H 2 O

1

2

2

25

1

25

2

0.025

1

1 ,

2 ,

2

2

25

2 0

0.13

1

1

20

0.13

1

25

1

25



1

2 5



0.025

2

1

25



0.025



2

0.05

25

25

20

0.13

i (

3 .

ii

3 .

KOH

56

1

KOH + HCl KCl + H 2 O

2

20

25

2

13

,

1

1

1

11

,

10.6

106

1000

0.1

1000

3

250

2

3 .

3

3

0.11

56

6 . 16

10.6

Na 2 CO 3

250

3

25

3

20

3

Na 2 CO 3

106

N 2 aCO 3

0.1

0.4

2

25

0.4

20

2

1

2

25

0.4

2

20

Na 2 CO 3 + 2HCl 2NaCl + H 2 O + CO 2

20

25

2

0.4

2

1

1

1

30

3

0.6

18

3

3

2

20

12

2.4

250

3

:

3

3

.

16

O

31

P

1

H

3

3.7

HOX

50

3

0.5

.

i (

HOX

.

ii

.

iii

HOX

3 .7

.

iv

HOX

.

4

3

2.80

25

3

12.5

3

.

i (

3 .

ii

.

iii

3 .

4

4

3

Na 2 CO 3 + 2HCl 2NaCl + H 2 O + CO 2

250

3 &

25

3

50

3

150

3

0.1

HCl

25

3 .

24.8

24.7

2

,

2

25

0.1

24.75

2

1

2

25

0.1

2

24.75

1

3 :

24.75

2HCl + Na 2 CO 3 2NaCl + H 2 O + CO 2

0.2

3

3

0.2

36.5

7.3

H 2 C 2 O 4

2KMnO 4 + 5H 2 C 2 O 4 + 3H 2 SO 4 K 2 SO 4 + 2MnSO 4 + 8H 2 O + 10CO 2

250

3

25

3

50

3

0.05

1

2

.

3

25

3

10

3

.

4

55

60

.

5

4

0.1

3

1

2

22.30

25

0.05

2

5

25

0.05

2

5

22.30

1

2

60

[, .

3

.

25

3 .

.

3 :

1

0.00

22.50

22.50

2

5.00

27.30

22.30

3

7.00

29.30

22.30

22.30

0.022

3

1 ,

,

3

1000

1000

1000

32

100

0.022

158

3.476

1

2

.

60

3

0.4

40

3

0.2



1 ,

1

2 ,

2

3 ,

60

0.4

40

0.32

5 0

0.2

1000

1000

50

0.2

1000

1000

1 ,

1

2 ,

2

3 ,

(.

50

3

0.2

50

3

Ca(OH) 2

0.2

HCl

Ca(OH) 2

Ca(OH) 2 + 2HCl CaCl 2 + 2H 2 O

1

2

HCl

0.010

Ca(OH) 2

0.010

2

HCl

1

Ca(OH) 2

HCl

Ca(OH) 2



0 . 010

HCl

0.005

Ca(OH) 2

1000

0.005

1000

100

30

0.2

1000

1000



Ca(OH) 2

HCl

Ca(OH) 2

0.010

0.005

0.005

3

0.05

17.16

X H 2 O

Na 2 CO 3 .

500

3

25

3

30

3

0.2

X

Na 2 CO 3 .X H 2 O

X

1

25

3

.

HCl

0.006

500

0.003

25

17.16

0.06

2

:

Na 2 CO 3 + 2HCl 2NaCl + H 2 O + CO 2

3

25

3

2

HCl

1

H 2 O

Na 2 CO 3 .X



0.006

HCl

0.00 6

0.003

2

4

H 2 O

Na 2 CO 3 .X

500

3 )

25

Na 2 CO 3 .X H 2 O

0.003

500

3

Na 2 CO 3 .X H 2 O



Na 2 CO 3 .X H 2 O

0.06

5

Na 2 CO 3 .X H 2 O

:

286

X

Na 2 CO 3 .X H 2 O

286

2

23

12

3

16

18

286

106

18

286

18

286

106

180

10



10

1

25

3

0.13

3 (

3 (

i (

ii

.

iii

.

iv

.

v

.

vi

.

vii

.

2

3

150

3

0.4

350

3

0.2

3000

3

0.1

3

25

3

0.4

15

3

0.8

4

3.15

H 2 O

H 2 C 2 O 4 .X

250

3

25

3

50

3

0.1

NaOH

.

i (

X

16

O

12

C

1

H

5

25

3

0.1

10

3

0.5

37.5

3

100

2

1000

16

20

20

100

3

2

H 2 C 2 O 4

0.2

2NaOH + H 2 C 2 O 4 Na 2 C 2 O 4 + 2H 2 O

2

NaOH

1

H 2 C 2 O 4

NaOH

0.2

H 2 C 2 O 4

2

0.2

0 .4



0.4

40

16

100

100

80

0.2

45

1000

1000

0.00 9

2

100

0.45

100

0.5

5

CaCO 3

45

0.2

HCl

0.009

CaCO 3 + 2HCl CaCl 2 + H 2 O + CO 2

1

CaCO 3

2

HCl

CaCO 3

009

,

HCl

0.0045

CaCO 3

0.045

100

45

,

CaCO 3

90

0.72

25

HCl

1

100

3

25

3

15.75

3

NaOH

0.2

2

15.7 5

0.2

2 5

2

1

1

15.75

0.2

1

25

1

100

0.126

1000

25

1

1000

NaOH

NaOH + HCl NaCl + H 2 O

1

1



2

0 . 0126

HCl

0 . 0126

HCl

0.025

HCl

CaCO 3

0.025

0 . 0126

0.0124

0.0124

2

CaCO 3

100

0.62

0.72

HCl

CaCO 3

CaCO 3 + 2HCl CaCl 2 + H 2 O + CO 2

2

HCl

1

CaCO 3

0.0124

HCl

CaCO 3



CaCO 3

0.0062

CaCO 3

CaCO 3

0.0062

100

0.62

CaCO 3

100

86.1

vi

] v

i .

