

# INDEX

Unit		Page
<b>KNOWLEDGE AREA</b>	<b>MATTER AND MATERIALS</b>	<b>15</b>
<b>Unit 1</b>	<b>ORGANIC MOLECULES</b>	<b>15</b>
	1.1 Organic compounds	16
	1.2 Structure of organic molecules	17
	Experiment 1	23
	Experiment 2	25
	1.3 Isomers	29
	Exercise 1	30
	1.4 Naming organic structures	35
	1.4.1 Alkanes	37
	1.4.2 Cycloalkanes	38
	Exercise 2	39
	1.4.3 Alkenes	44
	1.4.4 Cycloalkenes	44
	1.4.5 Dienes	45
	Exercise 3	46
	1.4.6 Alkynes	50
	1.4.7 Alkyl halides (haloalkanes)	50
	Exercise 4	52
	1.4.8 Alcohols	55
	1.4.9 Aldehydes	57
	1.4.10 Ketones	58
	Exercise 5	59
	1.4.11 Carboxylic acids	62
	1.4.12 Esters	63
	Activity 1	64
	Exercise 6	64
	1.5 Structural relationships and physical properties	66
	1.5.1 Boiling points	69
	1.5.2 Melting points	73
	1.5.3 Vapour pressure	76
	1.5.4 Physical state (gases (g), liquids (l) and solids (s))	79
	1.5.5 Density	82
	1.5.6 Flammability	85
	1.5.7 Odour	85
	1.5.8 Molecular shape	86
	Exercise 7	88
	1.6 Application of organic chemistry	97
	1.6.1 Combustion	97
	1.6.2 Preparation of esters	98
	Experiment 3	99
	Exercise 8	102
	1.7 Reactions	107
	1.7.1 Substitution reactions	107
	1.7.1.1 Substitution in alkanes	107
	1.7.1.2 Substitution in alcohols	108
	1.7.1.3 Substitution in haloalkanes (alkyl halides)	109

	1.7.2	Addition reactions	110
	1.7.2.1	Hydrohalogenation	111
	1.7.2.2	Halogenation	112
	1.7.2.3	Hydration	112
	1.7.2.4	Hydrogenation	113
	Experiment 4 (demonstration)		114
	1.7.3	Applications of addition reactions	117
	1.7.4	Elimination	118
	1.7.4.1	Dehydrohalogenation	118
	1.7.4.2	Dehydration	120
	1.7.4.3	Cracking	121
	Exercise 9		122
	Summary of Unit 1		133
	Mind maps of Unit 1		142
<b>Unit 2</b>	<b>PLASTICS AND FIBRES</b>		<b>149</b>
	2.1	What is a polymer?	150
	2.2	Plastics	151
	2.2.1	Addition reactions	151
	Experiment 5		152
	2.2.2	Properties and uses	155
	Activity 2		157
	Activity 3		158
	2.3	Fibres	159
	2.3.1	Condensation polymerisation	159
	2.3.1.1	Nylon	159
	2.3.1.2	Polyesters	160
	2.3.1.3	Poly(lactic acid) (PLA)	161
	Experiment 6		163
	Experiment 7		164
	Experiment 8		165
	Experiment 9		167
	2.4	Identify	169
	2.4.1	Monomer	169
	2.4.2	Reaction	170
	2.5	Recycling	172
	Activity 4		173
	Exercise 10		173
	Summary of Unit 2		180
	Mind maps of Unit 2		184
	Question paper		185
<b>KNOWLEDGE AREA</b>	<b>CHEMICAL CHANGE</b>		<b>201</b>
<b>Unit 1</b>	<b>RATE OF REACTIONS</b>		<b>201</b>
	1.1	What is reaction rate?	202
	1.2	What is required for reactions to occur?	203
	1.3	Factors that influence reaction rate	204
	1.3.1	Nature of reactants	205
	1.3.2	Concentration	205
	Experiment 10		206
	1.3.3	State of division (reaction surface)	209
	Experiment 11		209

1.3.4	Temperature	211
	Experiment 12	212
1.3.5	Catalyst	214
	Experiment 13	215
	Exercise 11	217
1.4	Graphic presentation	222
1.5	Experimental determination	224
1.5.1	Colour change	224
1.5.2	Volume and mass changes	224
1.5.3	Temperature change	225
1.5.4	Change in pH	225
1.5.5	Turbidity	225
	Experiment 14	225
	Experiment 15	230
	Experiment 16	232
	Experiment 17	235
	Exercise 12	237
1.6	Reaction mechanisms	242
1.6.1	Activation energy	242
1.6.2	Activated complex	243
1.6.3	Energy changes during chemical reactions	243
	Exercise 13	245
1.7	Maxwell-Boltzmann distribution	247
1.7.1	Effect of temperature change	248
1.7.2	Effect of concentration	248
1.7.3	Effect of a catalyst	249
	Exercise 14	251
	Summary of Unit 1	254
	Mind maps of Unit 1	257
<b>Unit 2</b>	<b>EQUILIBRIUM AND CHEMICAL REACTIONS</b>	<b>259</b>
2.1	Open, closed and isolated systems	260
2.2	Reversible changes	261
2.2.1	Physical changes	261
2.2.2	Chemical reactions	262
2.3	Conditions of equilibrium	265
2.4	Catalyst	265
2.5	The equilibrium constant	266
	Exercise 15	268
2.6	Irreversible chemical reactions	272
2.7	Calculation of equilibrium concentrations	273
	Exercise 16	276
2.8	Dynamic chemical equilibrium system	286
2.8.1	Le Chatelier's principle	286
2.8.2	Dynamic chemical equilibrium in solutions	290
	Experiment 18	292
	Experiment 19	294
	Exercise 17	298
2.9	Equilibrium and reaction rate graphs	305
2.9.1	Equilibrium in an isolated system	305
2.9.2	Reactants change	305

