



INTERNATIONAL BACCALAUREATE ORGANIZATION

CHEMISTRY DATA BOOKLET

August 2001

To be used in the teaching and examination of
Diploma Programme chemistry

Valid for examination sessions from May 2003

Chemistry Data Booklet
August 2001

© International Baccalaureate Organization 2001

International Baccalaureate Organization
Route des Morillons 15

1218 Grand-Saconnex
Geneva, SWITZERLAND

Notes

This booklet cannot be used for paper 1 of the examination (HLP1 and SLP1), but the periodic table given on page 4 will be available as part of these examination papers. Clean copies of this booklet must be made available to candidates for papers 2 and 3 (HLP2, HLP3, SLP2 and SLP3).

Contents

1.	Some Relevant Equations	2
2.	Physical Constants	2
3.	Fundamental Particles	2
4.	Names of the First 103 Elements	3
5.	The Periodic Table	4
6.	Melting Points and Boiling Points of the Elements	5
7.	First Ionization Energy, Electron Affinity and Electronegativity of the Elements	6
8.	Atomic and Ionic Radii of the Elements	7
9.	Covalent Bond Lengths	8
10.	Average Bond Enthalpies at 298 K	8
11.	Organic Compounds—Thermodynamic Data	9
12.	Ellingham Diagram	10
13.	Enthalpies of Combustion	11
14.	Lattice Enthalpies at 298 K (Experimental and Theoretical Values)	12
15.	Standard Electrode Potentials	13
16.	Strengths of Organic Acids and Bases	14
17.	Acid–base Indicators	15
18.	Infrared Data	16
19.	¹ H NMR Data	17
20.	2-amino Acids	18
21.	Structural Formulas of Some Important Medicines and Drugs	20
22.	Structural Formulas of Some Important Biological Molecules	22

1. Some Relevant Equations

$$E = hf$$

$$E = mc^2$$

$$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$t_{\frac{1}{2}} = \frac{0.693}{k}$$

$$\log_{10} \frac{I_o}{I} = \epsilon lc$$

$$k = Ae^{\frac{-E_a}{RT}} \quad \ln k = -\frac{E_a}{RT} + \ln A$$

$$[A] = [A]_o e^{-kt} \quad \text{or} \quad \ln \frac{[A]_o}{[A]} = kt$$

2. Physical Constants

Avogadro's constant (L) = $6.02 \times 10^{23} \text{ mol}^{-1}$

Gas constant (R) = $8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Molar volume of an ideal gas at 273 K, $1.01 \times 10^5 \text{ Pa} = 2.24 \times 10^{-2} \text{ m}^3 \text{ mol}^{-1}$ ($22.4 \text{ dm}^3 \text{ mol}^{-1}$)

Speed of light in a vacuum (c) = $3.00 \times 10^8 \text{ m s}^{-1}$

Planck constant (h) = $6.63 \times 10^{-34} \text{ J s}$

Specific heat capacity of water = $4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (= $4.18 \text{ J g}^{-1} \text{ K}^{-1}$)

Ionic product constant for water (K_w) = $1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ at 298 K

(1 atm = $1.01 \times 10^5 \text{ Pa}$)

(1 dm^3 = 1 litre = $1 \times 10^{-3} \text{ m}^3$ = $1 \times 10^3 \text{ cm}^3$)

3. Fundamental Particles

	Proton	Neutron	Electron
Mass/kg	1.672648×10^{-27}	1.674954×10^{-27}	9.109534×10^{-31}
Charge/C	1.602189×10^{-19}	0	1.602189×10^{-19}