25

3

30

3

0 . 04

:

H 2 SO 4(aq) + Ba 2+ BaSO 4 (s) + 2H +

(aq)

2

30

0.04

25

2

1

1

30

0.04

25

ii

25

3

20

3

0.25

:

KOH (aq) + H +

(aq) H 2 O(l) + K +

(aq)

V1

V

i .

V1

0.048

V1

1

H 2 SO 4

2

H +

0.048

H 2 SO 4

H +



0.48

2

0.096

3



H +

H 2 SO 4

0.096

3

ii

H +

KOH + H + H 2 O + K +

,

,

2

2 0

0.25

25

1

1

2 0

0.25

25

2

0.2

1

2

H +

200

,

H +

H 2 SO 4

096

,

H +

HNO 3

104

,

)

V

(

HNO 3



)

V

(

H +

3

0.104

4

30

3

HCl

0.5

45

3

1.18

3

38

3

21.2

3

20

3

14.85

3 .

1000

100

1.18

38

1000

36.5

100

45

12.29

1000

i (

ii

iii

) i

ii

) i (

1 ,

1

2 ,

2

45

3 (

21.2



106

0.2

Na 2 CO 3 + 2HCl 2NaCl + H 2 O + CO 2

1 ,



2 ,

2



20







3



3

929.4

3

3

3

0.5

4

31

1.106

.Ba.Cl 2 .X H 2 O

35

3

AgNO 3

0.2

i (

BaCl 2 . XH 2 O

.

ii

X

BaCl 2 . XH 2 O

.

BaCl 2 + 2AgNO 3 2AgCl + Ba(NO 3 ) 2

(aq) (aq) (s) (aq)

AgNO 3

0. 2

35

0.007

1000

1000

1

BaCl 2

2

AgNO 3

BaCl 2

0.007

AgNO 3



BaCl 2

0.007

2

0.0035

H 2 O

BaCl 2 .X

1.10 6

316

0.0035

ii

H 2 O

BaCl 2 .X

316

18

2

35.5

137

316

18

71

137

316

18

316

208

18

108

108

6

18



H 2 O

BaCl 2 .X

6

1

6.171

3

25

3

0.1

24

3

2H 2 O

H 2 CO 4 + 2NaOH Na 2 C 2 O 4

1

2

.

3

.

4

.

5

.

1

2

3

] v

HNO 3

i (

0.3

0.6

3

3

0.126

50

3

.

4

45

10

5

1.2

29.2

3 .

3

.

3

.

3

0.12

, .

6

250

3

50

3

7

8

U

0.5

200

3 .

9

.

1

10

3

1

40

0.5

2

20

3

0.4

50

0.08

10

U

i (

ii

11

25

3

0.075

25

3

0.15

12

15

3

0.4

20

3

.

) i

ii

13

0.2

i (

20

3

0.2

, .

ii

1.06

.

iii

25

250

5.6

.

14

1.2

50

3

0.2

.

15

4

NaNO 3

NaHCO 3

3

25

3

15

3

0.05

3 :

i (

HNO 3

ii

NaHCO 3

U .

iii

NaHCO 3

U .

iv

NaHCO 3

U .

16

:

5Fe 2+ + 8H + + MnO 4

- 5Fe 2+ + Mn 2+ + 4H 2 O

8.34

FeSO 4 .XH 2 O

3 .

40

3

24

3

0.1

FeSO 4 .XH 2 O

FeSO 4 .XH 2 O

X

FeSO 4 .XH 2 O

17

1.5

35

3

100

3

20

3

18

3

0.1

18

500

3

HCl

0.25

0.20

19

H 3 AsO 4

:

H 3 AsO 4 + n OH - H (3-n) AsO 4

n- + nH 2 O

25

3

0.15

25

3

0.05

n

20

3

500

3

v

36

1.20

10

1

3 U

221

222

223

224

228

236

246

223

Energy Changes in Chemical Reactions

224

Law of Conservation of Energy

5

1

5

1

1

5

1

2

5

1

3

5

1

3

1

5

1

3

2

5

1

4

225

5

1

5

5

1

6

5

1

7

Thermochemistry

5

1

8

Chemical Energy

226

1

2

227

5

1

5

2

H 2 O

5

1

9

228

) 5

2

5

2

1

C + O 2 CO 2 + heat

2H 2 + O 2 2H 2 O + heat

C + 2S + heat CS 2

N 2 + O 2 + heat 2NO

5

2

2

H

H

229

5

2

2

1

2 – H 1

H 1

H 2

C + O 2 CO 2 + 383.7KJ

C + O 2 CO 2 + 383.7KJ

1 – H 2

230

C + O 2 CO 2

5

1

393.7

C + O 2

CO 2

231

H 2 + I 2

5

2

H 2 + I 2

232

5

2

2

2

H 2 )

