

# APPENDIX C

## CUBIC EQUATION WORKSHEET

<b><math>ax^3 + bx^2 + cx + d</math></b>	
$S = -b/a$	
$Q = c/a$	
$P = -d/a$	
$\Delta_1 + \Delta_2 = QS - 3P$	
$(\Delta_1 - \Delta_2)^2 = Q^2S^2 - 27P^2 - 4PS^3 + 18SPQ - 4Q^3$	
$\Delta_1 - \Delta_2 =$ either square root of the above	
$\Delta_1 = \frac{(\Delta_1 + \Delta_2) + (\Delta_1 - \Delta_2)}{2}$	
$\Delta_2 = (\Delta_1 + \Delta_2) - \Delta_1$	
$E^3 = S^3 - 3QS + 9P + 3\omega^2\Delta_1 + 3\omega\Delta_2$	
$F^3 = S^3 - 3QS + 9P + 3\omega\Delta_1 + 3\omega^2\Delta_2$	
$EF = S^2 - 3Q$	
$E =$ any cube root of $E^3$	
$F = (EF)/E$ or any cube roots of $F^3$	
$\alpha = \frac{S + E + F}{3}$	
$\beta = \frac{S + E\omega + F\omega^2}{3}$	
$\gamma = S - (\alpha + \beta)$	

**NOTE:** The cube roots must match so that

$$EF = S^2 - 3Q.$$

So if  $E \neq 0$  calculate F as  $(EF)/E$ .

(In this case there is no need to calculate  $F^3$ .)

However if  $E = 0$  then F must be calculated as a cube root of  $F^3$ .