4. Names of the First 103 Elements

Element	Symbol	Atomic Number	Element	Symbol	Atomic Number
actinium	Ac	89	mercury	Hg	80
aluminium	Al	13	molybdenum	Mo	42
americium	Am	95	neodymium	Nd	60
antimony	Sb	51	neon	Ne	10
argon	Ar	18	neptunium	Np	93
arsenic	As	33	nickel	Ni	28
astatine	At	85	niobium	Nb	41
barium	Ba	56	nitrogen	N	7
berkelium	Bk	97	nobelium	No	102
beryllium	Be	4	osmium	Os	76
bismuth	Bi	83	oxygen	O	8
boron	B	5	palladium	Pd	46
bromine	Br	35	phosphorus	P	15
cadmium	Cd	48	platinum	Pt	78
caesium	Cs	55	plutonium	Pu	94
calcium	Ca	20	polonium	Po	84
californium	Cf	98	potassium	K	19
carbon	C	6	praseodymium	Pr	59
cerium	Ce	58	promethium	Pm	61
chlorine	Cl	17	protactinium	Pa	91
chromium	Cr	24	radium	Ra	88
cobalt	Co	27	radon	Rn	86
copper	Cu	29	rhodium	Rh	45
curium	Cm	96	rhenium	Re	75
dysprosium	Dy	66	rubidium	Rb	37
einsteinium	Es	99	ruthenium	Ru	44
erbium	Er	68	samarium	Sm	62
europium	Eu	63	scandium	Sc	21
fermium	Fm	100	selenium	Se	34
fluorine	F	9	silicon	Si	14
francium	Fr	87	silver	Ag	47
gadolinium	Gd	64	sodium	Na	11
gallium	Ga	31	strontium	Sr	38
germanium	Ge	32	sulfur	S	16
gold	Au	79	tantalum	Ta	73
hafnium	Hf	72	technetium	Tc	43
helium	He	2	tellurium	Te	52
holmium	Ho	67	terbium	Tb	65
hydrogen	H	1	thallium	Tl	81
indium	In	49	thorium	Th	90
iodine	I	53	thulium	Tm	69
iridium	Ir	77	tin	Sn	50
iron	Fe	26	titanium	Ti	22
krypton	Kr	36	tungsten	W	74
lanthanum	La	57	uranium	U	92
lawrencium	Lr	103	vanadium	V	23
lead	Pb	82	xenon	Xe	54
lithium	Li	3	ytterbium	Yb	70
lutetium	Lu	71	yttrium	Y	39
magnesium	Mg	12	zinc	Zn	30
manganese	Mn	25	zirconium	Zr	40
mendelevium	Md	101			

5. The Periodic Table

1	2											3	4	5	6	7	0	
1 H 1.01		Atomic Number Element Atomic Mass																2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95	
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80	
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30	
55 Cs 132.91	56 Ba 137.34	57 † La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.21	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra (226)	89 ‡ Ac (227)																
		†	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97		
		‡	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)		

9. Covalent Bond Lengths

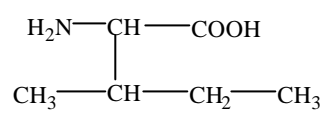
Bond	Bond length /nm	Bond	Bond length /nm
H-H	0.074	C-H	0.109
C-C	0.154	Si-H	0.146
C=C	0.134	N-H	0.101
C≡C	0.120	P-H	0.142
C-C (in benzene)	0.139	O-H	0.096
Si-Si	0.235	S-H	0.135
N-N	0.146	F-H	0.092
N=N	0.120	Cl-H	0.128
N≡N	0.110	Br-H	0.141
P-P (P ₄)	0.221	I-H	0.160
O-O	0.148		
O=O	0.121	C-O	0.143
S-S (S ₈)	0.207	C=O	0.122
S=S	0.188	C-O (in phenol)	0.136
F-F	0.142	C-N	0.147
Cl-Cl	0.199	C=N	0.127
Br-Br	0.228	C≡N	0.116
I-I	0.267	C-N (in phenylamine)	0.135
		C-F	0.138
		C-Cl	0.177
		C-Cl (in chlorobenzene)	0.169
		C-Br	0.193
		C-I	0.214
		Si-O	0.150

10. Average Bond Enthalpies at 298 K

Bond	DH / kJ mol ⁻¹	Bond	DH / kJ mol ⁻¹
H-H	436	C-H	412
D-D	442	Si-H	318
C-C	348	N-H	388
C=C	612	P-H	322
C≡C	837	O-H	463
C-C (benzene)	518	S-H	338
Si-Si	226	F-H	562
Ge-Ge	188	Cl-H	431
Sn-Sn	151	Br-H	366
N-N	163	I-H	299
N=N	409		
N≡N	944	C-O	360
P-P	172	C=O	743
O-O	146	C-N	305
O=O	496	C=N	613
S-S	264	C≡N	890
F-F	158	C-F	484
Cl-Cl	242	C-Cl	338
Br-Br	193	C-Br	276
I-I	151	C-I	238
		Si-O	374