Cl 2

5

2

2

3

5

2

2

4

233

H 2 + Cl 2 2HCl ; H = - 185 KJ

5

1

H  H

Br  Br

N  H

H  Cl

C  C

H  Br

O  H

Cl  Cl

C  F

S  H

C  Cl

C  H

234

5

1

CH 4 + Cl 2 CH 3 Cl + HCl

H H

H H



235

5

2

C +O 2 –Heat C O 2

H 2 + ½O 2 Heat H 2 O

H 2 +I 2 +Heat 2HI

C + 2S + Heat CS 2

5

3

5

2

3

H 2(g) + Cl 2(g) 2HCl (g)

236

) 5

3

5

3

1

Heat of Formation

f P

5

3

2

5

3

25ْ

H f

Al 2 O 3

1676

CO

110.5

CO 2

393.5

CH 4

74.9

C 2 H 6

84.7

C 6 H 6

49.4

C 2 H 2

227

CH 3 OH

278.6

HCOOH

363

CH 3 CH 2 OH

278

CH 3 COOH

487

CaO

635.5

Ca(OH) 2

986.6

H 2 O (l)

286

H 2 O (g)

242

HCl

92.5

NH 3

46.19

237

H f

N 2 O

81.5

NO

90.4

NO 2

34

NaF

561

NaCl

411

NaBr

360

NaI

288

Na 2 O 2

504.6

NaOH

426.8

Na 2 CO 3

1131

SO 2

297

SO 3

396

H 2 SO 4

813.8

ZnO

348

SiO 2

910.9

Br 2

H 2 + Cl 2 2HCl





238



5

2

CH 4(g) + 2O 2(g) CO 2(g) + 2H 2 O (g)

CH 4

CO 2

H 2 O

CH 4 + 2O 2 CO 2 + 2H 2 O

5

3

CaO (s) + 3C (S) CaC 2(S) + CO (g)

CaC 2

CaC 2

CaO + 3C CaC 2 + CO

239

CaC 2

CaC 2

CaC 2

5

3

3

H f & Compound Stability

5

3

240

5

4

5

5

2Al + 3/2O 2 Al 2 O 3 H =  1676 KJ

2Fe + 3/2O 2 Fe 2 O 3 H =  822 Kj

2Al + Fe 2 O 3 2Fe + Al 2 O 3

5

3

4

Heat of Combustion -

H =  393.7 KJ

C (g) + O 2(g

)) CO 2(g)

241

CH 4(g) + O 2(g) CO 2(g) + 2H 2 O (g)

C 2 H 5 OH (g) + 3O 2(g) 2CO 2(g) + 3H 2 O ( g) H = - 1367KJ

5

3

5

5

3

5

1

Calorific Value

5

3

5

2

Fuel

242

5

6

C 2 H 2

C 2 H 2

CH 4

CH 4 + 2O 2 CO 2 + 2H 2 O H = - 850 K J

CH 4





243

5

8

C 2 H 5 OH + 3O 2 2CO 2 + 3H 2 O

C 2 H 5 OH





5

9

C 2 H 2

C 2 H 2 + 5\2 O 2 2CO 2 +H 2 O H= -1300Kj\ mole

g)

g)

(g)

g)

244

5

3

6

HCl (aq) + NaOH (aq) NaCl (aq) + H 2 O H=  57.7 KJ

H + + Cl - + Na + + OH - Na + + Cl - + H 2 O H = -57.7K J

H + + OH - H 2 O H =  57.7 KJ

HNO 3(aq) + NaOH (aq) NaNO 3(aq) + H 2 O H =  57.7 KJ

(1)CH 3 COOH+NaOH CH 3 COONa+H 2 O H =  55.7 KJ

(2) CH 3 COOH CH 3 COO  + H + H = D

H =  57.7 K J



245

5

3

7

NO 2

N2O 5

NH 3

N 2 O

246

2Na + Br 2 2NaBr

PCl 5

2P (s) + 3Cl 3(g) 2PCl 3(l) H =  66 K J

PCl 3(l) + Cl 2(g) PCl 5(s) H =  141K J

C 2 H 6

C 2 H 6(g) + 7 O 2(g) 2CO 2(g) + 3H 2 O (g)

247

C 2 H 2

C 2 H 2(g) +5\2O 2(g) 2CO 2(g) + H 2 O (l) H =  1300 KJ

NO 2

SO 2

C (s) + O 2(g) CO 2(g) H  =  393.5 K J

CO (g) + 1O 2(g) CO 2(g) H  =  283 KJ

( ;

248





249

2C (s) + 2H 2(s) C 2 H 4(s)

CS 2

C 6 H 6

1

2

3

4

5

6

7

8

9

10

11

12

2H 2 (g) + O 2 (g) 2H 2 O (g)

2

2

3 .

Δ [A]

Δ t

A + B C + D

A

R = K

R

A

3 9 t

Δ [C]

Δ t

2N 2 O 5

4NO 2 + O 2

C

R = + K

2N 2 O 5 4NO 2 + O 2

CH 3 Cl +I - CH 3 I + Cl -

25ْ

298

1

K = 1

I

3

0.5

0.45

0.41

0.35

0.27

180

360

720

1440

180

.

R = - K [I - ]

t

(i

R

0.45

0.50

0.05

0.05

4.6

10

6

3

180

60

180

60

180

60

(ii

360

1440

R

3 .

N 2(g) + 3H 2(g) 2NH 3(g)

3

4NH 3(g) + 5O 2(g) 4NO (g) + 6H 2 O (g)

0.24

3 .

4

5



5

4

0.2 4

3

3 .

