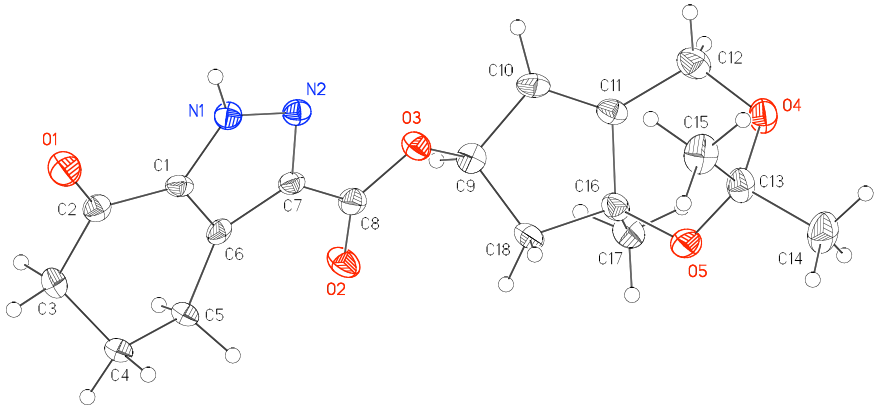
APPENDIX SEVEN

X-Ray Crystallography Reports Relevant to Chapter Five

A7.1 Crystal Structure Analysis of Pyrazole 225

Figure A7.1.1 Crystallographic data for pyrazole **225**



Crystallographic data have been deposited at the CCDC, 12 Union Road, Cambridge CB2 1EZ, UK and copies can be obtained on request, free of charge, by quoting the publication citation and the deposition number 656609.

Table A7.1.1 Crystal data for pyrazole **225** (CCDC 656609)

Empirical formula	$C_{18}H_{22}N_2O_5$
Formula weight	346.38
Crystallization Solvent	Not given
Crystal Habit	Column
Crystal size	0.41 x 0.28 x 0.19 mm^3
Crystal color	Colorless

Table A7.1.2 Data collection for pyrazole **225** (CCDC 656609)

Type of diffractometer	Bruker SMART 1000
Wavelength	0.71073 Å MoKα
Data Collection Temperature	100(2) K
θ range for 5408 reflections used in lattice determination	2.38 to 32.03°
Unit cell dimensions	a = 6.970(2) Å b = 7.005(2) Å c = 34.186(11) Å
Volume	1669.1(9) $Å^3$
Z	4
Crystal system	Orthorhombic
Space group	$P2_12_12_1$
Density (calculated)	1.378 mg/m^3
F(000)	736
Data collection program	Bruker SMART v5.630
θ range for data collection	2.38 to 36.11°
Completeness to θ = 36.11°	76.6 %
Index ranges	$-8 \le h \le 10, -10 \le k \le 9, -45 \le l \le 54$
Data collection scan type	ω scans at 4 ϕ settings
Data reduction program	Bruker SAINT v6.45A
Reflections collected	15494
Independent reflections	5579 [R_{int}= 0.1208]
Absorption coefficient	0.101 mm^{-1}
Absorption correction	None
Max. and min. transmission	0.9810 and 0.9597

Table A7.1.2 Structure solution and refinement for pyrazole **225** (CCDC 656609)

Structure solution program	SHELXS-97 (Sheldrick, 1990)
Primary solution method	Direct methods
Secondary solution method	Difference Fourier map
Hydrogen placement	Geometric positions
Structure refinement program	SHELXL-97 (Sheldrick, 1997)
Refinement method	Full matrix least-squares on F^2
Data / restraints / parameters	5579 / 0 / 229
Treatment of hydrogen atoms	Riding
Goodness-of-fit on F^2	1.298
Final R indices [I>2σ(I), 3654 reflections]	R1 = 0.0694, *w*R2 = 0.1073
R indices (all data)	R1 = 0.1046, *w*R2 = 0.1141
Type of weighting scheme used	Sigma
Weighting scheme used	$w=1/\sigma^2(Fo^2)$
Max shift/error	0.001
Average shift/error	0.000
Absolute structure determination	Not able to reliably determine absolute conformation
Absolute structure parameter	0.2(12)
Largest diff. peak and hole	0.422 and -0.342 e.Å^{-3}

A7.2 Spectral Refinement Details for Pyrazole 225

Refinement of F^2 against ALL reflections. The weighted R-factor (*w*R) and goodness of fit (S) are based on F^2, conventional R-factors (R) are based on F, with F set to zero for negative F^2. The threshold expression of $F^2 > 2\sigma(F^2)$ is used only for calculating R-factors(gt), etc., and is not relevant to the choice of reflections for refinement. R-factors based on F^2 are statistically about twice as large as those based on F, and R-factors based on ALL data will be even larger.