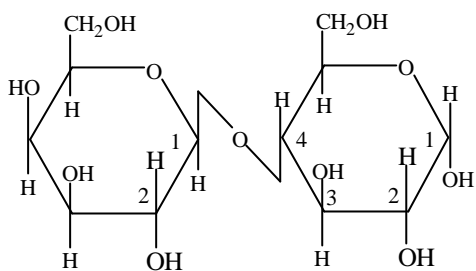
isoleucine

Ile

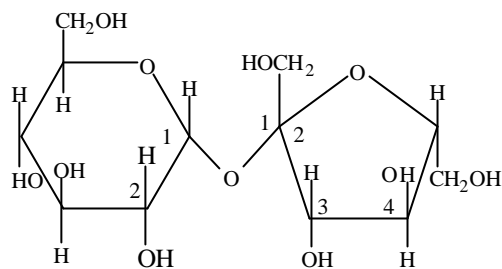


6.0

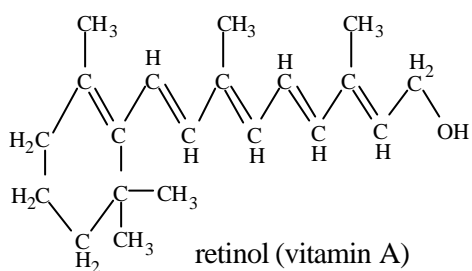
22. Structural Formulas of Some Important Biological Molecules



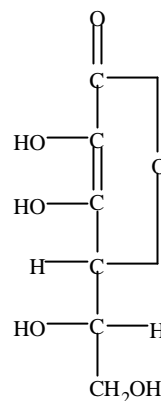
lactose



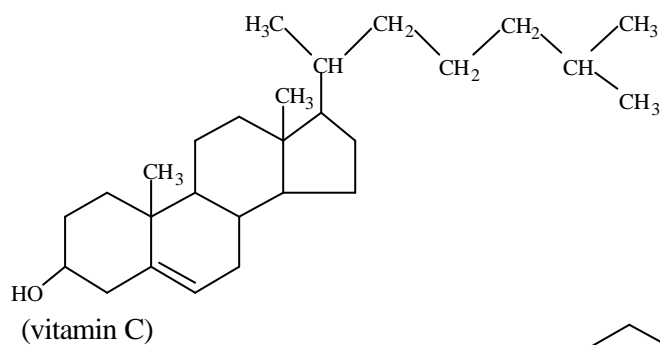
sucrose



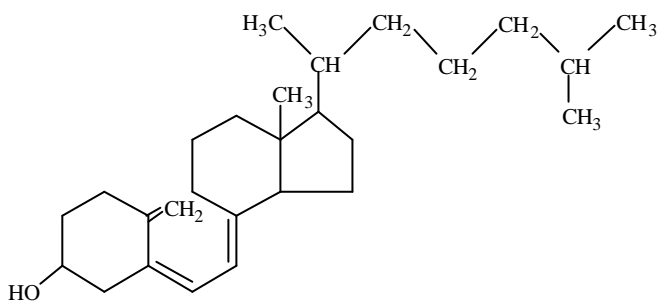
retinol (vitamin A)