6

4

0.24

3

3 .

x A + y B

R = K [A] x [B] y

K)

2NO + O 2 2NO 2

د / 3

د / 3 . ث [O 2 ]

1

2

3

4

5

10

20

40

20

20

20

20

20

40

60

28

57

114

228

486

R = K [NO] [O 2 ]

1

3

O 2

NO

O 2



1

2

4

NO

O 2

4

NO

5

9

NO



2

R = K [NO] 2 [O 2 ]

1

2

3

:

CH 4(g) + 2O 2(g) CO 2 + 2H 2 O (g)

0.16

3

CO 2

H 2 O

AgNO 3 (ag) + K I

AgI (s) + KNO 3 (ag)

(aq)

) i (

ii

CH 4 (9) + Cl 2 (9)

CH 3 Cl + HCl

Mg + 2H 2 O

Mg(OH) 2 + H 2

1

2

K

Ga

Na

Mg

Al

Mn

Zn

Cr

Fe

Ni

Pb

H

Cu

Ag

Hg

Au

2K + 2H 2 O

2KOH + H 2

I 2

H 2

I 2

1

2

.

Activation Energy

H 2 (g) + I 2 (g) 2HI(g)

I 2 H 2

2KClO 3 (s) + MnO 2 (g)

2KCl (s) + 3O 2 (g) + MnO 2

H 2 I 2

H 2 I 2

Catalyst

Fe 3 O 4

g)

N 2 (g) + 3H 2 (g) + Fe 3 O 4 (s) 2NH 3 (g) + Fe 3 O 4

KClO 3

2KClO 3

2KCl + 3O 2

( activated complex

(acivation energy

A + B AB

"K

A + K AK

AK + B AB + K

A + B + K AB + K

MnO 2

2SO 2 (g) + O 2 (g) + NO (g)

2SO 3 (g) + NO (g)

2H 2 O 2 (ag)

2HO (l) + O 2 (g)

I (ag)

2H 2 O 2 (ag)

2H 2 O (l) + O 2 (g)

2SO 3 (g) + O 2 (g)

2SO 3 (g)

CH 2 CH 2 (g) + H 2 (g)

CH 3

-- CH 3 (g)

Pt (s)

Ni (s)

O 2 (g)

2KClO 3 (s) MnO 2 (s) 2KCl + 3O 2

1

2

3

.



(

3

4

4

8

.

H 2 (g) + I 2 (g)

2HI (g)

2NaCl (ag) + Pb(NO 3 ) 2 (ag)

2NaNO 3 (ag) + PbCl 2 (s)

1

2

3

.

4

5

6

7

:

.

2H 2(g) + 2NO (g) N 2(g) + 2H 2 O (g)

H 2(g) + 2NO (g) N 2 O + H 2 O

H 2 + N 2 O N 2 + H 2 O

2H 2(g) + 2NO 2(g) N 2(g) + 2H 2 O (g)





2 ]

NO

H 2

K

R

2 ]

H 2

2 ]

NO

NO 2 Cl

NO 2 Cl NO 2 + Cl

NO 2 Cl + Cl NO 2 + Cl 2

I

II

.

I

2NO 2 Cl 2NO 2 + Cl 2

II

 NO 2 Cl 

R = K

1

2

3

A

B

A (g) + 2B (g)

i (

A

ii

B

1

2A 4B + C

3

10

20

30

40

50

1.000

0.80

0.667

0.571

0.500

0.444

0.40

0.667

0.858

1.000

1.112

K = 1x 10 5-

A

B

A

B

20

40

C

2

i

HCl

1

3 (

ii

HCl

1

3 (

i

1

HCl

1

3 (.

ii

1

HCl

1

3 (.

i .

HCl

0.1

3 (.

ii

HCl

1

3 (.

i

HCl

25ْ

ii

HCl

40ْ

3

i (

ii

iii

iv

v

4

NO 2(g) + O 3(g) NO 3(g) + O 2(g)

25

3

NO 2

O 3

1

2

3

5.0

10

5.0

10

2.0

10

1 . 0

10

3

2.0

10

2.0

10

0.022

0.044

0.022

5

NO 2(g) + CO (g) NO (g) + CO 2(g)

NO 2 + NO 2 NO 3 + NO

NO 3 + CO NO 2 + CO 2

i (

ii

i (

NO 2

ii

CO

1

1

.

.

.

.

2

.

(.

.

2





1

2

.

3

.

3

1

.

277

278

279

1

2

3

4

5

6

7

8

9

10

11

12

13

14

280

KMnO 4

281

282

(i) AgNO 3 (ag) + NaCl (ag) AgCl (s) + NaNO 3 (ag)

(ii) NaOH (ag) + HCl (ag) NaCl (ag) + H 2 O (l)

(iii) 2KclO 3 (g) 2KCl (s) + 3O 2 (g)

Fe 3 O 4 (s) + 4H 2 (g) 3Fe (s) + 4H 2 O (g)

3Fe (g) + 4H 2 O (g) Fe 3 O 4 (g) + 4H 2 (g)

Reversible Reactions

Fa 3 O 4 + 4H 2 3Fe + 4H 2 O

(i) PCl 5 PCl 3 + Cl 2

(ii) CH 3 COOH + CH 3 CH 2 OH CH 3 – C O O – CH 2 – CH 3 + H 2 O

283

) i (

NH 4 Cl (s) NH 3 (g) + HCl (g)

ii

NH 3 (g) + HCl (g) NH 4 Cl (s)

iii

NH 4 Cl (g) NH 3 (g) + HCl (g)

7

1

284

CH 3 COOH (l) + CH 3 CH 2 OH (l)

CH 3 COOCH 2 CCH 3 (l) + H 2 O (l)