All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account

individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

Table A7.2.1 Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for pyrazole **225** (CCDC 656609). U(eq) is defined as the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U_{eq}
O(1)	8129(2)	6441(3)	6756(1)	29(1)
O(2)	527(2)	6007(2)	7862(1)	26(1)
O(3)	2492(2)	6164(2)	8378(1)	21(1)
O(4)	-159(2)	8678(2)	9815(1)	27(1)
O(5)	-1479(2)	9411(2)	9205(1)	26(1)
N(1)	6724(3)	6421(3)	7577(1)	19(1)
N(2)	5613(3)	6387(3)	7891(1)	18(1)
C(1)	5703(3)	6412(3)	7239(1)	17(1)
C(2)	6436(3)	6325(3)	6839(1)	19(1)
C(3)	4890(3)	6008(3)	6539(1)	24(1)
C(4)	3014(3)	7014(3)	6646(1)	21(1)
C(5)	2241(3)	6406(3)	7042(1)	20(1)
C(6)	3815(3)	6393(3)	7337(1)	17(1)
C(7)	3819(3)	6357(3)	7746(1)	17(1)
C(8)	2126(3)	6165(3)	7997(1)	20(1)
C(9)	832(3)	5747(3)	8627(1)	20(1)
C(10)	1545(3)	5599(3)	9039(1)	21(1)
C(11)	450(3)	6555(3)	9284(1)	20(1)
C(12)	645(4)	6878(3)	9711(1)	27(1)
C(13)	-263(4)	10052(3)	9509(1)	24(1)
C(14)	-1250(4)	11746(3)	9686(1)	34(1)
C(15)	1716(4)	10556(4)	9355(1)	31(1)
C(16)	-1210(3)	7474(3)	9076(1)	21(1)
C(17)	-3087(3)	6460(4)	9153(1)	26(1)
C(18)	-603(3)	7381(3)	8646(1)	22(1)

Table A7.2.2 Bond lengths [Å] and angles [°] for pyrazole **225** (CCDC 656609)

O(1)-C(2)	1.216(3)	O(1)-C(2)-C(1)	123.74(19)
O(2)-C(8)	1.211(2)	O(1)-C(2)-C(3)	123.06(19)
O(3)-C(8)	1.327(2)	C(1)-C(2)-C(3)	113.17(18)
O(3)-C(9)	1.467(2)	C(2)-C(3)-C(4)	112.45(17)
O(4)-C(13)	1.423(3)	C(5)-C(4)-C(3)	112.74(18)
O(4)-C(12)	1.425(3)	C(6)-C(5)-C(4)	110.20(18)
O(5)-C(13)	1.415(3)	C(1)-C(6)-C(7)	104.29(17)
O(5)-C(16)	1.439(3)	C(1)-C(6)-C(5)	122.95(18)
N(1)-N(2)	1.323(2)	C(7)-C(6)-C(5)	132.8(2)
N(1)-C(1)	1.358(2)	N(2)-C(7)-C(6)	111.65(18)
N(2)-C(7)	1.345(3)	N(2)-C(7)-C(8)	122.42(17)
C(1)-C(6)	1.359(3)	C(6)-C(7)-C(8)	125.78(19)
C(1)-C(2)	1.459(3)	O(2)-C(8)-O(3)	123.5(2)
C(2)-C(3)	1.504(3)	O(2)-C(8)-C(7)	121.78(18)
C(3)-C(4)	1.529(3)	O(3)-C(8)-C(7)	114.76(19)
C(4)-C(5)	1.519(3)	O(3)-C(9)-C(10)	107.39(17)
C(5)-C(6)	1.491(3)	O(3)-C(9)-C(18)	113.16(17)
C(6)-C(7)	1.398(3)	C(10)-C(9)-C(18)	103.33(17)
C(7)-C(8)	1.464(3)	C(11)-C(10)-C(9)	111.7(2)
C(9)-C(10)	1.495(3)	C(10)-C(11)-C(12)	130.6(2)
C(9)-C(18)	1.521(3)	C(10)-C(11)-C(16)	111.37(18)
C(10)-C(11)	1.316(3)	C(12)-C(11)-C(16)	118.0(2)
C(11)-C(12)	1.484(3)	O(4)-C(12)-C(11)	110.19(17)
C(11)-C(16)	1.502(3)	O(5)-C(13)-O(4)	110.81(18)
C(13)-C(14)	1.499(3)	O(5)-C(13)-C(14)	105.85(19)
C(13)-C(15)	1.518(3)	O(4)-C(13)-C(14)	105.18(18)
C(16)-C(17)	1.512(3)	O(5)-C(13)-C(15)	111.29(18)
C(16)-C(18)	1.531(3)	O(4)-C(13)-C(15)	111.50(19)
		C(14)-C(13)-C(15)	111.9(2)
C(8)-O(3)-C(9)	114.78(16)	O(5)-C(16)-C(11)	111.12(18)
C(13)-O(4)-C(12)	115.78(16)	O(5)-C(16)-C(17)	106.05(19)
C(13)-O(5)-C(16)	116.51(17)	C(11)-C(16)-C(17)	112.52(18)
N(2)-N(1)-C(1)	112.58(17)	O(5)-C(16)-C(18)	111.75(18)
N(1)-N(2)-C(7)	104.28(15)	C(11)-C(16)-C(18)	102.84(19)
N(1)-C(1)-C(6)	107.18(17)	C(17)-C(16)-C(18)	112.72(18)
N(1)-C(1)-C(2)	127.87(19)	C(9)-C(18)-C(16)	104.75(17)
C(6)-C(1)-C(2)	124.86(19)		