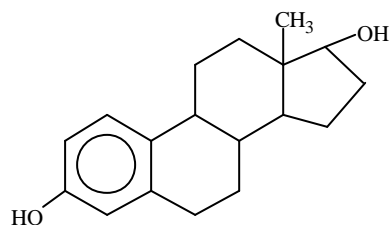
ascorbic acid



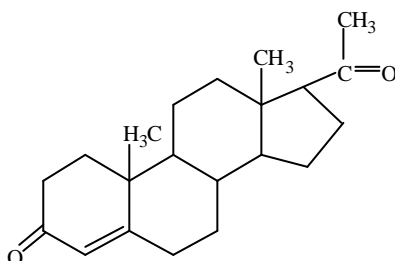
cholesterol



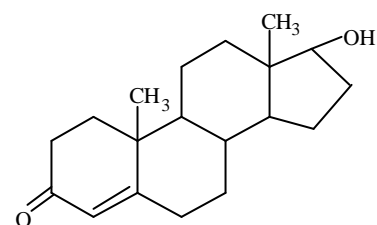
vitamin D



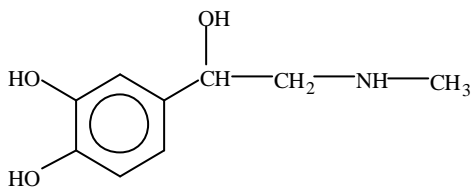
oestradiol



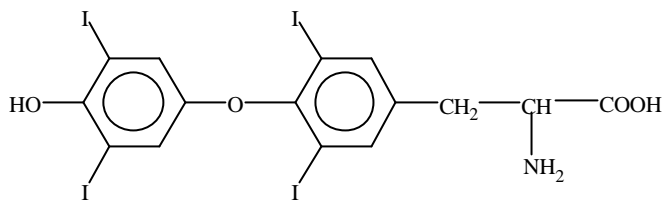
progesterone



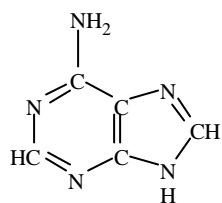
testosterone



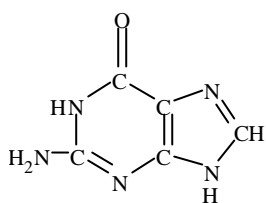
adrenaline



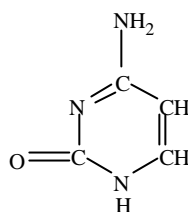
thyroxine



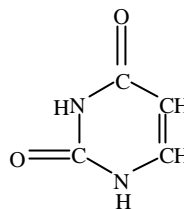
adenine



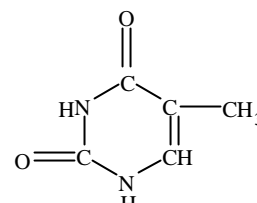
guanine



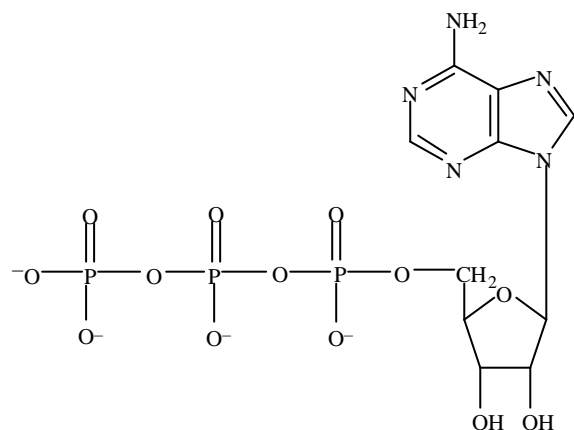
cytosine



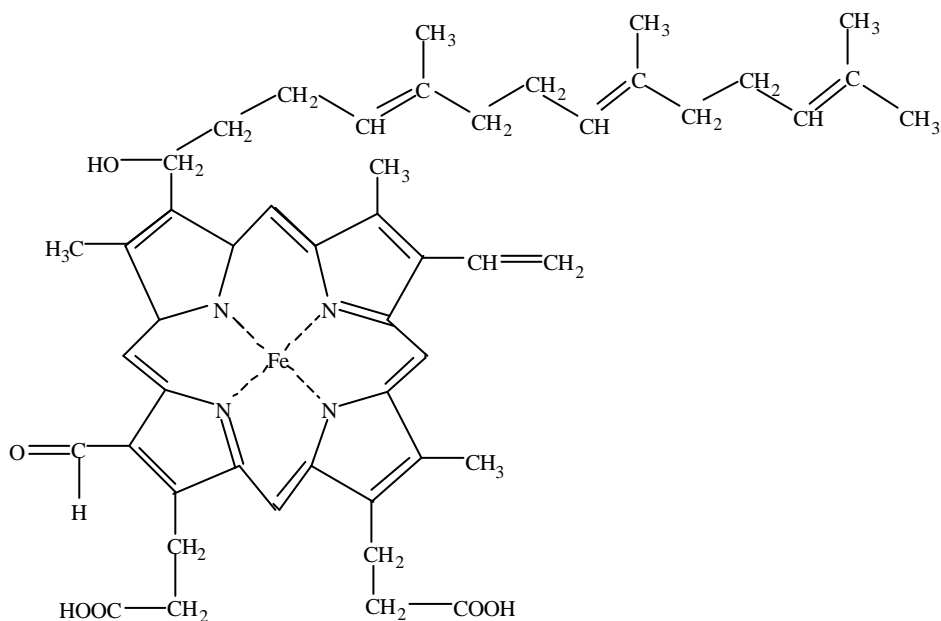
uracil



thymine



adenosine triphosphate (ATP)



The haem group from cytochrome oxidase