) i (

ii

CaCO 3(s) CaO (s) + CO 2(g)

H 2 (g) + I 2 (g)

2HI (g)

N 2 (g) + 3H 2 (g)

2NH 3 (g)

285

2NaHCO 3(s) Na 2 CO 3(s) + CO 2(g) + H 2 O (l)

K

K = (H 2(g) ) (Na 2 CO 3(s) ) (CO 2(q) )

(NaHCO 3(s) ) 2

NaHCO 3

Na 2 CO 3

NaHCO 3

NaHCO 3

NaHCO 3

3

NaHCO 3

Na 2 CO 3

Na 2 CO 3

NaHCO 3

Na 2 CO 3

K = (H 2 O (l) ) (CO 2(g) )

H 2 O (l) H 2 O (l)

K = (H 2 O (l) )

:

286

CaCO 3(s) + He at CaO (s) + CO 2(g)

i (

ii

iii

(

iv

v

vi

vii

viii

ix

x

(

CaCO 3

CaO

CaO

CaO

CO 2

CO 2

+ H +

(aq)

(aq)

CH 3 COOH (aq) CH 3 COO

(aq)

NH 4 OH (aq) NH 4

+

(aq) + OH

287

1

2

3

4

5

6

7

288

K 1 [C] c [D] d

K 2 [A] a [B] b

aA + bB cC + dD

R 1 = K 1 [A] [B]

R

K

d ]

D

c

C

K 2

R 2

R 1

R 2

d ]

D

c ]

C

K 2

b

B

[

a ]

A

K 1

K =

K

K

289

[C] c [D] d

[A] a [B] b

K =

A B

K

=

K

=

10

B

A

B

A

Q

K

1

K = Q

2

K < Q

290

2HI (g)

H 2 (g) + I 2 (g)

Q

K

.

3

K > Q

Q

K

.

K 2

65

[HI]

0.500

[H 2 ]

2.80

[I 2 ]

3.40

291

[H 2 ] [I 2 ]

[HI] 2

3.40

2.80

0.500

2

[ B ]

1

[A]

10

Q

Q

:

38.1

K 2

65

K > Q

Q

(.

K

0.1

A

B

K

K

K

292

N 2 O 4

2NO 2

[NO 2 ] 2

[N 2 O 4 ]

0.625

N 2 O 4

5

3

NO 2

N 2 O 4

0.075

3

1

:

K

2

:

0.625



5

0.125

3

N 2 O 4

0.075

3



N 2 O 4

0.075

0.125

0.05

3

NO 2

1

N 2 O 4

2

NO 2

0.05

N 2 O 4

NO 2

0.05

2



1

0.1

3

N 2 O 4

0.075

NO 2

0.1

0.1

293

[NO 2 ] 2

[N 2 O 4 ]

0.1

2

0.075

1

10

NO 2

3

K

K

0.133

H 2 (g) + I 2 (g) 2HI (g)

440

49.0

1.0

H 2

1.0

I 2

10

3

440

HI , I 2 , H 2

H 2

I 2

0.1

3

HI

3

H 2

I 2

HI

H 2

I 2

HI

3 (

3 (

H 2

I 2

HI

0.1

0.1

2

H 2

0.1

I 2

0.1

2

294

H 2

K

49

2 ]

HI



H 2

I 2

49

2

2



0.1

0 .1

2

2



0.1

2

2



0.1

7

2

0.7

7

9

0.7



0.7



9

0.078

H 2

0.100

0.078

0.022

I 2

0.100

0.078

0.022

HI

2



0.078

0.156

460

SO 2 (g) + NO 2 (g) SO 3 (g) + NO (g)

85

460

295

SO 2

0.04

NO 2

0.05

SO 3

0.2

NO

0.3

SO 3

NO



SO 2

NO 2

Q



Q

0.2

0.3



0.04

0 . 05

0.06



0.002

30

Q

K

Q

K =

Q

K

1

H 2 (g) + 0.5O 2 (g)

H 2 O (g)

K = H 2 O

H 2 O 2

2

2H 2 (g) + O 2 (g)

2H 2 O (g)

296

2 ]

H 2 O

O 2

2 ]

H 2

O 2

CO 2

2

K 2

K 2

(K 1 ) 2

1

:

CO (g) + 0.5O 2

CO 2

CO 2

K 1

H 2 2 O 2

CO 2 CO + O 2

K 2

K 2

297

1

:

(i) N 2 (g) + O 2

2NO (g)

(ii) 2NO (g) + O 2 (g)

2NO 2 (g)

(iii) 2H 2 S (g) + 3O 2 (g)

2H 2 O (g) + 2SO 2 (g)

2

3

4

(1) H 2 (g) + Cl 2 (g)

(2) 0.5H 2 (g) + 0.5Cl 2 (g)

2

1

298

H 2 (g) + I 2 (g)

2HI (g)

H 2

H 2

H 2

I 2

HI

HI

I 2

H 2

299

I 2

I 2

HI

I 2

HI

H 2

I 2

1

2

3

.

2NO 2 (g)

N 2 O 4 (g) + 58Kj

300

[NO 2 ] ÷ [N 2 O 4 ]

N 2 O 4

NO 2

Q

7

2

1.

2.

1

2

7

2

301

7

2

N 2 (g) + 3H 2 (g)

2NH 3 (g)

4

302

H 2 (g) + I 2 (g)

2HI (g)

N 2(g) + 3H 2(g) 2NH 3(g) , H = - 92 Kj

303

500

350

1.

2.