Table A7.2.3 Anisotropic displacement parameters ($Å^2 x\ 10^4$) for pyrazole **225** (CCDC 656609). The anisotropic displacement factor exponent takes the form: $-2\pi^2$ [$h^2 a^{*2} U^{11}$ + ... + 2 h k a* b* U^{12}].

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
O(1)	213(9)	398(10)	258(8)	-17(8)	16(7)	-17(8)
O(2)	192(8)	386(11)	195(7)	5(7)	-37(6)	-33(8)
O(3)	194(8)	249(8)	180(6)	3(6)	-17(6)	-20(7)
O(4)	364(10)	221(9)	210(7)	-4(7)	40(7)	15(8)
O(5)	336(10)	185(9)	264(8)	-12(6)	-50(7)	52(8)
N(1)	149(9)	204(10)	205(8)	-19(7)	-4(7)	-12(9)
N(2)	189(9)	149(9)	202(8)	14(7)	-9(7)	-2(9)
C(1)	181(11)	133(11)	188(9)	18(8)	-47(8)	11(10)
C(2)	185(12)	172(11)	222(10)	-5(9)	-5(8)	-3(11)
C(3)	269(14)	278(13)	171(10)	-48(9)	-28(9)	17(11)
C(4)	202(12)	239(12)	175(9)	-4(8)	-55(9)	30(10)
C(5)	199(12)	229(12)	156(9)	-2(9)	-52(8)	20(11)
C(6)	180(12)	97(10)	221(10)	-31(8)	-11(8)	10(10)
C(7)	166(11)	133(11)	199(9)	-6(9)	-38(8)	20(10)
C(8)	221(13)	160(12)	222(10)	-19(9)	-34(9)	8(10)
C(9)	188(13)	192(12)	233(10)	0(8)	9(9)	-38(10)
C(10)	226(13)	168(12)	242(10)	58(9)	-52(10)	-1(10)
C(11)	222(12)	156(11)	211(10)	27(8)	-48(9)	-24(11)
C(12)	318(14)	253(14)	230(11)	41(9)	-26(10)	-18(11)
C(13)	329(15)	176(12)	220(10)	-12(9)	33(10)	-30(11)
C(14)	489(17)	191(14)	333(13)	-39(10)	75(12)	3(13)
C(15)	356(16)	225(13)	342(12)	-3(10)	61(11)	-65(12)
C(16)	279(14)	172(12)	170(10)	14(8)	-22(9)	-1(10)
C(17)	276(13)	285(13)	224(10)	15(10)	-11(10)	-10(12)
C(18)	229(13)	275(13)	159(10)	23(9)	-44(9)	2(11)

Table A7.2.4 Hydrogen bonds for for pyrazole **225** (CCDC 656609)) [Å and °]

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
N(1)-H(1)...O(2)#1	0.88	2.03	2.839(2)	152.4

Symmetry transformations used to generate equivalent atoms:
#1 x+1,y,z