**Unit 3**

2.9.3	Products change	306
2.9.4	Temperature change	307
2.9.5	Pressure change	308
2.9.6	Catalyst	310
Exercise 18		311
2.10	Equilibrium in industrial chemical processes	319
2.10.1	Haber process	319
2.10.2	Contact process	320
Exercise 19		321
Summary of Unit 2		324
Mind maps of Unit 2		327
<b>ACIDS AND BASES</b>		<b>329</b>
3.1	Properties	330
3.1.1	Acids	330
3.1.2	Bases	331
Activity 5		332
3.2	Acid-base theory	332
3.2.1	Arrhenius	332
3.2.2	Brønsted-Lowry	333
3.3	Monoprotic and polyprotic acids	334
Experiment 20		335
3.4	Acid-base reactions	337
3.4.1	Conjugate bases	337
3.4.2	Conjugate acids	337
3.4.3	Conjugate acid-base pairs	337
Exercise 20		340
3.4.4	Ampholytes	342
3.5	Strong and weak acids and bases	343
3.5.1	Acids	343
3.5.2	Bases	344
3.6	Hydrolysis	345
Exercise 21		348
3.7	Reactions of acids	350
3.7.1	Acid-metal reactions	350
3.7.2	Acid-metal oxide reactions	350
3.7.3	Acid-metal hydroxide reactions	350
3.7.4	Acid-metal carbonate reactions	350
3.8	Neutralisation reaction between acids and bases	351
Experiment 21		352
Experiment 22		354
Experiment 23		356
Experiment 24		358
3.9	Indicators	361
Exercise 22		362
3.10	Solutions	365
3.10.1	Calculations	365
3.10.2	Preparation of a standard solution	368
Experiment 25		368
3.10.3	Dilution	371
Exercise 23		372

3.11	Titration	375
3.11.1	What is a titration?	375
3.11.2	How is a titration conducted?	375
3.11.3	Calculations	376
	Experiment 26	377
	Experiment 27	380
	Exercise 24	383
3.12	Equilibrium constant	386
3.12.1	$K_a$ values	386
3.12.2	$K_b$ values	387
3.12.3	Relationship between $K_a$ and $K_b$ values	387
3.13	Distinction between strong and weak acids	388
3.13.1	pH	388
3.13.2	Conductivity	388
3.13.3	Reaction rate	389
3.14	Concentrated and dilute acids and bases	389
	Exercise 25	390
3.15	Water	392
3.15.1	Autoionisation	392
3.15.2	Ion product, $K_w$	392
3.16	pH scale	393
3.16.1	Calculation of pH – strong acid	395
3.16.2	Calculation of pH – strong base	396
3.17	Applications	397
3.17.1	Chloro-alkali industry	397
3.17.2	Hair salons	397
	Exercise 26	398
	Summary of Unit 3	404
	Mind maps of Unit 3	406
	<b>ELECTROCHEMISTRY</b>	<b>407</b>
4.1	Oxidation and reduction	408
4.1.1	Oxidation numbers	408
4.1.2	Direct electron transfer	410
4.1.3	Indirect electron transfer	411
4.1.4	Oxidation and reduction half reactions	411
	Experiment 28	416
	Experiment 29	418
	Exercise 27	420
4.2	Electrochemical cells	426
4.2.1	Electrolytic cell	427
4.2.1.1	Electrolysis of a melted ionic substance	427
4.2.1.2	Electrolysis of an ionic solution	428
	Experiment 30	430
	Exercise 28	432
4.2.1.3	Applications	436
	Exercise 29	442
4.2.2	Galvanic or voltaic cells	447
4.2.2.1	Salt bridge	449
4.2.2.2	Cell notation	450
4.2.2.3	Standard conditions	451

## Unit 4

	Exercise 30	451
	4.3 The standard hydrogen electrode	457
	Experiment 31	459
	4.4 Prediction of cell potential	461
	Exercise 31	462
	4.5 Equilibrium, current and emf	469
	4.5.1 Current and reaction rate	469
	4.5.2 Potential difference and equilibrium	470
	Exercise 32	470
	Summary of Unit 4	474
	Mind maps of Unit 4	477
	Question paper	481
<b>KNOWLEDGE AREA</b>	<b>CHEMICAL SYSTEMS</b>	<b>495</b>
	<b>THE FERTILISER INDUSTRY</b>	<b>495</b>
	1. Nutrients required by plants	496
	2 NPK fertiliser	498
	2.1 NPK ratio	499
	2.2 Calculations	499
	3 Preparation of fertiliser	501
	3.1 Synthesis gas – Sasol	501
	3.2 Ammonia	501
	3.3 Urea	503
	3.4 Ammonium nitrate	503
	3.5 Ammonium sulphate	504
	3.6 Ammonium phosphate	505
	3.7 Superphosphate and triple superphosphate	505
	4. Sources	506
	5. Influence of fertiliser on people and the environment	506
	Activity 6	506
	6. Sasol's role in fertiliser manufacturing	506
	7 Eutrophication	507
	7.1 Causes	507
	Activity 7	508
	7.2 Consequences	509
	7.3 Reduction and prevention	509
	Activity 8	510
	8. Alternatives to inorganic fertiliser	510
	Activity 9	510
	Exercise 33	510
	Summary	516
	Mind maps	519
	Question paper	521
	Information pages	533
	Work cited	537