3. U

:

H 2(g) + CO 2(g) H 2 O (g) + CO (g) , H + 15Kj

+ 8 ! %-" % %( H 2

:

) i (

CO 2

.

ii

H 2 O

iii

.

iv

.

v

.

4

(i) N 2 (g) + 3H 2 (g)

2NH 3 (g)

(ii) H 2 (g) + Cl 2 (g)

2HCl (g)

(iii) 2O 3 (g)

3O 2 (g)

304

1

2

3

4NH 3(g) + 3O 2(g) 2N 2(g) + 6H 2 O (g) , - H

NH 3

O 2

N 2

H 2 O

.

4

(1) 4HNH 3 (g) + 3O 2 (g)

2N 2 (g) + 6H 2 O (g) K 1× 10

-- 31

(2) N 2 (g) + O 2 (g)

2NO (g) K 5 × 10

-- 31

(3) 2HF (g)

H 2 (g) + F 2 (g) K 1 × 10

-- 31

(4) 2NOCl (g)

2NO (g) + Cl 2 (g) K 4.7 × 10

-- 4

5

4

305

PCl 5 (g)

PCl 3 (g) + Cl 2 (g)

6

CO (g) + 2H 2 (g)

CH 3 OH (g) + 98Kj

7

A + B C

A

2.0

3

B

3.0

3

C

1.0

3

8

A

B

A + B C + D

0.2

A

0.5

B

0.36 .

9

.

[PCl ] 5

[PCl] 3

[Cl] 2

1

2.3

10

3

2.3

10

1

5.5

10

2

2

10

10

3

1.5

10

1

37

10

2

3

85

10

3

9.9

10

1

47

10

2

306

10

N 2 (g) + 3H 2 (g) 2NH 3 (g)

350

10

2

450

3

727

2 . 37

10

3

11

0

12

:

H 2 O 2 (g) H 2 O + 0.5O 2 (g)

800

6



10

6

800

(i) 2H 2 O 2 (g)

2H 2 O (g) + O 2 (g)

(ii) O 2 (g) + 2H 2 O (g)

2H 2 O 2 (g)

13

1

.

.

.

2

H 2

F

N 2

.

307

.

Fe 3 O 4

.

.

3

.

.

.

4

.

.

.

.

14



)

)

) (

308

309

310

1

:

2

.

3

.

4

:

.

.

.

.

$ .

.

5

.

6

:

.

.

311

7

:

.

8

.

9

10

.

312

.

.

313

.

1

2

1

2

1

2

314

+

2+ + H 2 (g)

Zn + H 2 SO 4 ZnSO 4 + H 2

:

2+ + 2e

+ + 2e

--

H 2 (g)

H +

Zn

2AgNO 3 + Cu (s) Cu(NO 3 ) 2 + 2Ag (s)

2+ + 2e

2Ag

+ + 2e

--

2Ag (s)

Ag +

315

2+ + 4e

--

Cu

2Pb (s) + CO 2 (g)

C C 4+ + 4e -

Pb 2+

C

CaO

Ca Ca 2+ + 2e -

O + 2e - O 2-

NH 3

1

3

1

2

Na +

1

Fe 2+

2

N 3-

3

316

3

CaO

Ca 2+

O 2-

2

2

4

NO 3

1

PO 4

3-

3

NH 4

+

1

5

2

1

H 2 O 2

Na 2 O 2

2

OF 2

6

1

1

NaH

MgH 2

.

7

1

Na

K

(.

8

2

Ca , Mg

(.

9

1

.

317

10

H 2 S

FeS

2

4

6

CaSO 4

2

2



2

4

2



2

8



6



6



6

2

Cr 2 O 7

2

2



2

7

2

2

2

14

2



2

12



6



6

Ca (NO 3 ) 2

318

2+

3+ + e

000

3

2

1

1

2

3

000

000

3

2

1

1

2

3

000

2

2

2

3

2

2

2

12

2

10



10

2

5



5

2

3

Zn + Cl 2 ZnCl 2

Cl 2

1

Zn

2

.

319

1

2

3

1

CH 3 Cl

2

CH 4

3

CH 2 Cl 2

4

CHCl 3

5

CCl 4

6

9

1

4

2

2

(.

3

(.

4

2

(.

5

4

320

2KI + Br 2

2KBr + I 2

1

2

:

Fe + Cl 2 FeCl 2

CuSO 4 + Zn ZnSO 4 + Cu

2H 2 S + O 2 2H 2 O + 2S

3

:

PbO 2 + 2H 2 O Pb + 2H 2 O

3Cu + 2NH 3 3Cu + 3H 2 O + N 2

4

KMnO 4

H 2 SO 4

)

ClO 3

C 2 O 4 ) 2-

K 2 Cr 2 O 7

.

5

6

.

7

:

.

321

.

.

322

Zn

Cu

H 2 SO 4

.

323

1800

.

8

2

Cu (s) + 2Ag + Cu 2+ + 2Ag (s)

aq) (aq)

AgNO 3

324

Cu (s) + Zn 2+

(g)

(1) Cu (s) Cu 2+

(aq) + 2e

(2) 2Ag +

(aq) + 2e 2Ag (s)

(3) Cu (s) + 2Ag +

(aq) Cu 2+ + 2Ag (s)

1

2

3

1

2

Cu

Zn(NO 3 ) 2

325

Electrode potential

M

M n+

electrode

half - cell

8

4

1

.

2

M n+ + ne - M

.

3

M n+

.

M M n+ + ne -

Zn

ل ZnSO 4

)

1 ل

/

د 3 (

326

Cathode

Anode

327

1

2

:

3

Cu

)

(

Zn

)

(

ل H 2 SO 4

-

+

328

25

1

1

3

3

25ْ

329

8

6

0.76

Zn Zn 2+ + 2e -

+ + 2e

--

H 2

0.76

H 2

+ + 2e

ل HCl

)

1 ر

(

Pt

Zn

ل ZnSO 4

)

1 ر

(

330

2+ (ag) + 2e

Cu (s)

Cu 2+ + 2e - Cu (s)

0.34

0 .34

0.76

Zn (s) Zn 2+ (aq) + 2e -

0.34

1.1

Zn (s) + Cu 2+ (aq) Cu (s) + Zn 2+ (aq)

0.76

331

1

Li +

3.05

2

K +

2.92

3

Ba 2+

2.9

4

Ca 2+

2.76

5

Na +

2.71

6

Mg 2+

2.38

7

Al 3+

1.76

8

Mn 2+

1.05

9

Zn 2+

0.76

10

Cr 3+

0.56

11

Fe 2+

0.44

12

Co 3+

0.28

13

Ni 2+

0.23

14

Sn 2+

0.14

15

Pb 2+

0.12

16

H +

0

17

Bi 3+

0.22+

18

Cu 2+

0.34+

19

Hg 2+

0.79+

20

I

0.54+

21

Br

1.06

22

Cl

1.36

23

F

2.85

332

2Na + Cl 2

+ + e

Na + H 2 O

NaOH + H 2

Ni/Ni 2+ , Cu/ Cu 2+

0.34

0.59

Ni

0 . 59

0 . 34

25



0.25

1

Cl + e - Cl -

2Na + Cl 2 2NaCl

2

333

Mg + H 2 O

MgO + H 2 (g)

(i) 2HCl + Ca

CaCl 2 + H 2 (g)

(ii) H 2 SO 4 + Mg

MgSO 4 + H 2 (g)

.

3

$ .

4

:

5

CuSO 4 + Zn (s) ZnSO 4 + Cu (s)

2NaI + Br 2 2NaBr + I 2

6

1

:

2

3

4

:

334

ﺔ

335

8

7

Zn Zn 2+ + 2e -

H 2 SO 4 2H + + SO 4

2-

H + +1e - H 0

H 0 + H 0 H 2

336

Polarization

Local Reaction

337

1

3

338

Pb

PbO 2

H 2 SO 4

6

339

1.25

3 (.

Pb + SO 4

2- PbSO 4 + 2e

PbO 2 + SO 4

2+ + 4H + + 2e = PbSO 4 + 2H 2 O

2

4

2

340

2.04

1

2

.

3

341

PbSO 4 + SO 4

2- + 2H 2 O PbO 2 + 2H 2 SO 4 + 2e -

12

.

342

1

:

2

.

3

.

4

5

.

6

.

343

1

2

3

4

5

6

1

2

0..  
 .. 1..  
 ..  
 \*..> \*/..

Non electrolytes

344

3

Electrolytes

.

:

CaCl 2 , CuSO 4 , NaCl , NaOH , HCl

CH 3 COOH , Na 2 C 2 O 4

345

+ + Cl

-- , ZnSO 4

2+ + SO 4

CaSO 4

2+ + SO 4

1880

1

:

2

3

2

2

4

5

1000

6

7

346

-- , OH

1

2

HCl H + + Cl -

H 2 O H + + OH -

H +

+ + e

--

H 2 ( g )

OH -

Cl -

Cl -

Cl -

OH -

Cl - Cl + 1e -

Cl + Cl Cl 2

347

+

Cl 2

H 2

H 2 SO 4 2H + + SO 4

2-

H 2 O H + + OH -

+ + e

--

H 2

348

-- , S O 4

--

--

H 2 O + O

O 2 ( g )

i (

H 2 SO 4

ii

.

iii

.

iv

H 2 SO 4

H 2 SO 4

.

349

H 2 O

+ + OH

CuSO 4

2+ + SO 4

2--

2+ + H

2+ + 2e

--

350

2+ + 2e

2+ + 2e

1. SO 4

2- SO 4 + 2e -

2.OH - OH + 1e -

3.Cu Cu 2+ + 2e -

Cu

2+ + 2e

CuSO 4

Cu(MnO 4 ) 2

351

1

.

.

.

2

3

352

1791

1867

Coulomb

1

2

96500

353

3

4

5

6

7

6

7

4

8

H

9

96500

96500

(

96500

354

9

8

10

11



12



13

1

2

CuSO 4

H 2 SO 4

Cu(NO 3 ) 2

NaOH

.

1

2

.

96500

96500

96500

96500

355

3

.

4

.

5

.

6

.

1

2

AgNO 3

CuSO 4

.

1

2

.

356

3

.

4

.

5

.

6

.

7

6

(.

108

31.8

0.5

54

15.9

0.00001

0.00112

0.00033

1

96500

108

96500

31.8

96500

357

1.5

30

1.08

.

1.5

30

60

2700

1.08

>  
 !

(

96500

2700

96500

3

358

115.8

2

15

193

1.2

2

15

60

193

1.2

3



3

3

II

0.555

.

.

.

108

64

1.08

96500

3

2700

96500

2

15

60

193

96500

1.2

359

3

60

60

0.555

1

108

496

1

0.164

0.05

96500

0.555

96500

1

108

0.555

32

108

496

3

60

60

360

.

.

.

.

.

0.000124

0.3

0.7128

361

2

3

0.159

31.8

108

4

5

6

7

0.20

0.5

8

8



96500

96500

362

9

2

CuSO 4

8

.

.

8

.

63.4

363

1

2

1. 3HCl + HNO 3 + 3CrCl 2 3CrCl 3 + NO + 2H 2 O

2. 2KClO 3 2KCl + 3O 2(g)

3

:

1. 2FeCl 2 + Cl 2 2FeCl 3

2. Zn + H 2 SO 4 (dil.) ZnSO 4 + H 2

4

.

364

OH -

.

.

2

+ H

2

+ Cl

4

SO

2

Na

+

4

Mn SO

4

SO

2

Cl + 2H

a

2N

+

2

O

Mn

S 2 Cl 4 , Cr 2 O 7

2- , VO 2

+ , MgCl 2 , ClO 3

-

10

8

Al 2 O 3

i .

ii

1

365

2

II

0.125

31.8

108

1

2

3

4

.

1

.

.

.

.

.

2

MnSO 4

KMnO 4

366

3

.

1

2

3

.

4

5

6

7

8

9

Nuclear Chemistry

9

1

9

1

9

1

1

1895

(Rontgen)

(X - Ray)

(H. Becquerel)



β

(Nucleons)

(Mass number)

(Nuclide)

1

2

3

:

H H H

U , U , U

(A)

(Z)

A

Z

1

H

1

1

2

H

2

1

1

3

H

3

1

2

9

2

9

1

2

1930

4

He

2

2

2

2

2

0.000549

0.001098

2

2

1.007286

2.014572

2

2

1.008665

2.017330

4.033000

He

4.03300

4.002603

0.030397

0.030397

.

1905

(Albert Einstein)

E = m c 2

E

m

c

9

1

3

1

O

17 X

16 X

17 X

16 X

7 9 8

Th

90

140

230

320

A X

A Y

Z+1 Z

2

55.85

1.0072

1.0087

Fe

3

) 9

2

Bi 83

83

(Po)

84

(Ra)

88

92

He 2+

2

2

86

4

10

8

Ra Rn + He

226

222

4

88

86

2

S + n P + P

(n)

(p)

12

n

p

9

2

1



(He 2+ )

Ra Rn + He

)

9

3



0 e

Pb

Pb Bi + e

1

1

9

2

2

i. 207 Po 203 Pb + 4 He

82 2

ii. 207 Po 207 Bi + 0 e

84 83 +1

iii. 207 Po + 0 e 207 Bi

84 -1 83



1 P 1 n + 0 e

+1 0 +1

Electron

capture

1 p + o e 1 n

+1 -1 0

9

2

3

1

i. 238 U 234 Th

234 Pa

234 Th

ii.

226 222

iii. Ra Rn + ..................

88 86

2

U

Th

u

P

3

O

O

Cl

) 9

3

U

Pb

Ra

U Pb

1

238

206

32

32

8

4

4

Pb+ 8He

U

2

82

92



β

10



U Pb + 8 H e + 6 e

232 Th

208 Pb

90

Th Pb + ……. + …….

U

Pb

Ac

U Pb + ….. + …..

M β ¯ Y

X

1

i (

ii

iii

2

i (

ii

iii

.

9

3

1

(Half life)

1

2

t

U 234

Th + 4

He

92 90 2

t

4.5

10

9

232 Th 228 Ra + 4 He

90 88 2

t

1.41

10

234 Th 234 Pa + 0 e

90 91 -1

t

24.1

216 At 212 Bi + 4 He

t

3

10

4

9

1

Rn

0.008

t

4

12

Rn

+ He

Po

Rn

3 4

t =

12

3

12



4

3

0.008

4

0.004

0.008

0.5

0.5

0.008

0.5

0.002



3

0.008

0.5

0.5

0.5

0.008

0.5

3

0.001

12

0.001

0.5

12

3

0.008

1

0.004

2

0.002

3

0.001



0.5

0.008



0.001



0.5

0 .008



3

0.001

12

3

12



4

3

9

2

12

50

0.75

12

6

3

1.5

0.75



4

50



50



4

12.5

9

3

2

1

Bi

5

16

20

2

32

20

:

i .

ii

) 9

4

1919

O

:

O + p

He

+

N

P

27 Al + 4 He 30 P + 1 n

13 2 15 0

9

4

1

(Nuclear energy)

Ra

4

10

8

1939

1945

1939

U

9

4

E = m c 2

E

m

c

c )

3

10

8

(Megaton)

(TNT)

50

U

235

9

4

2

U

U

Po

9

5

9

4

3

1

206 Pb

U

2

C

CO 2

(Cosmic rays)

14 N + 1 n 14 C + 1 p

7 0 6 1

CO 2

14 C

14 C

14 C

C

14 C

40

3

131 I

60 Co

P

99

Tc

Tl

14 C

14 C

6CO 2 + 6H 2 O C 6 H 12 O 6 + 6O 2

9

4

4

1

2

3

239

238

4

: 1

2

3

1

i .

ii

iii

2

14 C (i)

60 Co (iii) 131 I (ii)

6

27 53

3

(i) Cr ………… + e

(ii) Bi ……….. + He

(iii) Co + n ………. + He

(iv) N + He ……… + P

(v) K + e …………..

Th

ii.

Au

i.

4

(i) Ra Rn + ………..

(ii) Pu Am + …………

(iii) Co + n Fe + …………

(iv) Kr Kr + ………….

) i

i) Be ii) Sn

ii

i) Rn ii) Bi

5

0.01

0.0025

20

20

80

5

6



i (

ii

iii

7

H

H

Al

N

8

9

:

10



11

60 Co

99 Tc

201 Ti

131 I

14 C